AN INVESTIGATION OF CAD/CAM POSSIBILITIES IN THE PRINTING OF TEXTILES: WITH REFERENCE TO THE APPLICATION OF COMPLEX REPEAT PATTERNS

GILLIAN ELIZABETH BUNCE

A thesis submitted in partial fulfilment of the requirements of The Nottingham Trent University for the degree of Doctor of Philosophy

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ABSTRACT

Computer-Aided Design and Manufacture (CAD/CAM) is used extensively in the production of printed textiles. Historically, new technologies affected the structural characteristics of design styles. They have usually been applied to current styles, with delays occurring between their introduction and their exploitation for design innovation. As yet, no radically new styles are associated with CAD/CAM. Pattern construction is an area where computer facilities could enable creative use of technology and link with the traditions of printed textile design. This has not been exploited, although systems do provide basic repeat functions related to the contemporary emphasis on unstructured or repetitive design.

The research, development, and implementation of textile printing technologies cannot be divorced from the socio-economic and aesthetic climates in which they are introduced. Any proposals regarding the future implementation of CAD/CAM must be evaluated in a context which acknowledges these wider influences. This work investigates and evaluates the circumstances surrounding the introduction of textile printing technologies and the effects of combined influences on the historical and contemporary uses of repeat in printed textile design.

Variations in the importance of structure as a considered design component have reflected differing philosophical attitudes towards mathematical explanations and representations of the natural world. These have also affected the classification and interpretation of design sources. This work proposes a classification system for the analysis, classification, and construction of designs which uses a modular approach applicable to CAD repeat specification. The understanding of structural organisation which this provides has importance in the present eclectic design climate. The thesis also proposes potential future CAD/CAM developments in relationship to current technological developments, design trends, and changing perceptions of order. It suggests that the use of computer technology combined with education could lead to the development of new design styles.

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INTRODUCTION

Design is a compromise between creativity and the limitations imposed by stylistic, technical, and commercial concerns. Printed textiles are designed, modified, and repeated within the technical requirements of the production processes and the economic limitations of the market, according to the current stylistic criteria. In this context, style is defined as a collective individuality, exhibited in the designs of particular cultures, eras, and movements, which results from distinctive combinations and uses of visual characteristics, such as line, colour, imagery, visual format, spatial organisation, and scale.

It is usually assumed that new technologies are neutral and objective media. But, when examining past developments in printing and engraving technology, it is clear that technological innovation has altered production methods, thereby affecting design methods and styles. A design's structural characteristics largely determine its overall effect, thus, by changing the potential or economic scale and complexity of repeat, technological developments have instigated stylistic changes by redefining the parameters which control the structural organisations of designs.

Because technical developments have usually derived from existing production methods, most new technologies have been used to replicate current techniques and styles before their full potential was realised. But, although new technology has removed many previous technical limitations and CAD/CAM provides transformation and simple repeat facilities, these advances have not, as yet, influenced design or been associated with any radically new styles or effects.

The early stages of this research revealed that the image manipulation techniques of computer graphics technology facilitate fast, accurate, and flexible methods of pattern construction which are directly applicable to the design of printed textiles. These could promote a renewal of interest in structured designs, and the provision of comprehensive repeat facilities at the design stage might encourage an innovative approach to the use of repeat. Although applications relating to these aspects of design have been suggested since the 1970's, only relatively simple facilities are provided by CAD/CAM. This early research identified the most important area of investigation as not only *what* new approaches computers could offer for repeats and structure, but *why* such facilities had not already been exploited for design innovation or developed further.

The research, development, and implementation of textile printing technologies cannot be divorced from the socio-economic and aesthetic climates in which they are introduced. Therefore, any proposals regarding the future implementation of CAD/CAM must be evaluated in a context which acknowledges these wider influences. This work investigates and evaluates the circumstances surrounding the introduction of textile printing technologies and the effects of combined influences on the historical and contemporary uses of repeat in printed textile design. To do this entailed devising new methods for the analysis and classification of designs in which factors relating to technical changes, such as the scale and complexity of repeat, were recognised. The thesis proposes potential future CAD/CAM developments in relationship to current technological developments, design trends, and changing perceptions of order.

Because this work covers such a broad area some background chapters are included for reference purposes. In Chapter 1, an overview of the history of printed textiles provides a framework to evaluate the relationships between design trends and technological changes. The development of textile printing has always been a dynamic process in which progress has occurred when the combined economic and aesthetic conditions have been conducive to technical innovation.

The implementation and exploitation of new processes by established industry have often been hindered through the absence of a ready market for their products. Such a lack of developmental stimuli inhibited potential early technical advances until the 17th century, when a demand for imported prints created by increased foreign trade and the changing aesthetic ambience, provided an economic impetus to copy Indian designs and production methods. Since then, technical innovations have been prompted by increased consumer demands and drives to reduce costs.

Although most new techniques and processes were developed to replicate current design styles, their associated characteristics usually became catalysts for stylistic innovation. But the degree to which new technologies have been actively exploited for stylistic development has varied. For example, early 19th century eclectic trends and an obsession with novelty combined to embrace technical and stylistic innovation. This aesthetic ambience was receptive to new mechanically engraved prints, and their popularity and cheapness encouraged the development of techniques for more complicated design structures.

The contemporary Quick Response ethos shows similar eclectic sources operating within a comparable industry which is grappling with rapid technological changes and competitive markets. But recent technological developments have not been associated with design innovation because investment has been directed towards cost reduction and the expansion of production capacity and capability. This has mostly been within high-production companies selling to wide markets whose designs are generally reactive. In this way, technology has been used to exploit developing trends, rather than to initiate them.

Over the last twenty years, technological development has concentrated on replicating established procedures and, with the automation of the conversion process as a prime objective, the 'essential value' of early CAD/CAM systems was seen as 'reducing weeks of skilled and tedious work to a matter of hours'.[1] In this environment, repeat was considered to be a production, rather than a design, concern. CAD/CAM repeat facilities are still promoted primarily as conversion aids and repeat is used at this post-design stage for proofing and correction prior to production; 'any alterations to the design repeat can be made simply and quickly . . . changes can be visualised immediately and a design can be stepped out on a monitor screen to show any lines or faults in that repeat'.[2] Most designs are produced in croquis form, to be converted and put into repeat prior to production. This emphasis on CAD/CAM as a production tool has generally limited its use for design applications. While it has emphasised designers' artistic roles, it has, at the same time, made them more remote from the technology. Because the use of repeat is perceived to be a practical function, rather than a part of a creative process, only a limited number of repeat types are deemed necessary. Repeat is now used mostly for design continuity, not for design organisation, and there has, therefore, been no demand for more integrated approaches to its use in CAD/CAM.

The lack of interest shown in the potential development of comprehensive repeat facilities is symptomatic of the present aesthetic climate in which the use of structure and order are generally considered to restrict creativity or to impose *unnatural* mechanised appearances on designs. Any repeated design forms a pattern regardless of scale and, if structure is disregarded, recurrent design elements often produce unintended patterns. A patterned effect may be subtle and more apparent to some people than others. In order to encompass all scales and complexities of repeat, this work makes use of Christie's definition of a pattern as 'a design composed of one or more devices, multiplied and arranged in an orderly

[1] Suchecki, S.M., *Innovations in Printing Machinery Technology,* Textile Chemist and Colourist, 1980, Vol.12, Part 5, p.23.

[2] Holmes, J., *CAD in Production Proofing,* Manufacturing Clothier, June 1993, p.16.

sequence'.[3]

Chapter 2 contains background information concerning visual perception of pattern. Research for artificial intelligence and machine vision is revealing the subtlety and complexity of human perception and, with previous studies of pattern perception, provides a theoretical basis for commonly used design terms, like those implying movement or direction. It also indicates that traditional design methodology is highly dependent on perceptual and technical skill, not purely on innate artistic ability.

Pattern perception, although governed by physiological factors, is also acknowledged to be affected by cultural and environmental influences. The dominance of order in primitive pattern may express human reaction to the apparent chaos of nature, and an increased acuteness of pattern perception in the predominantly ordered environment of today's *carpentered world* contributes to the current antipathy to structured design.

Designs are essentially products of their time and culture, therefore, for the contemporary viewer, historic patterns contain accumulations of association that were not present at their conception, and are now *seen* differently. Because designers absorb and adapt concurrent visual forms, other media developments, such as the use of multilayered images and text in graphic, video, and multi-media formats, may affect perception, thus influencing future uses of, and responses to, pattern.

Various pattern classification methods are described in Chapter 3. Most were found to be subjective, reflecting the current intellectual and scientific hegemony, with the factors used for defining classes relating to contemporary stylistic concerns. Categorisation is often based on visual characteristics, but the emphasis placed on particular visual components varies according to the method and precision of the classification. Designs are, therefore, grouped together in very different ways by different systems according to which factors are selected as meaningful similarities. Many systems were based on a shared body of knowledge and, although attempting to apply rational and precise categories, were often contingent on current stylistic terminology. Such terms contain implicit information and, due to changing design concepts and influences, often become redundant or develop different connotations at a later date.

[3] Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, p.1.

Introduction

In structural classification systems, design elements are regarded as building material, and no importance is placed on their historical and cultural significance. Crystallographic classification is restricted to symmetrical patterns and, because it takes no account of a design's orientation, has limited use for textile applications. Designers generally use flexible descriptive vocabularies which mix classification methods and vary according to the job in hand and the current stylistic emphases.

The effects of changing concepts of order on pattern construction and design structure are evaluated in Chapter 4. It is suggested that 'the artist is often an unconscious mathematician, discovering, rediscovering, and exploring ideas of spatial arrangement, symmetry, periodicities, combinatorics, transformations, discovering in an intuitive sense visual theorems of geometry'.[4] Repeated design implies a conscious or intuitive use of such ordering, but the overt use of structure to create both ordered and *natural* appearances has fluctuated. These changes in patterns' structural emphases have reflected differing philosophical attitudes towards mathematical explanations and representations of the world.

The search for mathematical laws uniting man and nature was expressed in Gothic designs by the application of symmetry and proportion. The use of holistic construction methods to create harmonious ordered designs continued until 18th century Romanticism reacted against Rationalism, splitting the Arts and Sciences. The resulting affirmation of creativity and renunciation of order as an imposed discipline still retain their influence on design.

During the Industrial Revolution, 'craftsmanship was replaced by mechanical repetition and haphazard filling of a space with patterns that bore little relevance to the fabric or its use'.[5] This association of mechanisation with badly designed products fuelled the division between arts and sciences and, in the mid-19th century, reactions against increased industrialisation and rampant eclecticism produced two opposing schools of thought. Firstly, the indiscriminate use of pictorial imagery was countered by ideas, derived from botanical science, which symbolised nature's innate order. Newly formulated design laws regarding the use of geometric structures stemmed from the Gothic Revival, and they became important ingredients in the synthesis of eclectic themes which formed the style of the Arts and Crafts Movement. The counter view was of nature as wild and

[4] Davis, P.J. and Hersh, R., *Descartes' Dream,* English edition, London, 1990, p.43.

[5] Robinson, S., *A History of Printed Textiles,* London, 1969, p.30.

unconstrained, and considered that the reductionist approach disregarded the variety and apparent chaos of the natural world. This Ruskinite attitude has continued to produce an underlying emotional reaction against technology. It has been evident in a gradual rejection of mechanical perfection and in the contemporary antipathy to the overt use of structure.

Many designers have expressed a distrust of science and technology, but reductionism, being the major paradigm of the age, has inevitably influenced the arts. Paradigms are conceptual frameworks within which scientific theories are constructed. They are absorbed by contemporary attitudes forming the philosophical climate in which other ideas, including aesthetics, are formulated. They fundamentally affect design and provide long-term frameworks in which underlying trends can be related. Although science has generally been denigrated by artists, a reductive approach, demonstrated by concerns with specific components of the visual vocabulary, such as structure, form, line, colour, and texture, influenced the formulation of 19th century design laws and has been integral to 20th century art and design.

There has been a continuous trend in which different combinations of visual components have been major stylistic factors but, within which, there has been a gradual, though fluctuating, rejection of structural organisation in favour of repetitive order. These uses of structure produce strong visual characteristics and because they influence current responses to earlier designs, some previously popular designs are now denigrated or disregarded because they do not conform to current aesthetic conceptions of order. For instance, most 19th century machine-engraved roller prints are regarded as lacking in aesthetic qualities because their mechanical perfection is now an anathema in the contemporary design climate. Such rejection of groups of designs affects the selection of material in publications and, therefore, the common knowledge of different periods and cultures.

Paradigmatic shifts are dynamic changes in conceptual frameworks. They usually start with developments in apparently unconnected areas which contemporaneously are often considered as passing trends. These mark the transition to new conceptual models and 'when this happens even old-established observations and experiments change their significance'.[6] The two main paradigms of post-modern thought are holistic concepts, which stress the interdependence and multi-layered character of living systems, and chaos theory,

[6] Gregory, R.L., in *The Oxford Companion to the Mind,* Oxford, 1987, p.576.

which has created an awareness that such complex systems are affected by very small changes. 'Although much can be learnt from the study of isolated interactions, the current change in emphasis suggests that a living system cannot be understood unless it is seen as a whole, and part of what makes the whole is its environment and relationship to other species'.[7] These paradigms mark a change from the previous reductive view of nature, and the resulting fundamental shift of consciousness is affecting all disciplines.

These developments are stimulating a new scientific awareness of pattern structures and influencing theories of visual perception. They will eventually affect more general concepts of order which, acknowledging that apparent disorder can reveal an underlying order affected by variables, may consequently become subtler. Such changes may create new responses to pattern, which will influence its use in design.

The practicalities of engraving and printing repeats have had an impact on the use of structural order in European printed textiles. Chapter 5 provides a historical background to technical developments for reference purposes. This is not original research and, being taken from a variety of sources, may include errors. Documentation of technical developments is incomplete and often inaccurate because most innovations were developed within printworks, and were closely guarded trade secrets.

This chapter concentrates on changes in printing and engraving equipment, but these were often interlinked with developments in colouration and dyeing processes. The wider implications of new colours and dyestuffs are not examined in this thesis, but developments that were seen to have affected the scale or repeat of designs are included. For example, in the 1790's, the introduction of discharge printing permitting printing on dyed or patterned grounds, and prompted a range of developments in block and roller printing.

European prints have been subject to various aesthetic, technical, and socio-economic influences. Those perceived to be the main design influences are detailed in Chapter 6. Printing, being unrestricted by considerations of fabric construction, allows free use of imagery. This flexibility has enabled the translation of ideas and structures derived from other textile processes. For example, early

[7] Tilby, A., *Soul: An Introduction to the New Cosmology - Time, Consciousness and God,* BBC Publications, London, 1992, p.27.

European prints employed the imagery and pattern structures of woven textiles partly to create cheaper alternatives but, also, because weaving's predominance determined the design ambience. Such design interpretation typifies the continual interchange of visual ideas between different disciplines.

Historical and cultural styles are part of the designer's vocabulary. The exploitation of these sources is part of a continuing theme which is now actively encouraged by the eclectic demands of the Quick Response ethos. Their effects on design have varied according to other current influences. For example, cross-cultural influences have, at different times, introduced new forms of imagery and affected stylistic changes. They have been absorbed by concurrent design trends, thus retaining a familiar visual frame of reference, but their manner of interpretation has varied according to the general aesthetic ambience. Often their imagery has been directly copied or adapted but, at other times, the structural organisation has been influential.

The end uses of fabrics have exerted variable influences on the scale and complexity of repeat. In fashion fabrics, these have often been associated with changes in garment shapes and, in furnishings, have been prompted by new forms of architecture and interior decoration. Fashion fabrics are relatively ephemeral and generally responsive to stylistic tends. Furnishings, representing a greater financial outlay and longer usage, have been more affected by the economic climate.

The changing role of the designer has influenced the exploitation of technology. The direct involvement of designers with processes has usually created strong associations between technique and design characteristics. This is particularly apparent with hand methods because, although designer/craftsmen had to acknowledge practical restrictions, such as limited sizes of impression, they were freer to exploit the design possibilities within the technical and economic constraints of the processes.

The more specialised knowledge required for mechanised printing gave the engraver an intermediary role, between the design and printing processes, which tended to dissociate the designer from the technology. In 1949, Wright commented that the secrecy surrounding engraving had 'rather a retarding influence on the production of practical designs'. . . for although, it . . . 'may be argued that it is the prerogative of the designer to design without hindrance, and that it is up to the engraver to interpret the design as per the sketch design. The appreciation of the difficulties and processes involved in each section is, however, not knowledge to be withheld if the best results of artisan skill are to be obtained'.[8] The role of craftsmen as design innovators has continued to be recognised, but an increased emphasis on designers as artists has generally distanced them from contact with technology.

The effects of combined technical and stylistic influences on the scale and complexity of repeat are evaluated historically in Chapter 7. The characteristics of new techniques, such as printed effects or new scales of impression, were usually exploited quickly for stylistic innovation but were, at first, used mostly with simple repeats. This is also apparent with the introduction of radical changes of imagery when, because such forms of novelty provided sufficient visual interest, structural complexity would have an unnecessary complication. As the effects became familiar, techniques facilitating complexity were often introduced. This is particularly apparent in the development of engraving methods for roller printing.

During the examination of classification methods (Chapter 3), it was found that designs are grouped together differently according to the factors selected as meaningful similarities. Also, individual classified items often share characteristics other than those on which the classification was based and, therefore, further information concerning associated items may be extrapolated or inferred.

Central to this research was the formulation of two new classification methods. The method, described in Chapter 8, was devised to investigate further the relationships between technical developments and stylistic changes. This is based on the visual characteristics of scale and spatial organisation. Categories relate to the size of design unit, the repeat complexity, and the size of impression. This research gave new insights into the complex links between technology, structure, and style, and, by grouping together designs from different eras, allowed continuing structural themes to be traced.

Complexity was found to be strongly connected with the scale of unit, with complex repeats most often occurring with small design units. Large-scale units were generally repeated using simple repeats. Historically, the size of impression and width of substrates have been determining factors in the links between complexity and scale of unit. The categories are illustrated by examples of printed textiles. For some categories, such as those using composite repeats with large

[8] Wright, R.H., *Modern Textile Design and Production,* London, 1949, pp.86 - 9.

units, no, or few, examples could be found. Modern technologies and wider substrates now provide the opportunity to create complex repeats with medium and large units, but it was found that they have not yet been exploited to any appreciable extent.

This research helped to devise a second method of pattern classification which is proposed in Chapter 9. It is a method based on structural analysis, and was the basis of the publication *Repeat Patterns.*[9] This book shows how a unit or motif can be developed through a series of repeat organisations to produce an infinite number of pattern variations. The various formats are illustrated by examples of a wide range of applications from different historical periods and cultures.

It is a modular system which can be applied to pattern construction using manual or computer-aided techniques. A pattern is formed by the regular repetition of a repeat unit in two dimensions using familiar repeats, such as the drop and brick; the unit can be a small simple element, like a dot, or a large complex design consisting of many elements or motifs. Transformations can be applied to these basic arrangements to create complex structures. These organisations of units are referred to as repeat formats, and can be specified in terms of the various translations and transformations performed on copies of the design unit.

The visual effects produced by different structural formats are described generally in Chapter 9, but it is acknowledged that these can be diminished or accentuated by other factors. As design *skeletons*, or underlying structures, these formats are important stylistic characteristics which influence a design's overall appearance. Some, such as block/horizontal-mirror formats, are characteristic of many design types and have been commonly used. Others are associated with specific cultures or periods of history. Examples of printed textiles are given for most of the categories, but there were some for which few, or none, could be found.

Continuing this research assisted the evaluation of the potential uses of computer graphics for pattern construction. A discussion of this is contained in Chapter 10. It was found that the characteristics of raster and vector graphics are suited to different methods of pattern construction. The majority of print CAD system are based on raster technology, and raster operations are directly applicable to extension methods of pattern construction and have been decisive factors in the development of repeat facilities. The design methods associated with

[9] Phillips, P., and Bunce, G., *Repeat Patterns: a manual for designers, artists and architects*, London, 1993, ISBN 0 500 27687 0.

raster operations tend to reinforce the current emphasis on pattern construction as a process which is essentially concerned with repetitive order.

Object-orientated software is generally limited by the lack of painterly facilities, but it does provide mathematical accuracy and greater control over individual design elements. Some packages provide functions which can be used as a basis for holistic methods of pattern construction. Combined vector and raster techniques, by linking painterly qualities and scanned imagery with high resolution and control of individual design elements, offer alternative types of CAD systems. These are used extensively in the pre-press industry and are appearing to a limited extent in the textile industry. For instance, the U4ia® software, marketed by CDI, provides an 'extensive array of vector and raster based drawing tools'. . . and . . 'is resolution independent, which means you can work on images of any size'.[10]

The lack of exploitation of CAD for innovative design partly results from the implementation of technology being determined by the facilities provided at the software level. This differs from the introduction of previous technologies and processes which could more easily be adapted by individual users. Development is gradually progressing from general applications, determined by the analysis of existing procedures, towards more sophisticated or specific applications.

Experienced users, who have developed an understanding of the technology's potential, are capable of making informed suggestions for additional features or new approaches. The CAD industry customises systems for companies and introduces new features when development costs can be recouped by increased sales, or are deemed necessary in the competitive market. The 'Cad industry is receiving user feedback. By expecting technology to meet our demands, we promote experimentation and solutions within the Cad industry'.[11]

These demands are based on existing practices, and there is little incentive to develop new design approaches in a production-led market. Although the CAD industry continues to add facilities in response to customer feedback, the prevalent use of CAD/CAM for conversion has meant that most development has been aimed at post-design procedures. Designers, having had little contact with the technology, have not been in a position to make suggestions for design-orientated

[10] *U4ia®,* Computer Design, Inc., Grand Rapids, September 1993.

[11] Dr. Shraga Efrat of Shenkar College, Israel, quoted in *User Case Study: Sr Gent Introduces New Line,* CADCAM International, October 1989, p.33.

developments and, in the worst cases, have had to adapt their manual methods to accommodate the technology. Schoeser commented that some 'are asked to paint their designs in very clearly defined colours, in order to facilitate electronic colour separation techniques'.[12]

CAD/CAM differs from previous technical developments because it is not specific to one process. Its potential flexibility and wide range of applications could encompass all the stages of printed textile design and production, and might initiate new processes. But, because software development is based on analyses of existing practices, CAD/CAM tends to reinforce current working methods rather than offer alternatives. As Vince argued: 'One of the dangers of computerizing any process . . . is just to translate existing manual procedures into computer procedures . . . Given a fresh start with different technology, new and innovative processes can be discovered'.[13]

In Chapter 11, the thesis projects future CAD developments which are based on the exploitation of computer graphics, but depend on the use of CAD as an integral part of the design process. While these relate to current developments in textile printing technology, they also acknowledge continuing stylistic trends and potential future changes in concepts of order.

The two-tier approach to design and design conversion was based on historical precedence; partly on the specialist skill required by earlier engraving processes, but also on the initially high cost of computer technology. This made it cost effective for specialist operators to modify designs for production, but economically prohibitive for designers to work directly on CAD systems. Computers are becoming less expensive and more user-friendly, and it is now time to explore the more creative possibilities of the technology.

Computers can potentially provide facilities for complex and accurate repeats, but the efficacy of such a provision will depend on a practical method of specification for the types of repeat structures based on a logical classification system. A fuller utilisation of the pattern structuring capabilities offered by computer technology could lead to innovation in the use of repeats in contemporary design, and allow the designer to regain control over this important part of the design process.

[12] Storey, J., *Textile Printing,* revised edition, London,1992, p.166.

[13] Vince, J., *Computer Graphics,* London, 1992, pp.85-6.

CHAPTER 1: EUROPEAN PRINTED TEXTILES

1.01. Transfer of skills

Attempts to understand the past are formed within contemporary conceptual frameworks.[1] The common supposition that textile printing 'probably originated with the Chinese, who were letterpress printing paper by wood-block two thousand years ago',[2] derives from concepts of linear development combined with contemporary preoccupations with industrial growth. This presupposes a single origin from which skills were disseminated to neighbouring populations.[3]

Analyses of archeological artifacts have shown that textile printing existed earlier, and was more widespread than formerly assumed.[4] Early documentation describes colour-fast textiles produced near the Caspian Sea, and later in Egypt.[5] It may be that these printing methods were introduced from India,[6] but they could have been independent, parallel developments.[7]

Technical developments have often been influenced by outside cultures and disciplines, producing a dynamic, rather than linear, development process.[8] Trade and migration are now recognised as important factors in the dissemination of

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[1] Paradigms are conceptual frameworks within which science operates. Similar frameworks exist, too, in philosophical thought, and these are often influenced by scientific theories. They are absorbed into contemporary attitudes and form the climate in which wider concepts are formulated. They influence the analysis of past or possible future developments. For example, during the Enlightenment the concept of history was changed by Edward Gibbon's proposition that human development was a continuous progression.

[2] Clark, H., *Textile Printing*, Princes Risborough, 1985, p.3.

[3] In the late 19th century, evolutionism influenced historical research. This engendered a preoccupation with the origin and subsequent linear developments of technical and aesthetic traditions. However a biological model restricts the understanding of technical development because it cannot allow for the cross-fertilisation of ideas that result from the meeting of different traditions. An evolutionist approach to pattern analysis has also existed since this period (3.07).

[4] Textile fibres containing traces of fast dye have been found from the Indus Valley Civilisation of 2500 to 1500 BC. Marshall, Sir J., *Mohenjo-Daro and the Indus Civilisation,* London, 1931, ch. IV, p. 32. Discoveries of stamps and seals also indicate that rudimentary forms of printing were practised world-wide (5.03).

[5] References to colour-fast textiles were made in the works of Herodotus (480 BC) and Pliny the Elder (AD 25-79). The method described by Pliny consisted of, firstly, painting a design using a mordant and then dipping the fabric in a dye bath. Brédif suggested that this method had been brought to Egypt from India. Brédif, J., *Toiles de Jouy,* London, 1989, p.10.

[6] Applying the concept of linear development has led to the assumption that evidence of early trade routes between India and Europe and the discovery of Indian textile fragments, which predate other examples, prove the process spread from India.

[7] Rudimentary printing was widespread, therefore there may have been parallel, spontaneous developments in basic techniques in different areas.

[8] Trade-goods could motivate the development of existing techniques. If basic techniques already existed, recipients would be aware of the potential and be receptive to external stimuli.

specialised techniques[9] and design styles.[10]

The concept of linear development also presupposes a transference of skills between crafts[11] that, until comparatively recently, was improbable because of the secrecy which commonly surrounded craft processes.[12] 'Fabric and paper printing have independent histories with mutual stimulation throughout the centuries',[13] but any exchange of technical expertise has depended upon both contact between the various practitioners and the perceived need for such exchanges. Lack of contact between the castes associated with different skills could explain why the development or introduction of block printing in India is undocumented.[14] A rigid interpretation of skills' transference would assume the development of letterpress printing in India at that time.[15]

Styles associated with transferred techniques have usually been assimilated and adapted gradually to local decorative traditions.[16] 'Archetypal' motifs and forms are now attributed to early movements of craftsmen, indicating that there has

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[9] Migrating craftsmen practised their skills in host countries, but transference of skills to the local inhabitants would not automatically follow, although the existence of these craftsmen may have stimulated technical experimentation. Technical knowledge and expertise have often been kept secret, resulting in the association of skills with particular groups. The movements of such groups were crucial in the expansion of 17th century European textile printing (1.03).

[10] Historical research is now more concerned with the complexity of multi-cultural interrelationships (3.07). The earlier ethnocentric approach concentrated on the study of separate cultures (3.03).

[11] Publication and access to technical information are relatively recent phenomena resulting from the rationalist concept of knowledge as factual representation, which has encouraged cross-discliplinary developments. This differs from the alchemic or pseudo-scientific association of science with magic in which the gaining of knowledge was an initiation into the mysteries.

[12] In China, letterpress printing and textile dyeing were two separate crafts. Knecht and Fothergill argued that secrecy would have made the transference of block printing skills to textile printing unlikely. Knecht, E. and Fothergill,l J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.4.

A similar situation also existed in Medieval Europe and in the late 16th and 17th centuries when guild exclusivity stifled or delayed the possibility of collaborative development of resist printing (1.02).

[13] Schulzen, H., *Additional coloristic possibilities with the subicolor process,* Melliand Textilberichte (English Ed.), 1974, Vol.55, Part 5, p.467. Such links exist clearly in the development of copper plate printing (5.13) and transfer printing (5.34).

[14] India is known to have a long history of textile production. Documents were written by high caste Brahmins. Printing was seen as a branch of dyeing and this 'being one of the industries carried on by the lower castes (Vaisyars and Sudras), was, naturally, not at all interesting *technically* to the Brahmins, and consequently any improvements made in its methods and processes would not be likely to come under their notice'. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.7.

[15] Written material was produced in limited quantities for an educated elite. The transfer of skills from textiles to letter-press printing would not have been deemed necessary, or even considered.

[16] This combined transference of technique and style is apparent in *indienne* prints (1.03). There is also a common association between the interpretation of technique and style in contemporary ethnic styles (6.07).

been a long tradition of cross-cultural influences.[17]

The combination of Islamic and Christian decorative traditions, evident in block-printed Byzantine textiles was produced by a general stylistic mingling that affected all decorative arts. If printing was Eastern in origin, it can be demonstrated that the inherent geometric aspects of Islamic design[18] provided the structural design format to which Western imagery was applied.[19] A continuing association between geometry and aesthetics within the classical tradition ensured the perpetuation of the Islamic structural aspects of Byzantine design in European decorative arts.[20]

1.02. Market forces

The earliest known examples of European printed textiles are from the 12th to 14th centuries, and the earliest written accounts of printing processes are from the late 14th or early 15th century.[21] Apparently resist methods were not used, although many designs were stylistically similar to resist prints,[22] which suggests a continuity of style, but not of process.[23] The exclusivity of the guild system stifled collaboration between printers and dyers. This prevented the re-discovery, or development, of resist printing for which medieval dyes were suitable, and affected the development of European resist printing until the late 17th century.

Textile printers were members of the Painters Guild, and this may have facilitated an exchange of technical expertise between wood-block cutters,[24] and

[17] An earlier view, expressed by Jung, was that the emergence of 'archetypal' forms resulted from the existence of innate symbols universally accepted as beautiful and holding specific significance.

[18] Geometry was integral to Islamic design, order was a symbolic and practical reflection of underlying cosmological concepts. Changing attitudes to geometry and its wider implications are inextricably linked with the integration of geometric structure in design (4.02).

[19] Byzantine styles were fundamental to European design styles until the late 16th century, and have continued to be a major stylistic contributor to European textiles (4.12 and 6.08).

[20] Concepts of ratio, proportion, symmetry, and harmony were central to the artistic movements related to classicism (4.04).

[21] Biriukova stated that the first written reference to European textile printing is to be found in the *Treatise on Painting,* written in the late 14th or early 15th century, by an Italian painter Cennino Cennini (born 1372). In this he described 'a means of dyeing fabric with a wooden block', giving details of the equipment, processes and dye recipes. Biriukova, N., *West European Printed Textiles: 16th -18th century,* Moscow, 1973, p.12.

[22] The common use of reserved designs on printed grounds gives the visual appearance of resist printed textiles (5.05). Printing the design rather than the ground would be the easiest and obvious method. This suggests that the alternative method was either a stylistic continuation of a lost process or an interpretation of imported resist prints.

[23] It 'is not possible to trace any continuous development between the resist methods such as wax batik and indigo starch printing from blocks and the use of a block to print the actual dye.' Robinson, S., *A History of Printed Textiles,* London, 1969, p.10.

[24] Paper impressions were made to record block-printed textiles. Block-prints were used in needle-point and bobbin lace pattern-books, and the same blocks were sometimes used for printed textiles (6.04).

stimulated the production of pictorial prints.[25]

Differing economic factors influenced the production of 14th-15th century International and German prints, and these affected design styles, materials, and the use of printing and engraving processes.[26] The weaving industry produced the majority of patterned textiles, providing the aesthetic environment for pattern design and the visual vocabulary for printed textiles.[27] German prints had dustings of gold and silver, and were produced as substitutes for expensive imported silks.[28] Designs for Italian prints were similar to those for weaving, but augmented the market for woven products, rather than competed with it.[29]

The 16th century saw a decrease in the market, resulting in a general decline in quantity and quality of most European prints, and many became simple designs printed in black on plain grounds.[30] The exceptions were resist printed textiles, produced in Holland and Flanders using techniques introduced from the Far East.[31] The designs tended to follow contemporary European styles with Javanese influence shown in the treatment of motifs. Although these prints were colourfast, the combination of printing and dyeing made the process lengthy and complex. This limited its spread to other European countries until the late 17th century, when a demand for printed textiles was established.

A variety of factors are always involved in the development, dissemination, and

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[25] Due to the increased specialisation of each process, wood engravers and wood-block carvers divided into separate professions in the mid 15th century, but links continued. Artists developed various techniques, such as chiaroscuro, which were eventually transferred to textile printing (6.19). Pictorial prints and patterns with strong pictorial characteristics have a long tradition in European printing and are often linked with particular engraving and printing processes (7.02).

[26] Design styles (3.02). Technology (5.05).

[27] By the end of the 14th century, Italian towns had established strong trade links with the East and controlled silk importation to Europe. Their silk weaving industries flourished, producing for domestic markets and export. Weaving has continued to be a major stylistic influence. This is apparent in the continued interpretation of fashionable silk designs for prints and in the revival of classic textile forms that originated from woven patterns (6.03 and 6.15).

[28] Economically and politically, Germany was less developed than Italy and had little silk weaving. Imported Italian and Eastern silks were transported along the Rhine, and textile printing was carried out in monasteries along the trade route in the Lower Rhine region.

[29] They provided cheaper fabrics for a separate, mostly local market. Biriukova quoted Cennini that prints were good for 'children's and youths' clothing and lectern cloths'. Biriukova, N., *West European Printed Textiles: 16th -18th century,* Moscow, 1973, p.12.

[30] Increased European weaving and imports provided relatively cheap silks and velvets. Rising living standards meant that more people could afford wool and silk, thus reducing the market for prints. They were produced mainly for the poor and for ecclesiastic use during times of plague.

[31] Peter Klock introduced knowledge of these processes from his travels in the East around 1550. The Dutch market declined in the 17th century due to the importation of Indian cottons and the development of European competition, although the process spread to other European countries at this time. Resist printing continued to be developed into the 19th century (5.06) and was used for exports to Java and Africa (6.13).

use of any technology. Guild exclusivity was still a potent factor which prevented resist printing in most of Europe. Woven textiles had created a limited expectation of what textiles should 'look like' and formed the framework in which prints were designed. Resist prints, with their similarities of style[32] and relative expense, were unattractive in an expanding market of affordable luxury textiles. Rothstein stated that 'some techniques impose much stricter limitations than others. In general, however, complexity entailed cost . . . and only if the market were ready could some textiles be made because they were, intrinsically, so expensive'.[33]

Expense relates to the immediate production costs, but also to the initial developmental costs. Expenditure is only seen to be economic if there is a perceived market in which these costs can be recouped in the long term.

1.03. The influences of Indian prints

Indian prints, imported in the 17th century, changed the market dramatically, and stimulated European production and technological innovation. Their combination of practical and exotic appeal made them immensely popular.[34] The Age of Reason had created an outward-looking attitude, in which foreign styles, rather than being treated as mere curiosities, were appreciated and adopted by the applied arts.[35] Through trade links, Indian prints were adapted to European tastes and uses.[36]

Spurred by accelerating consumer demand, European production grew rapidly. This was associated with new entrepreneurial printers who saw a potential market and became involved with its development. Existing producers are often slow to exploit innovative processes, especially if investment in new equipment, skills, or working practices is involved. Frequently a 'wait and see' attitude is adopted until a process has been proven economically viable.[37] The first of these entrepreneurs

[32] The same printing blocks were also used for the production of embossed velvets.

[33] Rothstein, N., in *Designs for British Dress and Furnishing Fabrics,* Victoria and Albert Museum, London, 1986, p.17.

[34] Indian prints were light and colourfast, but also colourful and stylistically different from European textiles. The expansion of European colonial powers and Eastern trade resulted in increased imports and engendered a general enthusiasm for the 'exotic'.

[35] Rationalist philosophy had wider implications for the arts. The mathematical theories of Descartes (1596-1650) led to a reductionist view of the physical world as separate from the mind (4.05).

[36] The 'Mughal Emperor Akbar and his successor Jahangir introduced foreign workers (Turks, Persians, Chinese, and Italians) in the early part of the century to train Indian artists to satisfy European taste'. Brédif, J., *Toiles de Jouy,* London, 1989, p.14. Indian prints for the export market were mostly floral designs which were recoloured and restructured to print as lengths, rather than panels (6.09).

[37] A similar reluctance affected the introduction of photoengraving (1.11) and transfer printing (5.34).

was previously engaged in block-printing playing cards,[38] and, helped by skilled Armenian craftsmen,[39] he adapted the process for textiles.[40]

Indian printing was a technical and a stylistic catalyst. It introduced a new range of styles and motifs which have continued to influence European design. It had developed from painting techniques and exhibited fluidity compared with the more formal European textiles. Producers exploited the new market created by imports and sought to copy, rather than interpret, designs. These printers' ideas were not rooted in textile traditions and hence were free from the conventions which previously determined the appearance of prints.[41] The relative cheapness of European prints and their homogeneity of design created a fashion that encompassed all countries and social classes; 'for the first time in European history consumer taste was nearly uniform'.[42]

The expansion of printing in France provoked a trenchant protectionism in the powerful wool and silk industries, which led to its prohibition in 1686.[43] The emigration of many French Huguenots[44] led to the setting-up of print-works in most

[38] The first European print-works using Indian processes was started in 1654 by Benoît Ganteaume in Marseilles, which was one of the main ports through which prints were imported. Other French print works followed, in Avignon (1677) and Nimes (1678). An English patent was granted to William Sherman (or Sherwin) in 1676 for printing by press, apparently using the French methods based on Indian prints.

[39] Armenians were traders in calico and had settled in the Levant and Persia where painted and printed calico was also produced. Marseilles was important for the introduction of goods and skilled craftsmen.

[40] Ganteaume had previously manufactured block-printed playing cards. Indian cottons ranged from totally hand-painted to totally block printed. Although European producers employed pencilling techniques, they concentrated on the less labour-intensive block printing techniques.

[41] Existing methods of resist and oil stain printing continued. The German Textile printing industry expanded during the poverty stricken times of the Thirty Years War (1618 -1648). Locally produced oil prints were bought as an alternative to expensive imported textiles. Traditional German oil prints on linen were not competitive with other European and Indian products once foreign trade had been re-established. An attempt was made to revitalise the industry in the late 17th century by the introduction of resist printing techniques from England, but this was delayed by the opposition of the Dyers' Guild.

The earliest documentary evidence of printing in England is from 1619. This is a patent for 21 years to George Wood for the printing and staining of linen in colours. 'Staining' implies the use of the German method of printing. In 1675, a patent was granted to Thomas Togood for 'tingeing' by way of impression, possibly using resist printing, which could have been introduced to England by Flemish workers.

[42] Chapman, S.D. and Chassagne, S., *European Textile Printers in the Eighteenth Century,* London, 1981, p.6.

[43] An edict was passed in 1686 which prohibited the sale of French and imported printed or painted calico. Many illegal print shops remained to cater for wealthy patrons, but the prohibition stemmed the expansion of the previously flourishing industry. Another reason for the prohibition could have been 'that the standards of block making and printing, and certainly of dye fastness, were not good enough to allow it to continue unchecked'. Storey, J., *Textile Printing,* London, 1974, p.30.

[44] In 1685, the revocation of the Edict of Nantes denied civil rights to French Protestants, many of whom worked in the textile industries. Approximately 50,000 French refugees came to England, where they stimulated printed textile production and also provided expertise to revitalise the British silk industry.

other European countries.[45] In England, too, the expansion of both imports and European production provoked protests from the established textile producers, and consequent prohibitions.[46]

1.04. Industrial development

The printing of linen and fustian was permitted in England from 1736[47] and, as production increased again, there was a greater emphasis on design.[48] English and Scottish schools of design started in the 1740's, and the names of individual designers are documented from this time. Designs were produced by in-house[49] or freelance designers. Freelancers often produced designs for a variety of other products and thus influenced printing styles.[50] During this period, indigo printing became well established in England, producing distinctive blue and white prints, mostly based on Chinese imagery.[51] The *chinoiserie* style existed in the applied arts, but had not been exploited for prints. The ingredients of a ready market, existing resist printing skills, and a style with corresponding colours created a climate for technical and stylistic development.[52]

Brédif commented that 'the fashion for printed cotton goods grew out of a real need, which was linked to their practical advantages: they were washable, hard-

[45] The Swiss textile printing industry had been held back by the competition of the fast dyed textiles of England and France. French Huguenots revived the flagging industry by opening the first new factory in Biel in 1688. They were also influential in reviving the declining German printing industry. In 1690, an English printing works was started by a French emigré in Richmond.

[46] The English wool manufacturers formed a powerful lobby and, in 1701, the Government passed an act prohibiting the importation of Indian prints. The English printers increased production to meet the extra demand, provoking further protests from the wool manufacturers. The Government imposed taxes on printed linen and calicoes in 1712 and, in 1721, following further tax increases, passed an act prohibiting the sale and use of all printed or dyed calicoes.

[47] Lancashire weavers improved the quality of fustian to produce an acceptable alternative to calico.

[48] In 1756, the Society of Arts held its first display of manufactured goods.

[49] Paper proofs from factory archives are sometimes named or initialled and can be attributed to specific designers. In-house designers, or artisans, would have knowledge of the specific processes used (6.23).

[50] The names of some freelance designers are known, such as William Kilburn who eventually ran his own print-works and John-Baptist Jackson who also worked in the 1760's at the Edinburgh School of Design training apprentices in both drawing, block cutting, and printing.

[51] Methods of resist dyeing with indigo, indigo pencilling, and china-blue printing were developed. Chinese goods, such as porcelain and lacquerwork, had been popular since the 16th century, and the *chinoiserie* style had been applied to many European products from the early 17th century. Printed *chinoiserie* designs were influenced by the imagery and colour of Chinese porcelain (6.10).

[52] Indian prints had created a market for 'exotic' textiles and broken stylistic constraints on prints. The awareness of alternative styles affected resist printing. The popularity of *chinoiserie* and a desire to apply the style to prints alone may have stimulated further development of indigo printing, but the prohibition of Indian imports made it an economic imperative.

wearing, and cheap'.[53] In 1752, the Paris Bureau de Commerce permitted the production of resist-printed fabrics and, in 1759, lifted the prohibition on textile printing.[54]

The factory system had first emerged in Europe under royal patronage,[55] and other businesses adopted this system as they developed.[56] The British and French industries differed. Although British manufacturers had the advantage of lower cotton costs,[57] many increasingly concentrated on the production of cheaper goods, being less willing to take chances in a highly competitive market.[58] In contrast, the Bourbon patronage of the Jouy factory encouraged a national emphasis on quality and innovation.

1.05. Mechanisation

An increasing demand for printed fabrics fuelled the drive to mechanise printing methods,[59] with the introduction of copper plate printing in 1752 and copper roller printing in 1785. By permitting large impressions and exploiting the techniques and detailed imagery of engraved illustrations, plate printing provided a new

[53] Brédif, J., *Toiles de Jouy,* London, 1989, p.20. During this time, the French Seven Years War (1756-63) was taking its toll on the French silk and wool industries.

[54] Taxes were imposed on plain and printed imported cottons in order to protect the home industry and, in 1785, a complete ban was imposed on imported cottons. Following the years of prohibition, there were no skilled French textile printers; those who had been printing illegally had not developed technically to match the advanced methods dominating the rest of Europe. Marseilles, as a free port, was the only place where legal printing had been established (1744). Alsace had a thriving printing industry, especially in Mullhouse, but this only became a part of France in 1798. Foreign workers were invited to move to France to set up print-works.

The British 1721 act was finally repealed in 1774, but heavy taxes were imposed on printed cottons.

[55] Many continental print works were set up under such patronage, including those in Vienna (1724), Erlangen (1744), and Munich (1747). The first large factory systems were set up with similar backing, at St Petersburg in 1753 and at Augsburg in 1772.

[56] The factory at Jouy was set up as an entrepreneurial business in 1760 and received the status of *Manufacture Royale* in 1783. Buildings were added around the original work shop as the business expanded and a factory was built between 1790 and 1793. The largest manufacturer in Britain, Peel's in Lancashire, had various works on different sites, but the largest works at Bury was not rationalised into one building until 1821.

[57] Britain had the strongest connections with India for the importation of raw cotton and had developed a strong spinning and weaving industry for fustian during the calico prohibition.

[58] Britain and the colonies represented the largest and richest free trade area in the 18th century and was an ideal market for mass produced goods. Production centred on London for the high quality and European markets, whilst Lancashire manufacturers concentrated on cheaper goods for the home and American markets. Most British manufacturers specialised either in one type of product, such as oriental designs, cravats, foulard prints, etc., or relied on specialist processes.

[59] There was a general shortage of skilled labour for the developing industry. Chapman and Chassagne cited the emergence of strong trade unions and the resultant rise in labour costs as an additional incentive for mechanisation in England. Chapman, S.D. and Chassagne, S., *European Textile Printers in the Eighteenth Century,* London, 1981, p.194.

stylistic impetus.[60] Roller printing was essentially a continuous form of plate printing. It was first used to replicate the styles associated with plate prints[61] and, later, to produce monochrome versions of block prints.[62] Roller printing did not supersede block-printing, but it provided increased production speeds with reduced costs,[63] and the processes were often combined.[64]

Cutting costs created a widening market for prints, from servants' clothing to expensive furnishings.[65] From the 1790's, the British industry grew rapidly.[66] The introduction of roller printing to the Jouy factory in 1797 provided comparatively cheap, mass-produced goods for a market which was expanding as that for luxury textiles declined.[67]

At the same time, improvements were made in woodblock cutting to simulate the new printing processes and the effects of other textiles.[68] Towards the end of the 18th century, 'the skills of block cutting had reached a level hitherto unknown so that block printing could rival plate printing for subtlety and detail',[69] and they 'had attained a level of sophistication such that they could compete successfully for the

[60] Although there was a history of pictorial prints, these detailed, large-scale prints introduced a new style of design by being essentially repeated pictures. The sources of imagery were in painted papers and engravings (3.04). Many companies also produced wallpapers (6.19).

[61] Early roller prints were smaller scale copies of plate prints (8.25).

[62] These were similar to block prints, especially simple, small-scale dress styles (8.04). They were of poor quality, but improved as knowledge and experience increased and eventually they revolutionised the production of printed textiles.

[63] Bell's machine 'could carry out the work of 40 block printers'. Miles, L.W. C., *Textile Printing,* Bradford, 1981, p.2. The use of roller printing was impeded in England by the continuing taxation on printed cottons (even though roller printing could produce patterned fabrics cheaply, its competitiveness was lost due to the high taxation on its products), and in France by disruption caused by the Revolution.

[64] Many print works used pencilling, wood-block, copper plate, and roller printing. The Jouy Factory started with block printing in 1760 and, between 1790 and 1793, expanded with plate and roller printing.

[65] Chapman and Chassagne quote from a meeting of Manchester calico printers in 1786 that 'three parts out of four of printed goods are consumed by the lower classes of people'. Chapman, S.D. and Chassagne, S., *European Textile Printers in the Eighteenth Century,* London, 1981, p.78.

[66] During this time, France was in turmoil due to the Revolutionary and Napoleonic Wars. Even with the annexation of the textile producing area of Alsace, the French industry could not compete with England and the important developing American and Canadian markets were won by the British manufacturers. Schoeser and Rufey commented that by 1795 these markets 'accounted for over half of Britain's cotton exports'. Schoeser, M. and Rufey, C., *English and American Textiles,* London, 1989, p.30.

[67] The prints of the Revolutionary period were mostly small geometric designs with the emphasis on cost minimisation to produce prints for the masses (6.18).

[68] Weaving continued to be an important stylistic influence, and there was a cross-fertilisation of design ideas throughout all areas of textile design (6.02).

[69] Newton, C., and Young, H., in *Designs for British Dress and Furnishing Fabrics,* Victoria and Albert Museum, London, 1986, p.11.

custom of fashionable clients with figured silks'.[70]

The unique characteristics of block-printing were also exploited for new products.[71] Many manufacturers cut costs by plagiarising fashionable designs,[72] using less skilled labour,[73] and developing cheaper techniques.[74] Some techniques, such as pinning, created distinctive characteristics which were then copied for other processes.

New engraving techniques were exploited to produce designs exclusively for prints. The Romantic interest in nature and rejection of order resulted in a wider use of illustrative imagery.[75] Images from non-European sources were popular[76] and these were combined with contemporary European design styles. The pictorial content of the new influences was absorbed, but not the structure. These factors accelerated the move towards less structured design which had started with the Indian influence. This emphasis on pictorial novelty developed into full-blown eclecticism in the following century.

1.06. Experimentation

By the start of the 19th century, printing became increasingly industrialised, providing affordable goods for larger sections of the population.[77] Roller printing was 'in general use for furnishing fabrics by about 1810 or 1815', and the following

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[70] Young, H., in the introduction to *Patterns for Textiles,* Victoria and Albert Museum, London, 1987, p.10.

[71] En-suite furnishings of the 18th century drew on the flexibility of block-printing, producing ranges of mix-and-match design elements (8.21). Blocks were also combined to build up large designs (8.24).

[72] William Kilburn was bankrupted due to plagiarism by Lancashire copyists; 'cheaper imitations were printed and marketed within ten days of the originals appearing'. *Rococo Silks,* Victoria and Albert Museum, London, 1985, p.8.

[73] Copper plate and roller engraving was slow, expensive, and relied on the skill of highly paid engravers. Skilled craftsmen for woodblock cutting also needed sensitivity and 'must have a feeling for the qualities of the design they are interpreting'. Storey, J., *Textile Printing,* London, 1974, p.36.

The division of labour produced by the factory system resulted in processes being broken down into separate operations that could be performed by an unskilled work force, the majority of employees were women and young apprentices.

[74] For example, pinning was done by women and was cheap and fast, which made it easy to respond to changes in fashion (5.08).

[75] Since the Renaissance, geometry had been used in the arts both as a compositional device and to depict perspective instead of for its earlier integrated and ordered symbolism. The Rationalist concepts of reason and mathematical unity as an imposed order were rejected by the Romantics, who sought to reaffirm human creativity. This was reflected in a passionate concern with the exotic or primitive and with nature as expressed by the irrational (4.05).

[76] Increased distribution of foreign goods and engravings of historical events and travel scenes resulted in a greater emphasis on pictorial images.

[77] King commented that mass-production, 'though not achieving more beautiful results, lowered costs and speeded up production so that by 1835 even the humbler classes could afford to have chintz'. King, B., *Chintz,* Textiles, 1991, no.1, p.25.

period to 1850 'can be characterized as one of experimentation'.[78] Schoeser and Rufey suggested that the 'improved printing techniques' between 1825 and 1860 'brought out the "look what I can do" spirit'.[79]

New dyes and processes, which had been developed around the turn of the century, stimulated new styles, increased production speeds, and allowed more variety in colouration.[80] Specialist engraving companies[81] supplied rollers which produced fancy machine grounds that were used with other printing processes.[82] The introduction of mill and pantograph engraving made an almost immediate impact on design styles.[83]

Clabburn commented: 'the guild system was breaking down, with a less thorough, less competitive training taking its place. Added to which machines were beginning to take over from hand-work and they were yet far from perfect and not wholly understood. The result was a dearth of competent craftsmen and a decline in taste'.[84] Manufacturers partly blamed this shortage of educated artisans for the increasingly uncompetitive state of the British industry.[85] In the 1830's, the Government established Schools of Design in an attempt to improve industrial standards.[86]

By 1842, 90% of British printed textiles were roller printed.[87] Fashions were

[78] Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p.287.

[79] The 'extravagant design' and 'bold, uninhibited approach' was 'in keeping with the youth of the textile-printing industry.' Schoeser, M. and Rufey, C., *English and American Textiles,* London, 1989, p.77.

[80] In 1785, the development of Quercitron, a fast yellow dye, provided a new range of colours which became fashionable as 'styles' in the early 19th century. The discovery of resist mordants and the development of indigo discharge printing also stimulated new design styles (5.07).

[81] Engraving required great investment in equipment and skilled labour. Some printers did their own roller engraving, but for many it made economic sense to buy engraved rollers. Joseph Lockett of Manchester designed and engraved rollers for textile and wallpaper printers from 1806.

[82] Developments in discharge printing allowed motifs to be combined with these all-over grounds. However their indiscriminate application led to patterns that were crowded with detail, exacerbating an existing emphasis on effect over content (8.04).

[83] Mill (5.17) and pantograph engraving (5.18) cut engraving times and costs, especially for small all-over patterns. Designers must have been aware of their potential to exploit them so quickly (6.23).

[84] Clabburn, P., *The National Trust Book of Furnishing Textiles,* London, 1988, p.57.

[85] Sir Robert Peel brought the question of design before Parliament in 1832 and proposed the founding of a National Gallery to improve the taste of the general population.

[86] Huygen suggested that when 'British entrepreneurs choose to work with designers this is generally out of economic interest, just as government interference with design has always been consistently directed at increasing export.' Huygen, F., *British Design: Image and Identity,* London, 1989, p.52.

[87] Early 19th century roller prints were usually in no more than 4 or 6 colours, but later machines were capable of printing 20 or more. Increased roller dimensions allowed larger vertical repeats.

dictated by city merchandisers, most styles having a life of about two years. Robinson stated that 'most calico printers catered for the increase in consumer demands for ever cheaper and cheaper cottons and only a few pursued the better-quality markets which demanded high standards of craftsmanship'.[88] This emphasis on quantity and low costs resulted in a further deterioration in design quality and working conditions.

The highest manufacturing costs were incurred by designing and engraving. These were reduced by re-working contemporary themes and by copying competitors' designs using cruder engraving techniques.[89] Most designs were supplied by artisans and usually reflected the exploitation of new processes, economy, and ease of production. Originality was expressed by technical innovation and novel combinations of eclectic imagery.

1.07. The design debate

The Great Exhibition in 1851[90] demonstrated industry's technical skill and ingenuity and exposed the prevailing design anarchy produced by general over-ornamentation and the mingling of diverse decorative styles. The poor quality of design and manufacture provoked strong reactions. Criticism centred on dissatisfaction with machine production and took two opposing forms. Huygen commented that these reflected the two persistent and opposing images of Britain as the 'Workshop of the World', and as 'England the Garden'.[91]

Elitist critics blamed mechanisation for declining design standards and desired a return to the traditional role of the craftsman. Industrialisation was associated with ugliness, utility, and commercial values. In addition, there was a growing awareness of the appalling working conditions in the textile industries. John Ruskin expressed an almost pathological hatred of machines and mechanical

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[88] Robinson, S., *A History of Printed Textiles*, London, 1969, p.24.
The increasing use of block printing for high quality furnishings and shawls made it less affected by the general decline in standards. The manufacture of these goods exploited the flexibility of the process for the production of complex or large designs (8.30). Changes in both dress and furnishing fashions decreased these markets. By 1860, the process was almost obsolete, but was revived in the 1870's by William Morris.

[89] Crude engraving was used in producing cheap copies of fashionable designs. It was also associated with the bold Pompeian styles combining new bright colours and strong black lines (5.07). French designs were bought by English manufacturers requiring up-market designs.

[90] The Society of Arts had held regular exhibitions of manufactured goods since 1756. This became the Royal Society of Arts in 1847 and emphasis was placed on the quality of design in keeping with the philosophy of the Government Schools of Design.

[91] One was forward looking and concerned with invention and innovation, the other was the world of the gentleman, rooted in tradition, and these 'were not infrequently at loggerheads with one another'. She suggested that the class system was partly to blame for the anti-industrial stance of the British intellectuals, who regarded industry with disdain. Huygen, F., *British Design: Image and Identity*, London, 1989, p.35.

processes.[92] The advance of capitalism and science was seen as a rejection of the aesthetic ideals of art, imagination, and emotion. This nostalgia for hand-crafted work ignored the drudgery of most commercial block printing and the fact that cheaper machine-made products had created a new mass market which could only be served by mechanisation.

The pro-industrialists believed that quality could be improved by raising design standards and that both industry and the consumer would benefit by the application of principles of taste and design in industrial manufacture.[93] They considered that the fault lay not with mechanisation, but with its implementation which placed greater emphasis on cost reduction and technical innovation than on design standards.[94]

The specialised skills required for engraving and printing had increased the division of labour.[95] Critics of industrial practices argued that this had demoted designers and artist-craftsmen to pattern cutters who were dissociated from production processes. But the speed with which new techniques were exploited tends to counter this view.[96] Their objection was more with the design limitations within which designers had to work. Quality of design was criticised by groups, such as the Design Reform Movement,[97] who presented a moral stance on the correct use of ornamentation.[98]

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[92] Ruskin's theories reflected the division between the arts and sciences stemming from the Romantic era (4.05). They were very influential and underlie present attitudes concerning the inhumanity of mechanisation.

[93] Artists, educationalists, and design reformers such as Owen Jones, Henry Cole, and Christopher Dresser were concerned with the interrelationship of the arts and sciences.

[94] This attitude had existed since the 17th century when manufacturers employed cheap labour to perform monotonous hand work, rather than invest in new technology and incur the higher costs of skilled engravers.

[95] Storey opposed the widespread belief that mechanisation 'killed all skills and turned everyone into mindless machine watchers' by stating that the 'engraved roller machine has always required a combination of skill and long experience for its successful operation'. Storey, J., *Textile Printing,* London, 1974, p.67.

[96] Manufacturers considered non-industrial designers incapable of designing for industry, indicating that in-house designers must have accommodated production limitations and potential in the design process.

[97] The members, including Augustus Pugin, Henry Cole, and Charles Eastlake, believed that designers should not seek to imitate nature or use illusion and perspective. They believed that over-ornamentation signalled a declining civilisation, but disagreed with Ruskin on the use of 'conventional' design. Pugin, a propagandist for the gothic style, was particularly vociferous in his views on honesty of purpose in design. His dissatisfaction with the quality of manufactured goods echoed Ruskin's and stimulated interest in hand-production (4.05).

[98] The concept of propriety in design gained importance in the latter part of the century and was echoed in the increasing number of publications on taste and style. For example, Dresser suggested that 'Art can lend to an apartment not only beauty, but such refinement as will cause it to have an elevating influence on those who dwell in it'. Dresser, C., *Studies in Design,* London, 1988, p.9. First published London, 1876.

1.08. Design laws

Eclecticism had created a design situation that lacked any cohesion. Gombrich proposed that the 19th century 'was obsessed with style precisely because it felt itself to be without a style of its own'.[99] He also suggested that a replacement was needed for the previous two guidelines: 'the study of nature and the acceptance of tradition'. The first having been 'severed by the reformers, the second by industrialization'.[100]

Through his 37 'propositions' for design, Owen Jones attempted to create formal laws applicable to the contemporary climate.[101] These derived from his study of Islamic design[102] and can be seen as a reaffirmation of a traditional use of structural order and symmetry, rather than a new approach.

Jones used foreign and historical designs to illustrate his propositions. Other encyclopaedic publications and Museums increased the growing interest in these styles and provided additional inspiration.[103] Publications often included sections on 'savage tribes', but these were viewed more as curiosities than design sources. Abstraction was regarded as primitive or degenerate.[104] Attitudes began to change with the impact of Japanese art. It was sophisticated, yet its asymmetry and apparent informality shocked designers, whose perceptions were based on formal concepts of order and symmetry.[105]

1.09. The artist-craftsman

In the 1860's, artists and designers, such as William Morris, E.W. Godwin, and Edward Burne-Jones, began producing their own designs, taking as their model the artist-craftsman. An involvement with production processes was seen to be integral to their work and resulted in the revival of hand processes, such as block-

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[99] Gombrich, E.H., *The Sense of Order*, second edition London, 1984, p. 198.

[100] Ibid, p.54.

[101] These propositions were taught in Schools of Design and were influential in the following decades on designers such as William Morris. They underlaid most design theories into the 20th century (4.12).

[102] 'Every principle which we can derive from the study of the ornamental art of any other people is not only ever present here, but was by the Moors more universally and truly obeyed'. Jones, O., *The Grammar of Ornament*, London 1856, reprinted London 1987, p.66.

[103] Jones intended his work to educate designers, but the plates were often directly copied or used in prints that combined pictorial elements from various sources (3.04 and 6.07).

[104] Since the Renaissance, pictorial representation had been considered the highest form of art in Europe. This attitude towards primitivism (3.07) existed until art started to draw on African sources (6.13).

[105] Trade with Japan had been restricted and very few products had been seen in Europe until the International Exhibition in 1862. Many designers, notably Christopher Dresser, Bruce Talbert, and Lewis F. Day, were influenced by Japanese art and popularised the style. Others, particularly Ruskin, disliked the abstraction and the seeming disregard for nature (4.05).

printing.[106] The need to work within the restrictions, but at the same time exploit the potential of the process, was an important stylistic influence.[107] The interest generated by 'art furnishings' encouraged some entrepreneurs to commission English artists and designers,[108] although most manufacturers thought that designers, inexperienced in industrial practices, would be incapable of producing repeat patterns suitable for mass-production.[109]

The philosophical cornerstones of the Arts and Crafts Movement established that the decorative arts were not inferior, and that a good designer was essentially an artist.[110] The first exhibition of the Arts and Crafts Exhibition Society, in 1888, was important for developing recognition of designers.[111] International magazines gave world-wide publicity to new styles and individual designers, and British designers increasingly sold designs in Europe and America. Their success encouraged manufacturers to commission similar work from freelance designers and studios.[112] Liberty's was the first shop to commission directly from British designers.[113] By the 1890's, Liberty's had retail outlets and agents all over the world and was influential in spreading the taste for Art Nouveau.

The Arts and Crafts Movement and Art Nouveau were stylistically and artistically

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[106] These designers were part of the movement that rejected industrialism, but they did not blame mechanisation for declining standards, rather the division and resultant devaluation of skills that it had engendered. They saw a return to the traditional values and ideals of craftsmanship as a way of restoring dignity to the decorative arts and status to the craftsman.

[107] The block-printing process was an important structural influence (7.01 and 8.15). William Morris's multi-disciplinary approach also introduced influences from other textile processes (6.03).

[108] Jeffrey & Co. commissioned designs from Owen Jones in 1865 and Walter Crane in 1875. Arthur Liberty commissioned various designers from 1880 onwards, including Christopher Dresser, William Butterfield, and Walter Crane.

[109] Some designers, such as Walter Crane, chose to work with manufacturers to reach a wider and less privileged market, but they were never truly reconciled to the restrictions imposed by the process or the quality of production.

[110] The concept of design as a moral improver appeared in magazine articles in the 1880's which expounded the virtues of the 'home beautiful' and echoed William Morris's belief that design should 'restore the dignity of art to ordinary household decoration'.

[111] Design education was influenced by the recognition that designers could be trained for industry at a craft level. The concept that aesthetic concerns were important started to permeate an industry which had been concerned primarily with technique and effect.

[112] The freelance designer, Arthur Silver, responding to the public's eclectic tastes, had produced designs in a wide variety of styles for manufacturers. He established the Silver Studio started in 1880 and in the 80's and 90's produced many William Morris type designs.

[113] Specialist shops had emerged in the 1830's to cater for the demand for shawls which became an indispensable clothing item in the 1840's. Arthur Liberty had worked in the oriental department of a shawl emporium before opening his own premises in 1875 specialising in oriental designs and, later, British contemporary designs.

influential on international design developments, but were a fraction of the period's textile production and represented the tastes of only a small portion of the population.[114] Their international popularity had little effect on the British textile industry.[115] Most manufacturers saw style as a resource to be used whilst fashions lasted and did not exploit this established design reputation.[116]

1.10. Art and design

The emergence of Modern Art at the turn of the century reflected a fundamental shift in consciousness, shown in a change from illusionist representation of the object world back to the flat picture plane.[117] Artists were 'wrestling with the representation of the empirical world' because 'the representation of purely physical appearances proved to be utterly inadequate to the reality they knew'.[118] The variety of visual experimentation transferred to French design, which drew on the influences of contemporary painting and naive forms of art. Peasant, primitive, and children's art were now seen as spontaneous and untrammelled by convention.[119] The involvement of artists in textile design arose from their intrinsic interest in decorative forms, and from manufacturers' commissions for modern designs.[120]

British artists and designers[121] continued to produce textiles by hand processes for a limited home market,[122] but the majority of manufacturers would not follow 'where the pioneers were trying to lead them'.[123] 'Design theorists had for decades been clamouring for a change of attitude towards textile design, yet the

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[114] Continuing eclectic trends co-existed with these styles, forming a larger share of the market (6.17).

[115] The Calico Printers Association, formed in 1899, included 85% of British calico printers. Its intentions were to boost trade and efficiency and reduce domestic rivalry in order to concentrate on the international market. Despite this, the industry declined during the 1890's, reaching an all-time low in the 1930's. A closer link between art and industry was then advocated, echoing the demands of the 1830's.

[116] European manufacturers carried the trends on and developed them further (6.23).

[117] Hughes proposed an association between abstraction and the perceptual shift in views of the physical world (2.20). Artists became interested in historic and non-European art in their attempts to find alternative ways of depicting reality, resulting in an intellectual appreciation of art that had previously been considered primitive and crude (6.18).

[118] Oeri, G., *Man and his Images,* London, 1968, p.19.

[119] Psychological concepts affected attitudes towards all forms of naive art. The Atelier Martine, set up by Paul Poiret, specialised in designs by 'talented working-class children who were encouraged to develop their ideas without the formal training and inhibitions resulting from the curricula of official schools of art and design'. Woodham, J.M., *Twentieth-Century Ornament,* London, 1990, p.19.

[120] Modern designs were required to complement new styles of dress and decor (6.22 and 6.23).

[121] The Omega Workshops (1913-19) produced prints reflecting Continental artistic influences (6.18).

[122] Block printing continued to be used into the 1930's for both modern (8.15) and traditional prints and, later, by manufacturers of document fabrics. By the 1960's, it was no longer commercially viable.

[123] Hunt, A., *British Textiles,* Architectural Review, December 1932, pp.293-6.

manufacturers continued to produce safe familiar patterns'.[124]

1.11. Diversity

Hand screen-printing was developed in the 1920's and 30's and its direct engraving techniques were exploited for avant-garde and experimental textiles to create loose and spontaneous designs.[125] Artists and manufacturers, committed to improving the image of mass-produced textiles, collaborated.[126] Photo-engraving of copper rollers became commercially viable in the 1920's and 30's, but, although it was assumed that the process would quickly supersede all other engraving methods, it was not widely used until the 1950's.[127]

Fully and semi-automatic flat-bed screen-printing was introduced in the 1950's. At that time, 'many more printing firms existed . . . than today, so that wholesale converters such as Warners could select that printer whose technique was appropriate to the desired effect'.[128] Technical, economic, and social factors combined to stimulate the experimental and energetic nature of 1950's design, probably best represented by screen-printed furnishing fabrics.[129] Postwar consumers had 'a genuinely positive attitude towards progressive design'.[130]

The increased use of freelance designers and continuing artistic collaborations brought a closer interpretation of artwork with the emphasis on retaining the original spontaneity and effects.[131] The abstraction and visual vocabulary of

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[124] King, B., *Modern Art in Textile Design,* The Whitworth Gallery, Manchester, 1991, p.2. Production was based on the traditional designs popular in the English market (6.15), but did not seek to exploit potential Continental and International markets pioneered by the artist/craftsmen of the late 19th century.

[125] The direct engraving stimulated the development of more painterly styles which reflected artistic concerns with spontaneity and prompted a move from structured, abstract designs (8.16 and 8.25).

[126] Manufacturers, such as Cresta Silks, Edinburgh Weavers, and Allan Walton Textiles, commissioned British artists to work on textile designs (6.23).

[127] Existing investment in equipment and skills was a major reason for delays in its adoption, especially 'where a firm of engravers is long established, with a work force well qualified in the older methods, and machinery which would otherwise be lying idle'. Storey, J., *Textile Printing,* London, 1974, p.97.

[128] Schoeser, M., *Pattern in Textiles,* Textile World, April 1985, p.39.

[129] The increased fabric widths pushed furnishing manufacturers into screen printing earlier than those for dress fabrics (5.31). They exploited larger screen sizes, giving selvedge to selvedge repeats (8.25).

[130] 'Perhaps because people had been deprived of new things for so long, they were generally much more receptive to modern design'. *The New Look: Design in the Fifties,* exhibition guide, Manchester, 1991. The postwar emphasis on design resulted both from a consumer need and Government attempts to stimulate the export market. The contemporary style was promoted by the Festival of Britain in 1951 and featured strongly in the new magazines of modern design.

[131] Technical developments concentrated on the faithful translation of artwork. The attitude of some companies, notably Ascher, was that artists should not be restricted by technical considerations (6.23).

painting were absorbed into textile design.[132]

Rotary screen-printing was introduced in the 1960's and predominated by 1985, accounting for more than 75% of British output.[133] But, as with previous technological developments, the old still existed alongside the new. [134] In the 1980's, various economic factors together with shorter print runs meant that the high productivity of rotary printing no longer gave it a clear economic advantage over flatbed printing. Elsässer stated that this situation 'illustrates how changing market conditions can prove existing equipment to be "off the trend", which is by no means to say that the machines in question ought to be classified as out of date'.[135]

The frequency and variety of fashion changes have increased the demand for short runs; 'growing individualism in consumer behaviour requires an ever-growing variety of designs and colours, forcing the retailer to constantly renew his collection. As a result, the market demand is harder to anticipate'.[136] Schaub saw individualism as a world-wide phenomenon, brought about by 'expanded communications', and observed that 'the function of textiles, and especially that of clothing is becoming less tradition bound'.[137]

1960's design drew widely from a diversity of sources, involving the reinterpretation, rather than copying of designs.[138] This renewed eclecticism continued but, in the late 1980's, it developed into a form of revivalism reminiscent

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[132] Influences from post-war art movements, such as Abstract Expressionism, and pre-war artists, such as Paul Klee, were absorbed into the contemporary style. Generally, although abstraction in the fine arts was still not to popular tastes, the majority of designs reflected contemporary aesthetic concerns (6.18).

[133] Schofield, S., *Textile printing: continuing dominance of the rotary method,* International Dyer & Textile Printer, February 1985, p.8.

[134] For specialist prints and very long runs roller printing is still economic, especially where there is an existing investment in older machinery. In 1987, Keighley commented that a Lancashire printer had been printing a nursery design for 30 years using the original roller. The company was running new rotary screen printing machines in addition to three older roller printing machines. Keighley, M., *Lancashire cotton printers make a fine impression,* International Dyer & Textile Printer, April 1987, Vol.172, No.4, p.14.

[135] Elsässer listed the economic factors as 'stagnating sales on the home market, drastically increased oil prices and their impact on the real income of consumers, a return to economic dirigism which causes competitive distortions on the international market, problems of environmental protection and, last but not least increasing imports of printed textiles from low-wage countries'. Elsässer, H.B., *Rotary or flatbed screen printing? An old question regains topicality,* Textil Praxis International, 1985, Issue 3, pp. XXI and XXII.

[136] Ten Kate, H.J.G., *Textile printing tomorrow,* Textile Industries Dyegest S.A., December 1988, p. 2.
The carrying of less stock by retailers has also increased the incidence of short runs and, consequently, of repeat orders. The resultant emphasis on reproducibility of designs and fast delivery times has affected the extent of automation in printing machinery (5.25)

[137] Schaub, J.H.W., *Future Prospects for the Textile Printing Industry,* Melliand Textilberichte / English Edition, 1982, Vol.63, Part 1, p.69.

[138] Sources included ethnic patterns, revivals of historic styles, contemporary art, and psychedelia (6.16). Designs were recoloured, changed in scale, and generally modified for the expansive, modern mood. The increased scale of design provided by screen printing was also applied to dress fabrics (6.22).

of the 1890's. The rampant eclecticism of Post-Modernism differs from that of the 19th century in the co-existence of a greater variety of styles and the speed with which they change and also in the application of technological innovations.[139]

1.12. Computer-Aided Design and Manufacture (CAD/CAM)

In this climate, the computer is seen as 'a powerful tool that enhances not only design quality and manufacturing capability, but response speed to market demands and management effectiveness'.[140] In 1990, Holme suggested that, as 'the market for textiles and clothing continue to demand quick response and individual design styling to customer requirements it is certain that CAD/CAM systems will increase in number in the next decade'.[141]

Reduction of labour costs has been a major factor in the West's use of Computer-Aided Design and Manufacture (CAD/CAM) to cope with Eastern competition.[142] Beard expressed a common concern, comparing the introduction of (CAD) with the advent of the Industrial Revolution; 'bringing an end to familiar working practices and throwing skilled artisans out of their jobs', but this time 'the employees at risk are the designers and artists'.[143]

Applying computers to increase design productivity has emphasised the scanning of art-work, rather than creative CAD. Hearle predicted the danger of this alienation when he stated in 1971 that 'to scan an artist's design on paper is to make him more remote from the fabric which he is designing'.[144] Haimes suggested that, whilst 'electronic systems can reduce costs and save time, technology that does not enhance creativity has little value'.[145]

[139] 19th century exploitation of technology was based on effects, whereas 20th century use centres mainly on the recycling of style. Post-modernism in particular makes reference to designs from multiple sources (6.15).

[140] Chong, T.F., *Computers in textile production,* Textile Asia, May 1990, p.56.

[141] Holme, I., *Tools for quick response,* Textile Horizons, February 1990, p.36.

[142] Commenting on lower labour costs in the East, Boothroyd argued that, if 'there is no major advance in technology in the future, the productivity gap between industrialised and developing nations will close considerably, at the expense of the developed nations'. Boothroyd, D., *Cut your cloth according to your computer?,* Electronic Times, 1984, vol.288, p.25.

[143] Beard, J., *Computers weave a new fashion,* New Scientist, 10 February 1990, p.48.
Schulzen suggested the alternative view that 'progress in chemistry, mechanics or electronics does not lead to unemployment, but poses new tasks which are formulated through other laws, namely those of growth'. Schulzen, H., *Additional coloristic possibilities with the subicolor process,* Melliand Textilberichte (English Ed.), 1974, Vol.55, Part 5, p.467.

[144] Hearle, J.W.S., *Function and Form: Computing as a tool in Textile Design,* Advance, 1971, vol.11, p.36.

[145] Haimes, R., *Graphic Design Technology Matures,* Computer Graphics World, February 1988, p.54.

1.13. Innovation

Innovation has often developed from a close involvement between the designer and the production process. Unfortunately, engraving processes, requiring the interpretative skill of specialists, have often undermined this involvement.[146] The commercial application of screen-printing concentrated on the replication of painterly effects, and this strengthened the perception of the designer as an artist whose role is concerned primarily with imagination and aesthetics.

When CAD was introduced into this design climate, systems were extremely expensive and restricted to the cost effective application of design conversion. Their use was extended from correction to manipulation, but this centred on the alteration, or re-design, of a croquis for manufacture, thereby exacerbating the separation of designer from production. Because designs are usually put into repeat at this stage of the process, designers are not required to 'think in repeat' and many have become generators of ideas, rather than producers of finished designs.

Large companies are unlikely to use CAD systems innovatively because they tend, in general, to follow design trends rather than set them. This restricted use of CAD has denied designers the opportunity to explore the design potential of this new technology.[147] CAD development is market led and, as yet, few customers have requested design-orientated functions. The concentration of research on design conversion facilities, such as scanning, colour correction, and pixel editing, has been to the detriment of research for innovative design applications.

Now, as the economic restrictions have relaxed with lower hardware costs and faster speeds, computer technology 'could extend the creative control of the designer into actual production'.[148] But, until CAD is exploited by small innovative companies or freelance designers, large companies will not see the economic potential of using this technology for creative design.

[146] This has not always been the case (1.07) but has increased as more emphasis has been placed on the role of the designer as artist (6.23).

[147] In most earlier technological developments, processes were exploited for their novelty and in hand processes, such as screen printing, the direct contact between designer and medium facilitated a creative exploitation.

[148] Haimes, R., *Graphic Design Technology Matures,* Computer Graphics World, February 1988, p.54.

CHAPTER 2: PATTERN PERCEPTION

2.01. Selectivity

Historical attempts to explain visual perception have produced a 'long and barren controversy'[1] between Empiricism[2] and Nativism;[3] between learning and intuition. Helmholtz argued that perceptions were 'conclusions' inferred from available sensory data,[4] but unfortunately, at that time, the climate of knowledge discouraged his line of argument.[5]

The selectivity of perception is now recognised; 'specific features of objects are selected and combined to give an internal account of the objective world'.[6] Blakemore suggested that 'perceptual experience might rely on a simple analysis of the orientation and length of the borders of objects and the angles between them'.[7] There is evidence that these stimuli are represented by the firing of single cells in the visual cortex. Gregory argued that 'tuning' of cells for specific features may be a result of early learning and that people are attuned more to those stimuli experienced at an early age.[8] Physiologists still do not know how these selected features are combined to give perception of objects.

2.02. Interpretation

The debate between Empiricism and Nativism continues. Research in brain physiology has revealed much about the mechanisms of perception and has lent credence to the concept of perception as an interpretive process.[9] But contemporary research into artificial intelligence has concentrated on a

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[1] Boring, E.G., *Sensations and Perceptions in the History of Experimental Psychology,* New York 1942.

[2] Locke believed that, at birth, the mind was a blank page, a *tabula rasa,* and that all knowledge of the external world was learned by the association of information derived from the senses. Locke, J., *Essay concerning Human Understanding,* London, 1690.

[3] Nativism assumes that some knowledge is inborn and not derived from sensations. Kant suggested that perception was a direct awareness of external reality. He proposed the term *anschaung,* or intuition, to describe this instinctual awareness. Kant, I., *Critique of Pure Reason,* 1781.

[4] Until recently, the assumption that inference had to be a conscious process had caused Helmholtz's ideas of *unconscious inference* to be thought self-contradictory. Helmholtz, H. von, *Treatise of Physiological Optics*, 1867. English translation, New York, 1962.

[5] Current scientific and philosophical thinking influence psychologists' analyses of problems and dictate the terms for formulating theories. Gibson suggested that theories relating to the perception of space have been influenced by the geometrical descriptions of Euclid and adapted by the three dimensions of the Cartesian coordinates, which emphasised the use of points and lines. Gibson, J.J., *The Perception of the Visual World,* Cambridge, Mass. 1950.

[6] Gregory, R.L., in *Illusion in Art and Nature*, edited by Gregory and Gombrich, London, 1973, p.50.

[7] Blakemore, C., ibid, p.29. Stimulated by orientation and changes of light levels between adjacent areas, perception can identify these borders.

[8] Gregory, R.L., ibid, p.54

[9] This is similar to Helmholtz's view that perceptions are defined as hypotheses based on available visual data, influenced by previous experiences.

mechanistic understanding of visual perception. Watt defined vision as 'the extraction and analysis of information from an optical image in preparation for, and execution of, behaviour within the scene'.[10] Studies have been mainly laboratory based, examining selected aspects of particular problems using specialised techniques and limited samples of test subjects in unnatural situations.

Research does not explain how objects are *recognised* as opposed to how they are *seen*. Commenting on recognition, McCrone stated that the 'almost metaphysical sensation of knowing that we know has been largely ignored', and that recognition may depend on a combination of intellectual processing and emotional responsiveness.[11]

Perceptual skill may be finely tuned by individual experiences. Designers often develop an acute awareness relating to their own specialities and many decisions are based on *knowing what looks right.* But, because such skills cannot be broken down into quantifiable processes, they have often been dismissed as innate artistic ability and regarded as less important than skills that can be taught methodically.

2.03. Familiarity

The amount of available information and the familiarity of the objects in view are important factors for perceptual understanding. Gregory illustrated this by describing the uncertainty experienced attempting to distinguish familiar objects in dim lighting. 'This decrease in reliability of recognition', he wrote, 'proceeds gradually and continuously as sensory data are removed, or become unavailable. There seems to be no break between *perceiving* an object and *guessing* an object'.[12]

Gibson distinguished between schematic and literal perception. Schematic, or everyday perception, he observed, consists of hypotheses derived from literal perception and tends to be 'selective, creative, fleeting, inexact, generalized,

[10] Watt, R., *Understanding Vision*, London, 1991, p.9. Disparate techniques, approaches, and theoretical standpoints characterising this interdisciplinary research make much of the work difficult to follow. As the problems of recognising objects from the analysis and interpretation of visual data are explored, a greater understanding of human visual perception may be achieved.

[11] Evidence is emerging that the brain's visual processing follows ventral and dorsal pathways. The first leads to the cerebral cortex for 'intellectual processing' and the second to the brain's emotional centres. Two conditions associated with brain damage illustrate the effect that disruption of either of these pathways has on total visual perception. If there is damage to the ventral pathway, prosopagnosia can occur which produces an inability to recognise familiar faces although tests have shown subconscious emotional responses. In contrast, damage to the dorsal pathway can produce Capgra's syndrome which destroys the 'sense of familiarity', and sufferers have an intellectual recognition of people and places but no emotional recognition, often believing that they inhabit a world of impersonators. McCrone, J., *My family and other strangers*, The Independent on Sunday, 1st March 1992, p.40.

[12] Gregory, R.L., from *Illusion in Art and Nature*, edited by Gregory and Gombrich, London, 1973, p.61.

stereotyped, and to have all the other defects so commonly ascribed to it'.[13] Two dimensional art represents objects using a limited amount of data. Thus a cartoon may suggest a whole scene with a few lines, its success dependent on the viewer's recognition of the artist's intention.

2.04. Visual cues

The perception and interpretation of illustrative or graphic representations is dependent on visual cues; a form of visual shorthand that relies on the use of perceptual hypotheses. Deregowski distinguished between pictorial and cultural cues (figure 2.01). The first he related to artistic conventions and the second to the familiarity of objects to the viewer.[14]

Many studies of cross-cultural differences in perception have been concerned with the correct interpretation of pictorial depth cues.[15] These relate to the use of perspective which, since the Renaissance, has been the dominant model for Western artistic representation of the visual world. Perspective drawings and most photographic images represent views from fixed points[16] and therefore depict one way of *seeing*.[17] Such pictorial cues are visual cues particular to Western culture[18] and are part of a learnt visual language which affects perceptual interpretation of simple illusions. Probably perception of such illusions depends on a combination of familiarity with the use of depth cues and other, more fundamental, differences in perception. People of different cultural backgrounds, training, interests, and

[13] Gibson suggested that literal perception was 'the world of colours, textures, surfaces, edges, slopes, shapes, and interspaces', and schematic perception, a 'world of objects, places, people, signals, and written symbols'. Gibson, J.J., *The Perception of the Visual World*, Cambridge, Mass. 1950, p.10.

[14] Deregowski illustrated the effect of cultural cues with a drawing (figure 2.01) which was interpreted in dramatically different ways by subjects from two contrasting cultures. Deregowski, J.B., *Illusion in Art and Nature*, edited by Gregory and Gombrich, London 1973, p.165.

[15] This correctness only applies to the Western understanding of an imposed pictorial device for the representation of three dimensional space on a flat plane. There is an inherent bias in any study of perception based on two dimensional images whose interpretation is dependent on a learnt visual language.

[16] This is the view seen by the fixed eye and differs from the visual world seen by the moving eye (2.07). The search for alternative representations of visual reality have been a major motivating force in the development of modern art movements (2.20).

[17] Hughes stated that 'perspective is a generalization about experience' which 'does not really represent the way that we see. . . Your eye is never still . . . Nor is your head in relation to the object; every move brings a fractional shift in its position which results in a minuscule difference of aspect'. Hughes, R., *The Shock of the New*, London, 1980, p.17.

[18] The relative sizes of objects within this visual framework are interpreted as indications of the distances between them and a fixed point. Thus a man in the background and a man in the foreground are 'seen' as men of the same size, with the smaller man in the distance. In other cultures and in pre-Renaissance Europe, this relative difference in size would be interpreted differently; as a giant and a midget or as an indication of social stature.

Figure 2.01. Deregowski's illustration of the effects of perceptual skill and cultural experience in the interpretation of graphic images.

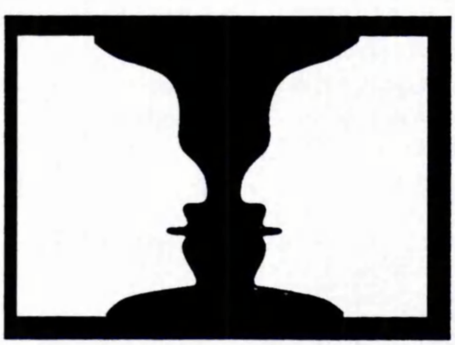

Figure 2.02. Rubin's vase illusion.

convictions do not see the *same world*. It has been suggested that topographical factors which relate to the natural and man-made environment may influence perception.[19] Deregowski argued that 'cultural issues do not affect the human perceptual mechanisms' fundamental nature, but shape them, accentuating this characteristic or that, so that strikingly different perceptual skills result'.[20]

Visual cues rely on the familiarity of the object and its manner of depiction.[21] The use of highly stylised forms, such as symbols and icons, depends on the viewer's recognition of their manner of representation. Symbols which have a traditional or contemporary significance in one culture or discipline may be seen as purely abstract forms in another.[22]

2.05. Figure-ground illusions

The visual ambiguity of figure-ground illusions, such as Rubin's vase (figure 2.02), is caused by two distinct hypotheses that can be drawn from a limited amount of data. An object cannot be seen without separating it from surrounding details, thus each figure is the background for the other and none is dominant; one figure may be perceived first, but neither can be completely dismissed. If either of the figures, or its method of representation, is unfamiliar to the viewer then it may not be seen and so the ambiguity will not exist for that person.

Christie illustrated this phenomenon of perceptual instability in relation to pattern with a regular series of white horizontal and diagonal lines on a black background (figure 2.03). This can be seen as white lines on a black background or black shapes on a white background. The pattern can be shown in a modified form (figure 2.04). Here visual cues indicate interlacing of the lines, providing extra data that strengthen one hypothesis and remove the ambiguity.[23]

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[19] Segall et al. found that the susceptibility of subjects to certain illusion figures was stronger in 'carpentered' cultures than ones in which rectangularity was a rarer phenomenon, and that environmental factors, such as prolonged experience of open spaces or dense forests, influenced the perception of horizontal-vertical illusions. Segall, M. H., Campbell, D., and Herskovits, M. J., *The Influence of Culture on Visual Perception*, Indiana 1966.

[20] Deregowski, J.B., *Distortion in Art: The Eye and the Mind*, London 1984, p.3.

[21] The Western interpretation of Deregowski's figure relies on conventional use of a limited number of lines to indicate an interior scene. The Western viewer is *attuned* to this manner of depicting space, and this 'reading' of the image is almost automatic.

[22] Often symbols are highly stylised representations of forms, emphasised more by their prior association than by their representational characteristics (3.08).

[23] Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, pp.69 and 70.

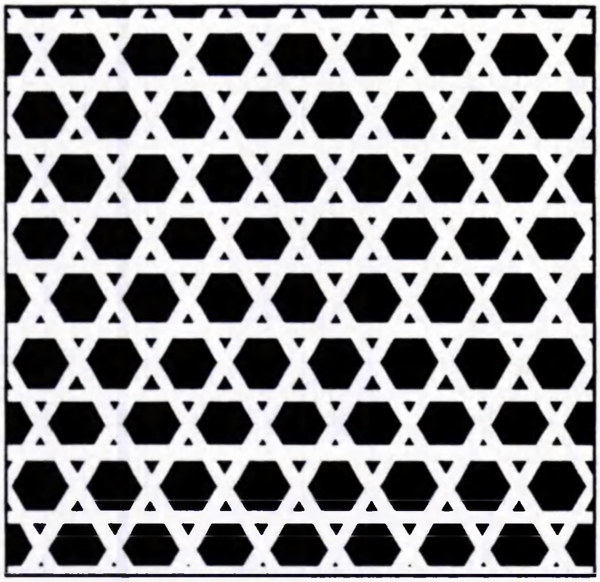

Figure 2.03. Figure-ground effect: it is not clear which is background or foreground.

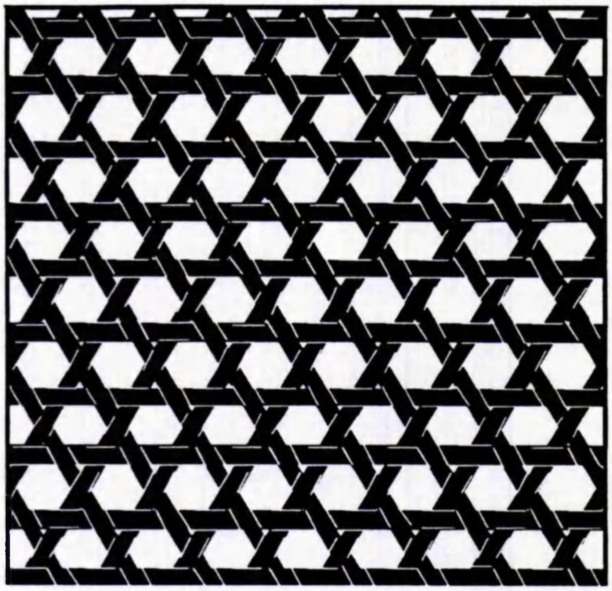

Figure 2.04. Added detail gives the illusion of interlaced bands, thus defining the foreground.

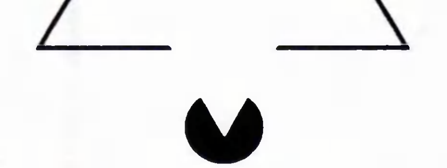

Figure 2.05. Kanisza's phantom triangle.

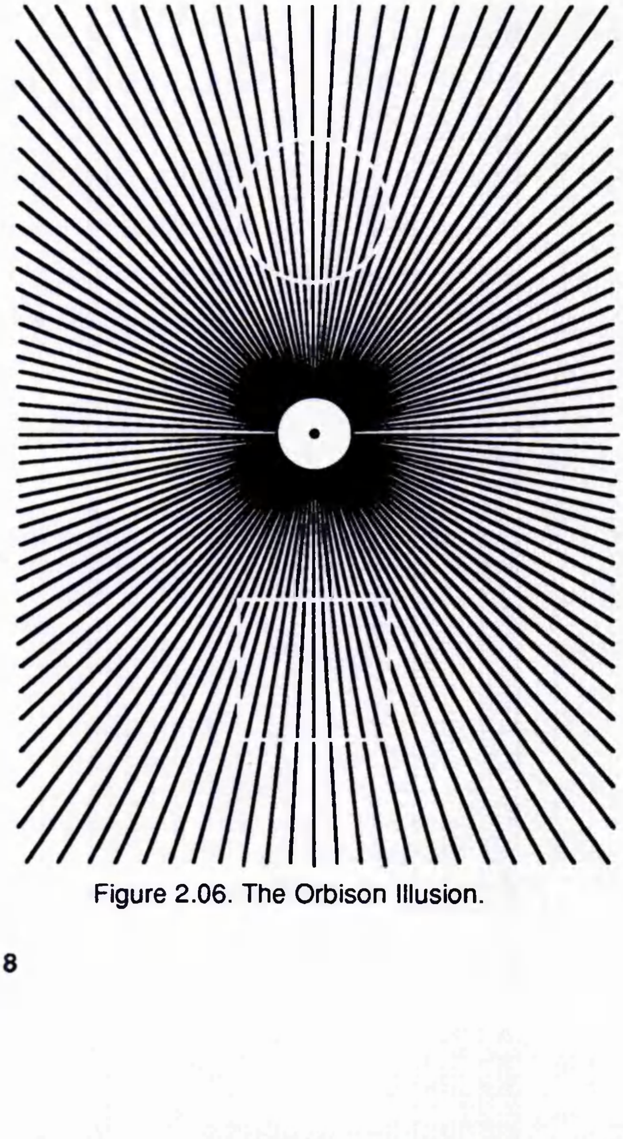

Figure 2.06. The Orbison Illusion.

2.06. The Outline

The outline is the feature that separates an object from its background. The ability to recognise an object from the limited amount of data available in a silhouette shows the importance of outline as a visual stimulus. The outline of an illusory figure may be inferred from incomplete lines or even non-existent lines, as in Kanisza's phantom triangle (figure 2.05).[24] In the Orbison illusion, a white outline is inferred from the breaks in the black lines (figure 2.06).[25]

The perceptual linking of elements to form a recognisable object has been investigated in psychological tests. For example, the Street test is used to assess the viewer's recognition of figures that have been interrupted, with only parts left visible (figure 2.07).[26] Gestalt theory explains these phenomena as 'closure'.[27] Gestalt theorists produced interesting ideas, and their experiments still have relevance. But their theories of perception have been disproved by recent research in brain physiology. Gibson stated that Wertheimer's laws 'are applicable, therefore, to some kinds of abstract drawings and paintings . . . not so much to ordinary visual stimulation'.[28]

2.07. Regularity

The eye does not focus on everything at once; most of the retina deals with general vision (scanning), while the fovea concentrates on objects selected for detailed vision (fixation points).[29] Focal attention is directed by the 'detection of textural changes in our environment that indicate the occurrence of objects'.[30] Watt

[24] Kanisza, G., *Organisation in Vision*, New York, 1979.

[25] *Illusion in Art and Nature*, edited by Gregory and Gombrich, London, 1973, p.92.

[26] Deregowski suggested that this perceptual process 'involves not only the automatic closure of the gaps by the simplest possible extrapolation from the geometric shapes presented, but also extrapolation in such a manner that the perceived object is meaningful'. Deregowski, J.B., *Distortion in Art: The Eye and the Mind*, London 1984, p.43.

[27] It was thought that electrical 'brain traces' adopted the shape of the object in view, stimulated by an innate predisposition for simple forms. Supposedly, spaces in the lines are filled by the tendency of the brain to merge the corresponding spaces in the mapped shape to create a continuous simple form. The Gestalt theorists, Rubin E. and Wertheimer M., formulated laws of perceptual organisation.

[28] Gibson remarked that these laws were based on arrangements of lines and points which disregarded texture, contour, and colour, and did 'not account for accurate perception'. Gibson, J.J., *The Perception of the Visual World*, Cambridge, Mass. 1950, p.196.

[29] Gibson distinguished between the 'visual world' (the continuous, panoramic view seen by the moving eye) and the 'visual field' (the view seen by the fixed eye). He described the visual field as 'our experience - when - we - introspect' and the visual world as 'our experience - when - we - do - not'. Ibid, p.43.

[30] Julesz used the terms 'pre-attentive' and 'attentive' to describe the phases of scanning and focussing. Julesz, B., in *The Oxford Companion to the Mind,* Oxford, 1987, p. 787.

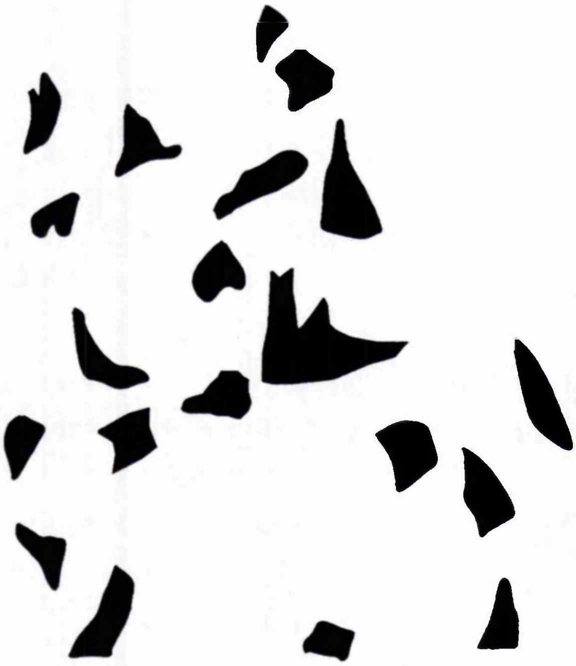

Figure 2.07. A figure from the Street test.

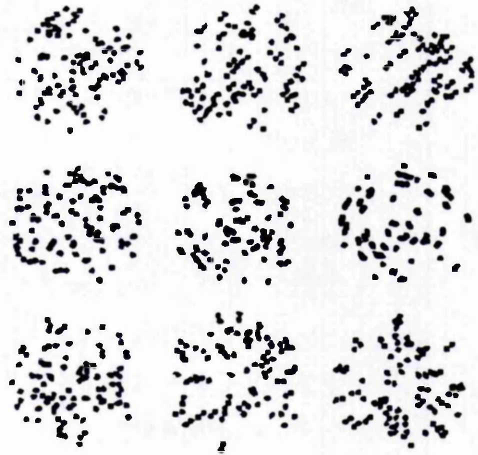

Figure 2.08. Stimuli used to assess the detection of Glass pattern structures.

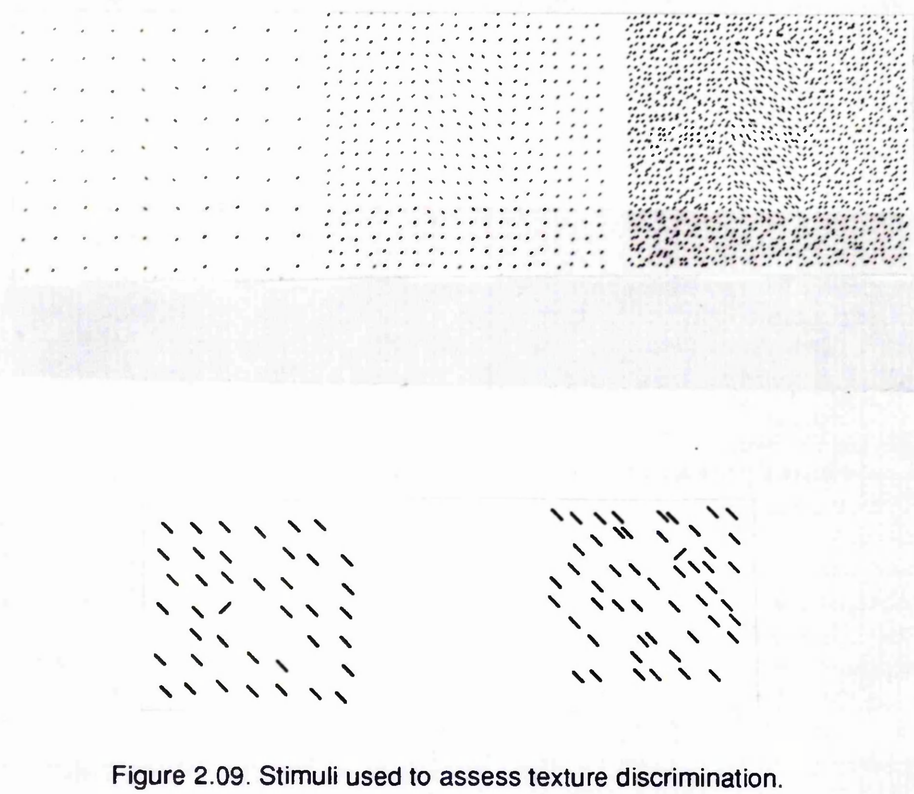

Figure 2.09. Stimuli used to assess texture discrimination.

described this process as 'alerting' and suggested that a design for machine vision 'would form some crude evaluation of everything in sight and draw attention to any unusual or suspicious manifestations'.[31]

Easy detection of regularity caused Gombrich to declare that 'we have a tendency to probe both the real world and its representations with a hypothesis of regularity which is not abandoned unless it is refuted', and 'that our visual system is attuned to the detection of spatial regularities'.[32] Popper wrote, 'It was first in animals and children, but later also in adults, that I observed the immensely powerful need for regularity - the need which makes them seek for regularities'.[33] Fantz, in his study of vision in young children, noted that 'visual patterns were discriminated by infants during the first six months'.[34]

A straight line of regularly placed dots can be seen even when surrounded by random placements of other dots, or 'noise'. This shows that, while simple configurations of regular spacings are easiest to detect, regularities can be detected even when heavily obscured (figure 2.08).[35] This makes the designing of 'random' patterns difficult.[36]

2.08. Order

Arnheim stated that 'order is a necessary condition for anything the human mind is to understand. Arrangements . . . are called orderly when an observer or listener can grasp their overall structure and the ramification of the structure in some detail'.[37]

Mathematicians now suggest that complete disorder may be an impossibility and that 'patterns' are implicit in any large, seemingly random structure, such as a group of stars or a series of numbers generated by the throw of a die.[38] Arnheim

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[31] Watt, R., *Understanding Vision*, London, 1991, p.6.

[32] Gombrich, E.H., *The Sense of Order*, Oxford 1979. p.5.

[33] Popper, K.R., *Objective Knowledge: An Evolutionary Approach*, Oxford 1972, p.23.

[34] Fantz, L.F., *Pattern Vision in Young Infants*, The Psychological Record, 1958 vol.8 pp.43-7.

[35] Maloney et al. studied subjects' responses to Glass patterns, formed by translation, rotation, and dilation, and compared the changes in the discrimination of patterns as noise was added. They found it was still reliable, even when the number of noise dots was far greater than the number of dot pairs. Maloney, R.K., Mitchison, G.J., and Barlow, H.B., *Limit to the detection of Glass patterns in the presence of noise*, Journal Opt. Soc. Am. A4 2336-2341.

[36] A scattered spot pattern has to be highly ordered to achieve the effect of disorder (9.35 - 9.38).

[37] Arnheim, R., *Entropy and Art: An Essay on Disorder and Order*, London 1971, p.1.

[38] If 'the number of objects in a set is sufficiently large and each pair of objects has one of a number of relations, then there is always a subset containing a certain number of objects where each pair has the same relation'. Graham, R.L. and Spencer, J.H., *Ramsey Theory*, Scientific American 1990 July, pp. 80-85.

echoed this view, suggesting that disorder 'is not the absence of all order, but the clash of uncoordinated orders'.[39]

2.09. Repetition

The 'simplest form of design is that which depends upon repetition; for practically any unit spaced at regular intervals by its ordered arrangement will produce patterns.'[40] Patterns of early and 'primitive' art often have a highly repetitive and geometric nature, using forms 'of such rare occurrence in nature, . . that they hardly ever had a chance to impress themselves upon the mind'.[41] Gombrich argued 'that it is precisely because these forms are so rare in nature that the human mind has chosen those manifestations of regularity which are recognizably a product of a controlling mind and thus stand out against the random medley of nature'.[42]

Pattern can be seen as the imposition of order on chaos. But an over-emphasis on order can produce banality, and the term 'repetitive' is often applied to that which is seen as boring or monotonous.

2.10. Monotony

Gombrich applied the term 'redundancy' to the boredom induced by simple repetitive patterns, and 'when the expected happens in our field of vision we cease to attend'.[43] Here redundancy does not imply superfluous elements, but an ease of perception and understanding of the structure of a pattern.[44] The 'expected' implies a predictability in the overall structure based on the evidence of conspicuously repetitive elements.

The 'expected' can also relate to an awareness of form caused by the 'process of conditioning that comes from repeated exposure to a certain style'.[45] The recognition of pattern structure depends on the 'character of the pattern' and the 'practice of the viewer'.[46] If the expectation is complexity then simplicity can be

[39] Arnheim, R., *Towards a Psychology of Art*, California 1966, p.125.

[40] Glass, F. J., *Drawing Design and Craftwork*, London, 1920, p.90.

[41] Boas, F., *Primitive Art*, Oslo 1927, reprinted New York 1955, p.31.

[42] Gombrich, E.H., *The Sense of Order*, Oxford 1979, p.7.

[43] Gombrich warned against the 'identification of the simple with the probable and redundant'. Ibid, p.9.

[44] In communication theory the term 'redundant' refers to any predictable regularity. Arnheim also questioned the application of this theory of redundancies to patterns; 'it depends entirely on how much repetition is required by the visual nature of the total pattern. The effect and meaning of the single unit varies with the number of its repetitions'. Arnheim, R., *Entropy and Art: An Essay on Disorder and Order*, London 1971, p.17.

[45] Gombrich, E.H., *The Sense of Order*, Oxford 1979, p.102.

[46] Justema, W., *The Pleasures of Pattern*, New York, 1968, p.29 .

unexpected and stimulating. Hess pontificated that 'boredom is defined only by the viewer's span of interest, which in turn is defined mainly by his conventional expectations, . . . the banal can be a sign of the common, of the primitive, archaic and elemental, whence it might be just a step to the universal, to that intellectually winged simplicity which is the object and craving of all art'.[47]

2.11. Irregularities

Once a pattern is understood, no longer being an unusual or suspicious manifestation, the viewer is alerted by deviations from order. The discrimination of single differences in textual arrays has been the subject of many experiments (figure 2.09), and the conspicuousness of irregularities is related to their relative orientation and the array density.[48]

Morphet, describing Warhol's work, noted that 'repetition might be expected to intensify one's recognition of and familiarity with a given image. Yet it tends (as in the rows of cans and Coke bottles within single canvases) to bring out the differences of treatment rather than similarities of form', and 'the simplest differences become of absorbing interest'.[49]

2.12. Visual accents

Differences in texture, direction of pattern elements, breaks in continuity, and other irregularities act as visual accents. Patterns tend to work on two levels which correspond to Gibson's definitions of 'visual world' and 'visual field'. They usually contain primary and subsidiary visual accents. Primary visual accents are the dominant forms, noticed while scanning the pattern from a distance, and they determine the first impression.[50] Subsidiary visual accents are not always 'seen' at first glance, they are design details, detected on closer viewing. They may enhance or tone down primary accents.

'When nothing superfluous is included and nothing indispensable left out, one

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[47] Hess, T. B., *Barnett Newman*, exhibition catalogue, Tate Gallery 1972, p.34.

[48] Bergen and Julesz used an array of oblique lines with one randomly placed vertical line. Different orientations of the oblique lines were tested and it was found that detection was quickest when these lines were horizontal (at right angles to the random line), and slowest for orientations of below 30 degrees. Bergen, J.R. and Julesz, B., *Rapid discrimination of visual patterns*, IEEE trans. Systems, Man Cybernet 1983 SMC-13 857-863. Nothdurft produced comparable results for the detection of areas of lines having a different orientation from the background pattern of oblique lines. Nothdurft, H. C., *Sensitivity for structure gradient in texture discrimination tasks*, 1985 Vision Re. 25 1957-1968.

[49] Morphet, R., *Andy Warhol*, catalogue of the Warhol Exhibition, Tate Gallery 1971, p.10. Irregularities in Warhol's silk-screened images were produced by variations in paint density and intentional mis-registration.

[50] Wallpaper designs are usually chosen from a sample book. A common problem, when the paper is hung, is the appearance of unexpected strong diagonal lines.

can understand the interrelation of the whole and its parts, as well as the hierarchic scale of importance and power by which some structural features are dominant, others subordinate'.[51] Deregowski argued that 'the principles of organisation, which are a purely perceptual key to the nature of the design' are sought in pattern, rather than pictorial meaning.[52]

2.13. Primary accents

The dominance of visual accents depends on the viewer's previous experiences. If the structural characteristics of a pattern conform to the viewer's conventional expectations, they may be subordinate to other details, whereas other viewers may see the structural features clearly. Frequent exposure to a particular structural form will produce a 'perceptual skill that comes with familiarity and allows us to proceed from the overall form to the detail'.[53] This phenomenon explains a common problem for the designer who, involved with design details, finds it difficult to 'see' the overall structure.

'Patterns may be largely representative and their associations quite conscious . . . or they may be mainly abstract and appreciated more at unconscious level through either a personal association or a recollection or on a racial or universal unconscious level'.[54] A motif may appear dominant to a viewer for whom it is especially significant or unusual. Without such associations, it may become a subsidiary accent, thus altering the whole visual emphasis of the design. The concept of balanced design is therefore closely related to a commonality of stylistic and visual experience.[55]

2.14. Symmetry

The central axis becomes the focus of attention in an arrangement which exhibits bilateral symmetry.[56] This allows the arrangement to be seen as a

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[51] Arnheim, R., *Entropy and Art: An Essay on Disorder and Order*, London 1971, p.1.

[52] He likened the process of perceiving a pattern 'to that of solving a crossword puzzle, fascinating, and absorbing in detail but not normally yielding a cohesive all-embracing denouement.' Deregowski, J.B., *Distortion in Art: The Eye and the Mind*, London 1984, p.99.

[53] Gibson stated that the development of perception in babies 'seems to proceed from the seeing of gross differences to the seeing of fine differences', although he noted that it was unknown whether this was due to learning or to the growth of the optic nervous system. Gibson, J.J., *The Perception of the Visual World*, Cambridge, Mass. 1950, p.17.

[54] James, H., quoted by Conran, T., *Printed Textile Design,* London, 1957, p.30.

[55] Jones proposed that 'true beauty results from that repose which the mind feels when the eye, the intellect, and the affections, are satisfied from the absence of any want', and that repose resulted from the application of fitness, proportion, and harmony. Jones, O., *The Grammar of Ornament*, London 1856, reprinted London, 1987, p5.

[56] Because of their symmetry, Rorschach cards 'offer to the first glance a striking total picture, which is far from being unstructured,' Arnheim, R., *Towards a Psychology of Art*, California 1966, p.91.

cohesive unit, and minor deviations from symmetry are tolerated.[57] Very high discrimination of symmetrical placements of dots within random dot arrangements is found, even when positional errors are introduced.[58]

Decorative art has exploited the innate perceptual stability and cohesion of a single symmetrical unit, one of the oldest and most common pattern structures. But it is used rarely in painting; Hess asserted that 'for the lethal artificiality of its dicta, symmetry substitutes to related dangers: boredom (or banality) and oversimplicity. . . It was supposed to stiffen a composition, to kill its sense of spontaneity, naturalness, variety'.[59]

Repetition of a symmetrical unit destroys the uniqueness of the central axis, but the regularity of the pattern is emphasised by strong visual accents, created by the series of double axes, to produce a staccato effect.

2.15. Depth

Depth is implied in paintings through the relationship between the foreground, or frame, and the use of perspective, graduation in size of similar forms, and other visual cues. Similar techniques are sometimes used in geometric patterns to create undulation or other spatial effects.

A regular series of white squares on a black ground shows the spatial ambiguity associated with figure-ground effects; the white or black can be read as either background or foreground. When detail is added to the squares they become the dominant forms, but, although a slight emphasis can separate them visually from the 'background', the ambiguity is still evident (figure 2.10).

2.16. Movement

Terms implying movement or stasis, such as stability, instability, restlessness, and repose, are often applied to patterns. Certain shapes (triangles and acute-angled figures which imply perspective) are traditionally associated with dynamism. Gibson asserted that:

'certain features of the retinal image are preserved during a locomotor

[57] Gombrich suggested that the central axis attracts because 'it is the only area which, by definition, is not repeated in the array', and the viewer will 'receive the same sequence of messages . . . to the right or to the left of the axis. . thus having formed the preliminary hypothesis that this form of redundancy will prevail throughout, peripheral vision will rapidly confirm it'. He also suggested that this 'redudancy' of peripheral elements accounts for the apparent expansion of the field of vision induced by symmetrical arrangements. Gombrich, E.H., *The Sense of Order*, Oxford 1979, p.126.

[58] Barlow, H.B. and Reeves, B.C., *The versatility and absolute efficiency of detecting mirror symmetry in random dot displays*, Vision Res. 19 783-793.

[59] Hess, T. B., *Barnett Newman*, exhibition catalogue, Tate Gallery, London, 1972, p.34.

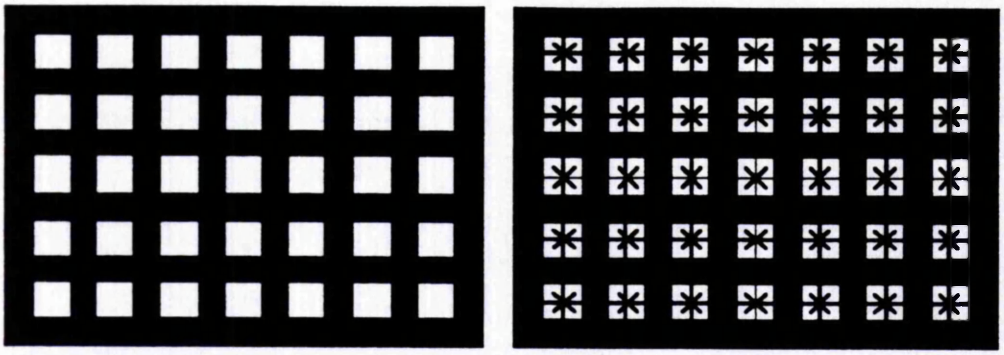
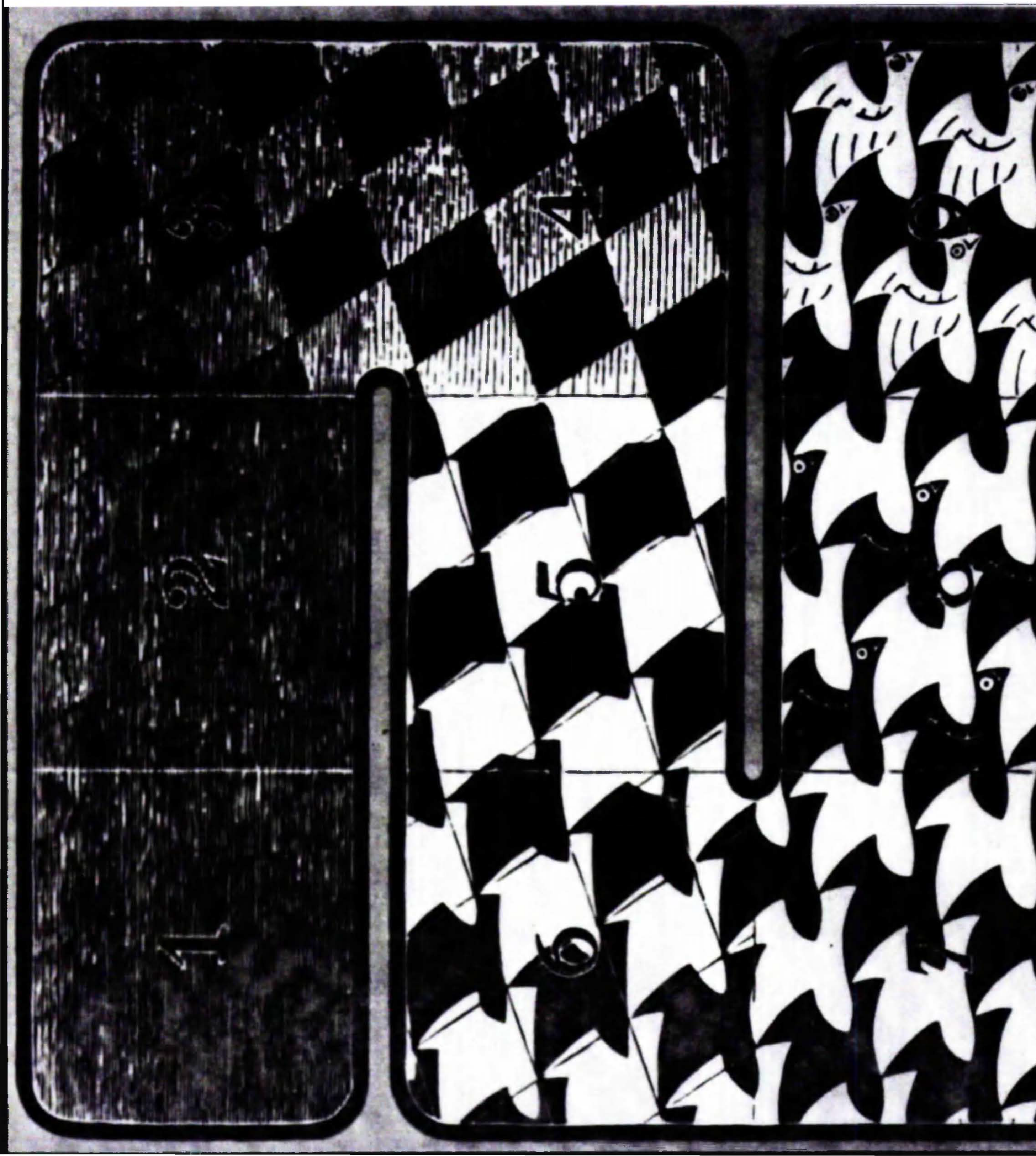


Figure 2.10. Adding detail to a pattern exhibiting a figure-ground effect emphasises forms which are then seen as the foreground.

Figure 2.11. Escher's regular division of the plane.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> transformation - order, continuity, points to points, and straight to straight lines - while other features are not preserved - angles, the congruence of shapes, and the metric properties of lines. The features that are preserved may be the mediators of a stable visual world and the features not preserved the mediators of the visual impression of motion'.[60]

Hogarth's idea of the line of beauty, 'that leads the eye a wanton kind of chase', supposed that the eye traces the outlines of shapes.[61] Studies of saccadic eye movements demonstrate that the sequence of fixation points is random, with each on an object of interest, or visual accent.[62] Further, Buswell noted that the eye's fixation point moved over the image by irregular jumps and zig-zags that had no simple relationship with the image.[63]

2.17. Restlessness

'Busy' patterns, designs containing many visual accents, evoke a sensation of restlessness because of their complexity, but simple, ambiguous patterns (2.05) can produce the same sensation. Gombrich cited the 'chequerboard pattern' as an example of this perceptual instability, created by alternate groupings of black and white diagonal lines and crosses.[64] This pattern's ambiguity was exploited by Escher in works based on *the regular division of the plane* (figure 2.11).[65]

Examples of interlocking geometric patterns can be found from many different sources, but Escher used recognisable motifs, such as fish, birds, and butterflies, laying great emphasis on outline to stress ambiguity. 'A contour line between two interlocking figures has a double function . . . On either side of of it, a figure takes

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[60] Gibson, J.J., *The Perception of the Visual World*, Cambridge, Mass. 1950, p.154.

[61] Hogarth, W., *The Analysis of Beauty*, London 1753, pp. 38-9.

[62] Photographs of eye movements have recorded the changes in fixation points detected during a subject's viewing of an image. Dodge, R., *Five types of eye movement*, American Journal of Physiology 1902, 8, pp.307-329.

[63] Buswell, G.T., *How People Look at Pictures*, Chicago 1935.

[64] 'Test the field for continuities of colour, and the diagonal rows of black or white squares will dominate the impression. Focussing on a white square and regarding it as a centre of a black cross', and vice-versa, 'you can test the field for redundancies and see that there is no contradiction'. The other grouping, he noted, was a black or white quincunx. Gombrich, E.H., *The Sense of Order*, Oxford 1979, p.131.

[65] Two sets of parallel lines act 'as guides for the division of the plane', forming a series of parallelograms, each of which was modified, using the principles of 'translation', 'axles', or 'glide reflection', to make a series of interlocking motifs. He stated that this regular division was complete 'only when all congruent figures fulfil the function of 'object'', as in the chequered pattern, where 'background and figure take turns changing functions.' Escher, M.C., *Escher on Escher*, edited by Wilson, J., New York 1989, pp. 94-8.

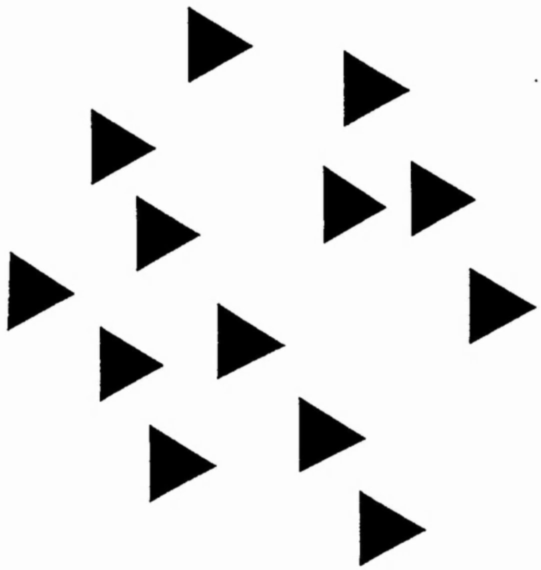
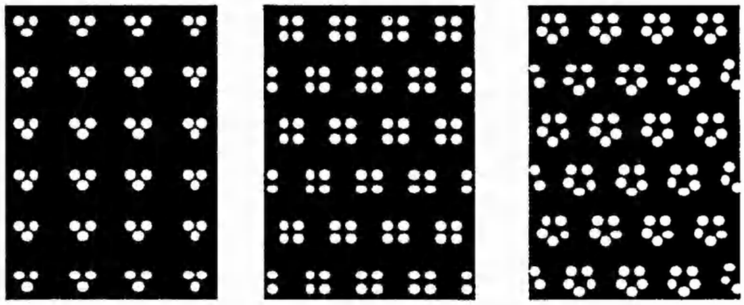


Figure 2.12. A group of triangles in which directional changes appear to occur spontaneously.



(a) (b) (c)

Figure 2.13. Patterns exhibiting alternative directional emphases.

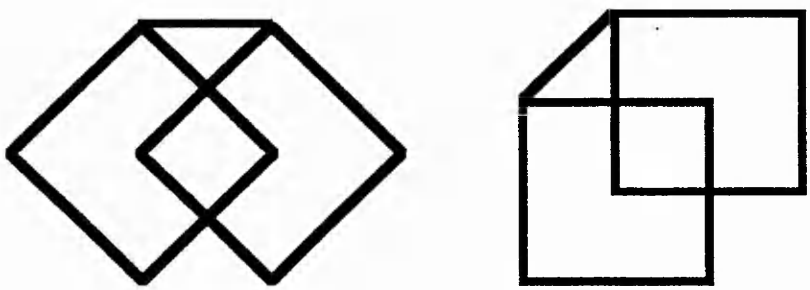


Figure 2.14. The effect of a change in orientation on the perceptual stability of a symmetrical figure.

shape simultaneously'.[66] Like Rubin's vase illusion, the perceptual hypothesis is formed by the silhouette, and any added details are subsidiary data that reinforce it.

2.18. Direction

Patterns are often described as having direction,[67] and a feeling of directional movement may be produced by a group of elements which all 'point' in the same direction. For instance, a group of equilateral triangles, having the same orientation, produces an effect where all the triangles appear to change direction spontaneously (figure 2.12), and three separate hypotheses can be made, with perception continuously switching between them.[68] Christie used an illustration of dots, arranged in groups to form patterns, which produced a similar effect (figure 2.13); 'the eye instinctively takes up vertical, horizontal, or diagonal sequences, as it pleases'.[69]

Arnheim stated that 'all visual patterns possess inherent movement, essentially following the direction of their axes',[70] and Gibson argued, 'we may infer that there is a visual vertical-and-horizontal frame of reference which is linked to gravity'.[71] An orientational change of a symmetrical figure, as illustrated by Deregowski (figure 2.14), can give the effect of asymmetry because symmetry is usually seen in relation to the horizontal or vertical axis, and depth illusion is created by 'reading' perspectival depth cues which, to the Western eye, exert a stronger influence than symmetry.[72]

2.19. The carpentered world

Visual perception is a multi-layered experience which is shaped by the environment in which the individual develops. Industrial society is a 'carpentered world', and the formative visual experiences of order this produces may be an important factor for pattern perception. For example, people may be more attuned to the horizontal and vertical structures that predominate in this type of

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[66] Ibid, p. 32.

[67] Meyer described rosette bands as either 'current' (with a definite direction sideways) or without direction (symmetrical). Meyer, F. S., A *Handbook of Ornament*, London 1894, reprinted London 1987, p.142.

[68] Attneave, F., *Multistability in perception*, Scientific American 1971 225 63-71.

[69] Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, p. 34.

[70] Arnheim, R., *Towards a Psychology of Art*, California 1966, p.98.

[71] Gibson, J.J., *The Perception of the Visual World*, Cambridge, Mass. 1950, p.33.

[72] Deregowski, J.B., *Distortion in Art: The Eye and the Mind*, London 1984, p.66.

environment.[73] Gombrich and Boas (2.09) observed that 'primitive' patterns contrasted with the environment. This suggests that the contemporary antipathy to highly structured patterns results from a reaction to ordered surroundings.

Today, pattern is seen as decoration or ornamentation, but Christie argued that the 'word "ornament" puts undue stress on decorative attributes, qualities which acquired so long ago an importance they did not always possess that they now seem to be the essential purpose of all design'.[74] However patterns must not be seen purely as reactive or as deliberate expressions of significant concepts, now they must also be seen as the outward manifestations of an underlying consciousness of the human relationship with the natural world.

2.20. Changes of view

Scientific development in the 19th century created a shift in consciousness which altered perception. Seeing the landscape from different viewpoints, such as from a train, with a rapidly changing succession of images, or from a height, were important factors in this shift. Hughes commented that the view from the top of the Eiffel Tower presented 'a new type of landscape' that 'began to seep into popular awareness', and this different 'way of seeing was one of the pivots of human consciousness'.[75] In the 1890's, modern art was already exploring flat, patterned space, and was influenced by other 'ways of seeing', but this new perspective 'opened the eyes' of ordinary people.

Photography created an awareness that painting was not strictly representational, but also interpretive.[76] Painting became a means of expressing individual perceptions, and artists began to explore *how* we see, as much as *what* we see.[77] Usually scientific theories are not applied directly by artists, but they encourage a general awareness of alternative visual languages and a climate of

[73] Evidence of subjects' susceptibility to depth illusions is used to support this. Such illusions 'work' in reference to a visual framework based on the perspectival model. When comparing interpretations, there is inherent danger of confusing differences in visual language with differences in actual perceptual ability (2.04).

[74] Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, p. 3.

[75] Hughes, R., *The Shock of the New*, London, 1980, p.14.

[76] This was noticeable especially in portrait photography which, 'in spite of the beautifying effect of retouching, contradicted some of the stereotyped views of personality, and for the first time people were able to examine expression in detail. They were also faced with a new form of portrait, which was no longer intended as a summary of career, character, and social standing, a monument for future generations'. Powell, T., in *'From today painting is dead': The Beginnings of Photography*, exhibition catalogue, London, 1972, p.9.

[77] Photography stimulated further research in optics and visual perception. Richard Jung stated that, although 'it may be useful for the artist to know some of the principles of vision and their possible applications to the visual arts, the relevance of physiological laws to the visual arts and to aesthetic values is limited'. Jung, R., on Art and Visual Abstraction in *The Oxford Companion to the Mind*, Oxford, 1987, p. 46.

visual exploration which eventually affects design at a wider level. Oeri suggested that artists' approach at this time was 'similar to that of contemporary physicists', because it used reductive processes that entailed breaking down matter 'until it revealed the essentials - energies, forces, light, structures, and forms'.[78]

Scientific developments have continued to provide new ways of looking at the world, giving micro and macro views that allow new comparisons and fresh perceptions of nature itself. The pattern seen in a detail from a Mandelbrot set fractal (figure 2.15) 'can also be seen in Nature: a developing nerve cell in the brain; the Mississippi delta in Louisiana; and the veins of chloroplasts of a grape-vine leaf'.[79] Barrow commented that sometimes mathematicians 'must seek new mathematical patterns to further the understanding of Nature . .' and that research '. . has revealed new areas of mathematics illuminated by the brilliance of the logical consistency of the interwoven forces of Nature'.[80] The study of pattern formation in nature is now a 'scientific specialty in its own right', and the investigation of 'the delicate tension between order and disorder' seems likely to produce a changed understanding and perception of pattern construction.[81]

Contemporary multi-media formats of television, video, and teaching materials form a multi-tasking environment which, to the inexperienced, creates an exhausting assault on the senses. Multiple layers of moving images and text are commonly used for computer games and media for the youth market.[82] When similar collage techniques are applied to static designs they can produce *busy* effects which, due to their unstructured and unpredictable character, often seem monotonous and chaotic.[83] Individuals growing up with this mixed-media onslaught may develop a selectivity of perception which might become a new way of seeing. Although at present we may be too close to see what is happening, there may be a developing commonality of visual and stylistic experience in which this seeming chaos will be understandable.

[78] Oeri, G., *Man and his Images,* London, 1968, p.19.

[79] Lecomber, T., *Antichaos & the Science of Complexity,* London, 1992, p.11.

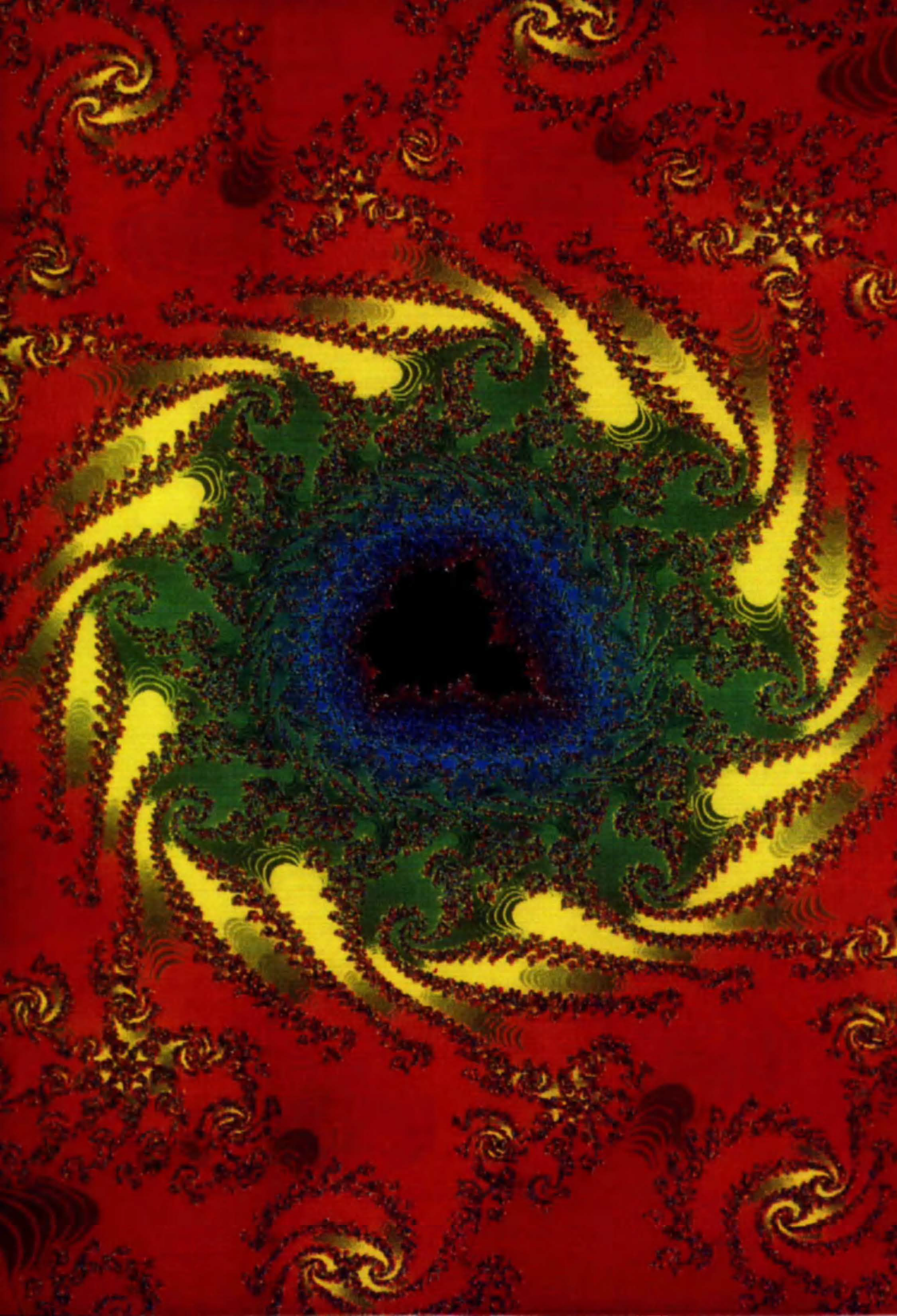
[80] Barrow, J., *Counter Culture,* The Guardian, October 21, 1993, p.12.

[81] 'The laws of pattern formation seem to govern snowflakes as well as microscopic crystals in metal alloys, the banding of underground gneiss as well as the slow diffusion of lichen across a rock surface'. Gleick, J., *Nature's Chaos,* London, 1991, p.30.

[82] This is reflected in youth clothing, particularly for the rave market (6.19).

[83] Designs using collages of images with multiple associations have been a major theme in the 1980's (8.13, 8.20 and 8.22).

Figure 2.15. A fractal derived from the Mandelbrot Set.



CHAPTER 3: PATTERN CLASSIFICATION

3.01. Classification

Classification is the attempt to produce a methodical framework in which things can be grouped according to selected similarities. Classification systems differ in the models on which they are based, often reflecting the intellectual and scientific hegemony.[1] There is always an ulterior motive for classification[2] which affects the selection of the characteristics used to define classes.[3]

Systems are generally based on a hierarchical structure, with primary and subsidiary classes reflecting degrees of relationship.[4] Individual classified items often share characteristics other than those on which the classification was based and by classing these together further information concerning associated items may be extrapolated or inferred.

The structure of the system determines the naming of individual items within it, and the purpose for which the classification is needed influences the precision with which an item is named.[5] Taxonomy depends on distinguishing 'homology (informative sameness) from analogy (misleading sameness)',[6] but systems that are not based on the evolutionary model, such as cladistics, demand 'explicit decisions on what are to be accepted as valid homologues'.[7] If the selection of characteristics is altered, then items will be classified and named accordingly.

Categories for anthropological, historical, or theoretical design systems may be

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[1] Some were based on the Linnaean model of genera, classes, and orders, attempting to apply systematic order during an era of design eclecticism (3.11). Darwinian theories prompted an evolutionist approach based on tracing the development of 'species' of motifs in patterns (3.07). Principles derived from crystallography stimulated the structural analysis of designs and the classification of patterns by mathematical notation (3.15).

[2] John Ray (1627-1705), who formulated the basic principles of plant classification, started his study with 'the intention of proving the Wisdom of God . . . by demonstrating how perfectly fitted creatures were for their environment'. Radford, T., *God = 10^{-43},* Impact, Autumn 1992, p.49.

[3] Linnaean classification of plants is 'a simple - but highly artificial - system based on the number of styles and stamens in the flower'. Its popularity was due to 'Linnaeus' substitution of the "binomial" (or "biverbal") method of naming plants for the cumbersome "polynomial" (or "multiverbal") method in use before him'. Gilmour, J. and Walters, M., *The New Naturalist: Wild Flowers,* London, 1962, p.17.

Although Linnaean classification was based on visual evidence, the categories and the relationships between classes have since been confirmed by genetic research.

[4] Taxonomic hierarchies are based on the evolution of groups of organisms. If knowledge of the evolution of a group is lacking, taxonomy can be based on structural or other similarities.

[5] For example, organisms, such as the house mouse, can be classified by class (Mammalia), sub-class (Rodentia), genus (Mus), specific name (Mus Musculus), or common name (mouse).

[6] To the evolutionist, homologies 'are seen as evidence of common ancestry, so that the hierarchy reflects real historical relations'. Patterson, C., in *The Oxford Companion to the Mind,* Oxford, 1987, p. 235.

[7] Cladistics is a system for classifying organisms, but is not necessarily associated with evolutionary sequences. The term 'clade' is used for a characteristic that can be used as a unit for defining classes and establishing hierarchies. The method can be applied to disciplines other than biology. Patterson, C., *Cladistics,* Biologist, 27, 1980, pp.234-40.

strictly defined. Categories for practical applications, such as presentation of design sources, are generally more flexible and, motivated by the need for accessible arrangements of material, have changed as more or different sources have been included.[8]

Patterns having the same provenance and types of motifs are generally assumed to be similar, as in; 'Three patterns formed of spiral units. From draperies represented in Attic vase-paintings. 6th century B.C' (figure 3.01).[9] Different classifications could distinguish the individual patterns according to specific motifs, visual format, or structure. Four main types of pattern classification system can be distinguished by the characteristics selected for the categories. Some systems combine these and others use different characteristics to define subsidiary categories.

Provenance	-historical and cultural origins	(3.02 - 3.05).
Imagery	-types of motifs, or pattern elements	(3.06 - 3.09).
Visual format	-effects produced by arrangements of pattern elements	(3.10 - 3.13).
Structure	-the arrangements of pattern units	(3.14 - 3.16).

3.02. PROVENANCE

Cultural classification gives primacy to the place of origin. Ancient patterns are generally defined by their place of origin, although names are usually associated with distinctive styles and particular periods in history.[10] Historical classification uses the date and place of a pattern's manufacture, but the stylistic similarities of patterns having the same provenance are important for dating. Meyer suggested that such classification was a 'convenient method of labelling'.[11] It does, however, give broad categories of time and place within which subclasses can be specified according to visual characteristics.

European patterns from the 12th century onwards are often defined in stylistic

[8] This has reflected changing design influences and the selective interpretation of characteristics (3.03).

[9] This caption does not describe or distinguish the patterns created by the three different arrangements of the 'spiral units'. Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London, 1969, p.64.

[10] The terms *Greek* and *Egyptian* generally refer to historical periods not the contemporary designs of the countries. For example, *Egyptian* commonly refers to patterns of Ancient Egypt, and reference to a century or dynasty is sometimes added. Terms, such as *chinoiserie* and Arabian, relate to general cultural influences which have been imitated and absorbed by European designers at various times.

[11] Meyer, F.S., the introduction to A *Handbook of Ornament*, London, 1894, reprinted 1987.

terms which relate to historical periods or country of origin.[12] Historians are now classifying changes within and between major historical periods. Styles, such as baroque and rococo, influenced all areas of design, but variations occurred within different disciplines. These are often only recognised by specialists in particular fields, and are usually defined by descriptive terminology.[13]

3.03. The problem of style

Because many systems rely on subjective judgment, distinctions between classification and stylistic terminology are hard to draw. Styles are characterised by their predominant combinations of form, line, colour, imagery, visual format, and spatial organisation.[14] The combinations of characteristics exhibited in particular eras, or movements within them, create a form of collective individuality. Meyer acknowledged this when he defined style as 'the peculiarities which arise from the reciprocal relation of material, form, and aim, more or less modified by the ideas of the Age and the natural characteristics of the Nation'.[15]

New styles never arise independently, they emerge in a continually changing design climate, synthesising contemporary styles and current influences.[16] Where they begin and end cannot be defined exactly, usually a transition or overlapping occurs. For classification purposes, definitive characteristics have been selected

[12] The term Gothic is applied to European designs from the 12th to early 16th century. Terms, such as early, high, or late are often applied to indicate more specific periods. There were strong regional variations, and so the country of origin can be used to distinguish stylistic variants. European printed textiles of the 12th to 14th centuries can be categorised as German (from the Rhine region) or International (from the rest of Europe, but predominantly Italian). Both were block-printed, but exhibited stylistic variations because of differences in printing and engraving processes, materials (5.05), and the economic factors influencing their production (1.02). Biriukova reflected the contemporary view that 'specimens can be divided into two fairly distinct groups'. Biriukova, N., *West European Printed Textiles: 16th-18th century,* Moscow, 1973, p.15.

[13] In relation to textile designs for dress between the late 1690's and early 1740's, 'historians distinguish a succession of phases which have required separate nomenclature - *bizarre, luxuriant, lace-patterned, naturalistic,* and *floral rococo* - in a period normally recognized as containing only a gradual transformation between the late baroque and early rococo'. Newton, C., and Young, H., in *Designs for British Dress and Furnishing Fabrics,* Victoria and Albert Museum, London, 1986, p.7..

[14] Spatial organisation is important in determining the provenance of patterns produced from the same motifs, materials, and techniques; 'most periods and/or people have their own sense of spacing'. Justema, W., *The Pleasures of Pattern,* New York, 1968, p.34.

[15] Meyer, F.S., the introduction to A *Handbook of Ornament,* London, 1894, reprinted 1987.

[16] Lewis and Darley's definition of Art Deco listed a variety of factors; 'the linear ornament of some Arts and Crafts designers, . . the sinuous interlacings of the Celtic Revival, the serpentine line of Rococo, the asymmetry of Japanese design and, above all, the strong return to naturalism prompted by the Gothic Revival coupled with the Symbolist fascination with the forms of nature. Apart from the consistent asymmetry, the vocabulary varied: stems, roots, elongated blooms and foliage, dream-like figures of women with half-closed eyes and drifting hair, set among undulating lines and whiplash curves or surrounded by entwining plant forms'. Lewis, L., and Darley, G., *Dictionary of Ornament,* 1990, p.39.

from a style's 'height'; that is, when it was most different from previous, later, or other current styles. This has enforced the concept that historical periods and cultures had very distinct styles and denied the extent of cross-cultural influences.[17]

3.04. Pattern books

Since the 15th century, styles have been increasingly well documented as the development of printing stimulated the production of written and illustrated material. The earliest known pattern book was published in 1523,[18] and similar publications, ranging from collections of loose engraved sheets to expensive folio editions, disseminated contemporary styles.[19]

The 18th century saw the development of imitative eclecticism inspired by a growing interest in historic and exotic designs, and this stimulated a demand for publications drawn from wider sources.[20] For instance, Darly included Gothic, Classical, and Chinese ornament applied to contemporary styles,[21] and Pillement published collections of *chinoiserie* and rococo designs.[22] These authors identified a wide audience and increased the cross-disciplinary stylistic dissemination.[23] During the early to mid-19th century, a scholarly approach was adopted in the presentation of source material. Engraved illustrations of archeological sites were published,[24] and distinctions were made between the styles of different periods and

[17] The extent of early cultural intermingling is only now being recognised (1.01).

[18] This book of embroidery designs showed a strong Islamic influence, Schönsperger, J., *Furm oder Modelbüchlein,* Augsburg,1523. It was reproduced in Italian by Tagliente, G. A., as *Essempio di recammi,* Venice, 1524, and in various other European languages. Schönsperger produced two more books which were similarly translated.

[19] Many books on architecture, needle-point, bobbin lace, embroidery, and other crafts were published from the 16th century. These spread styles (6.19) and production processes (6.02) between countries.

[20] The Picturesque taste derived from early eighteenth century romanticism and led to mixtures of historic and exotic styles (1.05 and 6.07). A growing interest in archeology was reflected in the depiction of ruined classical architecture in the decorative arts.

[21] Matthias Darly was the first author to include Gothic Revival designs in *A New Book of Chinese, Gothic and Modern Chairs* (1751). His *A New Book of Chinese Designs* (1754) was influential in the development of the *chinoiserie* style, and *A New Book of Ornaments in the Present (antique) Taste as now used by all Professions* (1772) was based on historic, mostly Classical, designs.

[22] Jean Pillement published many books of *chinoiserie* designs in the 1750's, including *A New Book of Chinese Ornaments* (1755), and of floral designs in the 1760's. Most were published in Paris and London, and he greatly influenced the use of pictorial imagery in printed textiles (6.19).

[23] Darly described his *The Ornamental Architect or Young Artist's Instructor* (1770) as 'essential to . . Architects, Painters, Engravers, Carvers, Stucco-workers, Potters, Ironsmiths, Silversmiths, Founders, Embroiderers'-pattern-drawers, . .' and many others. Pillement's designs have been identified on a wide range of different products, including porcelain, furniture, and textiles.

[24] Excavations at Pompeii, started in 1755, prompted publications, like *Pompeiana; the Topography, Edifices and Ornaments of Pompeii,* Gell, W. and Gandy, J.P., (1817-19) and *Voyages dans la basse et la haute Egypte,* Denon, D.V., Paris, 1802 and London, 1803. These generated popular interest by showing ornamental details and domestic utensils.

cultures, rather than terming them merely as 'antique' or 'exotic'.[25]

Later 19th century European publications tended to group foreign patterns according to wide historic or cultural origins. In 1856, Owen Jones's stated aims were 'to select a few of the most prominent types in certain styles closely connected with each other, and in which certain general laws appear to reign independently of the individual peculiarities of each'.[26] *The Grammar of Ornament* was arranged in chapters such as 'Savage Tribes', 'Egyptian Ornament', and 'Elizabethan Ornament'. He subdivided these into sections, depending on the type of design, method of production, or end use.[27] Jones regarded styles as expressions of separate cultures which outside influences, or 'borrowed styles', could debase. His opinions reflect a dissatisfaction with the 'copying' prevalent at the time.[28]

The late 19th and early 20th centuries saw many similar broad publications,[29] some of which attempted to draw links between cultural styles of antiquity.[30] Others dealt with specific historical periods, cultures,[31] or areas of design,[32] generally showing the most distinctive types of design from selected sources. These choices reflected contemporary taste and the author's personal interests. Less typical designs and those thought to be unappealing were usually ignored, but this

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[25] These were interpreted for design styles, such as *Grecian* and *Pompeian* (6.16).

[26] Jones, O., *The Grammar of Ornament*, London 1856, reprinted London 1987, p.1.

[27] Each chapter is organised in an individualistic manner, giving no coherent structure to the subdivisions. For example, Moresque Ornament is divided into interlaced ornaments, spandrils, lozenge diapers, square diapers, and mosaics; Byzantine into carved ornament, painted ornament, and mosaics.

[28] Jones suggested that Assyrian ornament 'must have been a borrowed style, or the remains of a more perfect form of art yet to be discovered. We are strongly inclined to believe that the Assyrian is not an original style, but was borrowed from the Egyptian, modified by the difference of the religion and habits of the Assyrian people'. Ibid, p.28.

[29] Racinet covered a similar range of periods and cultures as Jones. Racinet, A., *Deuxième Série de l'Ornement Polychrome,* Paris, 1885, reprinted as *The Dictionary of Ornament,* London, 1990.

[30] Speltz studied designs from ancient Peru through to 18th century German porcelain. His text emphasised the evolutionary approach of the 1890's (3.07). Speltz, A., *Das Farbige Ornament aller Historischen Stile,* Leipzig, 1915, reprinted as *The History of Ornament,* New York, 1989.

[31] Audsley, G., *The Ornamental Arts of Japan*, London, 1882-84. Audsley, G. and W., *Polychromatic Decoration as Applied to Buildings in the Medieval Styles*, London, 1882.

Prisse d'Avennes, A., *L'Art Arabe d'apres`les monuments du Kaire depuis le VIIe siecle jusqu'a la fin du XVIIIe siecle*, Paris, 1869-77, reprinted in part in *The Decorative Arts of Arabia*, London, 1989.

Jones, O., *The Grammar of Chinese Ornament,* London, 1867, reprinted London, 1987.

[32] Dupont-Auberville, M., *L'Ornement des Tissus*, Paris, 1877, printed in English as *Ornamental Textile Fabrics*, London, 1877, reprinted as *Classic Textile Designs*, London, 1989.

Silver, A., *The Silvern Series,* London, 1889. A publication of photographic reproductions of historic textiles from the Victoria & Albert Museum.

restricted appreciation of the sources' stylistic range.[33]

The popularity of encyclopaedic publications declined with the introduction of illustrated art journals.[34] Although early 20th century styles still derived from eclectic sources, the style of the derivation was marketed more than the original. New types of pattern books illustrating Art Nouveau [35] and Art Deco designs were produced to meet the burgeoning demand for fashionable new designs.[36]

3.05. Contemporary sources

The need for 'quick response' to changing market orientations makes the active seeking of influences a necessary function in the design process. This quest is reflected by fashion forecasting companies,[37] magazines, and periodicals.[38] There has been a resurgence of interest in design source books as well, and many 19th century publications have been reprinted since 1987.[39] Publications concerning contemporary, historical, and cultural design proliferate and are becoming more specialised.[40] Contemporary publications differentiate periods within the history of particular cultures, giving a greater range and understanding of their design styles.

The increased storage capacity of CD-Rom technology has provided a design

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[33] Audsley suggested that the Fret 'is commonly believed to belong exclusively to Greek Art, and in most works of ornament it is confined to that school, but by looking over a collection of Greek Frets, the student can gather partial information only regarding the subject Fret ornamentation, and he is not made aware of the fact that the Greeks were not the first or only people who used it'. Audsley, W. and G., *Outlines of Ornament in the Leading Styles*, 1882, reprinted as *Designs and Patterns from Historic Ornament*, London, 1968.

[34] Journals, such as *The Studio*, published in London from 1893, *Art et Decoration*, Paris from 1897, and *Die Jugend*, Berlin from 1896, had international circulation and led to new styles being adopted quickly by a widening readership. International and gallery exhibitions also aided dissemination.

[35] Such as Beauclair, R., *Dessins d'Ornementation plane en couleurs*, Paris 1900, reprinted as *Art Nouveau Patterns and Designs*, London, 1988.

[36] These usually contained the work of individual designers who chose this folio form 'in order to present their own ideas in an attractive manner and as a specific artistic statement'. Stephen Calloway, introduction to *Art Deco Designs*, London, 1988, reprinted from Benedictus, E., *Variations quatre-vingt-six motifs decoratifs en vingt planches*, Paris, 1926, and *Relais quinze planches donnant quarante-deux motifs decoratifs*, Paris, 1930.

[37] Fashion forecasting companies, by publishing trend 'predictions' for designers and manufacturers, supply a constant flow of ideas and influences for the fashion and textiles industries (6.01).

[38] Periodicals concerning decor, furnishing, and fashion had been in existence since the early 19th century, but their number and circulation grew rapidly at the start of this century. In the 1950's, a wider range of publications appeared featuring contemporary design from a general to a specialist level.

[39] *L'Ornement des Tissus* was first published 'when the interest in historic ornament was at its height' and had great appeal because British textile design in the second half of the 19th century was 'characterised above all by the revival of interest in historic patterns and by their imaginative reworking in the creation of new designs'. Harris,J., in the foreword to Dupont-Auberville, M., *Classic Textile Designs*, London, 1989, reprinted from *L'Ornement des Tissus*, Paris, 1877, printed in English as *Ornamental Textile Fabrics*, London, 1877.

[40] Modern publications tend to be concerned with particular techniques or periods and give a more detailed examination of the whole range of design types within specific eras. Allen, J., *The Designer's Guide to Samurai Patterns*, London, 1990, is one of a series of books covering specific periods of Japanese design.

source which is ideal for the present climate of revivalism and increasing CAD usage. Libraries of digitally stored images will allow easy access to source material which can then be modified and output in new forms.

3.06. IMAGERY

Categorising patterns according to dominant types of imagery can be seen as another convenient labelling method. Different categories have been used in classification systems intended for anthropological or design applications, and because images have multiple associations they can often be classified under various headings.

3.07. Evolutionary model

Although Owen Jones had implied the continuous development of design styles and motifs, his opinion that 'borrowed styles' exhibited a 'corruption of taste' was common until the 1880's.[41] Anthropological research into pattern evolution developed towards the end of the 19th century in an artistic climate which regarded realism as the highest art form and abstraction as either primitive or degenerate.

Designs were classified according to types of motifs or design elements.[42] Collingwood suggested that 'a limited number of typical motives' derived from symbols were 'the bases of all ornament'.[43] Wornum distinguished between 'aesthetic' and 'symbolic' ornament.[44] These distinctions are the bases of two conflicting theories concerning the origins of abstract patterns; that motifs evolved from processes (elaborations of patterns produced by weaving and plaiting) and were essentially geometric, or they developed from symbols (originally

[41] The Renaissance, 'abandoning the so-called Gothic style, revived classic art and borrowed its models from it. Thus reappeared those acanthus volutes . . . artistic designers of ornamental textiles alone resisted the general contagion, long refusing to adopt this motif in their patterns'. Dupont-Auberville, M., *L'Ornement des Tissus*, Paris, 1877, printed as *Ornamental Textile Fabrics*, London, 1877, reprinted as *Classic Textile Designs*, London, 1989, text accompanying plate 34.

[42] Previously, the occurrence of the same or similar motifs in different cultures and periods had been thought to be mainly coincidental. In an intellectual climate, influenced by Darwin's theories of evolution, some researchers now attempted to trace the evolution of certain motifs.

[43] He listed these motifs as the feather or tree, which he suggested originated from the date-palm, the zig-zag, symbolising water, and the triangle, or triquetra, symbolising 'the early mystic number and the triad of deities common to many religions'. Collingwood, W. G., *The Philosophy of Ornament*, London, 1883, p.12.

[44] 'We may term those styles symbolic in which the ordinary elements have been chosen for the sake of their significance, as symbols of something not necessarily implied, and irrespective of their effects as works of art, or arrangement of forms and colours. Those that are composed of elements devised solely from principles of symmetry of form and harmony of colour, and exclusively for their effect on our *perception of the beautiful* without any further extraneous or ulterior aim, may be termed aesthetic'. Wornum, R. N., *The Analysis of Ornament*, London, 1884, p.1.

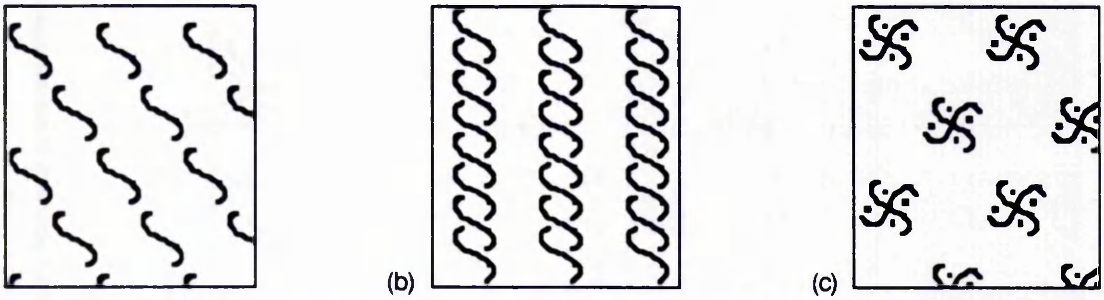

(a) (b) (c)

Figure 3.01. Three patterns formed of spiral units. From draperies represented in Attic vase-paintings. 6th century B.C.

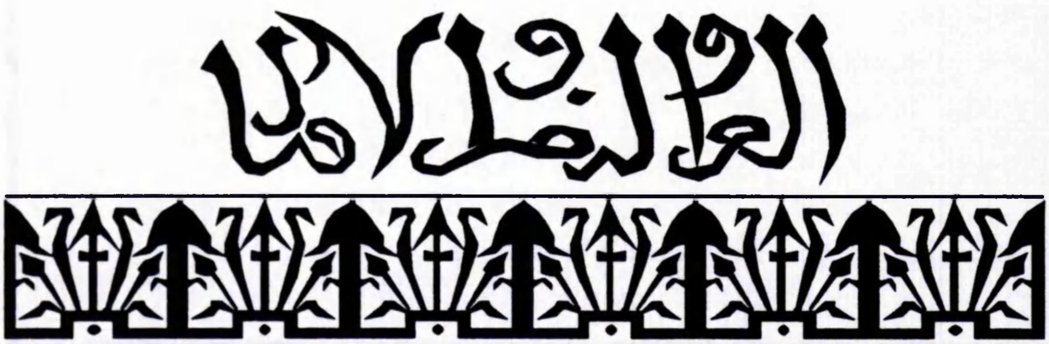
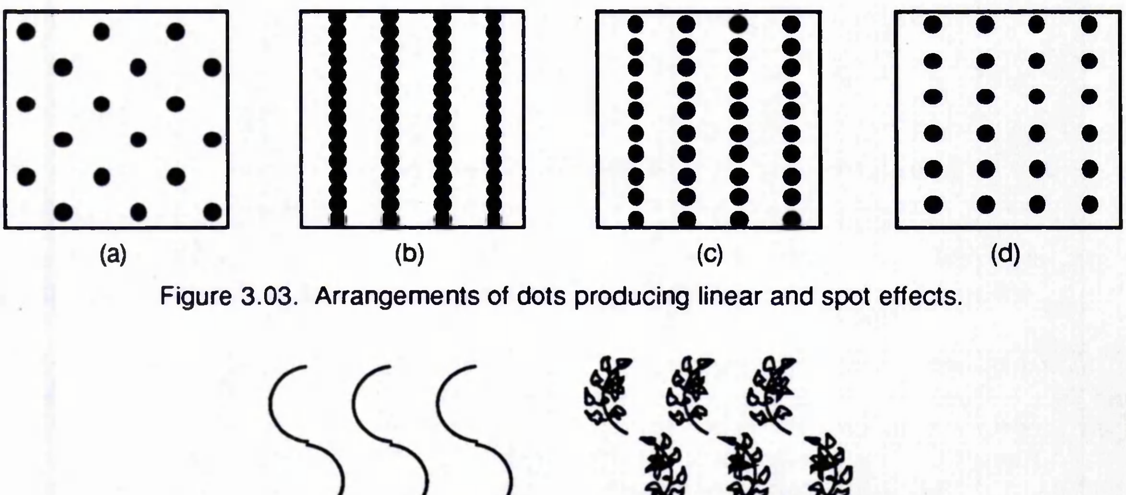


Figure 3.02. Arabic inscription and a derivative, European band pattern.



(a) (b) (c) (d)

Figure 3.03. Arrangements of dots producing linear and spot effects.

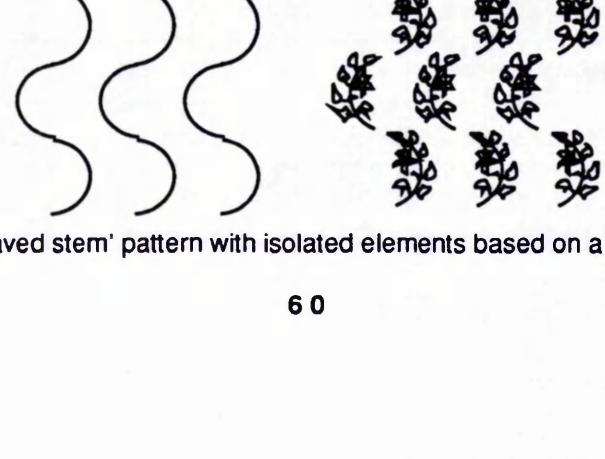


Figure 3.04. A 'waved stem' pattern with isolated elements based on a linear construction.

representations of real objects), and therefore any form of abstraction involved a degeneration from naturalism into decoration.[45] Riegl attempted to trace the continuous development of the Greek palmette motif,[46] and Goodyear, the development of the lotus motif.[47] Christie described the degeneration of Arabic script in Western imagery with reference to changes in the motifs' structure (figure 3.02).[48]

This evolutionist trend appeared in pattern analysis by the archeologist, Petrie; 'historic connections of design that can be traced, with due regard to place and period, give a strong presumption of a real connection between the designers'.[49] He categorised patterns in 'classes and families of arrangement', thus a class, such as the spiral, is subdivided into 'whorl', 'S form', 'tagged', and so on. The three spiral patterns (figure 3.01) would be classified as; (a) an S form of the spiral motif, (b) a continuous S form of the spiral motif, and (c) a swastika. The concept of pattern design as an evolutionary process has now been generally accepted; 'an infinite number of cognate designs, derived from a root idea, have been logically evolved, step by step'.[50]

3.08. Symbols

Highly stylised depictions of imagery, such as the rosette, are usually associated with specific structural forms.[51] These often have a symbolic value which has been largely forgotten in European art, and are generally used more for

[45] Collingwood argued that 'meaningless and wildly decorative creatures, as of Scandinavian art, are not primitive, but illustrate an age of decadence'. Collingwood, W. G., *The Philosophy of Ornament*, London, 1883, p.16.

[46] Riegl, A., *Stilfragen*, Vienna, 1893.

[47] Goodyear was interested in the symbolic significance of the lotus for the cultures in which it appeared. Goodyear, W., H., *The Grammar of the Lotus*, New York, 1891.

[48] Christie suggested that these, through successive copying by European weavers, degenerated into 'meaningless scribbles' because the original script was unintelligible to the copyists, but then 'instinctive desire for order . . . began to throw what remained of the Arabic letters into symmetrical form'. Then 'developing still further towards orderly appearance, eventually lost all semblance of script, and became a distinct type of pattern' with a symmetrical form. Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, pp.20-25.

[49] Petrie commented that the connections between the recurrence of motifs may have been caused by revivals and movements of people (the spread of empires, immigration, slavery, or trade connections). Petrie, F., *Decorative Patterns of the Ancient World*, London, 1930, reprinted, London, 1990, p.3.

[50] 'The slightest change in a pattern suggests others, either to be pursued at once by the same worker, or at some future time by another who might by chance pick up the thread'. Gombrich, E.H., *The Sense of Order*, Oxford 1979, p.87.

[51] The term rosette, a stylised symmetrical flower form, is also used for any circular ornament with elements radiating from its centre.

traditional than for symbolic associations.[52] Symbols appear as recurring motifs in cultures which place, or have placed, significance on them. They are important elements in the stylistic repertoire of that culture, even if their symbolic potency has diminished.[53]

New symbols constantly evolve, such as motifs incorporated in French and Russian Revolutionary prints which symbolised new political climates.[54] Highly stylised images (contemporary symbols) are found in most modern styles.[55]

3.09. Contemporary sources

Patterns are often classed according to representational, stylised, or abstract imagery, although distinctions between highly stylised images and abstract forms are often difficult to make. Categories vary according to changing trends, and other groupings occur.[56] Hierarchical structures can be created by subdividing classes. For example, pictorial and floral can be subclasses of representational imagery. Floral imagery can be divided into types such as rose or, again, into more specific types, such as cabbage and briar rose.

There are strong associations between provenance and imagery. For instance, floral designs are common to most sources, although their frequency varies greatly. Specific types, such as roses, occur in limited numbers, and particular depictions of roses are found only in a few styles or designs by certain artists.[57]

Within historical periods, there have been variations on popular themes which, because they exhibited specific stylistic characteristics, were usually named and

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[52] The 'original, simple, elementary forms have broadened into a rich stream of ornamental tradition' which generally, 'have lost not only their simplicity, but also their expressive power and symbolic meaning'. Smeets, R., *Signs, Symbols & Ornaments*, London, 1975, p. 11.

[53] Symbols can be seen as dominant design accents by viewers for whom they are significant (2.13), but they are often used purely as decorative elements when copied by later designers (6.07).

[54] French prints included motifs, such as 'the eye, as a symbol of enlightenment; the compasses, the level and the equilateral triangle, representing the equality of all men and justice for all . . . the tricolour ribbons and cockade'. Lewis, L., and Darley, G., *Dictionary of Ornament*, 1990, p.257.

Russian designers 'argued that clothing must present the Soviet man and woman as part of an international community (hence the "anonymous", abstract motifs devoid of local, ethnic images), that it must connect them with industrial civilization (hence the geometric or mechanical motifs), and that it must symbolize emancipation and mobility (hence the frequent application of kinetic forms)'. Bowlt, J.E., in the introduction to Yasinskaya, I., *Soviet Textile Design of the Revolutionary Period*, London, 1983, p.5.

[55] The strongly geometric structures of such designs also symbolises the modern machine age (4.12).

[56] Phillips distinguished between abstract patterns, stylised designs, flora and fauna, and pictorial designs. Phillips, B., *Fabrics and Wallpapers*, London, 1991.

Meller and Elffers identified five main categories; floral, geometric, conversational, ethnic, and art movements and period styles. Meller, S. and Elffers, J., *Textile Designs*, London, 1991.

[57] Cabbage roses occur mostly in Victorian and Edwardian design, the medieval briar rose in Arts and Crafts design, the rose bud in the Glasgow School, and roseballs in French Art Deco.

recognised within the design and merchandising community. At the present time, the names of floral types, such as formal, naive naturalistic, botanical, and cut paper designs imply particular characteristics, but, in the future, they may be classified collectively as late 20th century florals. Some treatments of imagery, although originating from specific historical periods, are, due to continuing reinterpretation, recognised as categories with their own stylistic characteristics.[58]

3.10. VISUAL FORMAT

The spiral patterns (figure 3.01), although having similar provenance and imagery, can be distinguished by their particular arrangements of motifs. Christie stated that the 'structural method, not the element used, is therefore the sole basis of classification'.[59] In such methods, structure can be defined as 'the mutual relation of the constituent parts or elements of the whole as determining its peculiar nature or character'.[60] Patterns are classified by the visual appearance produced by the arrangement and inter-relationships of the motifs, but systems vary according to which characteristics are selected as meaningful similarities.

3.11. Design elements and spatial inter-relationships

Christie defined two primary classes, spot and stripe, which he described as 'isolated' and 'continuous', with three subclasses of striped patterns; straight, waved, and chevroned. By combining or enriching these, further classes of cross-band, interlaced, and counterchanged cross-band patterns are formed. This type of classification is highly subjective and, being based on individual visual interpretation, produces many anomalies. Confusion occurs in the categorisation of simple ambiguous patterns (figure 2.10) which can be read either as spot or stripe patterns. The perceptual linking of isolated elements produces a further anomaly, in that the visual appearance of stripes can be produced by linear arrangements of separate elements (figure 3.03).[61] Christie proposed that such patterns could be classified by the dominance of visual forms. A pattern may be

[58] Such as *indienne* designs, which are distinguished by the exotic treatment of motifs, and are associated with structural characteristics originating from block printing (6.09).

[59] Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, p.66.

[60] *The Shorter Oxford English Dictionary*, Third Edition, London, 1986.

[61] In figure 3.03, (a) is a spot pattern, (b) is a stripe pattern in which the elements are linked, (c) is ambiguous, and (d) is a spot pattern because, although the elements are arranged in stripes, they are distinctly isolated. Broken or dotted lines are perceptually linked to give the effect of continuity (2.06).

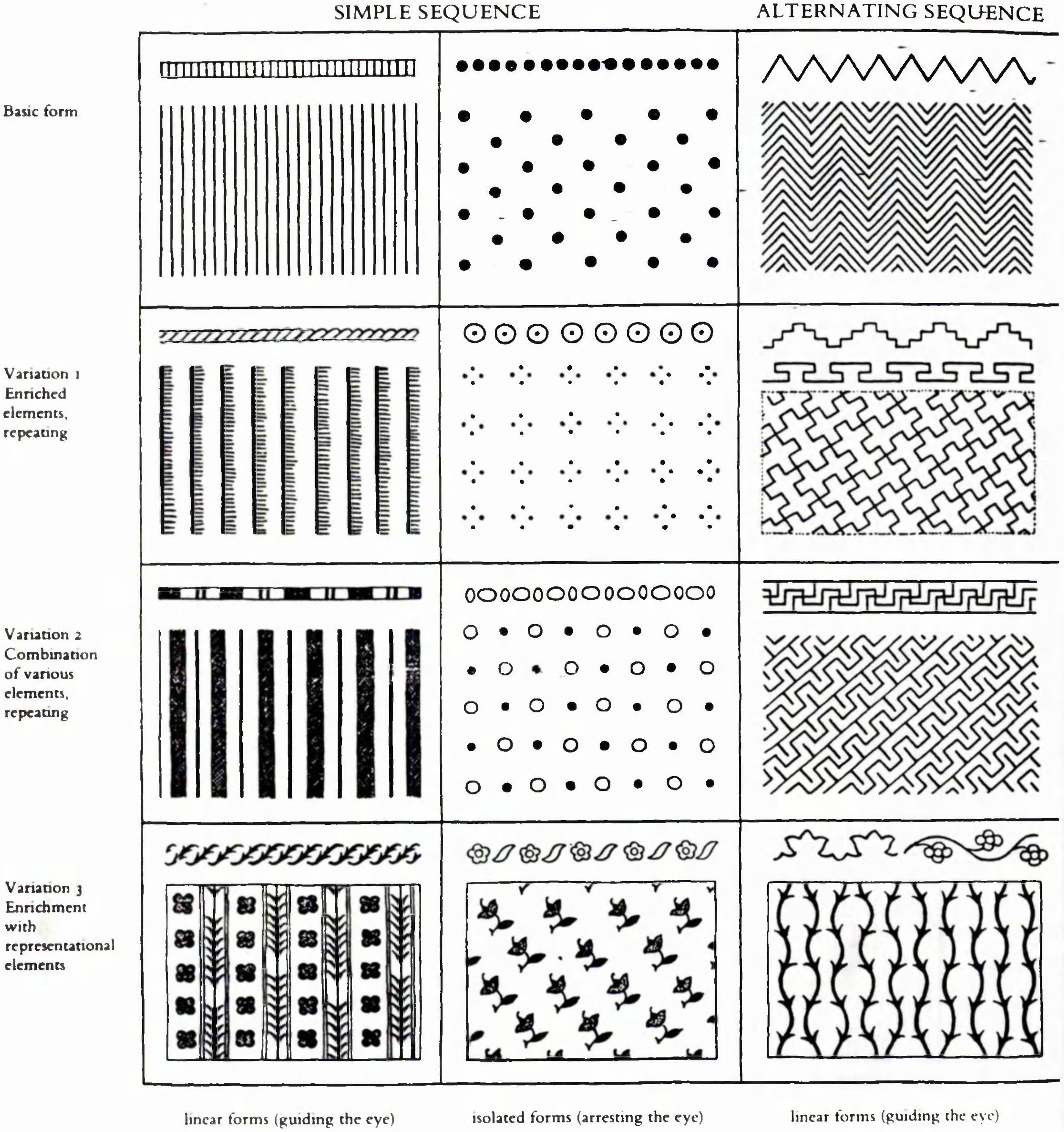
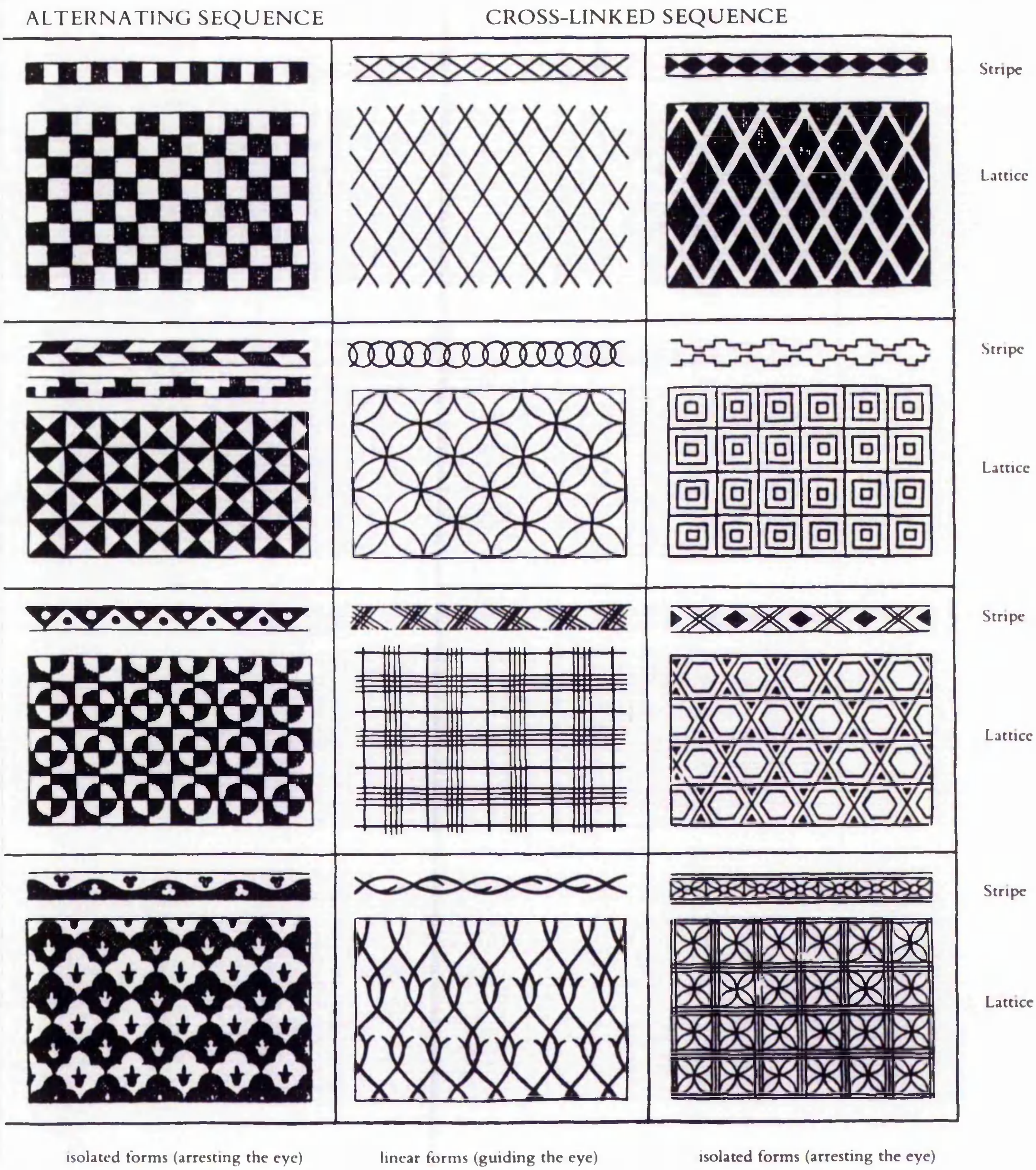


Figure 3.05. Pattern classification system by Wolfgang von Wersin, 1953.


ALTERNATING SEQUENCE
CROSS-LINKED SEQUENCE
Stripe
Lattice
Stripe
Lattice
Stripe
Lattice
Stripe
Lattice
isolated forms (arresting the eye)
linear forms (guiding the eye)
isolated forms (arresting the eye)

classified as a striped pattern if an underlying linear structure predominates; if the 'ornament is compactly designed, it alone may suffice to express the design. In such cases . . . features normally differentiating the stripes, become redundant and disappear, as the structural basis is adequately maintained without their aid'.[62] He noted that a pattern defined as 'a diagonal floral sprig powdering' (figure 3.04), 'approaches the waved-stem type by suggesting a vertical spiral movement' and that if the motifs were joined it would become this type of striped pattern.[63]

A pattern combining the two basic formats, for example, a stripe pattern with an additional spotted arrangement of motifs, would be defined as a striped pattern if the stripe were a strong feature, especially if the isolated motifs were arranged in a linear form. Alternatively, if the isolated elements were scattered but dominant to a striped background it would be defined as a spot pattern.

Von Wersin also defined two main classes of linear and isolated forms.[64] He distinguished four groups of motifs; the basic motif and three types of 'enriched' forms. Enriched forms were combinations of the same motif, combinations of various motifs, and the motif with additional representational elements.[65] He defined three forms of sequences of repetition; simple, alternating, and cross-linked, giving a total of twenty four classes of patterns (figure 3.05).

3.12. Design forms

Day's method arose from practical design applications and related to patterns' underlying structures. He aimed 'to show the affinity between groups of design to all first appearances dissimilar, and to lay bare the very skeletons upon which all possible pattern is framed'.[66] His method used design forms derived from combinations of grids and subsidiary lines. He distinguished four main classes of grid; the square, triangle, octagon, and circle.[67] The resulting forms can be used to create purely geometric patterns. They can be retained as strong, visual frameworks, or used as underlying structures to arrange design elements.

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[62] Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, p.161.

[63] Ibid, p.197.

[64] Wersin, W. von, *Das elementare Ornament und seine Gesetzlichkeit*, Ravensburg, 1953. The table, shown in figure 3.05, is taken from Gombrich, E.H., *The Sense of Order*, 2nd edition, Oxford, 1984, pp.76-7.

[65] Motifs, he maintained, were defined by their complexity not their imagery, with the exception of a distinction between geometric and representational elements. This retained the distinction between abstract and representational elements which dogged 19th century classification of imagery.

[66] 'Just as the man of science divides the animal world into families and classes, so may the man of art classify pattern according to its structure'. Day, L.F., *Pattern Design*, London, 1903, reprinted 1915, p.5.

[67] Grids provided methods for planning the structure of the design (4.13). Day's theories were concerned mostly with pattern construction, rather than classification (4.14).

Classification depends on the character of the pattern and the experience of the viewer, and, although it is based on structural analysis, the fact that the same form can be constructed from different grids means that it 'is not safe to pretend to say with authority, the way in which a given pattern was evolved'.[68]

Design forms have descriptive names which relate to their visual appearance, but actual definitions have varied. For instance, in the late 19th and early 20th centuries, many small-scale patterns based on regular structures were called diapers.[69] Some authors were specific in terms of coverage, and regarded patterns of separated motifs as a 'species' of powdered pattern.[70] Contemporary definitions emphasise structure as visual elements, rather than as underlying frameworks.[71]

Patterns in which there was a strong emphasis on the structural format, such as the scale pattern, were defined in structural terms. Variations on basic forms produced 'derivatives' with different visual characteristics. For example, wave, feather, ogee, and double ogee patterns could be derived from the scale pattern (figure 3.06).[72] Forms, such as ogees, when used as underlying structures, imposed visual formats on repeated designs, and were intrinsic to the overall 'feel' of the pattern.[73] Design forms, having traditional and cultural associations, were often used with specific types of imagery, but could be used as organisational structures for other types of imagery.

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[68] Day gave six possible construction methods for one pattern, and stated that 'there are usually several ways in which' a given pattern 'might have come about'. Ibid, pp.41- 4.

[69] Harrison and Townsend defined the diaper as 'an all-over repeating pattern in which the scale of repeat is small in comparison with the space occupied . . *frequency* of repeat is one of its characteristics. It may or may not be continuous, the field must be evenly covered, and no feature being specially prominent, its general effect is flat'. Harrison, T.Erat, and Townsend, W.G.Paulson, *Some Terms Commonly used in Ornamental Design*, London, 1906, p.17.

[70] Audsley defined the diaper as 'that species of design in which certain leading features or devices occur at regular intervals, and which are enclosed or connected by geometrical or flowing lines, sometimes independent and at others forming integral portions of the devices'. Audsley, W. and G., *Outlines of Ornament in the Leading Styles*, 1882, reprinted as *Designs and Patterns from Historic Ornament*, London, 1968.

[71] Lewis and Darley emphasised the regularity of the diaper pattern, but also stated that it was 'any design of repeated geometric pattern using a framework filled by such motifs as lozenges, squares, scales or formalised flowers or leaves'. Lewis, L., and Darley, G., *Dictionary of Ornament*, 1990, p.107. This modern emphasis on geometric network as pattern, rather than underlying structure, differs from the earlier definitions.

[72] Day, L.F, *The Analysis of Pattern*, London, 1887, p.

[73] They did not appear as an actual visual elements, but were used to aid the arrangement of motifs (4.15).

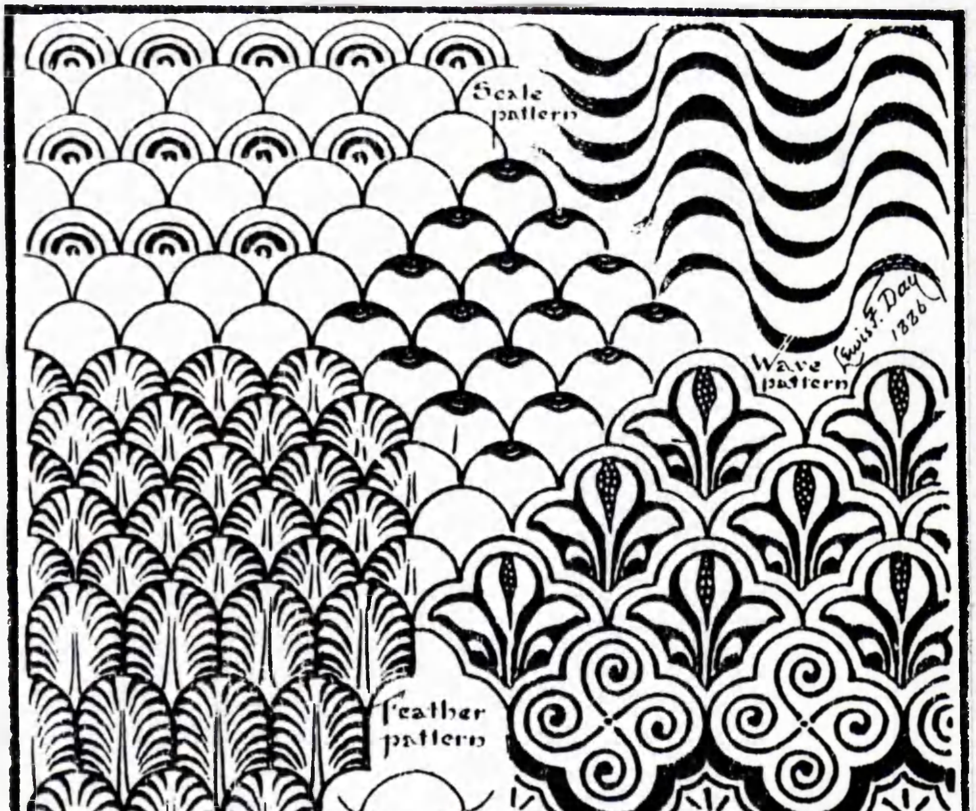

Figure 3.06. The scale pattern and its derivatives, from Lewis F. Day.

3.13. Design forms and imagery

These systems generally divide ornament into three types; enclosed ornament (non-repeating), bands (repeating in one direction), and all-over patterns (repeating in two directions). The types are subdivided into groups which vary with different authors.

Audsley grouped 'ornaments together which are similar in their motives and general treatment', and stated that patterns were classified 'according to their motives, under such heads as Fret Ornament, Interlaced Ornament, Diaper Ornament &c. The student will . . . be able to obtain OUTLINES of each, upon which he can base his own inventions and developments'.[74] One heading is 'Conventional Foliage', but this apparent confusion in aims between structural and image-based classification occurred in many publications of that period.[75] This may have been caused by strong associations between particular design forms and types of imagery.

Definitions often included both the structure and the type of imagery. Harrison and Townsend defined a sprig pattern as 'an all-over pattern in which the ground is covered at regular intervals by small detached portions of foliage, such as a single flower with a few leaves and buds attached, or little groups of flowers'.[76] This visual format applied to other types of motif was termed powdered ornament, and the spot pattern is its modern equivalent.

Dupont-Auberville used a variety of descriptive terms in his categorisation of historic textile designs. Some related to visual format; 'straight striped patterns', some to imagery; 'patterns of birds perched on the wing', and others that combine both; 'ribbon and serpentine stripe patterns'.[77] He defined three 18th century types

[74] Audsley, W. and G., *Outlines of Ornament in the Leading Styles*, 1882, reprinted as *Designs and Patterns from Historic Ornament*, London, 1968, preface.

[75] Meyer proposed similar classes based on 'elements of decoration'; 'Geometrical-lines, Ornament, Natural-foliage, Artificial Objects, Animals and the Human Figure. These may be considered as the "ingredients"; and are mixed, and applied, on various arrangements or "Features", according to certain acknowledged "recipes" which are termed "Principles"'. Meyer, F.S., in the introduction to A *Handbook of Ornament*, London, 1894, reprinted 1987.

[76] Harrison and Townsend proposed 'to set forth as precisely as possible the characteristics of the different kinds of patterns, taking their commonly accepted names, and defining, as nearly as may be, their limitations'. Harrison, T.Erat, and Townsend, W.G.Paulson, *Some Terms Commonly used in Ornamental Design*, London, 1906, p.17.

[77] These designs are from different historical periods. As styles changed, the type of imagery could be retained, but it applied to different design forms, or vice-versa. Dupont-Auberville, M., *L'Ornement des Tissus*, Paris, 1877, printed as *Ornamental Textile Fabrics*, London, 1877, reprinted as *Classic Textile Designs*, London, 1989.

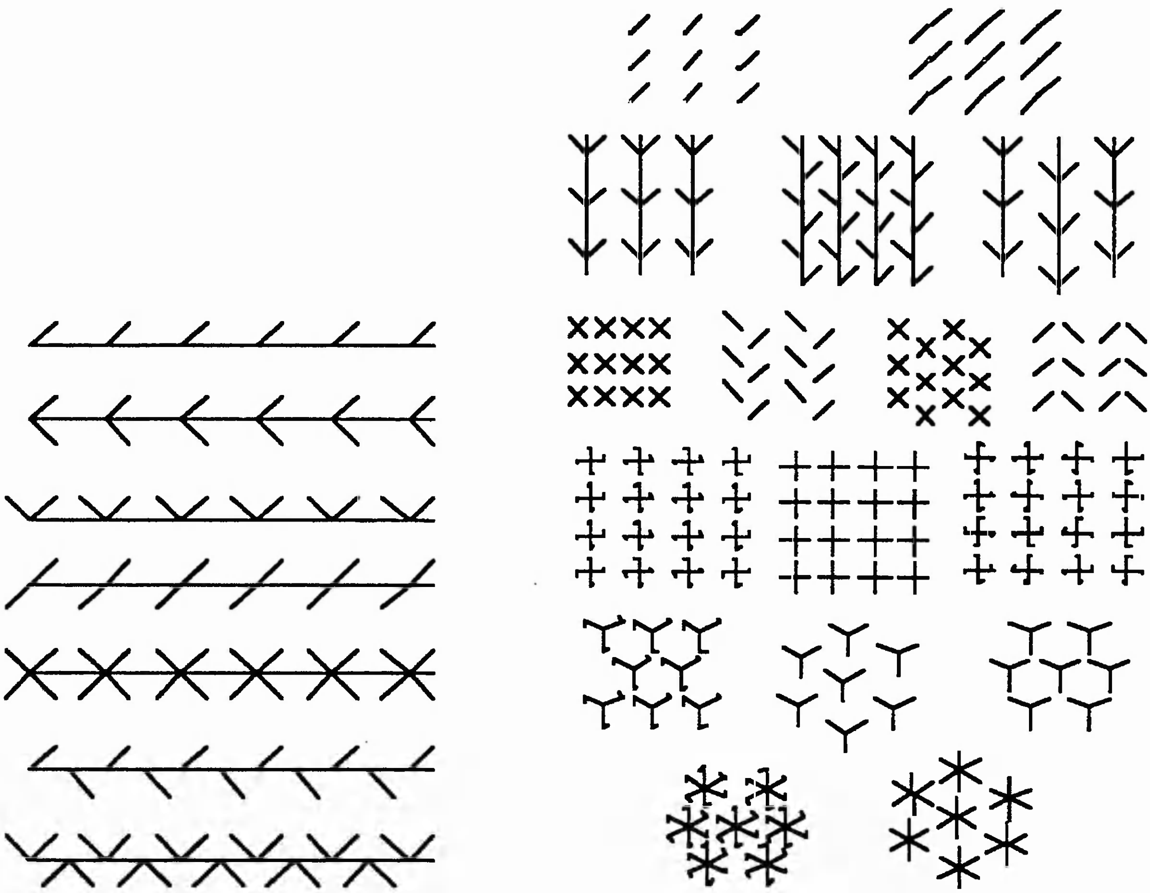

Figure 3.07. The 7 band symmetries and 17 pattern symmetries, from Speiser, 1937.

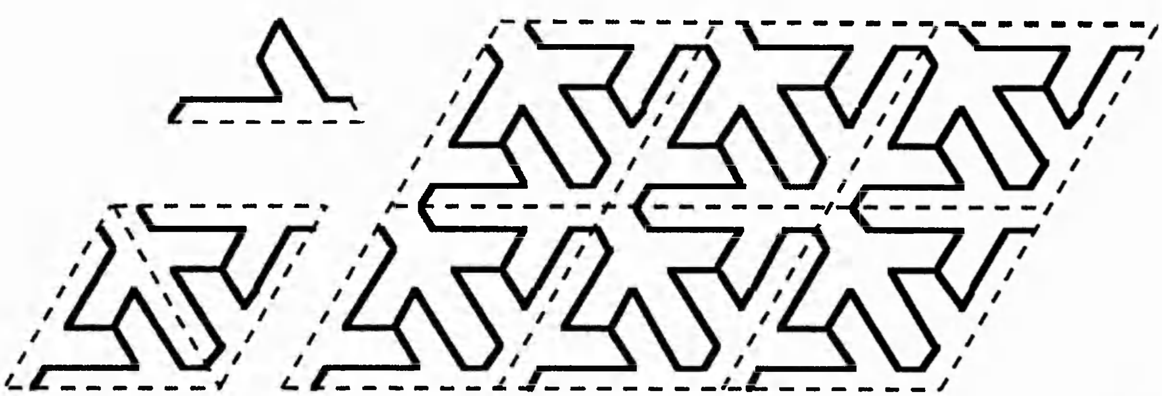

Figure 3.08. Islamic hexagonal pattern exhibiting symmetry **p31m**, the insets show the smallest unit and the repeat unit (see Appendix 2).

of ribbon pattern; 'twining ribbon patterns "a reserves"', 'ribbon and serpentine stripe patterns', and 'entwined ribbon patterns'. Such terminology is often specific to particular styles or historical periods. In the 18th century, 'ribbon pattern' would have had a precise meaning in relation to design forms and the overall appearance of the pattern.[78]

3.14. STRUCTURE

The confusion between visual formats and period terminology can be resolved by using purely structural analyses. Patterns can be broken down to a basic unit, and it is the way these are combined or repeated that defines the type of pattern.

3.15. Symmetrical analysis

The international notation system for symmetrical patterns was formulated during the 1930's from the study of crystallographic principles,[79] and has been applied to the analysis of natural and man-made patterns.[80] Seven types of band symmetry and seventeen types of all-over pattern symmetry are defined (figure 3.07). Analysis consists of determining the basic unit, or 'fundamental region',[81] and then working out the various operations of translation, rotation, mirror reflection, and glide reflection required to create the pattern by copying this unit.[82] This analytical method has been applied to the work of particular artists,[83] some of whom acknowledged its influence. Escher commented that although 'the *text* of crystallographic publications is mostly beyond my comprehension, the *figures* with which they are often illustrated bring me occasionally on the track of new possibilities for my work'.[84]

Although patterns can be constructed and analysed by the application of these

[78] Imagery is interpreted differently with various styles, so that a 1930's floral pattern is related to the decorative vocabulary of the time, its end use, and production methods (8.16).

[79] Speiser, A., *Theorie der Gruppen von endlicher Ordnung*, 3rd edition, Berlin, 1937.

[80] Shubnikov, A.V. and Koptsik, V.A., *Symmetry in Science and Art*, New York, 1974. Birkhoff, G.D., *Aesthetic Measure*, Cambridge, 1933.

[81] Stevens defined the fundamental region as 'the smallest portion of the pattern that repeats so as not to leave gaps or overlap with itself'. For separated motifs, this region includes background areas. Stevens, P.S., *Handbook of Regular Patterns*, London, 1980, p.99.

[82] The four symbols used to denote these operations are shown in Appendix 2.

[83] Macgilavry, C.H., *Fantasy and Symmetry*, New York, 1976, and Locher, J.L., ed. *The World of M. C. Escher*, New York, 1971.

[84] 'In this way a fruitful contact could sometimes be established between mathematicians and myself'. Escher, M.C., *Escher on Escher: Exploring the Infinite*, edited by Wilson, J., New York, 1989, p.31.

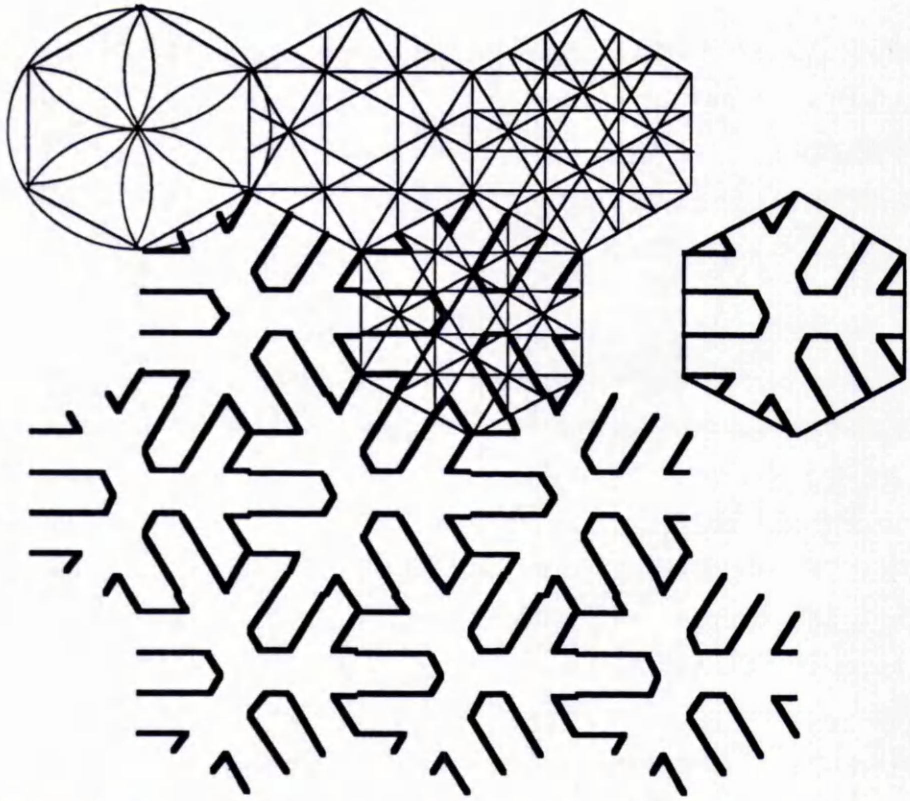

Figure 3.09. A geometric construction of the pattern shown in figure 3.08.

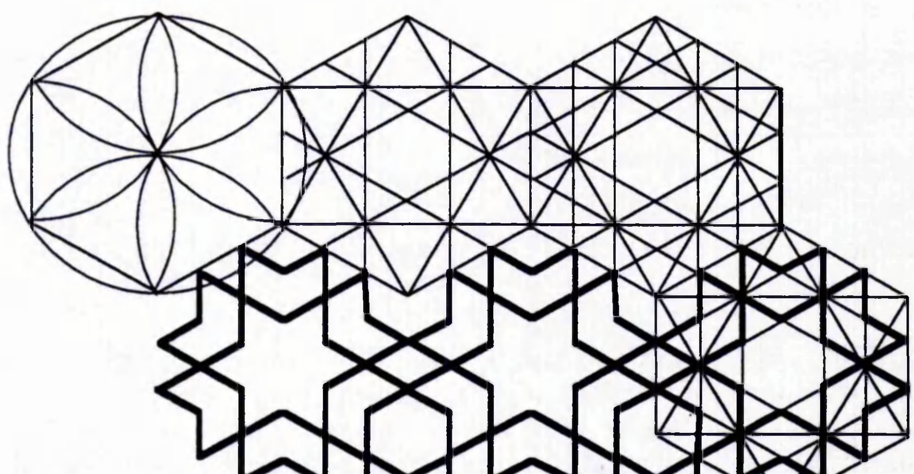

Figure 3.10. A pattern exhibiting symmetry **pm6**, this can be drawn using the same basic geometric construction as figure 3.09.

principles, the designer or artist did not necessarily use them in the construction.[85] According to El-Said and Parman's analysis of traditional construction methods, an Islamic pattern exhibiting symmetry **p31m** (figure 3.08)[86] and another exhibiting symmetry **p6**, derive from the same basic construction (figures 3.09 and 3.10).[87] A construction-based system would classify these two patterns, which have different symmetries, as similar.

Because analysis is restricted to symmetrical patterns and takes no account of orientation, this method has only limited use for practical textile applications.

3.16. Dynamic symmetry

Dynamic symmetry based on root rectangles was 'rediscovered' by Hambidge, who applied it to the analysis of Egyptian and Greek design.[88] Edwards extended these theories, using the term *Dynamarhythmic symmetry* to denote the application of its principles to pattern.[89] He based his analysis on the hypothesis that grid systems, related to theories of symmetry and proportion, were used in historic designs to create harmony and balance.[90]

3.17. Repeat units

This system relates to a pattern construction method which is commonly used in contemporary design. Construction involves repeating a basic unit using a selected format.[91] The categories are detailed in Chapter 9.

Justema proposed that, with 'the possible exception of stripes, all-over patterns can be reduced to two basic plans, the "block" and the "brick" '. Problems associated with the classification of spot patterns are dismissed with 'a polka dot is merely a spot *within* an invisible block or brick'.[92] A similar approach was proposed

[85] Patterns of interlocking units, such as Islamic patterns and Escher's designs, were mostly constructed using holistic methods (4.09 - 4.11), but they can be classified by symmetrical analysis.

[86] Padwick, R. and Walker, T., *Pattern: its structure and geometry*, Sunderland Arts Centre, 1977, p.37.

[87] El-Said, I. and Parman, A., Geometric Concepts in Islamic Art, London, 1976, pp.73 and 75.

[88] Hambidge, J., *Dynamic Symmetry*, New Haven, 1920. *The Parthenon and Other Greek Temples: Their Dynamic Symmetry*, New Haven, 1924.

[89] Edwards aimed to build 'a new structural fabric in design, based on the geometrical principles of order and proportion inherent in the system'. Edwards, E.B., *Dynamarhythmic Design*, 1932, reprinted as *Pattern and Design with Dynamic Symmetry*, New York, 1967, p.ix.

[90] Ghyka suggested that 'symmetry for Greek and Roman, and also Gothic architects, meant the *commodulation* or linking of all the elements of the planned through a certain proportion or a set of related proportions'. She traced the theories of geometrical proportion which were formulated by Vitruvius and Plato, developed in the Renaissance by Luca Pacioli in his book on the Golden Section, and rediscovered by Zeysing in 1850. Ghyka, M., *Geometrical Composition and Design*, London, 1956, p.14.

[91] Using the block, drop, or which ever gives the best effect (4.22).

[92] Justema, W., *The Pleasures of Pattern*, New York, 1968, p.120.

by Flower who gave two additional repeat types; the drop and the step.[93] Flower and Justema argued that the drop could be seen as a variation of the brick (i.e. the one rotated through 90 degrees creates the other).

When design orientation is considered, this classification depends on visual interpretation, and some patterns may be categorised in more than one class. Although the classification of a pattern is based on an analysis of the pattern structure, it does not necessarily indicate the actual construction method used.

3.18. Limitations of classification

Gombrich suggested that classification 'is always the product of an ordering mind, and the search for the "logical" system in which a unique place can be assigned to any ornamental motif is doomed to failure'.[94] Problems arise in the classification of patterns due to the subjectivity of visual interpretation, but also because different emphases affect the selection of characteristics. Classification generally reflects period influences and interpretations, therefore a system used in the 19th century would be inappropriate for contemporary design.

Stylistic terms use a mixture of different classification methods and are not limited by strict categories. By linking provenance, imagery, visual format, and structure, they form a flexible framework for exchanging information. Such terms are imprecise but, because they relate to a shared body of knowledge, they contain implicit information with multiple associations.

To designers, descriptions using stylistic references communicate more information than purely factual descriptions. This involves a knowledge of a range of styles, but also an awareness of how selected characteristics are interpreted in the contemporary design climate. Variations relate to the context in which patterns are seen and the type of information being transferred.[95] A designer may convey a general visual idea using provenance or imagery, but use a structural approach when dealing with practical design applications. The variety of different classification methods enables an appropriate method to be selected for the purpose in hand.

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[93] Flower, L., *Ideas and Techniques for Fabric Design*, London, 1986, p. 43.

[94] Gombrich, E.H., *The Sense of Order*, Oxford 1979, p.73.

[95] Patterns are perceived differently by viewers with dissimilar cultural backgrounds or professional interests (2.04). Pattern perception is affected by familiarity with the stylistic form and motifs (2.13).

CHAPTER 4: PATTERN CONSTRUCTION

4.01. ORDER AND STRUCTURE

This is essential to the design of most printed textiles,[1] but for aesthetic and practical purposes a strongly repetitive appearance is often undesirable. However, if order and structure are disregarded, recurrent design elements will usually produce unintended bands and focal points, and this means that a random appearance is often best achieved by careful planning.[2] Day asserted, 'It is all very well to protest that art is free of laws: they govern it none the less . . . when the pattern comes to be repeated, the very order of its repetition reveals the skeleton', although he continued, a 'pattern may be comparatively featureless; and, so long as there is in it no feature pronounced enough to distinguish itself, lack of order may perhaps pass unnoticed'.[3]

4.02. Structural order

Historically and culturally, the use of structural order in pattern has varied, and sometimes it has been deemed necessary to guard against, on the one hand, this type of featureless design and, on the other, the dominance of unplanned repetition. In such cases, design formats were often used to provide underlying structural organisations which, though essential, were concealed components of the pattern. At other times, structural order has been an integral visual feature of patterns, and was emphasised by the use of simple repetition or dominant geometric structures.

These relationships have been influenced by the changing philosophical explanations of the natural world proposed by cosmological, mathematical, and analytical theories.[4] They reflect degrees of aesthetic involvement with, or reaction against, such conceptual frameworks. The various methods of achieving structural order have been through the use of simple repetition, geometric structures, design formats, and trial and error.

[1] Exceptions are single panel designs, such as those for towels, duvet covers, etc., placement prints, and engineered prints (designs to fit specific garment shapes).

[2] The masking of repetition in a pattern is difficult because human perception is attuned to recognising regularities (2.07).

[3] Day, L.F., *Pattern Design*, London, 1903, reprinted 1915, pp.5 and 8.

[4] 'Even the earliest history of geometry as a theoretical study of spatial relationships and spatial structures reveals that it had, in addition, a powerful symbolic role in both imaginative and theoretically speculative thought. Thus, although the history of geometry can be told in purely mathematical terms, it is also, from another point of view, a history of forms of representation, of ways of thinking about the world and of views on the nature of thought itself'. Tiles, M.E., in *The Oxford Companion to the Mind,* edited by Gregory, R.L., Oxford, 1987, p.286.

4.03. Simple repetition

Three explanations have been proposed for the strongly repetitive character of most 'primitive' patterns. These were, firstly, that materials and processes determined their appearance,[5] secondly, that they illustrate a human reaction to the apparent chaos of nature,[6] and, finally, that a pattern's symbolism was more important than its decorative qualities.[7] Repetition of an image increases its visual dominance, and simple repetition is often used when imagery, whether pictorial or abstract, is an important factor in a design.[8]

4.04. Geometric structures

Holistic concepts, expounded by philosophical and religious ideologies[9] as well as by recent scientific theories,[10] have expressed links between man and the natural world using mathematical laws.[11] The use of geometric principles of symmetry and proportion to symbolise this unity[12] were the basis of Islamic and many traditional European design forms. 'During the Middle Ages, Islamic decorative ideas were so thoroughly absorbed that their presence has only been recognized comparatively recently'.[13]

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[5] Mechanistic explanations stressed the limitations of processes (4.13), but some design theorists proposed that abstract patterns derived from structures produced by processes (3.07).

[6] Dominance of order was thought to express human identity in contrast with natural disorder (2.09).

[7] The images were the principal reason for making pattern, and repetition reinforced their symbolic power (3.08). Now, perception of primitive pattern is influenced by contemporary design in which decorative qualities are essential ingredients (2.19).

[8] The combination of complex imagery and simple repetition is often used with radical changes in imagery (7.02), very large designs (8.25), and new techniques (5.12 and 5.36) where sufficient novelty is produced to create interest without recourse to complex arrangements. In this way, a pictorial design can be seen as a repeated picture, rather than a pattern.

[9] Cirlot proposed that the basis of the relationship between macrocosm and microcosm - 'which has occupied the minds of thinkers and mystics of all kinds in all ages - is the symbolism of man himself, particularly as the "universal man", together with his "correspondences" with the Zodiac, the planets and the Elements'. Cirlot, J.E., *A Dictionary of Symbols,* English translation, London, 1962, p.196.

[10] Critchlow noted that 'modern atomic physics has confirmed the essential mathematical and geometric patterns occurring in Nature; not, however, in the philosophical sense of displaying the intelligence within and throughout all creation - the starting point of Islamic art - but in the purity of essential relationships which lie beneath the visual surface of our world.' Critchlow, K., *Islamic Patterns: An Analytical and Cosmological Approach*, London, 1976, p.8.

[11] 'Throughout the history of ideas we find constant reference to mathematics as an aesthetic; to the recognition of fundamental orders, sequences and patterns'. Albarn, K., *The Language of Pattern,* London, 1974, p.12.

[12] Ghyka stressed the difference between the modern definition of symmetry (the identical disposition on either side of an axis or plane) and the Greek, Roman, and Gothic definition; 'symmetry resides in the correlation by measurement between the various elements of the plan, and between each of these elements and the whole'. Ghyka, M., *The Geometry of Art and Life,* New York, 1946, p.x.

[13] Durant, S., *Ornament: A Survey since 1830,* London, 1986, p.139. Islamic design has continued to be influential through the periodic revival of classic designs and the renewal of Western interest (6.08).

Islamic religious protocol discouraged the artistic representation of animals and people, and this has often been used to explain the sophistication of Islamic geometric designs.[14] This caused many design elements to be abstractions of natural forms. Lings and Safadi observed that 'the two chief elements of Qur'an illumination are arboreal and solar',[15] but their use is symbolic and subordinate to the geometric structure.

Geometric structures do not necessarily presuppose abstract patterns and they can be used to arrange representational motifs, as with early Christian iconographic patterns. With these, the construction provided order for the overall pattern and the harmonious distribution of elements. These characteristics were important, not merely for practical and decorative values, but also for their symbolic and mystical associations.[16]

4.05. Design formats

Descartes (1596-1650), as a rationalist, considered that the world could be interpreted using the laws of mathematics.[17] His theories of dualism signalled a departure from previous holistic concepts, and they influenced the development of a reductionist scientific approach. Romanticism was a reaction against this philosophical trend and caused a division of the arts and sciences into separate disciplines. In the attempt to reassert humanity's innate powers of creativity order, rather than symbolising unity, was renounced as an imposed discipline that separated man from nature.

Geometric structure which had a traditional and practical design application was still commonly used for planning the placement of elements. Designers took into account the overall visual effect imposed by a selected format, and drew elements and lines to work within it. The degree of structural order laid down by

[14] 'Unable to bring to their decorations the world of everyday objects, the image of man, animals or even plants, the artists had but one door open to them - geometry'. Viollet-Le-Duc, E., in the preface to Bourgoin, J., *Théorie de l'Ornement,* Paris, 1873, reprinted partly in *The Decorative Arts of Arabia*, London, 1989, p.10.

[15] Lings and Safadi also referred to the symbolism of these forms of imagery, and argued that 'the whole purpose of the art we are considering is to affirm the transcendence of the Qur'an'. Lings, M. and Safadi, Y. H., *The Qur'an*, London, 1976, p.13. The symbolic content of these designs was not usually understood or appreciated by Westerners, who saw the highly abstracted forms as decorative devices (3.08).

[16] Bain suggested that, although early Christian illuminations were 'undertaken for the glorification of God', it 'is possible that the mystique of Celtic art, in both pagan and Christian times, would have been a closely guarded secret, giving to its practitioners similar powers to those of the magician, or medicine-man, or miracle-worker in the eyes of the beholder'. Bain, I., *Celtic Knotwork,* London, 1986, p.13.

[17] Descartes believed in two radically different kinds of substance (*res extensa* and *res cognitans*), essentially the body and mind. He developed this into a theory, later known as Cartesian dualism.

design formats varied depending on whether they were used as underlying structures or dominant design features.[18]

A mid-19th century debate between the proponents of naturalistic and 'conventional' design reflected these variations in structural emphasis.[19] Ruskin, for example, abhorred mechanisation and the stylised symmetry and regularity of conventional design.[20] The analytical representations of plant structures, produced by 'art botany',[21] increased conflicting opinions about representations of nature and their design applications, and this created a legacy of opposing influences on the use of order in subsequent design styles.[22]

4.06. Trial and error

Albarn commented that, in Western culture, 'more emphasis is placed on analysis, which is understandable because it represents a more obvious type of ordering, and is, besides, identified with the quantifying methods of science. The arts, the "other half", are qualitative and have been polarized to the extent of apparent disorder'.[23]

Haftmann suggested that the 20th century move towards abstraction could be seen as a continuation of the Romantic tradition, in that it sought to 'restore unity with the world of things on a universal plane' and became 'abstract in consequence of the change in our picture of the world as a whole'.[24] Romanticism was not a radical rejection of all order, but a diminution of the emphasis placed on it, but, with the continuing concept of the free creative designer, the conception of

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[18] The degree of structural emphasis affected the classification of designs based on formats (3.12).

[19] There was a reaction to the plethora of pictorial and naturalistic designs. Designers, such as Pugin, had proposed a return to stylised forms and highly ordered 'Gothic' designs, and Owen Jones argued, 'Flowers or other natural objects should not be used as ornaments, but conventional representations founded upon them sufficiently suggestive to convey the intended image to the mind, without destroying the unity of the object they are employed to decorate'. Jones, O., *The Grammar of Ornament*, London 1856, reprinted London 1987, Proposition 13.

[20] Ruskin's statement that 'there is hardly any common natural form in which it is possible to discover a straight line', has remained a mainstay of those who decry any form of art that is not purely 'naturalistic'. Ruskin, J., *Seven Lamps of Architecture*, London, 1849, p.145.

[21] Art botany was based on the scientific study of natural forms. In 1852, the botanist Dr. John Lindley lectured to students on the application of botany to ornamental design. These lectures were published as *The Symmetry of Vegetation,* London, 1854. Other lectures and publications on similar topics were produced, such as Dresser, C., *Rudiments of Botany* and *Unity in Variety* , London,1859.

[22] The views of Jones, Dresser, and art botanists were echoed by Smeets in the 1970's: 'Creative man should not just take over or borrow directly from the forms of nature. He must discover its general character and seek no more than simplicity, unity, and harmony; balance, accent, and rhythm'. Smeets, R., *Signs, Symbols & Ornaments*, London, 1975, p. 99.

[23] Albarn, K., *The Language of Pattern,* London, 1974, p.62.

[24] Haftmann, W., *Painting in the Twentieth Century,* London, 1960, p.374.

informality has changed and succeeding styles have become increasingly less structured.

Order is often regarded with disdain in the present design ethos, and this accords with the predominant conception of artistic processes as spontaneous, individualistic, and natural activities.[25] The contemporary taste for unstructured design and emphasis on imagery is a continuation of this trend. Now, many textile patterns are drawn and put into repeat using a method that relies on trial and error. A design can be tried out in various repeats, and modifications made at the end of the design process can correct obvious or unwanted breaks in continuity.[26]

4.07. Construction methods

Holistic methods of construction are associated with geometric structures and design formats, and are based on the subdivision of areas to create patterns using predetermined frameworks. Alternatively, extension methods are associated with simple repetition and trial and error, and rely on the manipulation of basic units to form patterns.

4.08. HOLISTIC METHODS

Islamic and early European design methods were based on geometric principles derived from the same theories of symmetry and proportion, but they evolved into methods of expression that served the particular beliefs and practices of their respective cultures.[27] At first sight, the basic construction methods have similarities, but fundamental differences in methodology appear which are indicative of different philosophical attitudes. For example, a major distinction is that, in Islamic design, the application of these principles has remained an integral expression of a spiritual concept, whereas, in the European tradition, their use has fluctuated with shifts in philosophy and fashion.

4.09. Islamic design

Geometric purity in Islamic design has been retained because it is the starting

[25] This accords with the 'carpentered world' concept (2.19), in that contemporary patterns are seen to re-affirm unity with nature and its perceived freedom as a reaction against mechanistic surroundings.

[26] The use of this design approach has increased since the 1940's with the increased use of free-lance designers (6.23), and it has had a profound influence on the design of CAD systems (10.02).

[27] The cross-fertilisation of ideas between cultures has been catalytic for the development of mathematical and geometric concepts and their application to design. Albarn stated, 'The Muslims drew knowledge from East and West, from Greece, Rome, Persia, Egypt, India and China'. Albarn, K., *The Language of Pattern*, London, 1974, p.63.

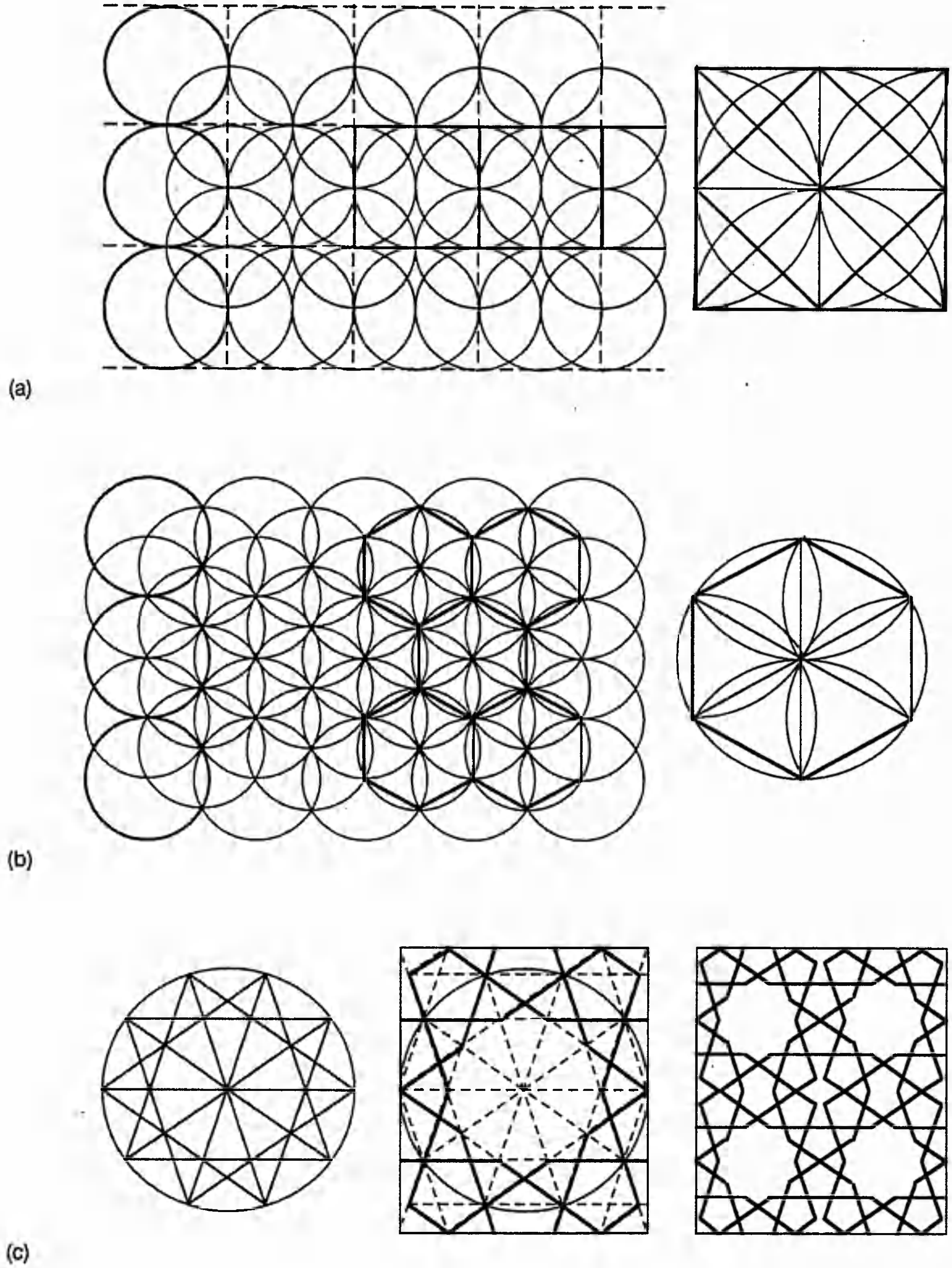

Figure 4.01. Islamic systems of proportion, (a) square, (b) hexagon, (c) pentagon.

point for each design, and it is also a primary ingredient in the finished work.[28] El-Said and Parman illustrated construction with a method based on the use of compasses and ruler only, and stated that 'it is the systematic arrangement of the repeat unit which produces the overall design'.[29] Systems of proportion, involving the square, the hexagon, and the pentagon, are derived from various arrangements of circles (figure 4.01).[30] These systems always produce a regular geometric form as the basic unit and, hence, regular equipartitions of the plane.[31] The inter-relation between the unit and the system creates a symmetrical homogeneity in the finished design.

4.10. Islamic grids

Initially, these grids are determined by the systems of proportion, but the possible internal divisions and resultant patterns are extremely varied. This method gives the designer 'the freedom of choosing his systems of construction as well as the freedom of constituting the variations made possible by these systems', and therefore 'cannot be regarded as a purely mechanical process on account of its capacity to accommodate human self-expression'.[32] Wilson noted that advantages of this system are 'that the number of identical units in the area to be decorated can be determined by first dividing the area into, for instance, squares or

[28] Although opinions differ, in the respective cultures it may not be necessary to have more than a rudimentary understanding of geometry to construct the grids, and design may be founded more on methodology than geometrical knowledge. Chritchlow suggested that 'the Islamic artist was not only versed in mathematics in the geometrical sense, but that mathematics was integral to his art'. Critchlow, K., *Islamic Patterns: An Analytical and Cosmological Approach*, London, 1976, p.8.

Wilson, on the other hand, said that although Islamic geometrical designs were seen 'as imbued with a sacred content . . . it seems unlikely that the craftsman decorating a wall or carving a door would have had these properties uppermost in his mind. Rather he would be following the teaching of his master and the traditional skills of his craft, and he would no doubt have left to others the philosophical interpretations of the traditional patterns he produced'. Wilson, E., Islamic Designs, London, 1988, p.15.

[29] The 'systematic arrangement' refers to the internal divisions of the unit which, in turn, are related to the system of proportion used. In patterns based on the pentagon, the actual repeat unit is a rectangle or rhombus, but the internal divisions (master grid) are formed from a pentagon constructed within a circle. El-Said, E. and Parman, A., *Geometric Concepts in Islamic Art*, London, 1976, pp.7 and 85.

[30] Critchlow wrote, 'The circle becomes the governing basis for all the geometric shapes that unfold within it. . . From the basic circle and the hexagonal arrangement of a group of tangential circles of the same radius surrounding it emerge the three primary shapes: the triangle, the hexagon and the square.' He explained the importance of the circle as 'the primary cosmological symbol, one of wholeness and unity.' Critchlow, K., *Islamic Patterns: An Analytical and Cosmological Approach*, London, 1976, pp.7 and 8.

[31] The square, the equilateral triangle, and the hexagon are 'the only regular polygons that cover a plane surface, and are known as the regular equipartitions of the plane surface.' Critchlow, K., *Order in Space*, London, 1969, reprinted 1987, p.60.

[32] El-Said, E. and Parman, A., *Geometric Concepts in Islamic Art*, London, 1976, p.114.

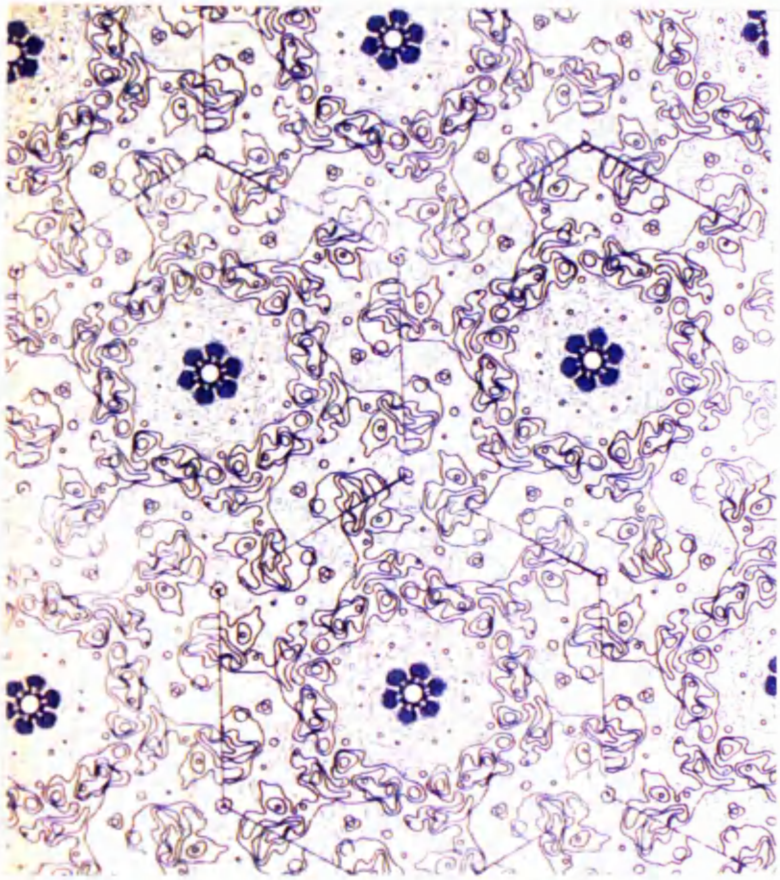

Figure 4.02. A crystallography design from the Festival Pattern Group (1951).

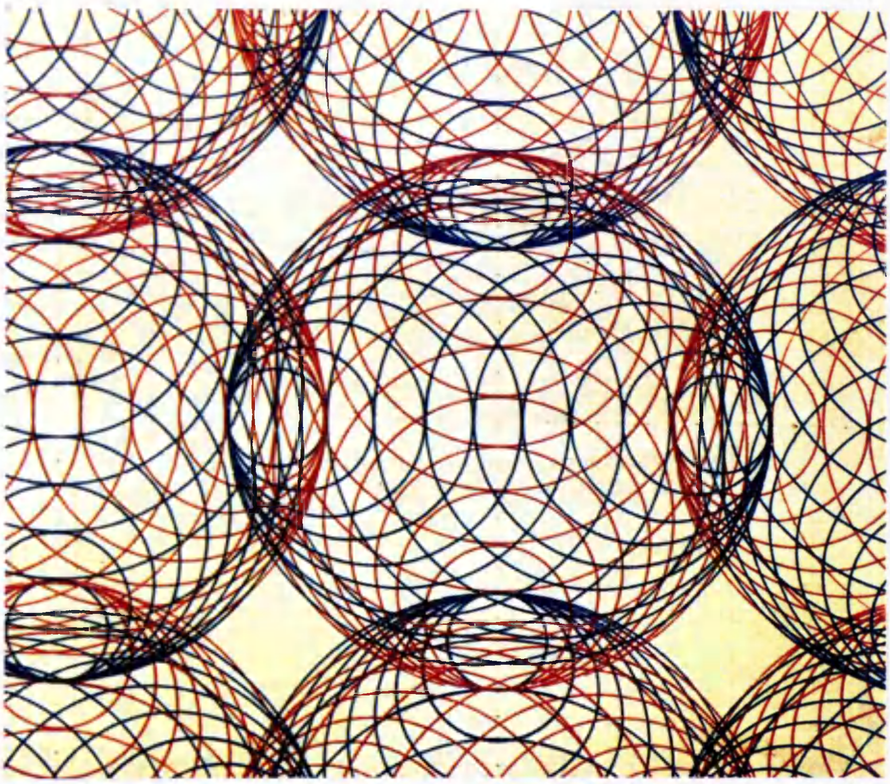

Figure 4.03. *Spirograph* textile design. Russian Constructivism, 1920.

hexagons of equal size . . ' and '. . that designs can be enlarged or reduced on the basis of the proportional relationships between geometrical figures'.[33]

4.11. Islamic grids applied to European imagery

Some European artists and designers drew inspiration directly from Islamic patterns and explored their principles of construction, but they used such structures mainly for the arrangement of images. Escher, observing the absence of imagery in Islamic design, commented on the lack of 'recognizable figures borrowed from nature. . . . This is hardly believable, for *recognizability* is so important to *me* that I never could do without it'.[34] He still retained an essential characteristic of Islamic design, which Locher called 'dialectic structuralism' and defined it as the 'interaction between unity and disparity'.[35] Escher's other main influence was crystallography,[36] and this can also be seen in the designs of the Festival Pattern Group (figure 4.02), which have a strong 'Islamic' appearance due to the inherent symmetry of their source imagery.[37]

4.12. European design

In European design, there has been a recurring sequence of rediscovery of geometric techniques followed by utilisation, degeneration into formulae, rigidity, and rejection.[38] 'Repose', or balanced design,[39] was the ideal of many 19th century designers, and most writers of that time agreed that this depended on

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[33] Wilson, E., *Islamic Designs*, London, 1988, p.15.

[34] Escher, M.C., *Escher on Escher: Exploring the Infinite*, New York, 1989, p.25.

[35] Locher, J.L., ed. *The World of M. C. Escher*, New York, 1971, p.47.

[36] 'Crystallographers have given us a definition of the concept and have researched and determined what and how many systems and methods exist for dividing up a plane regularly. By doing this they have opened up the gate that gives access to a vast domain'. Escher, M.C., *Escher on Escher: Exploring the Infinite*, New York, 1989, p.93.

[37] These designs, based on crystallography, were produced for the Festival of Britain (1951), and 'participating firms (known as the Festival Pattern Group) were issued with die-lines of over twenty different crystal structures'. Schoeser, M. and Rufey, C., *English and American Textiles*, London, 1989, p.202.

[38] The eclectic nature of European design has incorporated various oriental design styles and structural organisations into its design vocabulary. Durant noted that Japanese design manuals containing geometric networks 'appear to have been fairly readily available in London and Paris from the early 1870's'. Durant, S., *Ornament: A Survey since 1830*, London, 1986, p.173.

[39] 'As Architecture, so all works of the Decorative Arts, should possess fitness, proportion, harmony, the result of which is repose'. Jones, O., *The Grammar of Ornament*, London 1856, reprinted London 1987, Proposition 3. p.5.

Jones drew up a list of 'General principles' for design, Proposition 8 of which said that: 'All ornament should be based upon a geometrical construction.' This search for laws that governed 'good' design is a continuation of rationalism, but it is also an attempt to understand the welter of different styles produced by this age of eclecticism. He wanted to find laws that linked them which could be used to form objective, rather than subjective, judgments.

geometrical construction.[40]

Edwards argued, 'If there are laws of harmony and proportion which can be learned and applied in the planning of our work, it is foolish to argue that these laws should not be used because they do not allow us sufficient scope for the free employment of our innate artistic ability'.[41] This perception of geometric schema as possible obstacles to creativity does not exist in Islamic art which 'is far less a way of expressing emotion than a science . . . a Muslim artist will willingly subordinate his individuality to the, as it were, objective and impersonal beauty of his work'.[42]

Geometric principles and techniques have often been used by particular European artists and designers as expressions of personal interest and stylistic ideology, rather than as general cultural phenomena.[43] Modern styles, especially those using scientific and technological symbolism, have developed a strong geometric feel.[44] Woodham, commenting on a Russian Constructivist design (figure 4.03), said that 'mechanically realized decorative forms show a concern to move away from individualistic and idiosyncratic tendencies towards a more progressive, technology-based idiom',[45] but he acknowledged Bowlt's opinion that these designers 'were an elite and sophisticated group who really had little understanding of mass taste'.[46]

4.13. European networks

Most European methods distinguish between panels, bands, and repeating patterns; panels are self-contained units, bands repeat in one direction, and repeating patterns can be extended in two directions.

Networks for repeating patterns are linear constructions created by the division

[40] Durant observed that William Dyce, the author of *The Drawing Book of the Government School of Design*, 1842, 'taught his students the practical geometry necessary for the design of ornament - how to construct simple grids, to be filled with decorative motifs, how to divide and subdivide angles and the like', but he considered that it was not a comprehensive introduction to the study of geometry. Durant, S., *Ornament: A Survey since 1830,* London, 1986, p. 64.

[41] Edwards, E.B., *Dynamarhythmic Design*, 1932, reprinted as *Pattern and Design with Dynamic Symmetry*, New York, 1967, p.xix.

[42] Burckhardt, T., in the foreword to El-Said, E. and Parman, A., *Geometric Concepts in Islamic Art*, London, 1976, p.x.

[43] Bourgoin attempted to formulate a comprehensive and universal system of repeat patterns which drew heavily on Islamic geometry. Bourgoin, J., *Théorie de l'Ornement,* Paris, 1873.

[44] The use of geometry in these styles was often a positive statement about these designers' conception of the relationship between science and modern life (6.14 and 6.18).

[45] Spirograph textile design by Alexander Rodchenko, 1920. Woodham, J.M., *Twentieth-Century Ornament*, London, 1990, p.137.

[46] Bowlt, J.E., in the introduction to Yasinskaya, I., *Soviet Textile Design of the Revolutionary Period*, London, 1983, p.6.

of an area to produce regular arrangements of squares or triangles. Different authors have given a number of variations and combinations of these basic structures.[47] The square network can be adapted to a rectangular form, and changes in the angles of diagonal lines produce variations of the triangular network, such as the rhombus, equilateral triangle, and hexagonal forms (Appendix 3). Networks can be used like a customised graph paper, so that linear patterns, such as frets, can be constructed on the lines, and geometric patterns can be created by filling in the spaces.

The essential difference between Islamic and European methods is the variability of these basic structures, inasmuch as European networks, initially, form a more rigid framework than the Islamic method because they are divided into their smallest components. Two different construction methods for an Islamic pattern (figure 4.04) were illustrated by El-Said and Parman (figure 4.05)[48] and Day (figure 4.06). The first is based on intersecting circles, and the second, a European interpretation of its construction, is based on the triangular network. Day considered that the 'persistent' use of such patterns in mosaic and tile work resulted from the fact that forms, 'compounded of the triangle', could unite to give a 'complex and ingenious variety of pattern'.[49] His interpretation of the structure reflected a prevalent opinion that the character of a geometric pattern was determined largely by materials and processes.[50]

4.14. Secondary constructions

Secondary construction lines can be added to the basic networks by joining intersections with straight or curved lines, and, in this way, other networks can be created.[51] Circles can be constructed on a square or triangular network, using the intersections as centre points for their regular placements. Octagons can be

[47] Meyer defined three types of ornament; enclosed, band, and repeating. A variety of geometric structures were shown for each. Those for enclosed ornament were based on symmetrical divisions of geometric forms, and those for bands on the joining of regularly placed points. He defined six types of network for repeating ornament, including one for 'Moorish diapers'. Meyer, F. S., A *Handbook of Ornament*, London 1894, reprinted London 1987, p.11.

[48] El-Said, E. and Parman, A., *Geometric Concepts in Islamic Art*, London, 1969, p. 61.

[49] Day, L.F., *Pattern Design*, London, 1903, reprinted 1915, p.22.

[50] At that time, abstraction was regarded as primitive or degenerate (3.07), and the holistic concepts involved in Islamic design were not appreciated in the West (4.08).

[51] Geometric patterns based on secondary constructions, such as trellis and honeycomb patterns, can be used as grounds for larger motifs, thus providing continuity in a spot or stripe design. These 'fancy grounds' have been fashionable at different periods, especially in the early to mid-19th century (8.04).

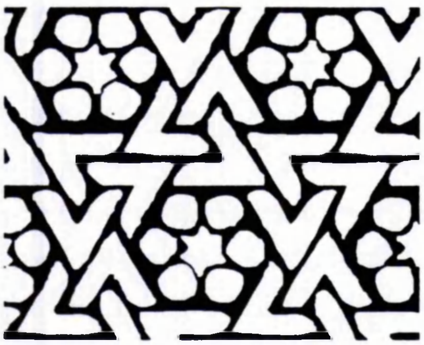

Figure 4.04. Islamic hexagonal pattern.

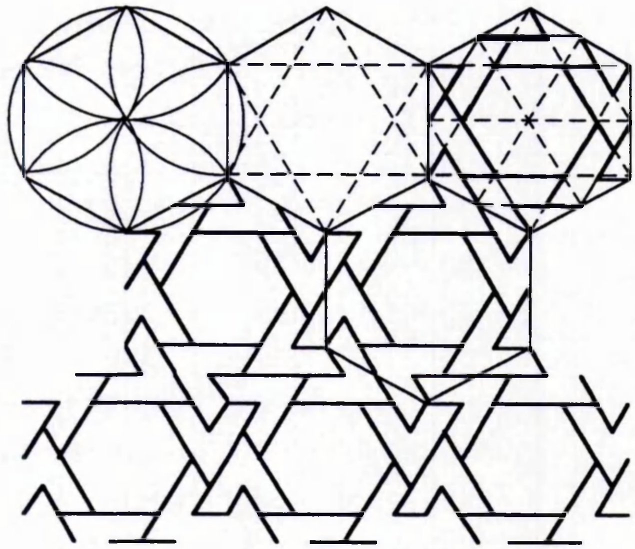

Figure 4.05. Islamic construction of figure 4.04.

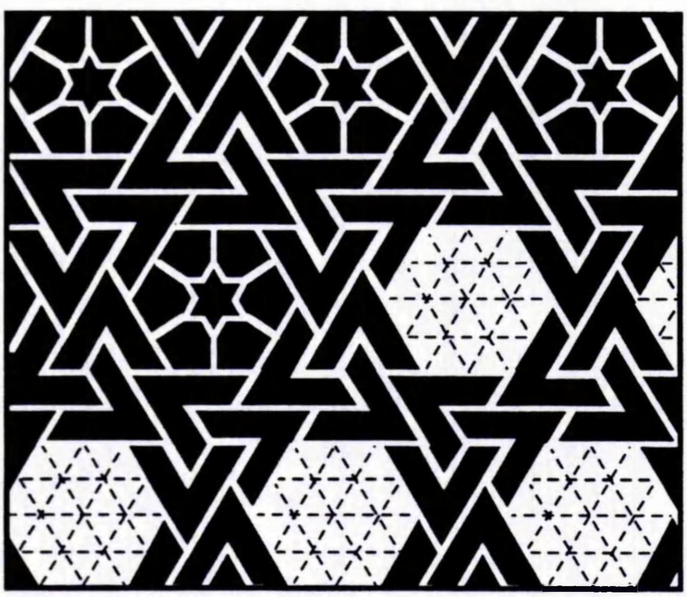

Figure 4.06. Construction of figure 4.04 based on a triangular network.

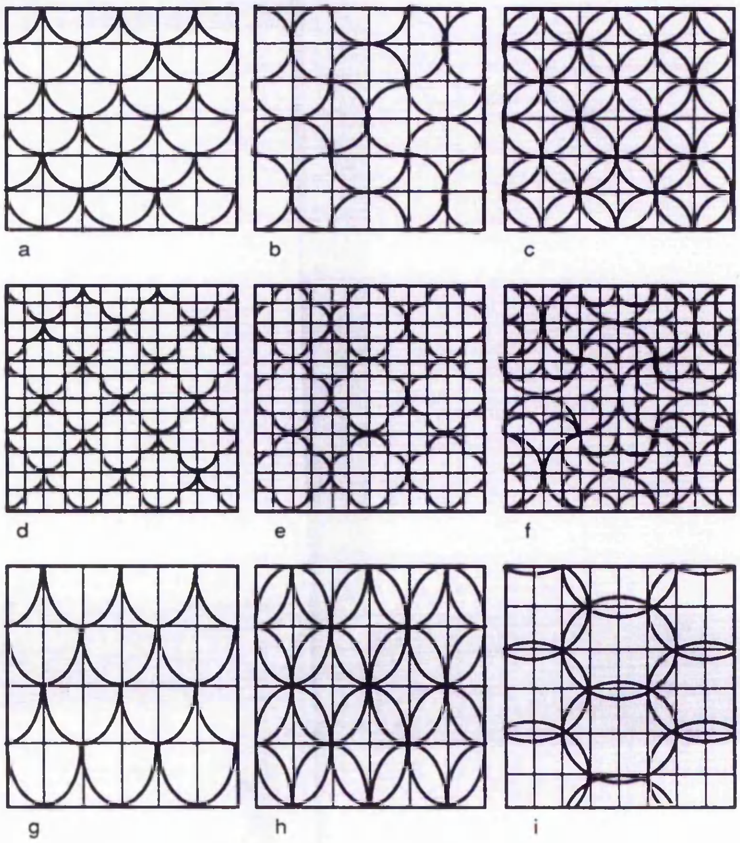

Figure 4.07. Meyer's square and rectangular networks with secondary construction lines. (a), (d), and (g) are varieties of scale pattern.

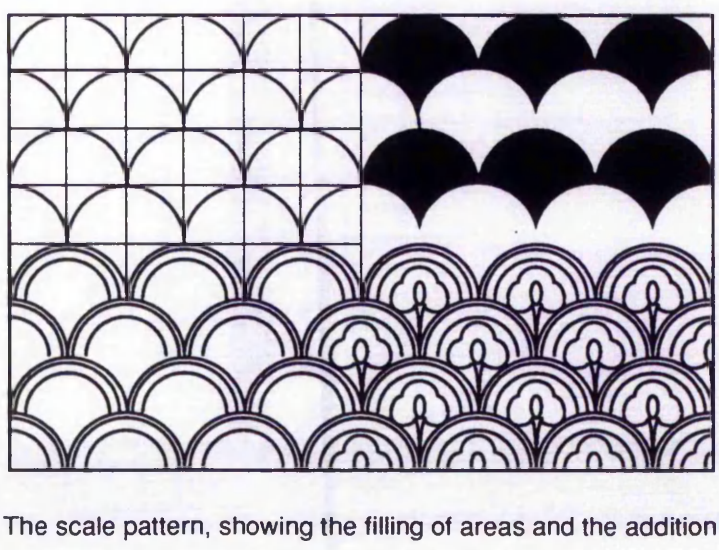

Figure 4.08. The scale pattern, showing the filling of areas and the addition of elements.

Figure 4.09. The scale pattern, showing the retention of the visual structure filled in with similar motifs.

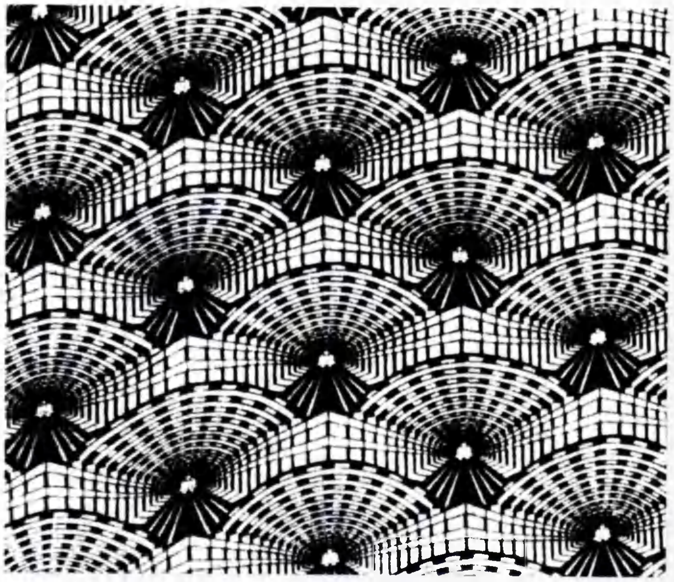

Figure 4.10. The structure of the scale pattern is emphasised in this geometric design.

Figure 4.11. The scale pattern used for the loose arrangement of motifs. The visual effect of the design form is retained without its strict geometric structure.

Figure 4.12. The scale pattern used as an underlying structure for the arrangement of elements.

constructed on a square network or a circle variant. Day regarded networks and secondary construction lines as a means of organising design elements, and he referred to them as the design's 'skeleton'.[52]

4.15. Design forms

Design forms, such as ogees and hexagons, can be formed by drawing secondary construction lines. Meyer illustrated some basic forms created from arcs drawn on square and rectangular networks (figure 4.07).[53] These included various 'scale motives'.[54] This form can also be constructed on a triangular network, and Day suggested that scales could be regarded as 'curvilinear diamonds'.[55]

Varying degrees of structural emphasis can be made by using design forms, as can be seen from the following examples based on the scale pattern. Geometric patterns can be created by simply filling in shapes within the basic form or by the regular addition of elements (figure 4.08). The form can be used as a visual framework, and can be filled with a variety of different motifs (figure 4.09).[56] Alternatively, the geometric structure can be emphasised in abstract or highly stylised designs (figure 4.10).[57] The form may be used without such a strict geometric structure (figure 4.11),[58] or it can be used as an underlying structure for more complex designs (figure 4.12).[59] Most often networks have been used in this last way as guidelines for the placement of motifs, and this has allowed designs to

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[52] Day suggested that 'a practical designer' should 'make them the framework upon which his pattern is built, the skeleton of his design'. Day, L.F., *Pattern Design*, London, 1903, reprinted 1915, p.10.

[53] Meyer, F. S., A *Handbook of Ornament*, London 1894, reprinted London 1987, p.11. Meyer distinguished between constructions formed by arcs, lines, or a mixture of both. His methods may have been due to the contemporary emphasis on categorisation. He was attempting to break patterns into their constituent parts, and his classification method encompassed types of imagery and design forms (3.13).

[54] In this example, a, d, and g are described as 'scale motives'. This design form is also referred to as the scale pattern, petal diaper, or imbrication. Other patterns, such as the feather and wave, and forms, such as the ogee ,can be seen as 'derivatives' of the basic scale pattern (figure 3.06).

[55] Day demonstrated the relation of the scale pattern to the diamond and ogee, showing how the ogee can be comprised of four rotated scale motifs. Day, L.F., *Pattern Design*, London, 1903, reprinted 1915, pp.34-5. A similar ogee construction can be seen in figure 4.04, example b.

[56] This is from part of a paper impression of a French printed textile design (1792). Brédif noted that the complete design had 18 different motifs. Brédif, J., *Toiles de Jouy, London*, 1989, p.116.

[57] In this Constructivist design, the tunnel image is highly stylised. *The Tunnel*, Russian printed textile design, 1927. From Woodham, J.M., *Twentieth-Century Ornament*, London, 1990, p.140.

[58] This French block printed textile design (1791) was produced at the same time and factory as the pattern shown in figure 4.09. It retains the scale pattern's imagery of overlapping filled shapes, although the construction is loosely drawn. Brédif, J., *Toiles de Jouy, London*, 1989, p.120.

[59] From Beauclair, R., *Dessins d'Ornementation plane en couleurs*, Paris 1900, reprinted as *Art Nouveau Patterns and Designs*, London, 1988, pl.1.

Figure 4.13. Symmetrical mirrored design showing one half roughed in.

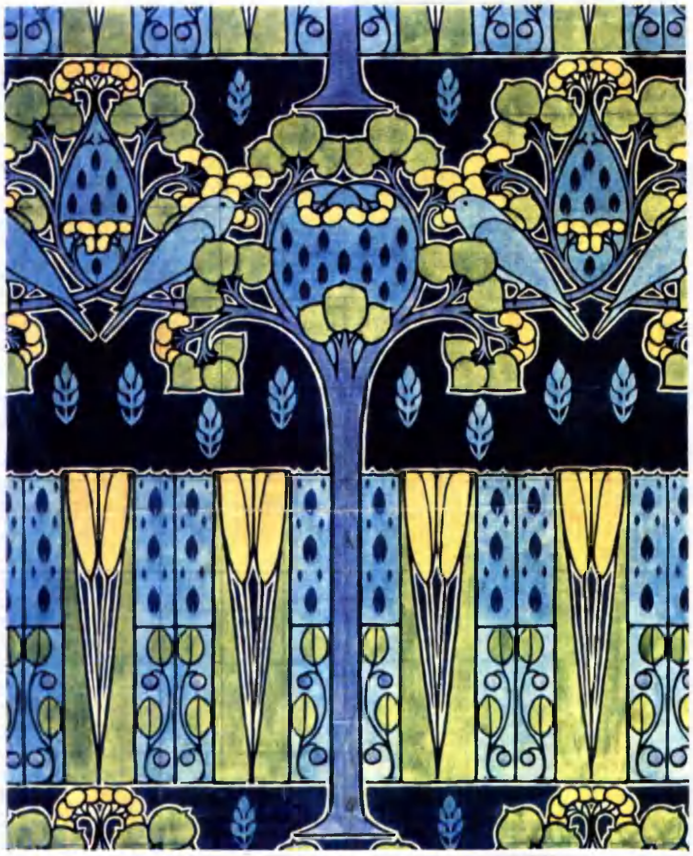

Figure 4.14. A mirrored design exhibiting strict bilateral symmetry.

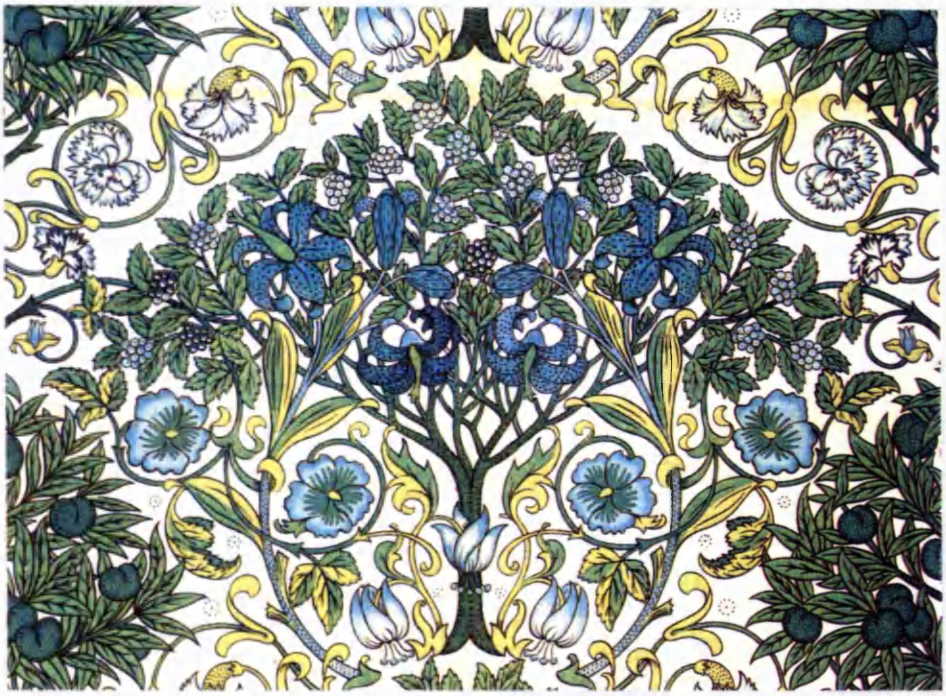

Figure 4.15. A mirrored design exhibiting deviation from strict symmetry on the vertical axis.

be drawn that did not necessarily have dominantly geometric appearances, although they were based on formal structures.

4.16. Symmetrical design forms

A similar informal use of geometrical structure is apparent in some mirror, or 'turn-over', designs that are symmetrical about a vertical axis.[60] The design area can be divided, one half drawn in full, and the other roughed in to indicate the whole repeat (figure 4.13).[61] In some designs the mechanical regularity engendered by the visually dominant central axis is diminished by leaving a small central vertical panel which is not strictly symmetrical.[62] Cheatham et al. referred to this type of variation as 'asymmetrical symmetry', and commented that, although the 'characteristics of symmetry like balance, correctness, or stability' are retained, 'enough visual variety can be introduced asymmetrically so that the image also evokes responses of human warmth, spontaneity, and so on'.[63]

The use of the turn-over in printed textiles has varied from strictly symmetrical designs, in which the symmetry is also emphasised by the clean lines (figure 4.14),[64] to those which have deviations from symmetry on the vertical axes (figure 4.15),[65] and those where similar design elements are arranged symmetrically (figure 4.16).[66]

4.17. Networks for planning

Limitations imposed by narrow fabric widths were important considerations in pre-20th century textile design,[67] making the use of networks not simply an

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[60] It has been suggested that the turn-over developed as a textile device from weaving techniques (6.03) and stencils (8.05 and 8.17).

[61] This repeat is based on an ogee form which has been visually retained to some extent by the branches. *Rose*, printed fabric design by William Morris (1883), from Parry, L., *William Morris and the Arts and Crafts Movement,* London, 1989, pl.2b.

[62] The symmetrical character is still retained when deviations from strict symmetry are used (2.14).

[63] Cheatham, F.R., Cheatham, J.H., and Haler, S.H., *Design Concepts and Applications*, London, 1983, p.41.

[64] Roller printed textile design, 1904. Parry suggested this may have been designed by Harry Napper. Parry, L., *William Morris and the Arts and Crafts Movement,* London, 1989, pl.66b.

[65] *The Melbury*, designed by Sidney Mawson. This has variations in leaves and stems on the central axis. Asymmetrical flowers and overlapping of leaves and stems on the axis are typical methods of introducing deviations from symmetry (see also figure 8.23).

[66] *Magnolia*, designed by Lewis F. Day, 1891. The arrangement is symmetrical about the central axis and provides balance to the overall design.

[67] Day related various networks to the standard fabric and wallpaper width of 21". 'If the repeat is on horizontal lines it must clearly be contained exactly twice, or three or four times, in the width; otherwise, when the material comes to be joined up, the design will not match'. Day, L.F., *Pattern Design*, London, 1903, reprinted 1915, pp.56-9 and pp. 81-2.

Figure 4.16. A design with similar elements arranged in a symmetrical manner.

aesthetic consideration, but also an economic method of practical planning. They divided the design area into sectors using mathematical divisions of the fabric width. This aided the planning of even coverage for small repeats[68] and the linking of larger repeats. Therefore, proofing a design would consist of minor, rather than major, modifications.

The half drop device evolved from the attempt to increase visually the width of a design that was to be printed on a narrow material. Day considered the drop to be a useful construction method in the design of wallpapers and fabrics that were of a limited width,[69] and textiles were often designed to be 'dropped' when the lengths were sewn together.[70] Planning was needed to create the desired continuous appearance, and designers effectively had to design outside the confines of the narrow repeat width of the fabric. To restrict the design to the dimensions of the actual repeat unit would almost certainly result in the lines of its boundaries being noticeable.

4.18. Repeated panel and band patterns

Panel or band patterns can be used to build up a design. Panel designs are usually based on the symmetrical division of a defined area and, when repeated, exhibit a regular grid appearance. Bands can be placed in rows to form stripe patterns.[71] The final form of a design does not necessarily indicate the original form on which it was drawn. For instance, a design on a serpentine, or waved, line may be mirrored or dropped to create an ogee form at the design or printing stage. Christie used an illustration of an Indian 'waved-stem pattern' which was dropped to give a 'reversed waved-stem pattern' on ogee lines (figure 4.17).[72] This technique introduces extension methods which are based on the copying and placing of design units to build up a pattern.

[68] A network method based on the construction of woven sateen patterns maybe used to plan the placement of motifs in the design of 'random' spot patterns (9.35 - 9.38).

[69] Day noted that, 'whilst it is obvious that the pattern must follow in a continuous line throughout the length of the stuff, it is not a matter of necessity that it should be designed to take the same level when the strips come to be sewn together or hung upon the wall. They have to tally - that is all.' Ibid, p.60.

[70] Wider textiles are now produced, and the drop is used as a device for repeating across the width of the fabric, rather than across consecutive widths. The need for wallpaper to be of manageable size has meant that the width has remained the same, even though it could be produced in a wider format.

[71] This technique was commonly used for block printing. Bands were printed as borders in conjunction with repeating patterns, or in rows as striped patterns. Double stripe patterns were printed by combining two bands (8.12).

[72] Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford 1910. Reprinted as *Pattern Design*, London 1969, pp. 187, 201 and 203.

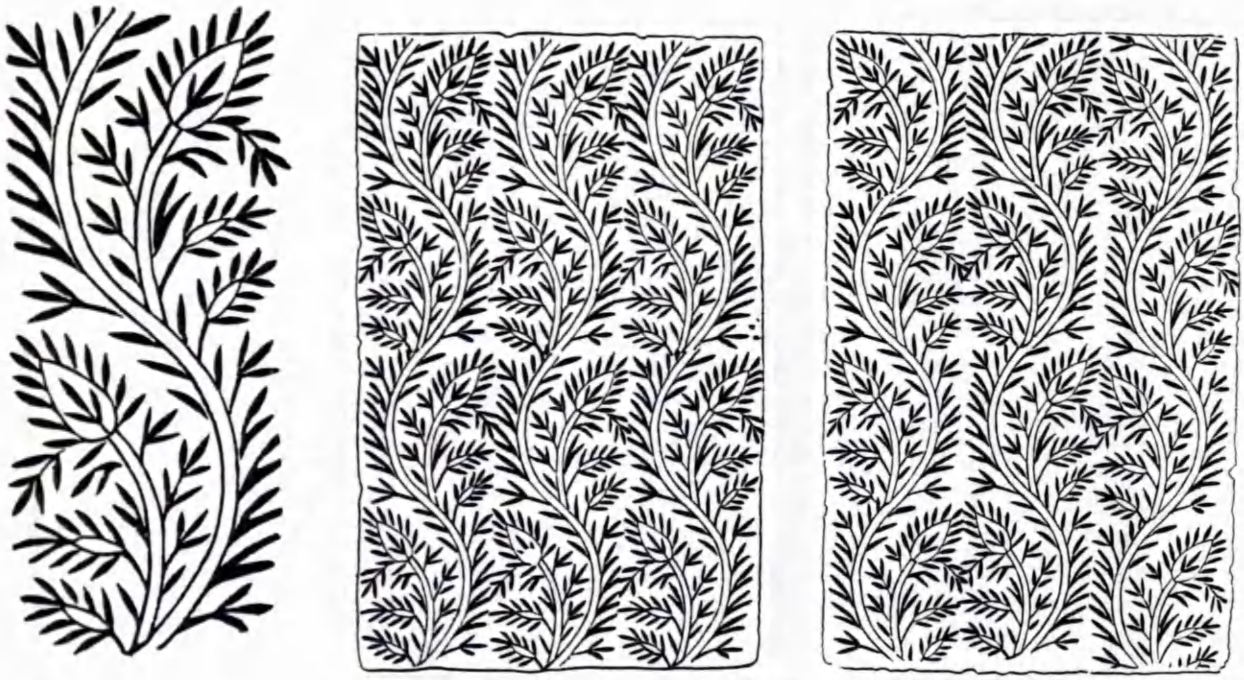
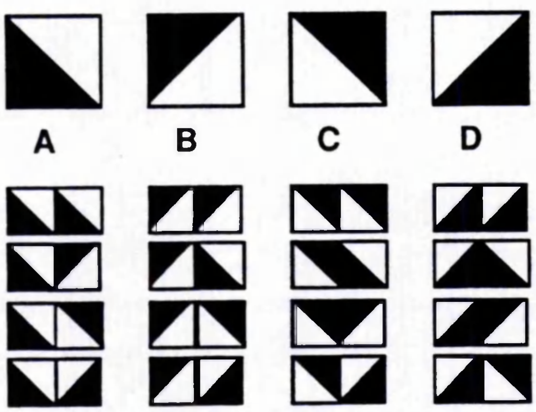


Figure 4.17. A design unit repeated to form a 'waved stem' design and dropped to form an ogee form.



AA	BB	CC	DD
AB	BA	CA	DA
AC	BC	CB	DB
AD	BD	CD	DC

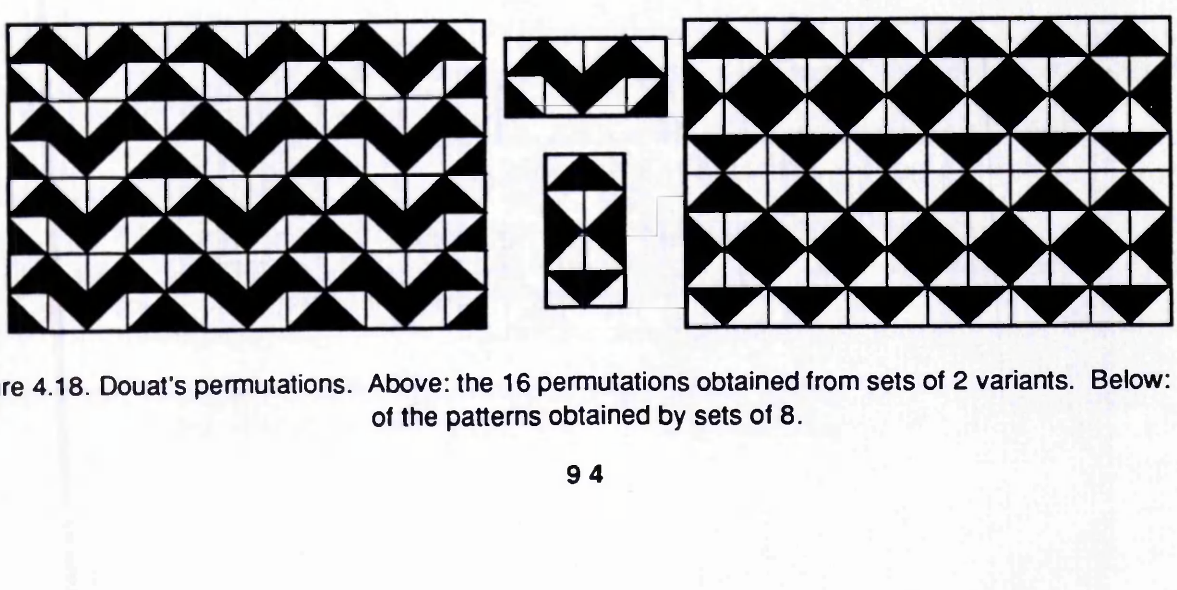


Figure 4.18. Douat's permutations. Above: the 16 permutations obtained from sets of 2 variants. Below: two of the patterns obtained by sets of 8.

EXTENSION METHODS

4.19. Repetition

At the most basic level, extension is the simple repetition of a motif or pattern unit, that is the regular translation of the unit in two dimensions.[73] By introducing transformations of the unit (rotation and mirroring), more complex arrangements can be built up. The units can be separated from each other, and pattern interest can be achieved by the variation of unit arrangements, rather than the intricacy of their imagery.[74]

4.20. Permutation

In the early 18th century, Douat developed a method of permutation based on a two-coloured square unit which, when rotated by ninety degree turns, produced three variations (figure 4.18). He then combined these in sets, showing that sets of two variations produced 16 permutations, sets of four produced 256, and by combining these combinations, he produced 65,536 permutations from one original unit.[75] Similar methods have been proposed for creating geometric patterns using rectangular units, and introducing other transformations and changes in orientation. For instance, Smith illustrated the composition of many complex geometric repeat patterns by a variety of arrangements of one simple unit.[76] There were other similar publications prior to the 1950's, but following this basic pattern making was considered to be less important in design education, and more emphasis was placed on developing students' individual creative potential.

4.21. Variation

Pattern variations can be achieved by a number of methods, such as changing the colours of alternate units within a regular repeat format (counterchange).[77] The size and/or spacing of units can be altered or graduated to produce variations of scale. Spot patterns are often given a random appearance by simple changes in the orientation of individual motifs, and patterns formed by the repetition of small

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[73] The polka dot pattern is the most obvious example of the simple form.

[74] This can be used with unsophisticated printing elements, such as stamps, simple blocks, and stencils, to cover an area with multiples of one motif. Units may be placed in rows, diagonal lines, or more complex arrangements. Stamps can be rotated and stencils turned over to produce mirrored units (8.05).

[75] Gombrich made reference to Douat's work (1704), as presented by Truchet, S., (Paris, 1722). He noted that the setting out of the system 'must recall to the modern reader the methods of demonstrating the genetic code as discovered in the "double helix" '. Gombrich, E.H., *The Sense of Order*, Oxford 1979, pp.70-2.

[76] Smith, A., *Fabric Printing*, London, 1953.

[77] Simple counterchange is illustrated in figure 3.05 as alternating sequence applied to isolated forms.

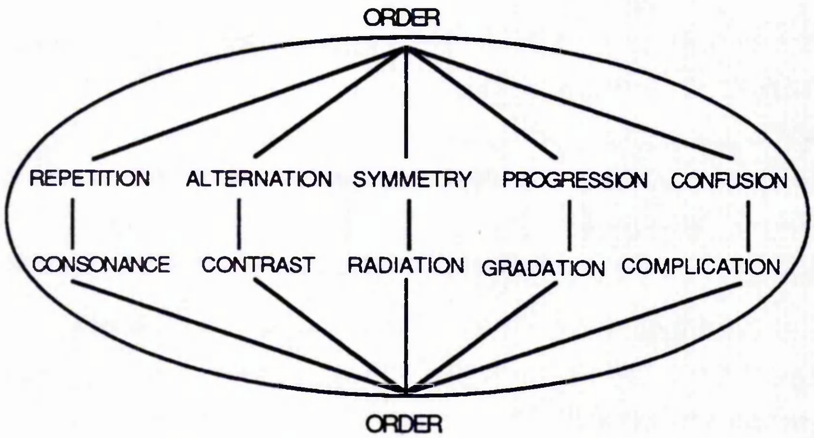
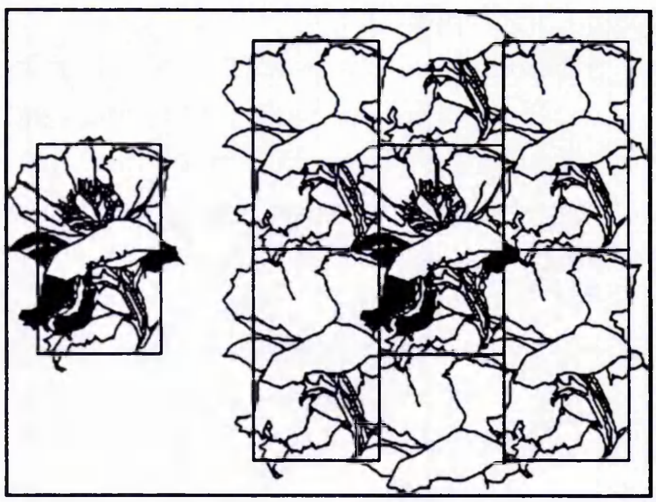


Figure 4.19. Diagram from Charles Blanc.



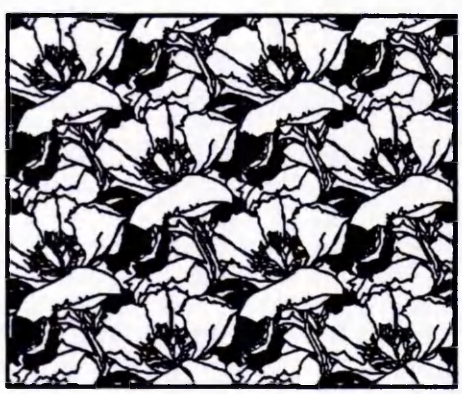


Figure 4.20. The construction of a half-drop design, showing the design elements exceeding the boundaries of the repeat unit.

motifs can be given a less mechanical appearance by introducing slight changes or irregularities in individual motifs.[78]

Blanc proposed design concepts which related to the use of order in pattern,[79] suggesting how it could be linked to variations on basic themes. He illustrated the main and subsidiary characteristics of pattern, showing contrast as a form of alternation and gradation as a form of progression (figure 4.19).

4.22. Repeat units

Most contemporary designers now rely on simple extension methods, and many designs are produced and sold in *croquis*, or sketch form. The design emphasis is on the aesthetic and stylistic characteristics of the imagery, and structure and repeat are used to extend the image, rather than being an initial consideration in the design process. A rectangular design unit, comprising a croquis or a selected portion of it, forms the repeat unit. Copies of this unit are placed in relation to the original, using the basic operation of translation. The distance moved during a translation relates to the width and/or height of the unit rectangle.[80] The unit can be tested in various repeats, with the rectangle being used as a guide to the placement of the copies. Copies can be mirrored, rotated, and counterchanged to create variations on the basic theme (see Chapter 9). Justema referred to these as 'tricks of the pattern trade not used until the plan has been established'.[81]

To achieve a striped or spotted effect, the basic unit may be wider or generally larger than the design, so that the elements are spaced in rows or isolated on the background. If a continuous effect is required, however, the design elements need not be completely contained within the basic unit rectangle so, when the unit copies are repositioned, any extending elements can overlap other units and negate the tendency to a grid-like appearance produced by noticeable gaps or joins (figure 4.20). Flower suggested that the 'rhythms and directional shapes that arise from the repeat cannot do so if the original design is placed within a square or rectangle like a motif, and an interesting pattern will only arise if the shapes are allowed to overlap or interlock on the repeat'.[82]

[78] Irregularities are often used in small-scale patterns (8.04), and are detected easily in arrays (2.11).

[79] Blanc, C., *Art in Ornament and Dress*, English edition, London, 1877, p.45.

[80] In printed textiles, this rectangle's dimensions should relate to the width of the fabric and the printing method to be used (7.03).

[81] Justema, W., *The Pleasures of Pattern*, New York, 1968, p.38.

[82] Flower, L., *Ideas and Techniques for Fabric Design*, London, 1986, p. 50.

The unit, or combination of units, can be modified. Isolated motifs may be altered if awkward shapes are produced by the background areas. If continuity is required, alterations can be made so that elements are joined, and gaps filled in to remove any breaks in the overall flow of the pattern. Modification can be performed by quartering the design. This places the edges of the repeat in the centre, and elements can then be linked or extended over the joins to mask any breaks.

4.23. Structure in contemporary design

Structure is integral to holistic design methods, and is considered at the initial stages. Design forms, such as the ogee, were often visually dominant, imposing rigid appearances. In the late 19th century, designers, such as Morris, developed a 'looser' style which, although based on these design forms, introduced a more organic use of imagery. Although, at that time, they were seen as relatively informal, today they are regarded as formal and ordered. The ease with which structure is recognised depends on the viewer's experience, therefore new, comparatively unstructured designs will appear informal. With the trend towards greater informality, these 'new designs' will soon appear more structured.

Gombrich suggested that 'delight lies somewhere between boredom and confusion', and he linked boredom to ease of recognition, but noted that 'a surfeit of novelty overloads the system', resulting in confusion.[83] The concept of novelty is now mostly concerned with variety of imagery and its manner of presentation. Structure is used to repeat imagery rather than organise designs.[84] The use of order has now become a design strategy to be employed as a statement in 'modern' design and in revivalist or 'ethnic' designs in which the structure is intrinsic to the overall feel.

A holistic approach to pattern has been revived by contemporary developments in scientific thought (2.20) and a renewal of interest in Islamic design.[85] This duality of the arts and sciences has compelled Albarn to comment, 'Perhaps we are now witnessing a change of emphasis, as science deals increasingly with the intangibility of "reality" '.[86]

[83] Gombrich, E.H., *The Sense of Order*, Oxford, 1979, p.8. (2.10).

[84] Wider fabrics and technological developments have reduced the reliance on structure as a means of producing continuous designs within the restrictions of a small repeat (8.15). Economic factors of pattern cutting wastage have increased the demand for non-directional fashion designs (8.16).

[85] Since 1970, there have been many publications about Islamic design, and its cosmological implications also seem to be taking root in the intellectual subconscious.

[86] Albarn, K., *The Language of Pattern*, London, 1974, p.62.

CHAPTER 5: TECHNOLOGICAL CHANGES

5.01. New processes

New textile printing and engraving processes[1] have never automatically superseded existing production methods; 'most of the advances have been evolutionary in nature. To qualify for revolutionary status, a development must replace an existing machine or system'.[2] New techniques have usually stimulated fashions; 'mechanical and chemical advances often brought about styles which date from the discovery of a new process'.[3] Styles associated with particular developments in printing and engraving technologies have not, however, been restricted to those processes. They became part of the textile vocabulary, and have often been adapted for established or new processes.[4]

Usually, established processes have continued and developed alongside new technologies,[5] and competition encouraged the development of new techniques as manufacturers sought to simulate novel effects or develop alternative specialist products. Many companies still use combinations of equipment and processes suited to the production of particular types of design, and, because of the high investment in machinery and skills, new processes are often added as companies expand to supplement, rather than replace, existing production equipment.[6]

The following sections of this chapter cover the development of printing and engraving processes. These are listed chronologically in Appendix 1.

5.02. Painting and pencilling

There were three techniques used in the production of painted textiles from which textile printing developed. These were using a resist or a mordant, both

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[1] Engraving is the general term applied to methods of transferring a design to a textile printing element. In the production of woodblocks, *engraving* and *carving* are applied specifically to the cutting of blocks for paper printing and textiles, respectively.

[2] Suchecki, S.M., *Innovations in Printing Machinery Technology,* Textile Chemist and Colourist, 1980, Vol.12, Part 5, p.23. Suchecki cited the Millitron system as a revolutionary development (5.41).

[3] Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p.141.

[4] Although the technique of pinning, or *picotage* (5.08), 'is no longer used, the look has remained a part of the design vocabulary' and the effects are seen 'in traditional floral chintzes that aim to recapture the old-fashioned block-printed look'. Meller, S. and Elffers, J., *Textile Designs,* London, 1991, p.106.

[5] For instance, block-printing was not discarded with the introduction of plate or roller printing, but was retained for its characteristic qualities. In 1949, Wright commented that 'block printing still persists and possesses a characteristic charm of its own'. Wright, R.H., *Modern Textile Design and Production,* London, 1949, p.72. Techniques were developed to copy the effects of new printing processes (5.07), to produce new effects (5.10), and to exploit the flexibility of the printing process for specialised products (8.21 and 8.30). Economic factors were also important in its continuance (1.05).

[6] Even though rotary screen printing is now dominant, flat bed screen printing is highly competitive (1.11), and roller and block printing are still used for specialist applications.

followed by dyeing, and direct painting, itself.[7] These techniques were normally combined for multi-coloured designs because different processes were required to produce the colour range.[8] The associations between colour and technique were important factors until the late 19th century.[9] Parnell listed six *styles of printing*, each associated with particular processes needed for the application and fixing of different colours, stating that 'by the proper combination of two or more of which the cloth may be ornamented with any pattern'.[10] Some of these have become obsolete due to advances in dyes and printing pastes. Now, most prints are produced by direct printing, although discharge and resist methods are used for specialist prints.

European 'pencilling' techniques were based on Indian processes.[11] Attempts were made to apply indigo directly, including the pencil-blue technique,[12] but 'so little time was available for application, quick dabs and dashes made for a rather

[7] With resist techniques, the design appears as a reserved pattern on a dyed ground. In mordant techniques, the dye is taken up by the painted design which then appears on a plain ground.

[8] This was apparent in the production of Indian textiles. Red and black were produced by the application of two different mordants, followed by immersion in a red dye bath. Blue was achieved by the application of a wax-resist followed by indigo dyeing, and yellow by the direct application of a dye. Other colours could be produced by exposing areas to more than one of these processes. Irwin and Brett summarised the Indian processes for fine cotton-paintings in ten stages to produce a range of colours. Irwin, J. and Brett, K.B., *Origins of Chintz,* London, 1970, p.8.

[9] Styles have often been associated with new colours. The introduction of turkey red in the 1790's 'sparked a vogue for monochrome cotton designs showing red on a bleached ground'. Williams, R., in *The Illustrated History of Textiles,* edited by Ginsburg, M., London, 1991, p.60. Similar influences are associated with the introduction of quercitron, direct printing of indigo, and processes such as discharge printing (5.07).

[10] Parnell, E.A., *Dyeing and Calico Printing,* London, 1849, pp. 115 - 7.

1. The *madder style*, 'for soluble vegetable and animal colouring materials', was a mordant process. 2. The *topical style* was a direct technique, in which the colour was printed (sometimes with a mordant) and followed by drying or steaming. 3. The *padding style,* for mineral colours, combined printing and padding to impregnate the cloth with two solutions. 4. The *resist style* combined the printing of a resist paste and vat dyeing. It was sometimes used in conjunction with the *madder style* to prevent the attachment of a mordant. 5. The *discharge style* involved the removal of colour from a previously dyed textile. 6. The *China blue style* involved the printing of a paste containing indigo, iron sulphate, and a thickener applied directly on to the cloth. The pigment was then dissolved and transferred onto the textile by successive applications of lime and copperas. The characteristic effects of different processes are associated with particular design styles, but processes were often combined to incorporate various effects.

[11] These textiles were called *les toiles peintes* (painted cloths). The popularity of imported Indian textiles stimulated the copying and adaption of designs and processes (1.03). Some colours such as yellow (from weld) were directly hand-painted, others were produced by resist methods or by painting a variety of mordants which produced a range of colours when combined with madder.

[12] European pencil-blue (1730's) and China blue (1750's) techniques were developed to allow the direct application of indigo. Until these processes came into use, blue could only be produced by resist techniques. Many British designs sent to India for dyeing had required up to 90% of the fabric to be covered with wax resist to achieve the desired light ground. Floud, P.C., *The English Contribution to the Early History of Indigo Printing,* The Journal of the Society of Dyers and Colourists, LXXVI, no. 6, June 1960, p.345.

crude, uneven *jaspé* appearance'.[13] The technique continued to be used with block and plate printing to add extra colours and details.

5.03. BLOCK PRINTING

The use of stamps to repeat combinations of design elements to build up a pattern is the oldest form of printing,[14] and many contemporary third-world prints, such as Adinkira and Adire cloths, are resist-printed with stamps and stencils.[15]

5.04. Wood-blocks

Designs are traced onto a flat block of close-grained wood (the parts to be printed being left in relief, and the remainder cut away). The raised parts of the block are charged with colour, and the block is pressed onto the substrate, transferring a reversed impression of the design.[16] Repeated impressions are made across the width and length of the fabric for continuous designs. The skill required for accurate registration results in slow production.[17]

The size of blocks is limited for easy handling.[18] Early blocks were relatively small and, although printers in the late 19th century regularly used dimensions of 15" (375 mm) square and 20" x 15" (500 x 375 mm), many were still no larger than 10" (250 mm).[19] The size of repeat varied according to the type of design and the width of the fabric to be printed. The width of the repeat was based on a division of the fabric width. To print a width of 30" (750 mm):-

Repeat width	5" (125 mm)	6" (150 mm)	7.5" (187.5 mm)	10" (250 mm)	15" (375 mm)
Repeats	6	5	4	3	2

[13] While pencilling 'is evident on polychrome textiles, it is most unlikely that a complete cloth would have employed this technique alone'. Katzenberg, D.S., *Blue Traditions*, Baltimore, 1973, pp.29 and 53.

[14] Stamp seals with simple linear designs, circa 7,000 BC, which may have been used for stamping textiles, have been found in Syria. These were made of stone, but later ones from Turkey were of baked clay. Later still, cylinder seals could create continuous designs. Collon D., *Near Eastern Seals*, London, 1990, p.14.

Clay stamps from the 'preclassical period of Mexican culture' were of various shapes, including cylindrical seals for borders. Smeets, R., *Signs, Symbols & Ornaments*, London, 1975, p. 130.

Stamps were sometimes used to apply wax or clay resist for Coptic prints.

[15] A resist of wax or cassava paste is used. Patterns are usually produced by the repetition of many small stamps which permits flexibility in the arrangement and orientation of individual elements (6.13 and 8.11).

[16] For multi-coloured designs, a separate block is needed for each colour.

[17] Some 20th century block prints were misregistered to exaggerate hand-crafted effects (8.15).

[18] Sizes have varied from small stamps up to about 20" x 15" (500 x 375 mm). The maximum size has also been affected by the extra weight introduced by the use of coppered and metal blocks (5.08 - 5.09)

[19] Storey quoted from *The British Manufacturers Companion and Calico Printers Assistant*, by O'Brien (1791) who said that blocks should not be 'above nine inches long, it being handier for working and not so apt to warp'. Storey, J., *Textile Printing*, London, 1974, p.41.

The height of a block was decided by the design's proportions, the maximum practical size being 20" (500 mm). Small repeats could be catered for by cutting copies of the repeat onto one block. Large repeats could be divided and cut on several blocks, and then joined during printing.[20]

5.05. Early European block printing

Most early wood-block prints were monochrome.[21] German prints were often separated rows of figures, stamped with small blocks[22] which were cut so that the design stood in relief. As the patterns were of isolated impressions, accurate registration was unnecessary.[23] International prints used larger blocks, therefore fewer impressions were required, providing a more efficient process. Most blocks were cut to print the background, leaving unprinted motifs on which additional details and colours were pencilled in.[24]

Design continuity had an important bearing on printing. For designs with printed grounds, misregistration would cause either dark lines or gaps in the ground colour if the impressions were overlapped or not butted-up. For those in which motifs were printed, any shifts in the horizontal or vertical would produce noticeable fault lines when elements failed to join up correctly. Therefore, to avoid obvious joins in the printed repeat, these blocks were cut in irregular shapes, allowing design elements to be printed as complete forms.[25]

5.06. 17th century European block prints

These were mostly based on imported Indian calicoes, and were produced

[20] This assembly method allowed the creation of large (8.24 and 8.26) or complex designs, and was exploited in the production of shawls, scarves, bedspreads, etc. (8.30).

[21] The earliest examples are from the 12th century (1.02).

[22] Some prints were on linen, but most were on imported silk, satin, and taffeta. These were printed with black gum, and sprinkled with powdered glass, silver, or gold, attempting to produce a rich effect (1.02). The 'colours used were only pigment and metallic colours applied to the cloth with gum and like substances to stick them'. Turnbull, G., *A History of the Calico Printing Industry of Great Britain,* Altrincham, 1951, p.17.

[23] From the late 14th century, German designs became more intricate, exhibiting continuity, and were printed using larger blocks. Being printed with coloured oils, they were smelly and streaky. The print stuffs and scale of design indicate that they were intended for hangings rather than personal use. Biriukova suggested that they tended to use 'somewhat simplified and schematised ornament' in comparison with Italian prints. Biriukova, N., *West European Printed Textiles: 16th-18th century,* Moscow, 1973, p.18.

[24] Most prints of the International group were on dyed or plain linen. They have the appearance of resist printed textiles with the motifs plain on a printed ground, but joins are apparent where impressions were out of register. Imported prints may have influenced them because resist printing was not used in Europe (1.02).

[25] The concept of repeat was much more important in designs for this group (8.15). Most patterns for block printed textiles were based on geometric structures (4.04). The pattern repeat could be contained within a geometric figure, but if the block was cut strictly in this shape, then any elements extending over the edges would be broken with parts printed in subsequent impressions. The problems of inexact registration and uneven pressure would cause visual breaks in the continuity of the design.

using mordant techniques.[26] Early designs were printed in outline on a plain ground using blocks no larger than 12" x 10" (300 x 250 mm), with additional colours and details pencilled in.[27] In the late 17th century, polychrome prints were produced by consecutively block-printing different mordants, and using a single madder dye bath.[28] Metal blocks were used to print wax resist.[29]

5.07. Reactions to competitive processes

From the mid-18th century, increasing competition from new printing methods stimulated the further development of block printing. New techniques were introduced to replicate the effects of engraved copper plates and, later, rollers. Printers made many attempts to print indigo directly,[30] and eventually succeeded with the China-blue technique.[31] Discharge printing allowed designs on dyed or patterned grounds. From its introduction in the 1790's, it prompted a range of developments in block and roller printing, often combining these processes.[32]

At the start of the 19th century, attempts to cut costs resulted in larger blocks and cruder designs with fewer colours. Motifs were drawn with thick black outlines to

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[26] To facilitate the transition from painting to printing mordants, two problems needed to be solved. Firstly, that the mordants needed to be sufficiently viscous to retain the printed shape, but at the same time, be easily removable from the cloth without affecting the madder-mordant action. Secondly, excess madder, which may have spread into areas required to be uncoloured, needed to be removed. The first problem was solved by Sherwin in 1676, with the use of thickeners combining starch, flour, and gum. The second by the use of clearing baths and sun-bleaching.

Exceptions were 16th and 17th century Dutch resist prints in which the design was block printed using a resist paste. The fabric was dyed and then washed to reveal a white pattern on a coloured ground. Oil prints also continued to be produced, particularly in Germany.

[27] Indian chintzes can be distinguished as fine (painted) and common (block-printed). The majority of imported textiles were in the former category (1.03 and 6.09). 'European methods of wood-block printing were less time-consuming, but could not emulate the fine flexible line of hand painting although French printers became skillful at painting fine outlines and shading in details'. King, B., *Chintz,* Textiles, 1991, no.1, p.25.

[28] Various tones of red, sepia, aubergine, and black could be produced using different mordants; 'colourful designs were accomplished by using multi-blocks, over-printing and madder dyes which permitted more than one colour to emerge from a single dye bath'. Katzenberg, D.S., *Blue Traditions,* Baltimore, 1973, p. 53.

[29] Metal blocks were used to print hot wax-resist. These were made of tin, lead, or pewter, and were used with a sand covered printing table to prevent seepage of wax. Floud made reference to documentation of this method in the late 17th and early 18th centuries. Floud, P.C., *The English Contribution to the Early History of Indigo Printing,* The Journal of the Society of Dyers and Colourists, LXXVI, no. 6, June 1960, p.345.

[30] Attempts had been made to apply pencil-blue techniques (5.02) to block printing during the 18th century, but problems had occurred.

[31] This was developed in the mid- to late 18th century, it was also used with plate printed toiles.

[32] From 1805, motifs were often discharge printed using blocks on dyed or fancy machined grounds. This allowed small, detailed pinned designs to be produced on dark grounds (5.08 and 5.14).

mask misregistration which, combined with new colours, gave a bold effect.[33]

5.08. Pinning, coppering and felting

Wood-block printing was most successful with designs incorporating line work and small areas of flat colour,[34] but, from 1780, metal elements were added to the blocks to permit finer details. Pinning, or *picotage,* was produced by hammering brass or copper pins into the surface of the block. The heads of the pins were often simple shapes, such as lines, crescents, and stars, and a variety of effects could be produced quickly and cheaply. Details and complete designs were formed by pinning, giving shadowy effects similar to stipple engraving. Inlaying thin copper strips, as narrow as 1/64", produced fine lines for intricate designs, and closely spaced diagonal lines created weave effects.

To print large blotches, the block was hollowed out and 'felted' (filled with a felt pad to ensure an even spread of colour), and metal was added to strengthen sensitive design areas. The extra weight of the metal decreased the manageable size, making the maximum size of a coppered block about 18" (450 mm) square.

5.09. Metal blocks

In the mid-18th century, blocks made entirely of metal were produced by making casts from wooden blocks.[35] These were expensive and their weight limited their practical size, but they created firmer impressions and lasted longer. Stereotype cast plates frequently had several repeats mounted together on a block to produce small all-over or border designs.[36] By the 1900's, these had replaced coppered blocks for printing small repeats.

5.10. Simultaneous colours

Several methods were introduced to allow simultaneous printing of more than one colour from the same block. Toby printing was effective with designs in which large colour areas were separate and distinct. The complete design could be cut into one block, and different colours applied to the various areas using a sieve

[33] Quercitron, a fast yellow dye, was introduced around 1800, providing the new colour ranges associated with the Pompeian and drab styles.

[34] Very fine lines were fragile and difficult to cut. The size of blotches was limited because the wood did not hold water-based dyes or mordants well, producing uneven impressions. Blocks with fine lines and blotches became uneven because the wood swelled through constant exposure to dye-stuffs. Line details needed thicker colour than blotches, therefore two blocks were used for lines and blotches in the same colour.

[35] The wooden moulds were cut using traditional methods. Gas and electric tools were introduced to engrave intricate designs. Metal blocks had previously been used for hot wax-resist (5.06).

[36] Stereotype blocks were especially good for small-scale detailed designs, such as tie prints and fine paisleys. They were often used for discharge printing detail on dark grounds.

containing sections for each colour.[37] This reduced block-cutting and printing costs. Rainbow stripes could be produced by applying various colours or varying tints of one colour across the whole block.[38] This effect was achieved using a sieve in which the colours could be arranged in horizontal, vertical, or diagonal lines, and merged to create graduated stripes.

5.11. Mechanisation

In spite of many attempts to mechanise block printing, the only early successful machine was developed by Perrotine in 1834.[39] Perrotine printing was produced by a three-colour printer, which had a restricted repeat height of 5.25" (130 mm), but could print the whole width of the fabric. This ensured regularity of repeat, and made it effective for repetitive small-scale designs.

Impact printing was introduced in the early 1950's. Here, the block was clamped onto a machine that ran on rails along the edge of the printing table. Registration was effected by setting stops, and impressions were made by a lever system that 'impacted' the block onto the fabric.[40] Rotary methods of relief printing were developed using rollers with the design cut in relief.[41]

5.12. COPPERPLATE PRINTING

The invention of copperplate printing is attributed to Robert Nixon, in Ireland, around 1752. The process facilitated the printing of large-scale detailed designs. Many repeats were about 40" (1000 mm) square, and even larger designs were assembled using 4 or 6 plates. Colour was applied to the surface of the plate and then wiped leaving dyestuff in the engraved lines. The plate was then pressed onto the fabric. Early cylinder presses restricted prints to single articles. The development of the flat-press machine allowed lengths to be printed, but, though 'the plate moves away automatically after printing, allowing the adjustment of the

[37] Knecht and Fothergill illustrated this method in detail. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.33.

[38] This effect was developed during the 1820's. It was used extensively in Continental Perrotine printing. It was also applied to roller and surface printing (5.16 and 5.21), and was popular until 1850 (6.19).

[39] It was widely used in Europe until the 1930's. Storey suggested that this method was not applied here because British industry had 'plunged so eagerly into mass production that the blockprinting machine was not sufficiently speedy'. Storey, J., *Textile Printing,* London, 1974, p.50.

[40] 'At its most efficient impact printing was fifty per cent quicker than hand block work'. Clark, H., *Textile Printing,* Aylesbury, 1985, p.15.

[41] Surface printing (5.21) and flexography for the printing of transfer papers (5.34 and 5.40).

repeat', the fitting was difficult and registration inexact.[42] It has been suggested that inaccurate registration prevented more than one colour being printed and, although there are references to two-coloured prints,[43] most prints were monochrome with additional flat colour introduced by pencilling or over-printing with blocks.

5.13. Engraving

Plates were engraved by hand using a burin, or steel engraver. The intaglio method was the same as that used for engraved illustrations, allowing the transference of techniques, such as cross-hatching and stippling for tonal effects, and the engraving of delicate lines.[44] The process was slow, and engraving expensive, so, to recoup the initial outlay, it was used mostly for furnishing fabrics because these designs stayed in print longer.

Towards the end of the 18th century, engraving became coarser and more mechanical in order to cut costs.[45] Montgomery wrote that 'novelty gradually overshadowed quality of design and drawing, and increasingly designers were required to satisfy specific markets with readily saleable subjects'.[46] The increasing emphasis on novelty made plate printing uneconomic and, by the 1830's, it was used only for specialist items, such as commemorative handkerchiefs.[47]

5.14. ROLLER PRINTING

From the 1750's, a continuous method of printing engraved images was sought, culminating in James Bell's six-colour copper roller printing machine in

[42] Brédif quoted from Schwartz,P.R., *Histoire générale des techniques,* Paris, 1968, p.716. Brédif, J., *Toiles de Jouy,* English translation London, 1989, p. 52. Knecht and Fothergill claimed that 'continuous designs are never attempted', and that plates were restricted to 'the printing of patterns that are either made up of detached objects or sprays, or that are complete in themselves without repeats'. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.53.

[43] Rothstein referred to two-coloured prints produced with two plates. Rothstein, N., in *Designs for British Dress and Furnishing Fabrics,* Victoria and Albert Museum, London, 1986, p.19.

[44] Engraving of copper plates for printing paper had been used since the 15th century. The techniques allowed the production of highly detailed pictorial prints. The plates were larger and engraved more deeply, the 'volume of the engraved recess being a determining factor in the intensity of the print'. Shore, J., *Machines for textile coloration,* Textiles, 1990, vol.19, no.1, p.19.

[45] As the fashion for pictorial prints waned, prints became simpler, often consisting of intertwining floral trails or stripes, interspersed with motifs, such as bouquets and cornucopia.

[46] Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p.251.

[47] In 1925 Knecht and Fothergill commented that it was still used with block printing in Switzerland 'for the production of a special style of handkerchief with a finely engraved border and a floral centre'. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.54.

1783, which combined a seamless engraved cylinder with a doctor blade.[48] This design has remained almost unchanged, with modifications concentrating on achieving faster running speeds and increasing the durability of rollers.[49]

Although roller printing could not produce the same quality of print as engraved plates, it had the advantages of continuity and registration, which allowed multicoloured prints and the fitting of repeats. Its advantages over block printing were speed, the potentially larger repeat size, and the accuracy of repeat once the roller had been engraved. Block printing was often combined with roller printing to add dense areas of flat colour or motifs to fancy grounds.

Engraving rollers is expensive, and the changing of designs and colourways is time-consuming, making roller printing economically viable only for long runs. It remained in wide use until the 1970's but, since the advent of rotary screen printing, is now rarely used in the West, except for specialist applications.[50]

5.15. Roller sizes

To ensure an accurate fit, the size of the repeat must be based on exact divisions of the circumference and width of the roller. Rollers were made in widths of 32" to 80" (800 to 2000 mm). The maximum vertical repeat is determined by the circumference of the roller, some early rollers were up to 22" (550 mm), although many were only 10" (250 mm).[51] In the 1940's, the standard vertical repeat for roller prints was 16" (400 mm). Solid copper rollers had diameters of 5" to 12" (125 to 300 mm), but their weight had a deadening effect on the print, especially if many colours were printed. Later, hollow, or shell rollers, were from 5" to 30" (125 to 750 mm) in diameter, and some were up to 40" (1000 mm), giving a vertical repeat of over 120" (3000 mm).[52]

5.16. Hand engraving

The engraving of copper rollers has always been a skilled, expensive, and time-

[48] The earliest patent for a rotary machine was granted in 1743 to Keen and Platt's three-colour engraved roller printing machine. Bell's was the first successful machine of this type. It differed from previous designs in the provision of the doctor blade which continually removed surplus colour from the surface of the roller.

[49] Since the late 1930's, the chromium plating of engraved rollers has extended their life span approximately tenfold.

[50] Such as hot-wax batiks. Brunschweiler (UK) Ltd. still uses copper roller printing for batik prints, most of which are exported to West Africa. Prints for this market have been produced in Lancashire since 1850 (6.13).

[51] This vertical repeat was much smaller than that possible with copperplate printing.

[52] Shell rollers were larger and lighter than solid rollers, but they were more easily damaged and difficult to repair. Solid rollers could be reused by turning and re-engraving, but each time this was done the roller would be slightly smaller, and the modern standardised sizes removed the advantage of recycling.

consuming process.[53] Engravers used sharp cutting tools (burins or gravers), punches, and drills. The design was traced on the surface of the roller, and then engraved using the appropriate tools for the required effect. Graduated tones could be achieved by stipple engraving, using small punched dots of varying depths.[54]

For designs that repeated over the surface of the roller, each repeat was engraved separately, resulting in irregularities. The introduction of mill and pantograph engraving solved this but, until the advent of photoengraving, hand engraving continued to be used to add delicate effects, and for large designs that had only one repeat on the roller.

5.17. Mill engraving

This was introduced in the early 19th century.[55] The design repeat was engraved on a soft metal roller, or die, and eventually transferred to a mill which was used to impress the repeat on the copper roller.[56] For very small-scale designs or fancy machine grounds, several repeats were engraved on the die.[57] Skill was needed to fit repeats accurately on the roller, and to create an even depth at each impression. Dies were retained to repair or re-engrave damaged rollers, and were reused for new designs. The process reduced engraving costs and saved time for many designs, ensuring also regularity of repeat. It was eventually superseded by later methods, and, by the 1980's, was little used 'except in the production of some fine and stipple effects for the shirting trade'.[58]

5.18. Pantograph engraving

This etching process was first used in the 1830's,[59] but more efficient methods were developed by 1854.[60] It involved one single repeat of the design being

[53] Some print-works had their own engraving departments, but many used specialist engraving firms.

[54] This enabled the printing of 'rainbow' stripes, an effect adapted from block printing which was often used as a ground with motifs discharge-printed on top.

[55] This use of steel roller dies was adopted by Jacob Perkins in the USA. It was first employed in 1808, and became widely used from 1820.

[56] The engraved die was hardened and run in contact with a second soft roller, or mill, of the same size on a clamming machine. The engraved design was transferred to the mill in relief and then hardened before use.

[57] Mill engraving also aided the production of blotch designs. A ruling mill was used to engrave diagonal scale lines for printing flat colour.

[58] Miles, L.W. C., *Textile Printing,* Bradford, 1981, p.22.

[59] Montgomery referenced Baines, writing in 1835, on an roller etching process using a 'diamond-pointed tracer' and a 'most complicated and ingenious system of machinery'. Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p.290.

[60] Rigby made the first curved-table pantograph in 1854, but this was replaced by the more efficient flat-table pantograph, invented by Shields in 1857.

enlarged onto a zinc plate.[61] At first, this was performed by tracing, but later photographic techniques were used. The design was coloured to provide a guide for the operator; one roller being engraved for each colour. The machine was set up for the number of repeats and their spacing by the positioning of a diamond head for each. These heads cut through the varnished surface of the roller as the design was traced.[62] The remaining varnish protected the blank areas of the design when the roller was finally etched.

5.19. Photo-engraving

This is also called photogravure or process engraving, and was first used commercially in the 1920's and 30's.[63] The roller was coated with a photosensitive emulsion, and a long film (a positive transparency of the design in repeat) was wrapped around it. The roller was then exposed, developed, washed, checked for imperfections, and then etched with the unexposed areas protected by the fixed coating.[64]

A variety of tonal, textural, and linear effects could be produced easily and, due to its speed and relative simplicity, this process eventually replaced other types of engraving for many types of design.[65] The preparation of art work and the production of long films was time-consuming and, although step and repeat machines could be used in the production of long films, mill and pantograph engraving were still faster, cheaper, and more accurate for the production of small-scale, geometric, and linear patterns.[66]

The introduction of electronic colour scanners for the production of colour separated films drastically reduced this preparation time and, therefore, increased the use of the process. The output from scanning systems was also used for direct engraving of copper rollers.

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[61] Designs could be enlarged from 2 to 6 times, and it could cope with engraved sizes as small as 0.5".

[62] Horizontal lines could not be printed directly because of the action of the doctor blade. Designs were engraved at an angle and printed onto cloth stentered to the same angle. The cloth was later stretched back into true. The pantograph had a slash arm which allowed designs to be engraved at a set angle, or slash.

[63] Niepce had pioneered photo-engraving in 1816 with the 'heliograph', but it was not until the 1890's that commercial experimentation began.

[64] Taylor stated that 'It is rare for one film only to be produced to give tonal variation: depending on the complexity of the job in hand, two films may be made to give a combination effect, and a roller may be etched 5 or 6 times to achieve the required subtlety'. Taylor, G., *Printing effects,* Textile Asia, May 1982, p.36.

[65] Its speed of introduction was slower than would be expected from a purely technical viewpoint (1.11).

[66] Step and repeat machines (5.29) were inaccurate for very small-scale effects, and produced shading at the repeat joins.

5.20. Intermittent roller printing

The intermittent, or jumper, printing machine was an adaption of the basic roller machine which allowed successive impressions to be made from two rollers. It was used for printing products, such as saris and scarves, which had continuous filling patterns with borders running the width of the fabric at each end. The border was printed by one roller which was then 'jumped away' and replaced by another roller for the filling pattern. When the required length had been printed, the border was reprinted.[67]

5.21. Surface printing

Burch produced the first successful machine in 1805. This was a rotary printer giving continuous printing, using coppered and felted wooden rollers and a doctor blade to give an even coverage of colour.[68] The process never came into 'general use for textiles, nor has it replaced, to any appreciable extent, other methods of block printing'.[69] The impressions were imperfect, lacking definition, and the prints were slightly smeared. Surface printing was used for designs that exploited its characteristic qualities, often with large-scale and comparatively coarse patterns.[70] Rainbow striped grounds were also produced by applying various colours across the width of the roller, which were merged by the action of the doctor blade.

Union, or mule, machines combined both copper and surface rollers, allowing the fine detail of intaglio engraving plus the surface bloom of relief printing. They were used from about 1805, following the introduction of surface printing.

5.22. SCREEN PRINTING

Japanese stencil printing was a sophisticated method of textile decoration. Stencils were cut from paper, and unconnected parts of the design were linked together with hair or silk, so fine that the applied colour was not blocked. Colour

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[67] Various systems were used to ensure exact registration of the sections printed by each roller, and to adjust the length of the filling pattern. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.88.

[68] Ebinger produced the first surface printing machine in 1800. The design was cut in a wooden roller, and the areas in relief were printed, as in block printing. This design failed, due to technical problems, the rollers being entirely wooden and liable to warp. Burch's rollers had a waterproofed wooden base onto which the design was applied using the coppering and felting techniques of block printing (5.08).

[69] They were used extensively in specialist applications, such as the 'printing of oilcloth, linoleum, yarns, and wall-papers . . . and certain classes of woollen goods'. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.39.

[70] Sanderson's *Eton Rural* range in 1922 was surface-roller printed. These designs had large areas of flat colour. The imperfections of surface printing were also used in the production of designs with textured effects, such as printed 'Jacobean tapestries' (6.05).

could be brushed, sponged, or sprayed directly onto the unmasked areas of the fabric, thus giving great variety and subtlety of effects. In Europe, during the 1860's, exhibitions of Japanese art created interest in the sensitive use of stencil printing, and stimulated the development of stencil and silk screen printing.[71] Stencil plates could not be 'manipulated quite so quickly as blocks', but they were economic for 'small orders, for which the expense of block cutting alone would be prohibitive'.[72] Sharp produced a stencil printing machine in 1894 which used a metal stencil, and could produce single colour, shaded, or striped designs with a perfect registration of repeats.

5.23. Early screens

These were of woven silk stretched over wooden frames to support a stencil, providing permanent ties between separate areas of paper stencils and giving more control over the application of the colourant. Greater durability was created by painting stencils directly onto the silk, and other faults were counteracted by the introduction of metal frames and synthetic fibres.[73] These stronger, more stable screens enabled accurate registration for multi-coloured designs which led eventually to the mechanisation of screen printing. Simon patented a silk screening method in 1907,[74] and, in 1910, Fortuny patented a continuous stencilling machine, using a photographically produced stencil on a silk mesh.

5.24. Automatic screen printing

The first fully automatic flatbed printing machine was developed by Buser in the early 1940's.[75] Development was delayed by the Second World War but, by the 1950's, screen printing was increasingly used commercially. It compared favourably with other processes because screens were easier and cheaper to make, allowing for greater experimentation with less financial risk.

An increasing emphasis on the 'quick response' ethos and a widening market for large designs ensured that flatbed printing continued. A commentator at ITMA,

[71] Rudimentary stencils had been used in Europe for simple applications, such as marking cloth bales and printing playing cards, but had not been considered as a practical method of textile printing.

[72] Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, pp.44-5.

[73] Waterproof lacquer or cellulose varnish were used for stencils. The water based inks had affected screen stability. Wooden frames easily warped and the hydrophillic screen fabrics stretched and distorted.

[74] This was used by Pilsworth, in 1915, for the printing of American army flags, and proved the economic viability of screen printing as a commercial production process.

[75] Early attempts were based on hand-printing techniques. The fabric was gummed to a long table, and the screens moved on a carriage. Some semi-automatic machines still use this method.

in 1979, noted as 'particularly striking' the 'very obvious resurgence of flat-screen printing despite the boom in rotary screen',[76] and Shore said, in 1990, that 'semi-automated flat screen printing is still important where high productivity is not the major consideration'.[77]

5.25. Computer controlled screen printing

Computer controlled flatbed printing machines are now more competitive due to their faster running times,[78] but they also provide the 'perfect reproducibility of prints',[79] which is essential in the climate of short runs, repeat orders, and fast delivery times. Computer controlled machines are also used for specialist prints, such as towels. In 1979, Reggiani produced a machine for this use 'which detects the borders and then automatically ensures that the print is applied in the mid position of the rectangle'.[80] Although rotary screen printing now dominates the industry, flatbed is still widely used because of its versatility, speed of design changes, simplicity of operation, and improved accuracy, which are all advantageous for short runs.

5.26. Screen sizes

Screen sizes vary according to design requirements. For example, in 1936, screens measuring up to 6 feet long and 4 feet wide (1800 x 1200 mm) were used for panel prints.[81] They can be as wide as the fabric to be printed and, in the 1950's, screens could be made to give selvedge to selvedge repeats on the wider fabrics being produced. The vertical repeat possible with semi-automated machines is larger than for any other printing process, making it ideal for duvet covers and other large panel prints. That of fully automatic machines is less, but still larger than rotary screens.[82]

In 1978, Schmid stated that flat printing provided the 'possibility to choose the length of the repeat indefinitely up to a practical maximum of about 3,000 mm',

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[76] *TW special report / Itma at Hanover,* Textile World, December 1979, Vol.129, part 12, p.82.

[77] Shore, J., *Machines for textile coloration,* Textiles, 1990, Vol.19, no.1, p.21.

[78] The Ichinose 7000 flatbed (1980) provided high productivity due to fast running speeds and an easy, quick change of screens. By 1985, over 180 were operating in the Far East, but only 2 in Europe. Elsässer, H.B., *Optimised flatbed screen printing,* Textil Praxis International, 1985, Issue 7, pp. IV - VII.

[79] *Top Ulster printer installs first Japanese unit in Europe,* International Dyer & Textile Printer, April 1985, p.6.

[80] *TW special report / Itma at Hanover,* Textile World, December 1979, Vol.129, part 12, p.87.

[81] Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.50.

[82] 'Tables vary in length from 14 to 40 metres and with a printing width up to 3,200 mm, the machine is able to cope with repeats of some 4,200 mm'. From a description of the Buser Hydromag 4-V flat-bed machine. *TW special report / Itma at Hanover,* Textile World, December 1979, Vol.129, part 12, p.84.

giving the designer 'complete freedom in arranging his artwork in both directions'. With rotary printing, 'this freedom of choice is more restricted since the repeat in the longitudinal direction is always fixed by the circumference of the screens'.[83]

5.27. Hand engraving

Designs are colour separated, and a screen produced for each colour. Hand painting of stencils in negative had made the use of fine lines difficult but, in the 1920's, a resist method for painting separations on screens was developed which made engraving a more direct process.[84] This stimulated the use of screen printing for avant-garde and experimental textiles and, by the 1930's, it was being used as a commercial process. In the 1950's, with 'some limitations (engraved rollers with finer detail and blocks with richer overlaid colours), screens could duplicate the styles of other printing techniques'.[85]

5.28. Photomechanical engraving

Early photomechanical screen engraving processes still relied on hand painting, where each separation was painted onto a clear or translucent film using opaque ink to create a diapositive which was used to expose a screen prepared with a photosensitive solution. The exposed areas hardened, and the masked areas could be washed out. This method is still used in colleges and by specialist craft printers.

Screens produce blotch prints with improved bloom and colour intensity, and also painterly effects, such as washed watercolour-like images, near photographic realism, and overlapping areas of dense colour. Brush, stipple, and other effects can be created using textured films, and photographic processes are used to create half-tone effects. Scanners are now widely used to produce diapositives from colour separations and from original artwork.

5.29. Step and repeat machines

Small designs can be repeated over a large screen using a step and repeat machine. A prepared screen is mounted on a movable carriage with the diapositive on a glass sheet above. The movements of the carriage can be set to

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[83] The restriction of rotary screen sizes is a shortcoming because 'new and usually larger sizes are being requested'. Schmid, F., *Intermittent printing on Buser rotary screen printing machine,* AATCC Textile Printing Symposium, January 1978, pp.27-9.

[84] I.G. Farbenindustrie produced a resist method whereby the design was painted onto the screen using a coloured solution. These areas resisted the masking varnish and could be washed out.

[85] Schoeser, M., *Pattern in Textiles,* Textile World, April 1985, p.39.

match the size of the repeat, and the screen exposed at each position. Early machines relied on manual control, but computer settings now provide accuracy and flexibility in repeat placements, including specification of horizontal and vertical movements, and rotations. The smallest repeat is not always used. It can be quicker and more accurate to repeat a unit horizontally by photographic means, and then repeat this strip vertically using the step and repeat machine.

5.30. ROTARY SCREEN PRINTING

Many attempts were made to form flat metal screens into cylinders for continuous printing, but most encountered the problem of soldered joins interrupting the continuity of the print.[86] A rapid expansion of rotary screen printing started in the 1960's with the introduction of galvano and seamless lacquer screens.[87] Galvano screens are made by adding nickel to a stainless steel mandrel. The non-printing areas are formed of solid metal, adding strength to the screen. Rotary printing proved to be faster and more economical than flat-bed printing for long runs, but setting-up and running costs were more expensive.[88]

5.31. Computer controlled rotary screen printing

This was introduced in the late 1970's,[89] and added computer processors to control repeat settings. Screen positions could be saved and recalled for further print runs. Machines, so adapted, provided improved registration and faster running times, and later developments were made in changeover times and quality control. These factors were important in an industry increasingly dealing with short runs combined with repeat orders. Holme, commenting at ITMA, in 1987, said 'virtually every exhibiting manufacturer of rotary screen printing demonstrated computer control systems'.[90]

Other improvements were made in screen meshes and engraving techniques, and now the effects of most other printing methods can be replicated.[91] The introduction of Stork Foamprint reduced paste and screen costs because 'a sharply

[86] This was solved in 1954 by Aljaba machine, in which the join was hidden in the design.

[87] The galvano screen from Zimmer (1961) and the lacquer screen from Stork (1963). Stork also showed their first automatic rotary screen printing machine in 1963, and by 1972, they had sold 600.

[88] '... various sources have indicated that the costs of dyes and chemicals can be up to one-third higher for flat screen printing'. Ellis, H., *Printing Techniques: The Choice,* Textile Horizons, April 1985, pp.37- 40.

[89] The Rotamac from Buser (1978) and others from Reggiani and Stork Brabant (1979).

[90] '... none of the mechanical components of the rotary screen printing machines were changed in great detail'. Holme, I., *Printing and dyeing in the 1990's,* International Dyer & Textile Printer, August 1990, p.38.

[91] Such as Stork's PentaScreen 255 (1979) which had 255 holes per linear inch, and was specially developed for printing moire-free half-tones.

defined line, a blotch and a raster' could be printed with one screen.[92]

The changeover from roller to screen printing happened at different times in the production of furnishing and fashion fabrics. By 1976, the increase in wide-width printing for furnishing textiles had encouraged the move to flat, and then to rotary, screens.[93] Fashion printers reacted more slowly to technological developments, maybe because 'they lacked the confidence in the long-term future for their products in the face of cheaper imports from the Far East'.[94] The move toward 60 inches as the standard width for fashion fabrics and shorter print runs meant that manufacturers had to invest suddenly in new technology in order to survive.[95]

5.32. Engraving

Photomechanical engraving of rotary screens is similar to that for flat screens. A long film of the design in repeat is wrapped around the coated screen which is then exposed, dried, and washed. Step and repeat machines can be used in the production of the long film. The use of long films for rotary screen production may be superseded by laser engraving which was introduced in the late 1980's, although many users of this newer technology may still 'need an added full-width film for many different purposes like sample flat screens'.[96]

5.33. Screen sizes

The size of rotary screens has increased, allowing vertical repeats up to 3 metres, but they still cannot compete with the scale possible with flatbed printers. Screen sizes and, therefore, the vertical repeats have been standardised. They are usually 16" (400 mm) or 18" (450 mm) for fashion fabrics, whereas furnishings are produced using a wider range of sizes, such as 16" (400 mm), 18" (450 mm), 24" (600 mm), 27" (675 mm), up to 36" (900 mm). Galvano screens can be from 18" (450 mm) to 64" (1600 mm) in diameter and up to 5.5 yards (5 metres) wide, and are particularly useful for carpet printing.

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[92] The author asserted that 'conventional printing requires at least two screens'. *Foamprint: commercial success for a 'revolutionary' system,* International Dyer & Textile Printer, January 1986, p.8.

[93] Holme suggested that a 'preference for blotch designs on wider fabrics' in the 1970's was an additional reason for the decline of roller printing. Holme, I., *Print Design: The Future,* Textile Horizons, May 1982, p.30.

[94] Schofield, S., *Textile printing: continuing dominance of the rotary method,* International Dyer & Textile Printer, February 1985, p.8.

[95] Keighley quoted a manufacturer who, in 1981, stated that, 'instead of getting runs of 12,000 yd. at, say, 36 or 45 in., we were suddenly printing 8,000 yd. at 60 in'. Keighley, M., *Lancashire cotton printers make a fine impression,* International Dyer & Textile Printer, April 1987, Vol.172, No.4, p.14.

[96] Stork produced a plotter compatible with their laser engraver (5.40) for this purpose. Ruckl, S., *The Technical Story,* Textile Month, March 1989, p.44.

Intermittent rotary printing was introduced to overcome the restriction of rotary screen sizes on the vertical repeat. The method is similar to that of intermittent roller printing. Two screens are used which can produce either designs with border and filling patterns or continuous designs.[97]

5.34. TRANSFER PRINTING

The design is transferred from printed paper to a suitable fabric by use of a transfer printing press, or calender.[98] The first patent was given in 1929, but the process was not developed fully until the late 1960's.[99] The design's transfer to fabric is quick because all the colours are printed at the same time. Papers can be printed by commercial printing processes used in the graphical printing and packaging industries. The gravure process results in the best quality and reproducibility, and its principles are basically the same as those of direct printing with engraved rollers. Flexographic machines use a surface printing method where the design is formed in relief on a rubber or composite moulding. Screen printing and lithography are also used.[100]

Printers could buy in printed papers and cut out the design and engraving processes. Companies which printed their own paper could keep stocks and print fabric in response to orders. Textile printers were slow to exploit the process, and this 'forced the producers of transfer papers to turn to other groups, namely weavers, knitters and garment manufacturers'.[101]

5.35. Transfer printing on natural fibres

Transfer printing expanded with the increased demand for man-made fibres in the 1970's, and it was thought that it might replace screen printing. But most natural fabrics are resistant to thermoprinting techniques and, by 1976, the growth of transfer printing slowed owing to the decreased demand for polyester fabrics. In

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[97] Continuous designs demand greater accuracy in the fit. Schmid, F., *Intermittent printing on Buser rotary screen printing machine,* AATCC Textile Printing Symposium, January 1978, pp.27-9.

[98] There are two main types of machine; the continuous machine, in which the paper and fabric pass together around a heated cylinder calender, and the flat-bed press.

[99] The first patent was to British Celanese Ltd. in 1929, but commercial development was not possible until new fibres, such as polyester, were developed in the 1950's. Development was carried out by Sublistatic SA, and was a collaboration between three companies producing dyes, textiles, and printed papers.

[100] CAD/CAM developments in paper printing were applied to transfer printing. This coincided with a boom in sales of transfer printed goods, making this method the first fully to exploit computer technology (5.40).

[101] This slowness was attributed to the 'conservative behaviour and the waiting deliberation' of textile printers. It would have required a large investment in machinery and expertise on the part of established printers, but was welcomed by other producers who were exploring the possibilities of new fibres. Schulzen, H., *Additional coloristic possibilities with the subicolor process,* Melliand Textilberichte (English Ed.), 1974, vol. 55, part 5, p.467.

1978, Schaub forecast 'a further growth in transfer printing thanks to new applications'[102] but, by 1984, 'the number of continuous transfer printers in active use' appeared 'to have reached a plateau and in some areas' was declining.[103]

Research has continued into the application of the process to natural fibres. In 1988, Stork announced new developments in this field which could yield huge market potential. 'With this system you can just buy preprinted transfer paper and fabric, set up the machine, and you are in business overnight. The principle is very easy compared to direct printing'.[104] In 1990, Stork publicised a process for cotton warp transfer printing with a paper named Transfacel.[105] Since then, papers have become available that allow computer hardcopy or photocopied images to be transfer printed onto cotton, permitting the production of customised T-shirts and placement prints.

5.36. Quadricolour (process colour) systems

The quadricolour printing method combines magenta, cyan, yellow, and black to produce all the colours in a design. A problem when screen printing with process colours is that a new set of screens is needed for each colour-way whereas, with conventional methods, multiple colourways can be printed from one set by changing the dyestuffs. It has been used since 1975 in the production of panel prints by flatbed printing.[106] In 1982, Taylor argued that, although the method was 'thought to give a superior, quality appearance', it had the disadvantages of higher film and dyestuff costs and problematic moiré effects, and had 'not yet been adapted for continuous printing . . . owing to the problem of making an accurate join between pattern repeats'.[107] With computer technology, full-colour photographic imagery could be exploited using 'the paper printing techniques of colour-

[102] Because of this expected resurgence Stork developed the Twinprinter, combining rotary screens with rollers for use in transfer printing. Schaub, H.H.W., *Combined rotary screen and roller printing, what possibilities can be expected?*, proceedings of the AATCC Textile Printing Symposium, January 1978, p.21.

[103] *Screens supreme into the nineties?*, International Dyer & Textile Printer, June 1984, p.13.

[104] Transfer printing onto natural fibres had been limited to resin-impregnated fabrics and sublimating dyes which gave poor fastness. *Stork launching diverse projects,* Textile World, June 1988, p.84.

[105] This differed from the conventional sublimation process in that the 'coating on the paper serves as a transport medium for the dyestuffs'. *Cotton warp yarn transfer printing,* International Dyer & Textile Printer, August 1990, p.36.

[106] By 1982, the method was used for non-repeating designs, such as isolated images on plain grounds, and placement prints on items, such as T-shirts and teacloths.

[107] Taylor, G., *Printing effects,* Textile Asia, May 1982, p.42. Moiré effects can occur between sets of coloured dots as well as between film, screen mesh, and fabric. It can be compared to the early plate prints that could produce a new type of imagery, but suffered from similar drawbacks with repeats.

separation, film preparation, and direct image-reproduction onto the printing element'.[108]

Quadricolour printing is used with ink-jet printers to produce hardcopy from computer images. This involves the conversion of RGB data to process colours. The future development of jet-printing may solve colourway problems because the colour change is made on the computer system, and the new data transferred directly to the printing mechanism, without intermediary printing elements.

5.37. COMPUTER-AIDED DESIGN AND MANUFACTURE (CAD/CAM)

CAD/CAM systems for printed textiles evolved from knitting and weaving pattern preparation systems[109] and from electronically-controlled engraving machines for pre-press industry,[110] which appeared in the late 1950's. Prepared designs were input via a light pen, scanner, or digitiser. Similarly, early print systems were intended 'to automate the conversion of an artist's sketches into colour separated films'.[111] Because the design process was considered to be a preliminary stage, most developments have been concentrated on input and output devices with facilities for design correction and manipulation added later. As Jerrard observed, 'the formation of c.a.d. textile systems usually starts with control mechanisms and works back through degrees of human interface'.[112]

The vector-based Textile Graphics system was developed in the late 1960's to produce long films for copper roller engraving.[113] Designs were traced, and the engraver's interpretative role was recognised by allowing the modification of line details in accordance with the requirements of the printing process.

Most further developments were concentrated raster graphics techniques. The

[108] *Full-colour fidelity for fabrics,* Textile Horizons, December 1982, p.43.

[109] These were off-line input preparation systems, which were used to convert design data into machine order code for the control of double jersey jacquard knitting machines and jacquard weaving looms. A paper design for these processes is diagrammatic. On a computer, the individual stitches could be represented by blocks of colour, and most designs could be displayed on a low resolution monitor.

[110] The first Hell Klischograph machine, in 1954, was for the production of letterpress printing blocks and, by 'the late 1950s, this had developed into a unit to scan a colour original and separate it into screened colour separations, engraving either blocks or mylar foils for offset printing'. *Dr.-Ing. Rudolf Hell GmbH: A Pioneer Faces the Changing World,* The Seybold Report on Publishing Systems, 1988, vol.18, no.5, p.3.

[111] Suchecki, S.M., *Innovations in Printing Machinery Technology,* Textile Chemist and Colourist, 1980, Vol.12, Part 5, p.23.

[112] Jerrard, R.N., *Computer-aided design of textiles,* Computer Aided Design, October 1976, vol. 8, no. 4, p.239.

[113] Lourie, J.R., and Lorenzo, J.J., *Textile Graphics Applied to Textile Printing,* IEE Fall Joint Computer Conference, 1967, pp.33-40.

A library of textured effects was provided which were used to fill areas with small repetitive patterns.

Scitex Response 200 system for printed textiles was first shown in 1975.[114] It had a high resolution scanner for designs up to 36" square. Originally, output was to a CRT film plotter, but was upgraded to a laser plotter in 1976.[115] Further developments were increased design size and storage capacity, the facility to interface with new output devices, and the provision of printing effects, such as half-tones.[116] Editing, colour correction, and functions for tidying up repeat joins became standard facilities. The Hell Textile Data Processing (TDP) 500 system, launched in 1977, was based on a scanning and film exposure unit with additional editing facilities. Output was also provided to the Klischograph engraving machine.[117]

As computer technology in general has developed, systems have become faster, providing larger design sizes, greater storage capacity, and more graphic manipulation facilities. Hardware costs have dropped, but a full production system is comparatively as expensive as earlier systems and, significantly, CAD systems are still viewed primarily as conversion tools, rather than design aids. However, individual design stations, networked to or compatible with production systems, are being increasingly used. This allows a skilled operator to deal with final design data and, therefore, might allow designers access to the creative capabilities of computer technology.[118]

5.38. Output devices

Developers of CAD/CAM systems for printed textiles have provided a variety of outputs to cater for a range of printing processes. These have been added as new

[114] This was developed from the Scitex Chroma-Scan system, first shown in 1971, which used an electro-optical scanner to input designs drawn in felt-tip pens or watercolour on Mylar sheets. Designs in up to six colours could be colour corrected, but there was no provision for design correction or manipulation. Data could be output for tape or direct control of knitting machines or for the preparation of jacquard cards.

[115] At this time, it was found 'that 40% to 50% of all print designs' could be prepared by the system. Suchecki, S.M., *Fast Film Service,* Textile Industries, December 1976, Vol. 140, part 12, p.107.

[116] In 1982, Taylor wrote that, although all printing methods used computer technology, for rotary screen engraving 'some of the top companies use Sci-Tex for the particular reason that the variety of screen meshes . . . all require a different dot formation on the pattern film for the mesh count used'. Taylor, G., *Printing effects,* Textile Asia, May 1982, p.39.

[117] Hell's involvement with the textile industry arose from the development of transfer printing. The company produced equipment for paper printing, and these technologies were transferable to printing transfer papers.

[118] Advances in the human/computer interface are making such computers easier to use and, over the last five years, the 'friendliness' of graphics systems has become a major factor in sales campaigns. A greater variety of creative tools are being used on textile systems. These were developed for paint systems, and have been adapted for the requirements of printing (10.03).

engraving processes, stimulated by the use of computers, have been introduced.

There are three types of output:
(i) Colour separated films, used to engrave printing forms (screens and rollers).
(ii) Digital interface with engraving machines.
(iii) Direct digital control of printing machines.

(i) was based on existing production methods, but (ii) and (iii) have resulted from the possibilities provided by computers. Each development has been concerned with the removal of intermediate processes, but (iii) is seen as ideal.

5.39. Colour separated films

In 1967, an on-line high speed photographic plotter was used with the IBM Textile Graphics System to produce long films to engrave copper rollers. The step and repeat settings and the width and circumference of the roller could be specified. A film wrapped around a cylinder was rotated under a CRT and exposed, using a scanning electron beam. The design could be scaled accurately to fit the roller size, using vector data. In 1975, the Scitex Response 200 system used raster output to a CRT plotter with a resolution of 200 lpi (lines per inch).

Laser plotters are used for the preparation of films for various engraving processes,[119] and are ideal for engraving companies supplying customers who use a wide range of printing processes. A laser exposes a film rotated on a cylinder, using a resolution of up to 800 lpi which was later raised to 2,200 lpi. Their advantages are the production of fine detail, exact registration, evenness of exposure, and speed. Scanner-recorders combine the functions of scanning and output for colour separated films, and are produced in a range of sizes, catering for various films.

5.40. Digital interface

The output from scanning systems was also used for directly engraving copper rollers with a diamond cutter.[120] This method and laser engraving developed from the pre-press industry.[121] Advances made in flexography coincided with the boom in transfer printing in the 1970's, and the application of laser engraving to

[119] They could be used for the preparation of films for flat bed, roller, and rotary printing. Scitex, Hell, Dainippon, and Crosfield film recorders are still used widely because of this variety of applications.

[120] The Hell Klischograph machine was developed for the paper printing industry, and this technology was used for engraving gravure rollers for transfer printing.

[121] In 1977, Crosfield produced a laser engraver for gravure cylinders. This was linked to the Magnascan 570 with an intermediate station for colour separation and disc storage of production data.

flexography for printing transfer papers was the first use of this type of process for printed textiles.

The introduction of laser engraving techniques for lacquer screens, in 1986, increased the speed and decreased the overall costs of screen production. In 1987, the Stork STK 2000 was said to enable 'ready-to-use screens to be prepared in 15 to 30 minutes'.[122] Data can be input in three ways; either directly from a compatible CAD system, or by scanning in prepared colour separations, or by the specification of simple designs, such as stripes and checks. This method also provided greater design possibilities, including 'extremely fine continuous designs' which previously 'could only be realised in roller printing',[123] and was made possible by the elimination of join marks produced when fitting films.[124]

5.41. Direct digital control

In 1979, Darlington suggested that the 'ultimate in progress would be to eliminate completely the need for an engraver'.[125] Jet printing does this and also removes all the processes involved with the production, engraving, changing, and storing of intermediate printing forms. The first patent was issued to Milliken, in 1978, for the Millitron machine. The process is entirely computer controlled, a design being scanned and corrected, using a colour monitor. Designs, stored as computer data, can be retrieved for fast changeovers. The data is used to control the spraying of colourant from an array of jets onto a moving substrate. Printing is continuous, and all the colours are applied in one pass.[126]

The process produces coarse prints, and is used for carpets in which the texture of the pile makes sharpness of image unnecessary. In 1982, Schaub remarked that 'it does not produce a genuine textile printing effect, but rather a jacquard weave look (fine dots)', suggesting also that 'high equipment and ink development

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[122] *ITMA Preview: Finishing,* Textile Month, September 1987, p.86.
A comparison between conventional and laser engraving showed a 'saving of 152 minutes per screen' for laser engraving. This is due to the elimination of the intermediate processes of the positioning of film, developing, polymerising, retouching, and routing. Lee, W.K., *Rotary screen printing developments,* Textile Asia, September 1987, pp. 165-6.

[123] *Automation a key feature in printing,* Textile Month, August 1987, p.42.

[124] Previously, 'it was virtually impossible to obtain a perfect screen because of joining problems' but now, 'even the most complex geometric patterns can be processed'. Fox, E., *Fashion Engravers, Inc.: Innovation in Screen Printing Technology,* American Dyestuff Reporter, February 1989, p.16.

[125] Darlington, F., *Modern 'engraving' done on computer tapes,* America's Textiles R/B Edition, 1979, vol.8, part 7, p.34.

[126] The Chromatronic jet printer, introduced by Zimmer (1979), differs in that it employs intermittent printing and a separate print head for each colour.

costs prevent its emergence into textile printing'.[127] At the same time, Holme argued that the 'extension of the jet printing principles of the Millitron and Zimmer Chromatronic machines to printed fabrics could ultimately present a direct challenge for blotch designs on printed fabrics by rotary screen'.[128]

Research undertaken into the production of finer quality jets and their application to fabrics, could lead the way to the process being used for mass production. The ease and speed of design change-over would make it an ideal tool in the present climate of the Quick Response ethos, but it will probably produce a characteristic print quality that would not be suitable for all products.

The quality of small jet printers for computer hardcopy has steadily improved. A0 size printers are now available which can print water-based inks or reactive fast dyes onto fabric. At first, cost restricted their use to very large organisations and bureau services.[129] Now, as prices reduce, they are being more widely used for sampling. It may be that making up sample lengths into garments will prove a more popular method of using design data for production decisions compared to computer visualisation. There is a major problem using jet printing for the making up sample lengths into garments because of the disparity between the sampling and production methods of printing. A design sampled in this way may not be suitable for rotary or flat screen printing. If, however, jet printing is developed into a commercial production process, there would no longer be a mismatch. The elimination of previous technical restraints and a direct link between CAD and CAM could stimulate a fuller exploitation of computer technology and new approaches to design.

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[127] Schaub, J.H.W., *Future Prospects for the Textile Printing Industry,* Melliand Textilberichte/English Edition, 1982, Vol.63, Part 1, p.70.

[128] Holme, I., *Print Design: The Future?,* Textile Horizons, May 1982, p.31.

[129] PPI in Paris offers its customers an in-house design studio, an ink sampling department, a drawing studio, an engraving department, a dye house, and a clothing department to make up samples. *Stork Excelerator ideal for judgment of created design,* Inter-Vision, No.11, October 1990, pp.24-5.

Microdynamics opened a British bureau service in 1992. The firm quote a time of 2 hours to print an A0 length, and charge a standard hourly rate for water-based inks. The cost of reactive dyes is approximately four times that of water-based inks but, at present, it finds this service uneconomic, owing to the change-over time and wastage of dyes. The cost of scanning is cut out by designs being accepted as a single repeat in a TAGA computer format.

CHAPTER 6: DESIGN INFLUENCES

6.01. Stylistic changes

The history of printed textile design has seen a succession of stylistic changes, reflecting many varied and interrelated influences. Apparently, styles have developed spontaneously because new themes were adopted and popularised by most manufacturers.[1] Outdated styles were absorbed into the textile designer's repertoire, often to be revived and reinterpreted. The interpretation of recurrent themes has varied at different times, depending on the combination of influences that were in vogue.

Currently, themes are emerging continually from a wide range of sources. Designers and consumers 'live, not in a single unitary culture, but in one which is plural' and 'are at liberty to pick and choose between different aesthetic and historical traditions'.[2] To allow manufacturers to prepare for future trends, the fashion forecasting industry has attempted to develop this eclecticism into a predictable cycle of changes.[3]

6.02. TEXTILE PROCESSES

Styles and effects associated with other textile processes have been imitated in printed textiles, and have become part of the designer's visual repertoire. Active competition has often resulted in superficial copying. However, there has also been a continual cross-fertilisation of imagery, effects, and structures between different textile forms, especially when a designer working on a variety of products has taken the influences of one form through to another.[4]

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[1] This has been described as a trickle-down effect; 'if design innovation is to succeed it must be seen to be popular at the top. Only then can the middle and lower markets be expected to follow suit. (This has been shown throughout textile history where design popularity has expanded through attempts to imitate special textiles of the upper classes)'. Brassington, L., *New Printed Textiles from India,* The Textile Society Magazine, Vol.17, Spring 1992, p.17.

Recently, this situation has altered and street fashions, such as hippie, punk, and crusty styles, have become influential on *haute couture* and, eventually, mainstream fashion (6.18 and 6.22).

[2] Lucie-Smith, E., *Cultural Calendar of the 20th Century,* Oxford, 1979, p.8. Contemporary designers have access to a greater range of specialised publications and exhibitions of foreign and historical design sources (3.05).

[3] Different forecasting companies have given varied and, often, contradictory explanations for the same theme. Animal prints, which now recur about every four years, were a dominant theme for winter 1992/93. A variety of sources attributed this trend to 'a mood based on antiquities and craftsmanship; we were interested in shades of brown and gold, inlaid woods, beautiful frames and animal skins'; to 'an evolution of the biker feel we saw last fall and also a reaction to the ecology movement'; or as a sensual complement to 'masculine' fabrics. Warkentin, J., *Anatomy of a trend,* The Guardian, September 28th, 1992, p.18.

[4] This is particularly apparent in the work of freelance designers and artist/craftsmen (6.03, 6.05, 6.19, and 6.23).

6.03. Weaving

From the 12th to the 14th century, the weaving industry produced the majority of textiles and formed the design ambience for print production.[5] Designs followed the forms of brocade designs, and were stylistically constrained by the dominance of structures derived from the weaving process, such as the 'turn-over'.[6] Those of the 15th and 16th centuries still generally followed brocade styles, such as pomegranate and small floral patterns,[7] and their influence continued during the 17th and 18th centuries.[8] The print industry was developing and competing with the dominant weaving industry, and the 'exigencies of fashion required that the same decorative vocabulary be used for both, but the use of different techniques led to results that were imitations rather than copies'.[9]

The continual revival and reinterpretation of classic designs has ensured the perpetuation of traditional woven forms.[10] William Morris's involvement with weaving and his interest in historic woven textiles are reflected in his prints. From 1876, he introduced 'a more rigid, formalized framework into his designs, many of which were based on a vertical turn-over structure' in which conventionalised elements were 'trained to fit shapes', and the 'marked diagonal emphasis characteristic of many patterns from 1883 to 1890' was based on Italian velvets.[11]

The visual characteristics of woven fabrics, such as printed broken twill and jagged draw loom weave effects, were used from the late 18th century in designs derived from Kashmiri shawls.[12] These effects appeared in small 'shawl' and 'cashmere' filling patterns and borders for dress or furnishings fabrics. They were

[5] Silk brocade designs of the 12th to 14th century were based on Byzantine styles. They were mostly flatly drawn images of foliage and heraldic birds or animals, often within the geometric structure of a circle or ogee.

[6] This was a common device used in weaving, relating directly to the setting up of the loom (4.16). The symmetrical structure was carried through into prints, even though it had no technical relevance.

[7] The pomegranate pattern was fashionable from the mid-15th century until the late 16th century. Dupont-Auberville described it as 'an Italian creation based on the Gothic lobed leaf, and marking the period of transition from the old Arabic to the more modern European taste'. He also included many examples of small 'flowrets disposed in horizontal lines' with mirroring on alternate lines forming interlocking patterns. Dupont-Auberville, M., *L'Ornement des Tissus*, Paris, 1877, printed in English as *Ornamental Textile Fabrics*, London, 1877, reprinted as *Classic Textile Designs*, London, 1989, text accompanying pls.17 and 32.

[8] Although Indian prints became a major influence, many traditional designs were still produced (1.03).

[9] Brédif, J., *Toiles de Jouy*, English translation London, 1989, p.88. The 'striped patterns which had been introduced in printed cottons by the 1770's, and which continued to be popular until the last decade of the century, had their origins in the patterns of figured silks'. Young, H., in the introduction to *Patterns for Textiles*, Victoria and Albert Museum, London, 1987, p.10.

[10] Many classic patterns originating from 17th century silk damasks were continually revived (6.15).

[11] Gillow, N.C., in the introduction to *William Morris: Designs and Patterns*, London, 1988, p.5.

[12] Fine details were produced with pinning (5.08), mill engraving (5.17), and pantograph engraving (5.18).

also used on printed imitations of woven Paisley shawls, and have been retained in modern interpretations.[13] Block printed 'moiré' grounds, imitating expensive watered silks, appeared at the same time and, later, these and striped 'woven' grounds were machine printed.[14] From 1885, machine printed checks became common for shirting and were 'sometimes indistinguishable from more costly woven plaids . . . Today a pattern this detailed would be more expensive to print than to weave'.[15]

The distinctive ragged edged motifs of ikat patterns have often been simulated. Between 1775 and 1800, patterns and small motifs imitating warp printed chiné or clouded silks were fashionable for dress fabrics[16] and, in the 1980's, printed interpretations of ikats, especially striped designs, were popular for furnishings.

6.04. Lace

Copies of designs from lace pattern books occurred frequently in the early 17th century,[17] and lace's fashionability influenced woven and printed textiles. Lace borders were printed as stripes and as frames for motifs, and many 17th century German and Italian prints were 'either straightforward imitations of lace or variations on the floral trails and exotic flowers in lace designs'.[18] In weaving, this theme developed into detailed large-scale designs which were then adapted for prints during the 18th century.[19]

Block making techniques were developed to simulate lace effects, and appear in the intricate honeycomb grounds and pinned motifs of late 18th century ribbon designs.[20] Lace designs and motifs were popular with the rococo-revival of the 1830's, and were often combined with rainbow striped grounds. These effects are

[13] Printing shawls was cheaper than weaving them, but from a distance they were visually similar (6.22). From being mere imitations, they were developed into a distinctive style which retained the weave effects.

[14] Developments in discharge printing and roller engraving increased the use of detailed patterns (5.17).

[15] Meller, S. and Elffers, J., *Textile Designs,* London, 1991, p.204.

[16] Motifs were given irregular outlines by using special block-cutting techniques, and were often combined with contemporary small floral patterns.

[17] Pattern books were block printed from the late 16th century (3.04), and the blocks were possibly also used for printing textiles. Such publications have generally stimulated cross-disciplinary influences (6.19).

[18] Biriukova, N., *West European Printed Textiles: 16th-18th century,* Moscow, 1973, p.52.

[19] Lace prints followed the trends set by silks; diapered panels with formal bouquets, followed by larger floral motifs, then serpentine borders, and stripes. At the same time silks were influenced by the detailed imagery of lace designs, introducing lacy ribbons interspersed with floral motifs

[20] Some of these lacy effects from the early 18th century predate the introduction of plate printing, which is usually credited as the stimulus for the development of the new block-cutting techniques (5.07).

recurrent themes in fashion forecasts.[21]

6.05. Embroidery

Printed embroidery effects have been a continual theme. Montgomery cited examples from the mid-18th century, of 'flower fillings, which resemble couchedwork in metal threads', exotic flowers similar to 'Indian chain-stitch embroideries', and a 'shell' pattern, which 'may also have a prototype in Indian needlework'.[22] In the 19th century, contemporary, traditional, and imported embroideries were continuing influences on all-over patterns and borders.[23] Between 1805 and 1855, Berlin work was interpreted as 'needlework chintzes', in which motifs with stepped outlines were often combined with naturalistic florals.[24]

The Arts and Crafts Movement revived traditional embroidery techniques, and Morris's designs with their 'emphasis on stems and attenuated lines . . were adopted by avant-garde designers for repeating textile patterns'.[25] In the late 19th century, Near Eastern embroidery designs were adapted for prints, especially small symmetrical all-over patterns.[26] At the turn of the century, the popularity of appliqué was influential on stencilled textiles, making similar use of flat areas with strong outlines.[27] From about 1910, block printed copies of embroidered bedspreads[28] and designs based on 16th and 17th century needlework were produced for the 'cottage' look. Printing effects were used to achieve an aged appearance, with block printing on linen to emphasise drawing irregularities, and surface printing for a worn look. Similarly, tapestry prints of 1985 drew on 'experiments with the use of printed colour to convey vibrancy faded by age'.[29]

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[21] 18th century silk 'lace' designs on rainbow grounds were used in 1970's large-scale dress prints. Similar effects, derived from 19th century printed lace designs, were included in Promostyl's 1988/89 predictions.

[22] Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p.115.

[23] These were common in the 1830's, and the treatment of motifs to give stitch-like effects exploited the developments in engraving techniques. Border designs were used for dress and furnishings.

[24] In 1805, Richard Ovey commissioned such patterns for upholstery fabric. Floud, P., *Richard Ovey and the Rise of the London 'Furniture-Printers',* Connoisseur, CXL, November 1957, p.96. The designs were mostly block printed, and were revived during 1826-30 and again between 1845-55.

[25] Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.101.

[26] Morrocan and European peasant embroidery prints were popular again in the 1970's as patterns and borders for 'ethnic' clothing (6.22).

[27] This also coincided with a revival of interest in stained glass, which had similar stylistic constraints, and also in the flat stylised forms of Art Nouveau.

[28] The popularity and wider market created by machine embroidery was exploited by printers.

[29] Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.237.

6.06. Patchwork

In the late 18th and early 19th centuries, central motifs were printed for incorporation into patchwork quilts[30] and, from 1850, simulated patchworks, based on the hexagonal format and incorporating old-fashioned patterns, were roller printed.[31] A renewed popularity of patchwork in the 1970's again prompted the printing of similar patterns for furnishings.[32] Around 1990, patchwork patterns were printed for the youth fashion market. These were mainly rectangular blocks combining paisley, floral, and geometric designs.[33]

6.07. CROSS-CULTURAL INFLUENCES

The art, design, and imagery of a wide variety of cultural sources have always influenced European textile design. Western styles and motifs have also been incorporated into non-European designs for domestic and export markets. These influences have worked at different levels:-

(a) Adaption of the designs of an exporting country for the tastes of importers.

(b) Direct copying, often for new markets opened by imports.

(c) Incorporation of the design motifs, imagery, characteristic colouring, and superficial stylistic factors into the designs of the importing country.

(d) Adoption of the structural characteristics combined with the conventional or natural imagery of the importing country.

The adaption of designs for export markets has often caused the dominance of one particular cultural style which has then, to the importers, become typical of the country's designs. Western tastes have consistently affected exporters' design and production,[34] and they have often geared their manufacture in accordance with

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[30] These circular, hexagonal, or octagonal designs were block or plate printed. They were also used for chair seats during the fashion for en-suite furnishings (6.21 and 8.21).

[31] These simulated patchworks reflected the revival of quilting, and their 'old-fashioned' associations are evident in their use of patterns from the 1830's. The hexagonal structure had derived from a growing interest in Islamic patterns, and had become popular for quilting around 1830 (6.08).

[32] The 1970's urban-rural and old-fashioned styles had similarities with the cottage look of the early 20th century. They coincided with the general ethnic influence, with other 'patchwork' forms from Japanese (6.12) and African (6.13) designs being produced.

[33] Old-fashioned designs were again used, but printed in bright, contrasting colours, often combining a variety of scales.

[34] Norman, commenting on 17th century Chinese porcelain exported to Holland, argued that there must 'have been some European prints available to the craftsmen . . One series of vases is decorated with a pattern of Dutch houses bordering canals and the backs of these have a ribbon swag distantly inspired by baroque wood carving'. Norman, G., *Junk Porcelain*, The Independent on Sunday, February 16th 1992, pp.52-3.

contemporary conceptions of exotic or ethnic design, and incorporated western imagery. Periodic fashions have produced a fluctuating market for such textiles, which were popular in the 1890's, and also with the 'alternative' lifestyles of the 1970's and the recently revived hippy look.

Direct copying has often been associated with the introduction of new production techniques, where the styles and imagery of popular imported products were copied as well as the processes.[35] In this way, Islamic and Indian design structures were absorbed into the European tradition.

Selected aspects of design sources have been incorporated into contemporary styles and decorative themes at different times.[36] Until the 1850's, most oriental imports were called Indian,[37] and derivative 'exotic' designs combined European styles with mixtures of Eastern imagery.[38] Ethnicism has been a recurring theme in 20th century design, especially during the 1970's, but interpretations have varied with changing attitudes.[39] The handmade textural qualities, characteristic of some sources, have often been simulated when a hand-crafted look was desired for ethnic or naive themes.[40]

Other sources, apart from Islamic and Indian design, began to provide structural influence by the late 19th century.[41] Since then, the structural aspects of non-European design have become more influential, and interpretations more sophisticated.

A wide range of cross-cultural influences have been absorbed and interpreted in many ways. Therefore, this chapter covers only those that are seen to be the most influential.

6.08. Islamic sources

The use of Islamic geometric structures in European design can be traced back

[35] The products that were copied may already have been adapted for western tastes and, therefore, would not have been truly representative of the source country.

[36] These aspects have varied according to contemporary perceptions and preoccupations (3.18).

[37] This was because all imports, including Chinese and Japanese goods, arrived 'via the Dutch and/or English East India Companies'. From the exhibition guide to *Parasols and Pagodas, Oriental influence in Western Wallpapers,* Whitworth Gallery, Manchester, October 1991 - April 1992.

[38] Although the more scholarly publications of the second half of the 19th century distinguished between them, the mixing of oriental motifs has continued partly due to revivalist prints.

[39] There is a current 'revival of "ethnic" imagery and style but this is now coupled with a suggestion of opulence . . . and is quite contrary to the "hippie" style of ethnic design that was typical of the 1970's'. Brassington, L., *New Printed Textiles from India,* The Textile Society Magazine, Vol.17, Spring 1992, p.17.

[40] Batik, block printing, and other hand processes have been explored by avant-garde designers during the 20th century. Their prints often emphasised this hand-produced quality.

[41] This followed the impact of Japanese design, in the 1860's, and the move towards abstraction in avant-garde art movements (6.18).

to Byzantine styles,[42] and was the basis of early woven and printed textile designs.[43] These structures underlaid the design of most formal patterns, and have remained a major part of the textile designer's visual vocabulary due to the continual revival and reinterpretation of classic designs.[44]

The spread of Islam influenced the decorative arts of many countries, all of which had local characteristics. Indian design was influenced by Persian floral patterns,[45] including the boteh motif found in Kashmiri shawls.[46] Paisley filling patterns derived from this source, and many had similar arrangements of motifs. In the mid-19th century, forms, such as stars, lattices, ogees, and arabesques, were popular. Motifs derived from Islamic calligraphy appeared in abstract and geometric patterns, and the hexagonal structure was adopted for quilting.[47]

6.09. Indian sources

Indian painted cloths of the 17th century were used as bedspreads and hangings. They became fashionable for clothing as exports were adapted to European tastes.[48] In the later 17th century, the majority of European prints were the trailing plant forms with exotic flowers on white grounds, called *indienne* designs.[49] These were adapted to the current styles of different countries, developing into 'the delicate sprigs, sprays and cabbage roses so characteristic of English fabrics, and the "fleurettes", ribbons and stripes, and "bonnes herbes" traditional in France'.[50] These have remained an important part of the textile

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[42] Byzantine design was a synthesis of Graeco-Roman forms with oriental patterns and motifs from Arab countries, and many of the traditional European forms developed from this era (1.01).

[43] Most sources cite Arabic influences on Italian woven designs of the 14th and 15th centuries (4.04).

[44] They were important in the formal patterns of the purist Gothic Revival designers (6.15). William Morris was interested in historic woven textiles (6.03) and various forms of Turkish and Persian design. He was quoted as saying that, for pattern designers, 'Persia has become a holy land, for there in the process of time our art was perfected, and thence above all places it spread to cover for a while the world, east and west.' Vallance, A., *The Life and Work of William Morris*, London, 1897, reprinted 1986, p.109.

[45] Persian textile printers 'were settled at Masulipatam and Madras in India where they produced fabrics for export to Persia . . . there is nothing which allows us to differentiate between cottons printed in Persia and cottons printed in these areas of India'. Wearden, J.M., in the introduction to *Persian Printed Cottons,* Victoria and Albert Museum, London, 1989, p.13.

[46] Rudzki suggested that patterns on Kashmiri shawls combined Turkestan weaving techniques and the influences of the Indian and Persian floral design traditions. Rudzki, D., in *Ratti and Paisley,* New York, 1987.

[47] Publication on Islamic designs, such as Owen Jones' analysis of Moorish patterns, stimulated interest in geometric structures and formal design (3.04 and 1.08).

[48] Designs for panels were printed on pale grounds (5.06), and adapted into repeating patterns (8.15).

[49] With the general fashion for exotic imagery, oriental motifs were often combined with the basic Indian trailing structure.

[50] Storey, J., *Textile Printing,* London, 1974, p.44.

vocabulary, especially for designs with a traditional or nostalgic look.

Kashmiri shawls supplied a new design source which was developed into the Paisley pattern. The basic motif was reproduced on printed shawls, and adopted for repeat patterns for all scales and printing processes. Paisley has remained a staple style, and has been constantly revived and reinterpreted in forms as diverse as small conservative tie patterns and huge grand paisleys of the 1970's.

Cheap block printed textiles were imported in large quantities for furnishing and clothing in the late 1960's and 70's.[51] The importation of Indian Ikats in the 1980's stimulated the production of printed interpretations.

6.10. Chinese sources

Chinese imagery has been a recurrent influence since the 17th century[52] and, as the *chinoiserie* style, has most often been associated with furnishing fabrics. The main sources, apart from derivative engravings, were imported painted papers, embroideries, and porcelain.[53] Motifs were incorporated in contemporary design forms, such as toiles and pillar prints.[54]

In the late 19th century the Silver Studio used motifs such as poppies, chrysanthemums, and blossoms. Although they were drawn realistically, they usually differed from chinoiserie designs by following the traditional Chinese continuous-stem arrangement.[55] In the 1960's and early 1980's, large-scale *chinoiserie* designs were popular for furnishings.[56]

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[51] Brassington, when advising Indian printers on design and production for the present European market, found that production had been largely concentrated on cheap prints favoured in the 1970's, and that many sophisticated traditional, but expensive, techniques were in danger of dying out. The incorporation of western images had been a major factor in adaption, but Brassington advised the Indian producers to use geometric pattern 'to avoid imposing Western figurative imagery onto the traditions of Indian printed textiles.' Brassington, L., *New Printed Textiles from India,* The Textile Society Magazine, Vol.17, Spring 1992, p.17.

[52] The designs of imported Chinese silks did not significantly influence European taste until the 17th century. Justema noted Pliny's comment from the 1st century; 'as Chinese textiles reached the west they were unravelled and rewoven in occidental designs'. Justema, W., *The Pleasures of Pattern*, New York, 1968, p.54 .

Dupont-Auberville commented on the 'regular character' of 17th century trade with China, and gave examples of Venetian and French silk damasks in 'imitation of Chinese designs'. Dupont-Auberville, M., *L'Ornement des Tissus*, Paris, 1877, printed in English as *Ornamental Textile Fabrics*, London, 1877, reprinted as *Classic Textile Designs*, London, 1989, text accompanying pl.37.

[53] The China blue technique was used to simulate blue and white Chinese porcelain designs (5.07).

[54] Motifs, such as palm trees, pagodas, monkeys, exotic flowers, birds, and vignettes of Chinese life, were copied from engravings (6.19) and Chinese products, adapted for the European market (6.07).

[55] Jones, in his analysis of these arrangements, stated that 'triangulation is the main feature, the geometrical arrangement is absolute and undisguised, but softened by a free treatment of the intermediate spaces left by the triangulation'. Jones, O., *The Grammar of Chinese Ornament,* London, 1867, reprinted London, 1987, p.7.

[56] Many were based on document designs reflecting the historical references characteristic of the period.

6.11. Egyptian sources

Ancient Egyptian motifs formed part of the neoclassical repertoire from the mid-18th century. The French classical style combined them with rococo elements.[57] Hieroglyphic symbols were used in designs for dress fabrics, and scale patterns were combined with European or oriental floral motifs.[58] Egyptian patterns influenced the forms and structures of Art Deco designs.[59] These included diamond and broken stripe patterns, symmetrical designs derived from pillar decoration, and all-over designs based on geometric and interlocking patterns. The motifs of lotus and papyrus were also commonly used in loosely drawn designs, without the rigid structure of Egyptian patterns. The abstract diamonds and broken stripes of Egyptian patterns influenced many 1950's Swedish screen prints, and symmetrical pillar patterns recurred in the 1960's Art Deco revival.

6.12. Japanese sources

The relative simplicity, balanced use of pattern, formal clarity, and conventional, flat imagery of Japanese design was influential in the development of Art Nouveau.[60] Designs transferred easily to block printing and stencilling.[61] The characteristic combination of geometric and natural forms in small-scale all-over patterns was also adopted.[62] The structural influence continued in Art Deco designs, with asymmetrical arrangements of flat natural forms on loosely drawn geometric backgrounds.

Japanese motifs were widely used into the 1930's, continuing the Oriental trend. Since the 1960's, the Japanese influence has emerged in various forms,[63] and contemporary Japanese designers are having an international influence.[64]

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[57] These became increasingly popular following Napoleon's Egyptian campaigns.

[58] Egyptian motifs and vignettes continued to appear in 19th century eclecticism. Ancient Egyptian motifs and roller printed copies of contemporary scenes were commonly used in the early 19th century and, in the late 19th century, Egyptian motifs appeared with the general interest in exotic and historic designs (3.04).

[59] The publicity surrounding the discovery of the tomb of Tutankhamen, in 1922, gave rise to a popular fashion, 'Tut-mania', which was applied to all areas of design.

[60] The designers Godwin and Talbert were particularly influential in popularising Japanese styles.

[61] Many Japanese designs were screen printed, and some stylistic aspects were directly related to the process. The interest generated by these prints led to experiments with stencilling techniques and, eventually, to European screen printing (5.22 and 5.23).

[62] These forms, adapted from Japanese pattern books, appear in many 19th century publications (4.12).

[63] For example, in abstract designs, such as 'Ikebana' by Barbara Brown, in designs using Japanese motifs of cherry blossom and circles in large repeats, and in Pat Albeck's 'Saki' design (1976) of an irregular patchwork of geometric and floral forms.

[64] Japanese designers working in Europe provide cross-cultural influences. Japanese fashion designers are often closely involved with textile design, continually reinterpreting traditional Japanese patterns (6.22).

6.13. African sources

Wax batik prints had been introduced into West Africa by the Dutch who produced machine printed batiks for the Javanese market since 1830. 'As a result Javanese batik motifs such as scorpions, fish and butterflies have become part of the design idiom of West Africa'.[65]

African art was a major influence on the concepts and imagery of modern art movements, such as Cubism, and formed part of the design ambience in which textiles were designed. The abstract forms and colours of contemporary art were translated into the Art Deco and 'jazz' designs of the 1920's.[66] In the 1930's, the theme was maintained using Westernised African imagery.[67] Abstract African-inspired patterns were block printed using simple repeats to produce striped arrangements, and were deliberately misregistered to give a naive look.

Tribal patterns, comprising simple stripes of symmetrical geometric motifs, were popular in the 1960's. An interest in craft techniques, such as batik and tie-dyeing, in the 1970's, was reflected in the production of prints, such as Warner's 'Ethnic Originals'.[68] Forms were stripes of geometric elements and geometric patchworks of abstract shapes. They were more sophisticated than the 60's styles, showing a greater awareness of African patterns and printing techniques.

6.14. Russian sources

The colours and forms of Ballets Russes were absorbed into the decorative Art Deco style. Simultaneously, in Russia, the post-revolutionary designers 'sought contact with the proletariat' in the 'Socialist dream of progress'[69] to create an internationalist flavour. The emphasis placed on creating low-cost, mass-produced designs led to innovative designs with limited colours and small-scale patterns.[70] These Constructivist designs were influential on the Bauhaus and other modern movements of the 1920's, and on British textiles of the 1930's.

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[65] 'Wax prints, which were never part of African native culture, are now officially recognised as African national dress'. From the exhibition guide to *Coronations and Cricket Bats,* Whitworth Gallery, Manchester, October 1991 - January 1992. From 1850, British printworks also produced speciality prints for West Africa in imitation of the traditional Adinkra and Adire cloths and, from the early 1900's, wax batik prints were exported.

[66] Many artists also became involved in design at this time (6.18 and 6.23).

[67] Flat semi-abstract motifs of warriors, shields, and spears were combined to form decorative all-over patterns. 'Jungle' fabrics incorporated exotic plants and flowers in conventional chintz arrangements.

[68] The batik look is a recurring theme in fashion fabrics, and its essential feature is a fissured texture, simulating the wax process. The type of imagery and scale of repeat have varied with different interpretations.

[69] Shvidkovsky, O.A., in the catalogue for *Art in Revolution,* Hayward Gallery, London, 1971, p.13.

[70] Revolutionary symbols, visual references to everyday life, and abstract motifs (3.08) were arranged in definite geometric structures (8.01).

6.15. HISTORICAL INFLUENCES

The continual revival of historic designs can be explained by the inter-linked influences of tradition and nostalgia. The establishment and perpetuation of 17th century damask patterns has been attributed to their traditional associations with 'palatial surroundings, which made them emblematic of a gracious, assured lifestyle', and to the 'long period these fabrics often remained *in situ*'.[71]

A nostalgia for a pre-industrial age arose in the mid-19th century as a reaction to increased mechanisation. This was most purely expressed by the Gothic Revival designers who accurately reproduced the stylised and symmetrical forms of Medieval patterns.[72] This trend was popularised in the late 19th century, with direct copies of historic and exotic patterns.[73]

Throughout the 20th century, there has been a fluctuating market for document textiles. In the 1960's, the emergence of fashion forecasting prompted an increase in the use of historic themes[74] and, since the 1970's, historicism has again become a major theme in design.[75] Nostalgia is cited as a major factor in 'the enduring taste for a "Laura Ashley" school of fabrics and furnishings which mass-market a style whose very cachet was once that it could not be industrialised'.[76]

The recycling of themes has developed, with the post-modern movement, into a return to unrestrained eclecticism in which 'the past (mostly the recent past) has been transformed into a mammoth lucky dip'.[77] A comparison may be drawn between the present situation and that of the mid-19th century, which Jones described as, 'that unfortunate tendency of our time to be content with copying,

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[71] Schoeser and Rufey stated that some remained on walls for over two centuries. Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present*, London, 1989, p.13.

[72] These designers rejected the contemporary design anarchy that accompanied increased mechanisation (1.07). At the same time, stylistic terms, such as Gothic and rococo, were broadly applied to reinterpretations of earlier patterns containing motifs and forms from a variety of sources.

[73] The encyclopaedic publications of the later 19th century provided sources for historic patterns (3.04). Printed 'Liberty Silks' included 'reproductions of Ancient Indian, Persian and other Classic Oriental originals'. Liberty's *Silks* catalogue, London, 1895.

[74] In 1966, Promostyl 'aimed to take fashion and develop it into a predictable science . . . The early 60's were the right time to develop the idea. They were years of rapid industrial and technological development, dynamism and a belief in the future'. Promostyl publicity material, 1988.

[75] In furnishing textiles, the nostalgia theme has developed into a preoccupation with authenticity (6.21).

[76] Adair, G., *The postmodernist always rings twice,* The Guardian, August 20, 1992, p.30. In fact, most of Laura Ashley's early designs were derived from early 19th century roller printed cottons, produced when industrialisation was rife.

[77] Ibid, p.30.

whilst the fashion lasts, the forms peculiar to any bygone age'.[78] Revivalism is now a world-wide phenomenon,[79] with design archives[80] and reprinted pattern books increasingly used as sources.[81]

6.16. Reinterpretation

Reinterpretations, although retaining some elements of the original sources, are essentially reworkings of historic themes for the contemporary design climate. For example, Schoeser and Rufey illustrated examples of similar classic designs, block printed in the early 19th century and 1930's, and screen printed in 1962. Each had a different treatment according to the trends of the time; the 19th century design has flat forms on a picotage ground, the 1930's design is multicoloured with a textured, 'aged' effect, and the 1960's design is printed in bold flat colours.[82]

Classical motifs have appeared continually on 18th century toiles, large-scale furnishing prints in the mid 1980's, and on recent fashion fabrics.[83] From the start of the 19th century, the increasing search for novelty prompted reinterpretations of earlier designs,[84] which were adapted to new printing and engraving processes

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[78] Jones disliked the 'dangerous tendency' of direct copying. He reproduced the illustrations in his books as examples of design 'principles', and suggested that they be used 'as guides to find the true path'. Jones, O., *The Grammar of Ornament*, London 1856, reprinted London 1987, p.1. and preface. There was a two-fold reaction to this eclectic trend. Some designers absorbed influences to create new design styles (Arts and Crafts Movement) (6.17), but others returned to a 'purer form' of design (the Design Reform Movement).

[79] An American company spokesman stated that 'most of the designs we print are derived from old to very old designs for hand printing and roller printing'. *The Stork IPS 2000 in the USA,* Inter-Vision, No.11, October 1990, p.4.

[80] In 1991, the archives of Lockett & Crossland were auctioned for £97,713. LePelley suggested that 'many of these designs would sell like hot cakes if they were available now'. LePelley, N., *Cotton Picking Lot,* The World of Interiors, May 1991, pp.106-11. David Evans & Company's archives go back to the 1840's. Some of the small-scale designs for classic menswear, 'are still being used today with some modifications'. *Printing on Silk,* Screen Process, May 1990, Vol.40, Part 5., p.60.

[81] '. . . historic ornament has been "re-discovered" as a visual language and the decorative arts are once again flourishing'. Harris, J., in the foreword to Dupont-Auberville, M., *Classic Textile Designs*, London, 1989, reprinted from *L'Ornement des Tissus*, Paris, 1877, printed in English as *Ornamental Textile Fabrics*, London, 1877. Many similar books were reprinted in the late 1980's (3.05).

[82] Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, pp.17 and 21.

[83] Greek and Roman forms were absorbed into European design as part of the neoclassical visual vocabulary. Timney Fowler's designs, such as *Roman Heads* (8.22), made use of classical architectural motifs, like columns, pedestals, and statues drawn with trompe l'oeil effects. The fine lines, monochrome character, and scale are reminiscent of earlier plate prints, but they were designed to be draped, and made use of a broken collage effect. Similar classical allusions and scale appeared in Versace's *Versus* collection of ready-to-wear shirts for 1992, and have now been absorbed into high street fashion.

[84] The 18th century taste for the exotic and historic developed into full-blown eclecticism. Classical styles, loosely termed Grecian, Pompeian, Etruscan, and Egyptian, were fashionable. This trend was stimulated by the increased publication of engraved illustrations of archeological finds and by a more scholarly attitude to past styles. Decorative ideas were taken from every available source (3.04). Even recent design ideas, such as printed Berlin work, were also subject to continual revival (6.05).

and combined with contemporary trends in imagery and colours.[85]

A constant theme in design reinterpretation has been a nostalgic recreation of the past. Early 20th century chintz designs incorporated 'old' motifs for the English country house look,[86] and this trend continued up to the 1950's, with furnishing prints such as 'Jacobean' chintzes.[87] 1960's reinterpretations of furnishing designs from 1910-20 included *chinoiserie* designs which, themselves, were derived from earlier designs.[88] The 1960's saw a mix of diverse styles, many looking to the past for inspiration, but Justema commented that, 'during these eclectic times, too many designers are on the defensive with regard to originality, and never more so than when their sources are clearly visible'.[89] Designers now are open about their sources and influences, and such research, rather than being regarded as copying, is now an accepted part of the design process.

6.17. Synthesis

The 19th century was characterised by reinterpretations of historic and exotic designs, ranging from direct copies to bizarre mixtures of various fashionable themes. The Arts and Crafts Movement, although eclectic in its inspiration, re-invented patterns as contemporary designs[90] and synthesised, rather than simply mixed, these influences.[91] 19th century Publications included design analyses and

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[85] Design forms, such as pillar prints, were redrawn incorporating the contemporary trends in imagery, like Gothic, *chinoiserie*, and classical motifs, and were printed in the new fashionable colours, the Drab and Pompeian 'styles' amongst others.

[86] This look was popular at the same time as Art Nouveau, and was inspired by the Arts and Crafts Movement and a nostalgia for pre-industrial times. Motifs, such as cabbage roses, pagodas, and flowering branches, were common.

[87] These were produced for all prices, from expensive block printed chinzes to cheaper roller printed cottons, and were often based on old needlework designs (6.05).

[88] Designs were restyled or recoloured and adapted for new printing processes and wider fabrics (6.10).

[89] 'If this were a creative period in the creative arts, the intelligent use of the past would be taken for granted. A frank attitude towards "copying" is, in fact, the sign of a healthy tradition'. Justema, W., *The Pleasures of Pattern*, New York, 1968, p.157.

[90] Most of the design theory of Arts and Crafts practitioners was based on their analyses of historic patterns (6.03), but their work differed from revival designs in the adaption of the structural aspects of these designs with less conventional representations of nature. This gave a more flowing and less stylised overall effect. Many designs have now become classics in their own right. 'Morris chintzes were the epitome of good design . . they seem to have existed alongside the fashions and trends that came and went with other textile designs'. Robinson, S., *A History of Printed Textiles,* London, 1969, p.36.

[91] The majority of well-known designers of the era were from this group, but their work represents only a small proportion of the textiles printed at the time. Its designers generally took an anti-mechanisation stance. Their rejection of technology and industry was a reaction against poor quality produced by the economic emphasis on machinery and the consequent dissociation of the designer from the production processes (1.07 and 1.09). Their predominant use of hand printing resulted in products only affordable by an elite, but their popularity stimulated manufacturers to commission designs after their style.

geometric theories, and introduced an awareness of structure as an important design ingredient.[92] Developments in the Fine Arts, combined with the socialist ideals of the Arts and Crafts Movement, led to modernism and, with new visual approaches, became the avant-garde styles of Art Nouveau and Art Deco.[93]

Eclectic trends continued alongside these, and a 'similar co-existence of styles pervades all other periods throughout this century, culminating in the cult of Post-Modernism'.[94] 'This rich combination of traditionalism, of unfettered eclecticism and of bold experiment in design, has persisted to the present day and makes any general summary of 20th century textile design less of a story of progress and innovation than one of complicated, overlapping impulses'.[95]

6.18. DESIGN INNOVATION

Design innovation represents a radical departure from current design styles motivated by political, philosophical, idealistic, aesthetic, and technical concerns. It is a catalyst for new styles which are then absorbed by the mainstream and, eventually, become additional elements of the design vocabulary.[96]

The austerity of French revolutionary prints can be seen as a reaction against the ornate styles associated with the previous regime. Equality was expressed in the utilitarian character of the designs,[97] and many designs were geometric with small and defined repeats.[98] Mechanisation was actively embraced in order to produce prints at an affordable price, with speed and cost of production as important factors. In this respect there are similarities with the prints of the Russian post-revolutionary period.[99]

Scientific and technological imagery has often been associated with 'modern' styles, seeking to create designs based on general, rather than individualistic,

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[92] Such publications were concerned with historic and non-European design methods (4.12).

[93] These styles represent a similar amalgam of wide ranging sources.

[94] Woodham, J. M., *Twentieth -Century Ornament*, London, 1990, p.9.
Post-Modernism takes this further, with the mixing of historical and cultural sources. The attitude of the Memphis Group was described as one that 'assimilates, or at least acknowledges, anthropological, sociological and linguistic inquiry, from Lévi-Strauss to Barthes to Braudrillard'. Radice, B., *Memphis: Research, Experiences, Results, Failures and Successes of New Design*, London, 1985, p.141.

[95] Newton, C. and Young, H., *Designs for British Dress and Furnishing Fabrics*, Victoria and Albert Museum, London, 1986, p.14.

[96] Fashion forecasters consistently draw on innovative designers in their predictions.

[97] They also included motifs symbolising the new political climate (3.08).

[98] 'In a fierce reaction, designs were based only on linear elements, organized in a great variety of combinations: squares, diamond shapes, triangles, occasionally softer ovals or half-circles'. Brédif, J., *Toiles de Jouy*, English translation London, 1989, p.96.

[99] These designs mostly had dynamic structures, and incorporated scientific or mechanical imagery (6.14).

symbols. Many 1950's designs were based on scientific diagrams of atomic structures and, during this period, many designers, such as Paolozzi, expressed interest in micro-zoology, and used scientific and pseudo-scientific symbols.[100] The motifs of many 1950's furnishing prints, with 'thin spiky lines reflected architects' and furniture designers' current preoccupations with the tensile strength and slimness of steel components'.[101] Such imagery has been absorbed into the visual vocabulary and used as fashionable forms, rather than as design statements.

Applied design has generally reflected artistic concerns. The post-renaissance emphasis on pictorial realism affected the adaption of 'exotic' designs in the 18th and 19th centuries, resulting in the copying of scenes and motifs.[102] It is also apparent in the use of trompe l'oeil effects and naturalistic representations of natural forms.[103]

The artistic ambience and the direct involvement of artists was important in the early 20th century, when many artists and designers 'were seeking for a new aesthetic with an intellectual curiosity and a desire to explore the further limits of artistic expression'.[104] In Britain, the Omega Workshops (1913-1919) were important in introducing this 'new approach to design'.[105] With the prevailing British taste for floral traditionalism, their painterly abstract designs were commercially unsuccessful, but 'were imitated by industry in later years'.[106]

At the same time, individual artists were producing similar abstract or geometric

[100] Images derived from microscopy and crystallography (4.11) have also reflected changes in the perception of nature (2.20).

[101] 'Such patterns complemented the lightweight appearance of angular wire balustrades and the graceful curves of chairs created from thin steel rods or moulded plywood'. Hinchcliffe, F., in the introduction to *Fifties Furnishing Fabrics,* Victoria and Albert Museum, London, 1988, p.8.

[102] Because pictorial realism was thought to be the highest form of art, emphasis was placed on the copying of images, rather than decorative or abstract forms (3.11). The printing of illustrations, permitted by copperplate engraving, increased the reliance on representational imagery (6.19).

[103] The increasing use of three-dimensional representation was one of the characteristics denigrated by the Design Reform Movement in the mid-19th century (4.05 and 6.21).

[104] Calloway, S., in the introduction to *Art Deco Designs*, London 1988, reprinted from Benedictus, E., *Variations quatre-vingt-six motifs decoratifs en vingt planches*, Paris, 1926, and *Relais quinze planches donnant quarante-deux motifs decoratifs*, Paris, 1930.

Changes in perceptual awareness had generally affected painting and the applied arts (2.20).

[105] 'Contemporary art directly influenced the design of the workshop - Modernism reached textiles'. Russel, A., *Industry, printed textile design and the mass market in the nineteen fifties,* The Textile Society Magazine, Vol.17, Spring 1992, p.21.

[106] King, B., *Modern Art in Textile Design,* The Whitworth gallery, Manchester, 1991, pp.2 and 5.

designs.[107] Art became a major influence on postwar design as abstraction was absorbed into the popular consciousness.[108] In the 1960's, Op Art[109] and Pop Art were similarly adapted, and artist's screen prints transferred easily into large, expansive textiles.

Street fashion has become a major influence, and tends to be more innovative because it is unrestricted by wider commercial concerns. Such anarchy 'keeps the experimental side alive if nothing else, and ensures a variety of approaches and plenty of discussion' and 'will inspire the other, hitherto ultraconservative clients to take a more adventurous line'.[110]

6.19. TECHNOLOGICAL INNOVATION

Developments in printing and engraving techniques have provided new design possibilities and styles. Dramatic changes of style have often occurred when techniques, adapted from comparable technologies, have allowed a transference of expertise and imagery. This has been apparent with the cross-disciplinary links between textile and paper printing.[111]

Pictorial textiles have been printed since the 14th century,[112] but became fashionable with copperplate prints which reproduced engraved illustrations.[113] Clark noted that 'similar pictorials appeared as transfer prints on ceramics and enamels, the same engravers often being associated with both'.[114] The effects and

[107] They were influenced by Russian Constructivist Art and other world-wide sources, including craft methods. These translated into the hand methods favoured by designers, such as Nash. Manufacturers attempted to adapt these designs for mass-production. Some artists became involved in the production processes but, more usually, the manufacturers converted their work into a printable form (6.23).

[108] The spiky 50's furnishing designs reflected a range of other sources from the Fine Arts, such as Calder's mobiles.

[109] For furnishings, Op Art was applied mostly to contract prints, but was important for domestic upholstery fabrics (6.21). It was also important in the use of 1960's geometric fashion fabrics (6.22).

[110] Huygen, F., *British Design: Image and Identity,* London, 1989, p.152.

[111] Developments in paper printing have affected trends by increasing the dissemination of design ideas. From the 16th century, the demand for fashionable designs was stimulated by craft publications which spread new styles (3.04). In the 18th century, publications by designers, like Jean Pillement, were influential in spreading such styles as rococo and *chinoiserie* (6.10).

[112] Late 14th century prints preceded wood engravings for paper and parchment, which did not appear until the mid 15th century. Storey mentioned some later 'exceptional examples which display finer lines and which make it fairly certain that sometimes designs were engraved on metal plates'. She suggested that these were similar to illuminated manuscripts produced in some monasteries by plate printing. Storey, J., *Textile Printing,* London, 1974, p.28.

[113] Many 18th century copperplate prints were copies of engraved book illustrations. A Bromley Hall design, *Peacock & Hen* (1765), was a copy of the frontispiece of *A New Book of Birds,* also published in 1765. *Designs for British Dress and Furnishing Fabrics,* Victoria and Albert Museum, London, 1986, p.35.

Engraved illustrations and maps were plate printed for embroidery patterns from about 1780.

[114] Clark, H., *Textile Printing,* Aylesbury, 1985, p.8.

imagery were adapted for block printing,[115] and 'represented a major departure from the starkly contrasting block prints seen in earlier periods'.[116]

Early printed textiles were frequently used as wall-coverings, and an exchange of influences has occurred between textiles and wallpapers.[117] Many pictorial designs for plate printed textiles were derived from hand-painted papers.[118] Wallpapers were also plate printed, some being direct copies of textiles and others having the same motifs in different arrangements.[119] Textile roller printing was later adapted for mass-produced wallpaper.[120] Rainbow stripes arose from wallpaper printing, and the technique was transferred to block printed textiles in the 1820's.[121]

Roller printing and the subsequent developments in its engraving techniques prompted stylistic changes.[122] These processes, however, depended on the intervention of a skilled engraver. The versatility of screen printing and its direct engraving methods allowed experimentation[123] and, combined with the ease of colour changes and low screen costs, was 'largely responsible for a radical change in design styles'.[124] Although many 1950's screen printed designs are 'now regarded as "kitsch", the use of washed, watercolour-like images and near-photographic realism were to have great impact on the vocabulary of designers in

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[115] In the 18th century, John-Baptist Jackson developed block printed chiaroscuro effects from his study of Renaissance engraving. William Curtis commissioned William Kilburn to produce engravings for his publication *Flora Londinensis* (1777-87). Kilburn's botanically inspired designs for block prints exhibited a delicacy of line only previously obtainable by copperplate printing, although 'something of their subtlety must have been lost in the process of cutting and printing'. *Rococo Silks,* Victoria and Albert Museum, London, 1985, p.12.

[116] Taylor, G., *Printing effects,* Textile Asia, May 1982, p.34. These were developments of earlier techniques for lace prints (6.04), and were also applied to block printed wallpaper designs.

[117] False tapestries were printed to imitate costly woven fabrics (6.21). Wallpapers were block printed in the 16th and 17th centuries, but wallpaper did not become widely used until the second half of the 19th century with the advent of mass-produced surface printed papers.

[118] These were mostly influenced by imported hand-painted Chinese papers (6.10 and 8.25).

[119] '. . . the copying was from cloth to paper', although it is 'difficult to prove a precedence unless dated documents can be found'. Brédif, J., *Toiles de Jouy,* English translation London, 1989, p.91.

[120] The first wallpaper roller printing machine, in 1839, was an adapted calico printing machine. Turner, M., in the exhibition catalogue for *A Popular Art: British Wallpapers 1930 - 1960,* London, 1989, p.8.

[121] In the 'early 1800's the Alsatian wallpaper firm of Zuber became famous for its ombrés'. Meller, S. and Elffers, J., *Textile Designs,* London, 1991, p.96. These were popular for textiles between 1820 -1850.

[122] These developments are covered in more detail in Chapters 7 and 8.

[123] This 'led to designs with a very specific look, more like block prints than roller prints, with an angular, sketch-like, energetic quality'. Phillips, B., *Fabrics and Wallpapers,* London, 1991, p.72.

[124] Storey, J., *Textile Printing,* London, 1974, p.110. In Britain, during the 1930's, screen printing 'quickly became the favoured medium for modern printed designs'. Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.182.

the following decades'.[125] Russel argued that, during the 1950's, 'some firms became carried away with the qualities the new technology offered', showing 'the new techniques proving master rather than servant'.[126]

Transfer printing provided another strong link with the pre-press and publishing industries,[127] and its future development could reinforce this.[128] With the dominance of printed media, graphic design has been an important influence during the 20th century. Designs incorporating text and collages of graphic images have been produced since the 1930's.[129] Photographic processes have allowed the introduction of 'found' imagery and textures. The multi-layered approach used in contemporary television, video, and computer media for the youth market is reflected in the increased use of collage formats. Jet printing, by providing a direct link between computer and substrate, may stimulate an innovative use of such sources.[130]

6.20. END USE

Contemporary textiles are specified as dress or furnishing fabrics, but this distinction rarely occurs in early documentation[131] and, when applied, has often been disregarded by consumers.[132] Seasonal fashion changes were promoted by manufacturers centuries ago to stimulate demand, and designs, especially for fashion fabrics, have had increasingly shorter life-spans. In the late 17th century, many furnishing designs stayed in production for about thirty years. In the early

[125] Schoeser, M., *Pattern in Textiles,* Textile World, April 1985, p.39.

[126] Russel, A., *Industry, printed textile design and the mass market in the nineteen fifties,* The Textile Society Magazine, Vol.17, Spring 1992, p.22.

[127] This technological cross-over allowed printing and engraving developments to be applied to textiles (5.34).

[128] Commercial transfer printing onto natural fibres may soon be possible (5.35), and improvements in quadricolour printing methods are expected (5.36). The printing of full-colour photographic images is a continuation of the pictorial theme, and has been used in 'modern toiles', with 'island' arrangements of pictorial detail (7.02).

[129] In the 1930's, Schiaparelli designed a printed textile of press cuttings. Her association with artists, such as Dali, led her to explore other unconventional combinations of imagery. Cartoons have provided a source of imagery, especially for children's wear and placement prints. Contemporary designers, such as English Eccentrics, popularised collage techniques using scattered blocks of graphic images and text (8.13).

[130] This would eliminate intermediate colour separation and engraving processes (5.41).

[131] In the 18th century, 'dress fabrics are rarely distinguished from furnishing fabrics'. Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p.18.

[132] Dress fabrics have been used as cheap furnishings and wall coverings (6.21), and furnishing prints (including large-scale designs) for dress fabrics (6.22). The first Laura Ashley shop (1969) selling both women's wear and home-furnishings was, at the time, seen to be an innovative marketing idea. 'With two different consumer groups and an unclear product image, the pundits said the company was doomed to failure'. Johnson, E., *Laura Ashley bursts its seams - with growth,* Textile World, June 1988, p.83.

19th century, all designs had shorter life-spans, and most fashion styles lasted for about two years.

By the 1950's, although traditional designs were still expected to be long lasting, contemporary furnishing designs lasted from five to seven years. In 1987, Keighley quoted a textile printer; 'some furnishing designs we can expect to run for two or three years. With fashion designs, we can put them into operation and some weeks later find they are discontinued'.[133] During recessions, such changes can be counterproductive because 'printed designs are more ephemeral and date more rapidly than piece-dyed fabrics'.[134]

6.21. Furnishings

Printed fabrics were used for wall coverings since the 12th century,[135] but the 18th century saw a general increase of prints for curtains, blinds, bed hangings, counterpanes, upholstery, loose covers, valances, and curtains. Large-scale pictorial toiles, similar to tapestries and hand-painted papers, were most effective when hung flat, but were used for all types of furnishings.

Block or roller printed fabrics were mostly on a smaller scale but, when used for curtains and bed hangings, the regularity of repeat was hidden in the drape. They were often lined with small-scale patterns.[136] En suite furnishing, using matching or coordinating fabrics for curtains, upholstery, and sometimes wall-coverings, became fashionable in the 1770's, and remained popular until the 1850's.[137]

The uses of furnishing fabrics changed around the mid-19th century; wallpapers started to replace textile wall-coverings, curtains became common, and bed-hangings were discarded. Conventions were established for designs that were appropriate for flat or draped textiles. Between the late-19th century and the 1960's, it was generally accepted that upholstery fabrics should not destroy the form of the upholstered unit, thus precluding the use of large-scale, strongly

[133] Keighley, M., *Lancashire cotton printers make a fine impression,* International Dyer & Textile Printer, April 1987, Vol.172, No.4, p.10.

[134] 'Plain colours can therefore be worn for a longer period without going out of fashion'. Holme, I., *Print Design: The Future,* Textile Horizons, May 1982, p.30.

[135] Printed textiles were often cheap alternatives to woven fabrics, tapestries, and wallpapers. Printed 'false tapestries' of the 12th to 16th centuries were copies of the contemporary woven designs. Prints continued to be used as wall-coverings until the second half of the 19th century (6.19).

[136] Small-scale patterns, such as vermicular and other fancy grounds, were also combined with motifs on larger scale designs (5.14 and 8.04)

[137] This fashion was exploited by block printers, who produced mix and match ranges (8.21).

geometric, or pictorial designs.[138]

Furnishings are now produced for contract or domestic markets, but the main distinguishing factor of scale did not come into effect until the late 19th century. Contract prints are mostly used with modern architecture that can accommodate contemporary large-scale designs,[139] but would be visually overpowering in most domestic settings. Domestic prints are usually smaller scale. A shorter vertical repeat creates less wastage when matching repeats for curtains, and the proportionately narrower width of repeat allows more design flexibility in the avoidance of banding in the overall effect.

From the 1880's, a widening of the market for domestic furnishings caused the scaling down of designs for smaller houses. Classic brocade and damask designs, originally intended for long drops, were reduced and the vertical repeat was often halved by the removal of a filling motif. Most late 19th century designers had aimed for an all-over effect in which the repeat was disguised.

The stylised Art Nouveau and Art Deco patterns introduced a formal, structured appearance which, in the late 1920's, was developed into designs with a strong horizontal emphasis. Modernist trends in the 1930's continued this structured look, with Cubist inspired designs.

The large-scale and bold patterns of most 1950's domestic furnishing prints can be attributed to a combination of changes in architecture, interior design, and printing technology.[140] The popularity of wide picture windows, patio doors, and the introduction of central heating all favoured the use of 'straight-hanging curtains with large pattern repeats'.[141] The effects created by folds in draped fabric became important design considerations. Girard stated that 'I have tried to conceive of patterns in their distorted state. This has led logically to the strict avoidance of any

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[138] From the mid-19th century, it was thought inappropriate to use illusions of depth in designs that were applied flat, such as upholstery, carpets, and wallpapers. This originated from design theorists, such as Pugin and Jones, who advocated 'conventional' design (4.05).

[139] In the 1930's, 'progressive architects felt that their carefully conceived interiors would not be enhanced by textiles which had their origins in 17th-century Italy'. King, B., *Modern Art in Textile Design,* The Whitworth Gallery, Manchester, 1991, p3.

[140] The majority of 1950's furnishing prints were screen printed, which made larger repeats possible. Smaller scale versions of contract prints were sometimes produced for the domestic market (8.25).

[141] 'Entire walls of such curtains were fashionable in both large and small rooms, providing a focal point for in rooms with central heating (and therefore, often, no fireplace) and compensating for the lack of architectural details such as coving and panelling'. Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p. 205.

representational forms which I feel do not lend themselves to distortion'.[142]

The introduction of simple seating units and the influence of Op Art in the mid 1960's broke the earlier convention restricting the designs of upholstery fabrics. Large-scale geometric designs were used, and some designers, such as Barbara Brown, used visual illusions to distort the forms. The free-form furniture of around 1970 was often covered in stretch fabrics printed with large-scale optical or swirling designs to emphasise their curvilinear shapes.

In the 1970's, the fashions for fabric wall-coverings[143] and for matching wallpapers and fabrics were revived, and the popularity of duvets produced a growing market for bedding ensembles. The en suite fashion has developed into the employment of coordinating, rather than matching, fabrics.[144]

Domestic furnishings represent a large financial outlay, but are often used for relatively long periods. In times of economic recession, consumers tend to buy designs that will not go out of fashion quickly, and this has created a continuing market for patterns with a classic or traditional look. Some have stayed in production and 'have been highly successful in commercial terms over many decades'.[145]

Historicism has been especially evident in this market. 'From turning your house into an early nineteenth-century country cottage with a Laura Ashley catalogue, to considering the accurate period decoration of your house is but a short step'.[146] 'Historical reference of some kind underlies most furnishing textiles of the 1980's. The touchstone of the decade has been authenticity, embodied in the faithful revival of the period textile document'.[147] This trend has continued into

[142] Also, he continued, 'I have avoided realistic forms as they tend to create varying degrees of depth, therefore destroying the fabric surface'. Alexander Girard quoted by Conran, T., *Printed Textile Design,* London, 1957, p.40.

[143] Conran suggested that any 'kind of fabric which doesn't stretch or distort too much, even ginghams or ticking' could be used. He illustrated Indian bedspreads used as wall coverings, reflecting the 'alternative' influences of the era. Conran, T., *The House Book,* London, 1974, pp.84 and 86.

[144] Like the en suite furnishings of the 18th and 19th century, this relies on the use of the same or similar motifs used in various scales and arrangements.

[145] Woodham illustrated a 'Jacobean' design, from 1913, which was selling well into the 1950's. He asserted that, despite 'its strong flavour of that period, its decorative elements also contributed to its enduring success in the marketplace'. Woodham, J. M., *Twentieth -Century Ornament,* London, 1990, p.6.

[146] Turner, M. and Hoskins, L., *Silver Studio of Design,* London, 1988, p.10.

[147] Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p. 231.

the 1990's.[148]

6.22. Fashion fabrics

Printed fabrics were rarely used for garments until the 17th century[149] when imported Indian cotton prints started to be used for colourful summer dresses because they were practical, light, comfortable, and colourfast.

Changes in dress styles have influenced textile design. Hand-painted and printed cottons and silks were highly fashionable in the 1770's,[150] with small all-over florals for full-skirted gowns and petticoats, and trailing floral *indienne* or *chinoiserie* designs to complement the draped forms of polonaise dresses.[151]

Striped floral designs of the 1790's emphasised the vertical lines of the new high-waisted dresses, but the accompanying caraco jackets usually had small all-over patterns.[152] The simple neoclassical fashions of around 1800 were similarly high-waisted, but with straighter skirts using simple sprigged designs.[153]

After 1820, larger all-over designs were suited to the fuller skirts.[154] Crinolines widened skirts further, and fabric 'printed so that it complemented the shape of the dress when made up was popular'.[155] Bustles emphasised the back of the skirt and gave a narrower line to the front of the dress, and fine straight stripes with tiny garlands and bouquets were used with this vertical line.

Printed shawls appeared in large numbers in the 19th century.[156] Changes in

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[148] An advertisement by Brunschwig & Fils showed a contemporary toile, and proclaimed: 'we can customize anything from a Greek revival to a French revolution'. *House & Garden,* London, March 1990, p.21.

[149] Biriukova quoted from a late 14th century Italian treatise on painting by Cennino Cennini, that block printed textiles were 'good for children's and youth's clothing'. Biriukova, N., *West European Printed Textiles: 16th-18th century,* Moscow, 1973, p.12. In the 15th to 16th centuries, prints were used for cheap clothing.

[150] These were block or plate printed with pencilled colours (5.06). They were also used as linings for men's jackets and waistcoats.

[151] The 1770's styles were on pale grounds, dark grounds becoming fashionable from the 1780's (5.07).

[152] These jackets emphasised the high waists of the dresses of the time. Patterns that did not distract from the complicated styling were often used.

[153] Monochrome dress prints were produced by plate and roller printing. Bright colours were little used, except for jackets, redingotes, and Indian shawls.

[154] The regularity of repeat would be lost in the folds. Printing developments provided effects, such as striped diagonal grounds and multicoloured designs, which contributed to the intricacy of patterns.

[155] Ginsburg used an illustration of a cotton day dress with a small diaper pattern on the bodice. The flounced skirt was made of the same design with a deep border, giving three horizontal rows of pattern. Ginsburg, M., in the text to *Four Hundred Years of Fashion,* Victoria and Albert Museum, London, 1984, p.39.

[156] Woven shawls had been imported in small quantities throughout the 18th century, but had been used as furnishings rather than articles of dress. After 1775, 'the shape of the female silhouette changed to a softer and narrower line, which was much more suited to the wearing of a shawl'. Clabburn, P., *Shawls, in imitation of the Indian,* Aylesbury, 1981, pp.7 and 11. The fashion for Kashmiri shawls stimulated European production of woven shawls based on Indian designs. They were printed on silk from about 1840 and, later, on cotton and wool.

dress styles affected their size, form, and drape, and also the scale and type of patterns.[157] Plaids often had long motifs that stretched from shoulder to ankle, large shawls had borders, filling patterns, and medallion centres, and lightweight printed gauzes usually had small all-over repeats.[158] Glasgow shawls were made in the shape of a flattened semi-circle, and the borders were printed with curved edge blocks.

Aesthetic dresses of the late 19th century, loosely based on historic costume, were made in softly draping fabrics.[159] The fashions of the 1920's, such as Poiret's Directoire style, also required soft but more colourful fabrics, and the straight tunic dresses were complemented by the simple repeats of the printed fabrics.[160]

From the late 1920's, the popularity of sports and leisure activities provided a new market for leisure-wear. Simple designs, such as stripes, were popular for beach wear and sports dresses. 'Striped fabrics, whether used for the whole dress, for a petticoat or just as a trimming, have always been popular for holiday wear'.[161] 'Brightly patterned cottons made practical yet attractive resort wear',[162] and their informality and frivolity provided the freedom to experiment with novelty images

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[157] Reilly traced the effects that changes in dress fashions during the 19th century had on the shape of the shawl. The rectangular softly draped shawl complemented the rather severe lines of the costumes up to the 1820's. With the change to waisted dresses with fuller skirts and large sleeves, shawls were made square and folded diagonally. These were worn to draw attention to the shoulders, with the point of the triangle accentuating the waist. The crinolines of the 1840's made coats impractical, and plaids were draped to provide an alternative form of outerwear. These shawls were made in rectangular shapes but were up to 50% larger than earlier versions (about 3m x 1.5m). The fashion for shawls ended in the 1870's when the bustle brought in a fashion for jackets and coats. Reilly, V., *Paisley Patterns,* London, 1989, p.10.

[158] Large shawls with borders and medallion centres were block printed but, from 1860, roller printing was used to print designs with smaller repeats (8.07). Many were printed in imitation of the woven types (6.03).

[159] They were totally different from contemporary tightly fitted, and bustled fashions. 'The Aesthetic Movement was a revulsion from the brash products of the Industrial Revolution, from the crude aniline dyes which had been introduced in 1859, from machine-made finishes, false veneers, over elaboration, and all the pompous ugliness of urban Victorianism'. Adburgham, A., *Shops and Shopping,* London, 1989, p.174.

Fortuny continued the historic theme, producing dresses based on ancient Greek styles with printed Renaissance motifs. Their timeless quality can be seen as part of a continuing anti-fashion theme.

[160] In France, there was a close involvement between haute couture and artists, such as Dufy, to create colourful, bold, abstract, and stylised designs for this new look (6.18 and 6.23).

[161] Lansdell also noted that *caleçons* (men's bathing costumes), which originated in France in the 1830's, were often striped with broad bands, and the man's one-piece costume 'being made and sold in the 1870's. . . resembled the French fisherman's short-sleeved, horizontally striped jersey with the bottom cut into short legs'. Lansdell, A., *Seaside Fashions: 1860 - 1939,* Princes Risborough, 1990, pp.23 and 19.

Mendes illustrated a summer day dress of cotton printed with vertical stripes, from 1905. 'Crisp-looking blue and white dresses such as this were popular for boating and beach wear'. Mendes,V.D., in the text to *Four Hundred Years of Fashion,* Victoria and Albert Museum, London, 1984, p.157.

[162] Mendes, V., in the introduction to *Novelty Fabrics,* Victoria and Albert Museum, London, 1988, p.7.

and structure.[163]

Dress fabrics of the 1930's were predominantly non-directional floral designs, using the lack of obvious repeats to create seemingly random effects.[164] These were essential for the 'long slim lines of the 1930's silhouette' which 'were achieved by cutting material on the cross'.[165]

Head scarves became popular during and after the Second World War as practical, colourful additions to utility clothing.[166] These and novelty dress fabrics were printed with 'propaganda' designs, such as 'Dig for Victory', rationing coupons, and the 'V' for Victory sign.

From 1947, with the introduction of Dior's 'New Look', until about 1956, there were two main silhouettes. These differed in the skirts, which were either pencil slim or full. Fabrics for dance and evening dresses were usually small-scale florals, and those for shirtwaisters often had abstract, geometric, or pictorial designs printed in bold horizontal bands to emphasise the full skirts. In 1952, Ascher 'introduced dress silks with enormous free, painterly, floral designs on a scale usually preferred for furnishing fabrics'.[167]

In the 1960's, the teenage market became dominant. Very short geometric shapes were fashionable, including 'A' line shift dresses with large geometric designs. McDowell linked this 'geometric approach to fashion' with Op Art, and suggested that it also affected attitudes to pattern in general, allowing stripes, polka dots, and wavy lines to be 'used together in the same garment'.[168] At the end of the 1960's, the influence of alternative lifestyles and travel was absorbed by mainstream fashion, creating soft flowing styles based on kaftans and smocks.

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[163] The designs for such 'novelty' prints often included nautical and seaside motifs, such as starfish, anchors, shells, and coral. Some were simple, with emphasis on imagery, and others were complex arrangements of rotated, interlocking motifs (8.10).

[164] There were two main types; scattered motifs on a plain ground and all-over 'random' designs (8.16). Most were roller printed, but the sketchy nature and freedom of line and form owe much to the imagery created by experimental screen printing. Photo-engraving of copper rollers was used to produce many of the tonal wash effects, loosely drawn lines, and brush marks (5.19).

[165] This resulted 'in complex piecing and intricate diagonal seaming'. Hinchcliffe, F., in the introduction to *Thirties Floral Fabrics,* Victoria and Albert Museum, London, 1988, p.10.

[166] The head scarf became a fashionable accessory after the war. Asher collaborated with contemporary artists to produce modern designs (6.23).

[167] In 1959, 'the youthful trend of making furnishings into dresses' was adopted by Ascher, who printed dress fabrics with large-scale patterns designed for furnishing fabrics, such as *Tropique* by Althea McNish. Mendes,V.D. and Hinchcliffe,F.M., *Ascher,* Victoria and Albert Museum, London, 1987, pp.108, 128 and 194. Although these were disliked by the press, they were taken up by designers, such as Dior, Schiaparelli, and Hartnell, and became fashionable in 1953. By 1959, the scale of such prints was so large that a dress could almost be made from one vertical repeat. This trend continued into the 1960's.

[168] McDowell, C., *McDowell's Directory of Twentieth Century Fashion,* London, 1984, p.28.

This cultural melange was reflected in a multitude of 'ethnic' and revival prints; from small-scale 'exotic' patterns (often combined in one garment) to large-scale reinterpretations of 18th century lace designs. T-shirts were printed with graphic designs, photographic images, and slogans.[169]

From the second half of the 1970's; 'Wave after wave of retrogressive fashion looks were revived and more and more ethnic styles paraded the runways'.[170] In the 1970's and 80's, the multi-layered and asymmetrical styles of contemporary Japanese designers, with their mixing of diverse types and scales of patterns, had a dramatic influence on international fashion. The leisure-wear market has continued to expand with developments in fabrics and images derived from logos being absorbed by the fashion industry generally. These and street styles became a major influence in British fashion.[171] Variety and individualism have since been increasingly important in the fashion industry.[172]

Fashion designers are involved to varying degrees with the production of the fabrics, and some consult closely with manufacturers or design their own fabrics.[173] 'Fabrics often prove the inspiration for dress designers, but designers also work with fabric producers to achieve exclusive cloths for specific styles. The "character" of a textile inevitably suggests appropriate forms to couturiers, and sometimes adventurous fabrics lead to new approaches to cut and construction'.[174]

6.23. DESIGNERS AND INDUSTRY

This relationship has been crucial in the development of new styles which have arisen in collaboration with, and sometimes in spite of, industry. The status and role of designers in the textile industry have been subject to many changes,

[169] Graphic images, text, and logos have since become an established part of the textile designer's visual repertoire, and text was used as a fashion statement by Hamnett in the 1980's with her huge slogan T-shirts.

[170] McDowell, C., *McDowell's Directory of Twentieth Century Fashion,* London, 1984, p.39.

[171] Westwood's themes, such as pirates (1981) and witches (1983), made unconventional use of layers and unrelated patterns. Her punk and new-romantic looks drew on street trends.

[172] 'In virtually every collection . . designers showed small groups of prints in dresses and clashing layers. Each print was a masterpiece of brilliant colour inspired by batiks, by Indian prints, by bold African prints, by wild animals, by the circus, by traditional Provençal flowers, or by Spanish shawls'. *Fashion Moves: Printed Anarchy,* Harpers & Queen, March 1990, p.141. In Western industrial societies, 'fashionable dress is paradoxical in that we use it both to affirm our membership of groups and at the same time to emphasise our difference from everyone else. . . We want to look like our friends but not to be clones'. Wilson, E., *Fashion and the meaning of life,* The Guardian, May 18 1992, p.34.

[173] Designers, such as Mariano Fortuny, Sonia Delauney, Elsa Schiaparelli, Zandra Rhodes, and Issey Miyake, have all produced textiles for their garments.

[174] Mendes,V.D. and Hinchcliffe,F.M., *Ascher,* Victoria and Albert Museum, London, 1987, pp.15.

depending on the size and economic and technical organisation of companies, and the degree of the designer's involvement with the engraving and printing processes.

During the Industrial Revolution, the designer's role was generally reduced to a pattern drawer. Designs were restricted to those seen to be commercially viable, emphasising speed and cheapness of production.[175] The impact that each technical development had on styles indicated a readiness to embrace new techniques and an awareness of their potential by some designers. However, the increased technicality of processes distanced designers from production.[176]

The combination of successive technical developments and eclectic design sources produced an emphasis on novelty that often overshadowed other design considerations. Dresser argued that, in 'all attempts at the production of what is new, there is a danger of being extreme, eccentric, or unrefined'.[177] In the mid-19th century, the perceived low standards provoked divided opinions between some, who championed the craftsman, and others, who wished to work with industry.[178]

Some designers returned to hand processes but, by rejecting industrial production, they also rejected the mass-market. Robinson suggested that William Morris's contribution 'was the first really conscious attempt to replace the hack designer and the commercial printer with a true union of artist-craftsman'.[179] His ideal of 'truth to material' was to influence later designers, and it acted as a catalyst in the development of Continental movements,[180] establishing a strong, continuing

[175] They generally followed trends, and innovation was expressed in the exploitation of new processes combined with the latest fashion in imagery. The work of innovative designers was usually copied, causing the bankruptcy of many quality companies. Most patterns combined recycled motifs with new ground or colours, and consisted of combining elements rather than producing new designs.

[176] Some companies dispensed entirely with the services of designers and relied on copyists who were often engravers, but an 'engraver must know at least the rudiments of drawing so that he can trace the design accurately'. Brédif, J., *Toiles de Jouy,* English translation London, 1989, p.84

[177] Dresser, C., *Studies in Design,* London, 1988, p.9. First published, London, 1876, p14.

[178] The aim of designers who wished to work with industry was to raise the standard of industrial design (1.07). Walter Crane's early work had mostly been individual commissions, and this was at variance with his socialist ideals. Only by working with industry could he reach a wider and less privileged market. He found that the design of repeating patterns demanded invention and ingenuity and, although he did produce some commercially viable designs for machine printing, he was never truly reconciled to the restrictions imposed by the process or the quality of the products.

[179] Robinson, S., *A History of Printed Textiles,* London, 1969, p.36. William Morris believed that good design could only arise from a thorough understanding and involvement in the production processes.

[180] The concern primarily with aesthetic values resulted in expensive products and a consequent elitism. This was also evident in the Wiener Werkstätte, which collaborated with manufacturers on textile production, but showed an 'unwillingness to address wholeheartedly the implications of industrial production', because this was 'felt by many of its participants to run contrary to the central and dominant role of the artist-craftsman'. Woodham, J. M., *Twentieth -Century Ornament,* London, 1990, p.19.

tradition of crafts-based design.

The role of the craftsman as a design innovator has continued to be recognised. In 1967, Johnston and Kaufman noted that 'Industry utilizes design ideas developed by craftsmen and adapts them to production methods. Industry also employs craftsmen to develop new concepts relating design to materials and processes. The craftsman, on the other hand, utilizes the technical developments in his own studio work'.[181]

Freelancers have been consistently important in the introduction of new ideas[182] and, although not bound by the production requirements of particular companies, must still be aware of technical and economic constraints. They always have to produce designs that will sell in the contemporary design climate,[183] as tastes change, so does their style[184] and, without design orientated manufacturers, the capabilities of freelancers are not exploited.[185]

During the Second World War, 'many companies were forced to run down their design studios. Rather than invest in building them up again after the war, they could instead make use of the increasing number of freelancers'.[186] This situation has continued, with companies buying croquis which are then converted into printable designs. In the 20th century, many artists have been involved with design, and they introduced contemporary aesthetic concerns without the constraint of tradition. In the early 20th century, the main design impetus came from

[181] 'These interrelationships between creative individual craftsmen and the designing-producing-marketing complex are subtle and intricate. They are, however, necessary for a continued positive growth in the field of fabric decoration'. Johnston, M.P. and Kaufman, G., *Design on Fabrics,* New York, 1967, p.26.

[182] Many freelancers produced designs for a variety of products and, therefore, have increased cross-disciplinary influences.

[183] Many Art Nouveau designs were produced by freelance designers. In the 1880's, Liberty started to commission original designs from British designers and had close contact with the Silver Studio. There were two main design sources, the small formalised patterns of Near East silks and the large swirling patterns of 16th and 17th century European textiles. These two types form the majority of designs in the *Silvern Series* (3.04). From 1895 to the early 1900's, production was predominantly of Art Nouveau designs for home, European, and American markets.

[184] In Britain, Art Nouveau lasted until about 1910 and, with its demise, the designs of the Silver Studio became less innovative and 'tended to be simpler and more formal and often on a smaller scale, more suited to the oak "cottage" type furniture'. Morris, B., *Liberty Design,* London, 1989, p.33.

[185] On the Continent 'manufacturers used English Art Nouveau textile designs as a basis for developing new directions in pattern design'. Turner and Hoskins contrasted this with the English situation, where the middle class 'regarded Art Nouveau as a quaint modern style, an alternative to Louis XVI or Queen-Anne'. Turner, M. and Hoskins, L., *Silver Studio of Design,* London, 1988, pp.24-5.

[186] Russel, A., *Industry, printed textile design and the mass market in the nineteen fifties,* The Textile Society Magazine, Vol.17, Spring 1992, p.22.

France, where artists became involved with textile design through the patronage of interior designers seeking modern designs for wealthy clients.[187]

British manufacturers, seeking to emulate the popular Art Deco style, produced 'jazz' fabrics and, from the 1930's, some of the more enlightened industrialists commissioned designs from artists and modern designers.[188] The artist, Paul Nash, collaborated with Cresta Silks. He involved himself with the production and allowed his name to be used in marketing.[189] The 'role of such an avant-garde firm in a depressed industry is interesting to contemplate. Where else do new ideas come from and who but a committed independent owner would be willing to take risks during a time of depression?'.[190] British manufacturers have generally been criticised for their lack of attention to design, but companies investing in it have usually benefited.[191]

From the 1940's, Ascher collaborated with artists. The 'versatility of the firm's silk screen process allowed any design to be accurately reproduced, and the artists were allowed great freedom', they 'were not asked to formulate designs, but to produce paintings and drawings, so as not to restrict the creative process'.[192] The

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[187] Following the First World War, French textile manufacturers responded to the increased consumer demand for new designs to complement modern styles of decor and dress. Artists, such as Dufy, Sonia Delauney, Seguy, and Benedictus, produced designs in the Art Deco style. Dufy collaborated with leading textile companies and eventually set up his own factory, specialising in woodblock prints finished by pencilling. Seguy used the common Art Deco Egyptian motifs and others with classical references, but he combined his loose, spontaneous drawing and bold colours to create a personal style. There is 'little reliance on the precedence of historic forms, and the overall impression given is of unflagging invention'. Calloway, S., in the introduction to *Abstract and Floral Designs,* London, 1988, reprinted from Seguy, E. A., *Suggestions pour Etoffes et Tapis* and *Floreal, Dessins et Coloris Nouveau,* Paris, 1925.

[188] In the 1930's, British manufacturers, such as Cresta Silks, Allan Walton Textiles, and Edinburgh Weavers, commissioned artists to produce textile designs.

[189] Paul Nash was vociferous in his denunciation of both the nostalgia trend and the Art Deco copies that filled the market. He produced abstract block printed designs.

[190] King, B., *Cresta Silks Ltd (The Textiles of the 1930's),* The Textile Society, vol.15, 1991, p.8.

[191] Government bodies have often intervened when the export market has been in decline and were influential in promoting design following the Second World War. Low standards of design were blamed for the poor quality of goods in the 1830's and for the decline in the industry in the 1930's. In both cases, closer ties between education, designers, and industry were advocated in order to stimulate the export market.

In 1985, an 'innovative approach and constant emphasis on the design aspect' were proposed for the success of Skopos. *Investing in high quality design,* International Dyer & Textile Printer, April 1985, p.15.

Strines saw the role of their designer as providing a link between the company, their suppliers, and customers. The company stated that 'design innovation and versatility across a wide range of styles are just as important as delivery requirements'. *Investment in energy saving pays off at Strines,* International Dyer & Textile Printer, June 1985, p.23.

[192] Ascher did not expect the artists to become involved in the technical processes, and 'production methods were adapted to accommodate an artist's technique'. There was an awareness that 'freshness and daring could fall victim to the laws of repeat pattern design'. King, B., *Modern Art in Textile Design,* The Whitworth Gallery, Manchester, 1991, pp.6 and 7.

success of fabrics depended on the work being 'sensitively interpreted and skillfully put into repeat'.[193] Manufacturers selected the processes chosen to reproduce the artist's work but, unlike Nash, many artists 'have left so much to the manufacturer that in many cases' . . . 'Without the hard work by anonymous designers in the studios of manufacturers such designs could never be realised'.[194]

6.24. COMPUTER-AIDED DESIGN

The attitude described above has been absorbed by the industry, and has increased with the use of scanning systems and sophisticated engraving techniques to convert painterly artwork. This has further dissociated designers from production, and designs are usually *'re-designed* in an expert studio to meet the practicalities of production'.[195] CAD systems and international communications networks may radically change the role of the designer in the next century by allowing designers to work at home, communicating with customers and sending design data via computer connections.[196] But this will rely on companies investing in technology and altering their working practices.[197]

As CAD systems become more widely used and computer-literate designers enter the industry, their emphasis may move from conversion to design. Further developments in transfer and jet printing may catalyse this by reducing technical constraints. The effects of such changes may eventually be comparable to those following the introduction of plate and screen printing, and usher in new styles and treatments of imagery. Because delays usually occur between the introduction of new technologies and their full exploitation, it is expected that the contemporary eclectic trends will continue to dominate for some time.

The world's arts have been explored, documented, and constantly recycled to the point where, it seems, no new influence can radically affect European design. Constant exposure to stylistic diversity has produced a climate in which nothing

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[193] Mendes,V.D. and Hinchcliffe,F.M., *Ascher,* Victoria and Albert Museum, London, 1987, pp.96.

[194] 'Until the First World War designers indicated very clearly what they intended'. Rothstein, N., in *Designs for British Dress and Furnishing Fabrics,* Victoria and Albert Museum, London, 1986, p.35.

[195] Murdoch, J., ibid, p.5.

[196] Miller suggested that this will not be possible until the problem of compatibility of computers is solved. Miller, L., *A day in the life of the designer of the future,* Textile Horizons, August 1986, p.18.

[197] Stead McAlpine have already developed a link between design studios and their production plant by 'a state-of-the-art computer and a ubiquitous facsimile machine'. *State-of-the-art at Steads,* The Gazette, 1 December 1990, p.113. With such links, the distance between companies will become unimportant and will increase the ability of companies to operate in a worldwide market.

appears fresh or shocking enough to create the changes in awareness that underlie new styles.[198] But most styles have arisen from a synthesis of influences and CAD, although it will probably increase the superficial mixing of sources, could provide a catalyst for design and technical innovation.

[198] The effect that the exhibition of Japanese art in London, in 1862, had on artists and designers cannot be replicated. The influence of comparable events, such as the Japanese Year in Britain in 1991, is superficial, transitory, and soon superseded.

CHAPTER 7: INFLUENCES ON THE USE OF REPEAT

The overall effect of a design is governed by the scale and complexity of the repeat. The use of repeat has been affected by technological limitations and developments, but has not been determined solely by technological factors. Its application is inter-linked with stylistic influences relating to printed effects, types of imagery, and scale of designs. This chapter investigates how these interrelated influences have affected the use of repeat.

7.01. Repeat and technology

By altering the potential and economically viable scale and complexity of repeat, technological developments have been contributory factors in the types of repeat used at different times. Designs are applied to a substrate by successive or continuous impressions of a printing element,[1] and these have ranged from small stamps up to huge flat screens. New printing processes have often increased the area that can be printed by one impression and sometimes resulted in larger sizes of repeat. For example, copperplate printing (5.12) dramatically increased the size of impression, and this was exploited by printing much larger repeats than had been produced previously (8.25).

Such simple correlations cannot always be drawn between the maximum size of impression and the size of repeat. For example, the width of impression produced by roller printing could be as wide as the fabric, but the vertical repeat was limited by the roller's circumference. A strong banded effect would be produced if the size of repeat was the same as the size of impression.[2] Therefore, more than one repeat was usually engraved on the roller, with the vertical repeat determined by the roller's circumference and the horizontal repeat being a division of the fabric width.

Flat screen printing, like plate printing, could produce larger impressions than had been previously attainable and, following the production of wider fabrics, eventually stimulated the printing of huge repeats. This size of vertical repeat has continued to be exploited following the introduction of rotary printing. Flat and rotary screens both allow the full width of the fabric to be printed, but impose different conditions on the size of repeat (5.26). With rotary printing, the vertical

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[1] In the production of structural textiles, the design process involves both the formation and decoration of the fabric.

[2] The maximum vertical repeat was about 22" (550 mm), which was about half that of plate prints. Early roller prints copying the style of plate prints used the full size of impression for repeats (8.25). Most rollers had smaller circumferences and, therefore, produced shorter vertical and narrower horizontal repeats.

repeat is limited by the screen circumference.[3]

Some styles have developed from a rejection of technology and a return to hand processes. For instance, the Arts and Crafts designers actively embraced the limitations imposed by block printing because, as Morris argued, the 'comparatively easy' production processes of the time posed 'no special difficulties to stimulate the designer to invention'.[4] They exploited this process to produce large-scale prints because, by joining impressions from several blocks, they could achieve longer vertical repeats than the contemporary roller prints (8.24 and 8.26).[5] The greater consideration of design structure and treatment of motifs, imposed by block printing's limitations, created stylistic changes. For example, the flat colour and clear outlines exhibited in Butterfield's designs were stylistic factors which influenced the development of Art Nouveau.[6]

The introduction of new engraving methods has allowed the production of new, previously difficult or expensive, types of design. Such innovations have usually created trends which stimulated the further development and exploitation of these techniques. Mill engraving (5.17), for instance, facilitated the accurate repetition of very small-scale repeats on copper rollers (8.04). Printing these designs using large impressions resulted in pattern continuity and production economy, but also created a market for more complex styles (8.07).

The effects produced by new engraving techniques have also prompted changes of style, imagery, and scale. Their application usually reflected general trends in the arts and was related to end use. The novelty of such effects has often become an important design characteristic, and this has been emphasised by the use of simple pattern structures. For instance, tonal variations and pictorial imagery were exploited using monochromatic techniques for the large copperplate and china-blue prints of the 18th century. The engraving techniques allowed the inclusion of imagery from contemporary illustrations,[7] and the scale, composition,

[3] Intermittent printing has been used to increase the vertical repeat (5.33).

[4] '. . he can get any design done on his cloth; the printer will make no objections, so long as the pattern is the right size for his roller'. Vallance, A., *The Life and Work of William Morris,* London,1986, p.102. First published, London, 1897.

[5] Large-scale block prints had previously been produced in competition with plate prints.

[6] He also excelled at producing effective designs with a minimum number of blocks. For example, *Tiger Lily* (1896) used only five blocks.

[7] The images were transferred from engraved illustrations (6.19) and relied on the technical expertise developed by paper printers.

and directionality was appropriate to wall coverings.[8]

In the 1950's, the themes of abstraction and tactile qualities were reflected in designs with simple structures using abstract or highly stylised forms. These exploited the textural effects made possible by screen and lithographic engraving. Consideration of the pattern distortions created by the draped fabric became a design priority (6.21). Such concerns affect how contemporary designers react to designs of the past. Like Johnston and Kaufman who commented, in 1967, that toiles, when draped, created 'a delicate texture rather than a pattern . . . ' and this '. . . was an approach to design that paid little heed to the final use of the cloth, and by present standards may be judged ineffective design'.[9]

Other effects have prompted the production of small-scale complex styles, like discharge techniques which, by permitting the printing of small detailed motifs on dark dyed and printed grounds (5.07), started a fashion for floral spot patterns (8.03). Variations of individual motifs gave a scattered appearance when using small repeats (8.09), and changes in their orientation produced variety and non-directionality with small-scale designs for dress fabrics.[10] The further development of pinning techniques (5.08), used for these detailed block prints, led to the production of intricate designs, such as seaweed, fern, and coral patterns. These types of design were then interpreted for roller printing using pantograph engraving.

Screen engraving methods allowed a direct painterly approach, which was used to introduce variation to small repeats (8.04) and provided textural interest in larger abstract styles (8.16). Some of these effects were translated to roller prints, such as the loose floral designs of the 1930's (8.16). The emphasis placed on retaining the quality of the original artwork stimulated experimentation with mark making at the design stage (6.23) and, from the 1950's, designers started to use a wider variety of media and techniques (8.31). The use of technical drawing equipment by some designers was an important factor in the hard-edged geometric designs of the 1970s.

[8] These techniques were used for large-scale, one-directional pictorial prints. Large printing elements were used for finely engraved plate prints (8.25), and combinations of blocks were used for relatively coarse and poorly registered china-blue prints (8.24). They were mainly used as printed tapestries (6.21), but also for general furnishings.

[9] Johnston, M.P. and Kaufman, G., *Design on Fabrics,* New York, 1967, p.18.
Conran made the same comment in 1957. Conran, T., *Printed Textile Design,* London, 1957, p.24.

[10] These were popular for the simpler styles of dress at the end of the 18th century (6.22).

The growing influence of design media continued to develop with the use of photographic and photocopying techniques which stimulated the production of designs incorporating collages of graphic images (8.13 and 8.22). In the same way, a fuller exploitation of computer graphics facilities at the design stage could provide a further stimulus for stylistic changes.[11]

New styles created by changes in printing, engraving, and design methods have usually been simulated using concurrent printing methods, and have often led to the development of new techniques for established processes (5.01). These styles have become part of the design vocabulary and have often been reinterpreted using succeeding processes. The continuance of printing methods has depended on flexibility across a range of styles, but some processes have remained in use for long periods because their effects could not be replicated. This is apparent with mill engraving, the accuracy and detail of which was unattainable by any other means until the introduction of laser engraving techniques for rotary screens (5.40).

Developments in rotary screen engraving have merely concentrated on the replication of the effects and styles produced by other processes (5.31). Flat printing has been continually used for design innovation and new products and, therefore, remains economically competitive with rotary printing (5.24).[12] This contrasts with the situation following the introduction of rollers, which eventually superseded copper plates. The main developmental thrust with roller printing was technological innovation. The relative cheapness of its products and their continually new effects meant that the scale and finer quality of plate printing became unimportant factors in the face of increasing novelty.

The present design climate and quick response ethos forces manufacturers to produce short runs of widely different styles using a variety of repeat sizes within short lead times. Many manufacturers, therefore, use a range of production methods to cater for such variety, and this has created a continuing technical diversity.[13] CAD/CAM has developed in this eclectic era and has been exploited

[11] A major dissatisfaction expressed with CAD systems has been the distancing of designer from the tactile qualities media (10.03).

[12] Large-scale flat printing has an established and expanding market in contract furnishings.

[13] An Italian company 'processes all articles and various widths from 90 cm to 150 cm. The patterns are also extremely varied, geometric, floral, Paisley, foulards, etc. in a wide range of repeats (from 80 cm to 180 cm)'. To cope with this range of products the company uses both direct and discharge printing and a range of printing methods, including rotary screen, automated and semi-automated flatbed, and hand printing. An automated flatbed machine was adapted to enable the fast change-over from small repeats of 70-80 cm to the larger size of 180-200 cm. *A reliable address: Printed SpA, Como,* Buser Gazette, September 1990.

for the reinterpretation of design styles. An emphasis on its production capabilities has restricted its exploitation as a design media (10.17). The introduction of computer technology has made no significant impact on design and, unlike earlier technological changes, there is no style that can be associated exclusively with it

7.02. Imagery and pattern

Imagery has an important influence on the structure and scale of designs. Some types of imagery are strongly associated with particular structural forms and, in most re-interpreted designs, the structural form is integral to the design's style (6.15). These have eventually been absorbed into the design vocabulary and then often used independently, such as the imagery of *indienne* designs which was adapted to traditional European forms (6.09).

The familiarity of the imagery and structure influences the viewer's response to a design, and too much novelty may lead to confusion.[14] Therefore, exotic designs have often been interpreted, either pictorially or structurally, in order to retain a Western frame of reference. In the *chinoiserie* style, Chinese imagery was incorporated into contemporary design forms (6.10). Whereas the structural aspects of Islamic design influenced many 19th century designers, who applied familiar European imagery to Islamic design forms (6.08).

Various influences have affected the emphasis placed on imagery or pattern, and these have been reflected in the scale, complexity, and direction of the repeats used. In general, the post-renaissance concern with realism emphasised the pictorial content, and 20th century art prompted a move towards abstraction (6.18). Pattern classification in the textile industry generally uses three main categories of imagery; pictorial, stylised, and abstract. These categorisations are subjective and, because they are intended to give a general visual summary, there are designs that do not fit exactly in any one category (3.09). In each category there are general differences in the ways that structure is used.

Pictorial designs are essentially repeated pictures and, because the recognisability of the image is usually important, they are often one-directional with images arranged in a simple or familiar format. New types of imagery have often been applied to contemporary or traditional formats, such as the exotic vignettes which were used in pillar prints and toiles (6.07). They have often been associated with process innovation and new types of imagery.

[14] Familiarity affects the perceptual understanding of images and structure (2.03 and 2.13).

Designs with pastoral, historic, and exotic scenes were commonly used for 18th century large-scale copperplate prints. These reflected the contemporary taste for the picturesque and also exploited new engraving and printing techniques (7.01). Many consisted of 'isolated islands' of imagery because registration difficulties made continuous designs practically impossible (5.12). Justema argued that, although detailed pictorial subjects 'rarely make good patterns', these could be considered within 'the sphere of patterns', due to their stylised drawing.[15]

This isolated island form appeared in many early roller prints although ground effects, permitted by continuous printing, were often used to link the pictorial areas together.[16] It has been continually re-interpreted using new techniques, especially when there has been an emphasis on representational imagery or photographic realism,[17] or when comparable registration problems have been involved.[18] This fashion for picturesque scenes affected block printing, and new techniques were developed to simulate the fine engraving of plate prints. Designs were mostly one-directional and used the island form, vertical stripes, or cartouches (figure 8.26.a). By combining blocks, new pictorial trends could be mixed with other patterns, such as fillings, stripes (8.21), or roller printed grounds.

Styles using radical changes of imagery have often relied on shock value for the effectiveness of the designs.[19] They have mostly used simple arrangements of blocks of images to form box-like, striped, or diamond structures. This has applied to a variety of scales of design. Linear arrangements of small images can be intriguing because, from a distance, they appear as simple or textured stripes and the pictorial content is only seen close to. More complex arrangements often detract from the imagery, and the designs have an abstract appearance.[20] These are rather rare and occur mostly in small-scale novelty prints, particularly for leisure

[15] Justema, W., *The Pleasures of Pattern*, New York, 1968, p.20.

[16] Rollers had a smaller vertical repeat than plates, and attempts to fit in a similar amount of detail usually produced a squashed and crowded appearance (5.15 and 8.25). The design continuity and ground effects of roller prints fed back into plate printing.

[17] For example, Ferrière illustrated a 1950's print 'adapted from eighteenth century copper engravings of Swiss landscapes', with coloured photographic landscapes arranged as isolated islands of imagery. Ferrière, M.T., *Swiss Textiles,* Brighton, 1953, p.17.

[18] Such as the quadricolour process (5.36 and 8.25).

[19] The novelty and the lighthearted approach of many 1950's designs which depicted everyday objects can be seen as a reaction to austere utility prints of the war years. The 1960's saw many images from the fine arts translated into prints. One source was Pop Art, which incorporated graphic imagery from popular culture and was, itself, often concerned with the repetition of stylised images.

[20] The Russian Constructivist designer, Anufriyeva, created dynamic prints, such as 'Aquatic Sports', by using complex arrangements of small figurative motifs which, at first sight, appeared as abstract patterns.

and children's clothing (8.10).

Stylised designs are 'based on recognizable images which have been ordered or arranged so that the pattern becomes more dominant than its individual parts'.[21] Often the design elements have become so stylised that they are recognised as particular pattern types rather than the original imagery.[22] Many are so much a part of the design vocabulary that their identity is retained, even when they are re-interpreted in vastly different scales or degrees of complexity.

The paisley pattern typifies this group. Originally a stylised branching floral motif, it was gradually confined to the pine cone shape which became its main visual characteristic.[23] From the 18th century to the present day, an extraordinary range of variations on this basic form have been produced by European designers. A major application of the pattern in the 19th century was for shawls (8.30). As fashions changed, the basic form, while retaining its essential characteristics, was elongated, distorted, and elaborated to suit the proportions and drape of styles and fabrics (6.22). Its combination of stylised natural forms and strong structural characteristics have ensured its continuity and, with differing styles of interpretation, it can be suggestive of historicism or modernity. Rudzki suggested that its current popularity stems from the same factors that made it popular in the 19th century. 'With a vague hint of foreign lands or an overwhelming tangle of vibrant images and shapes . . . it provided exotic fascination, but implied a methodical, precise assembly'.[24]

Animal prints, such as leopard spots and tiger stripes, are a constantly recurring theme and can be included in this category. Although they retain the characteristic shapes and spacing of the source material, because their degree of stylisation is often so great, their recognisability results from the patterns' being part of the textile vocabulary. Printed effects used to simulate other materials have usually employed the associated structural characteristics. For instance, weave effects generally have small regular structures, whereas moiré or marbling effects tend to have an organic appearance, and repeats are usually larger scale.

[21] Phillips, B., *Fabrics and Wallpapers,* London, 1991, p.123.

[22] Highly stylised images have symbolic associations (3.08), and recognition depends on cultural familiarity (2.04).

[23] Paisley patterns of different scales have been produced by block, roller, and both types of screen printing.

[24] Rudzki, D., in *Ratti and Paisley,* Fashion Institute of Technology, New York, 1987.

Abstraction, as a major form of design, has developed during the 20th century and has created a greater awareness of the importance of pattern uncomplicated by strong visual associations. In abstract designs, the pattern is dominant and its motifs, although they may be derived from objects or natural forms, are not instantly recognisable.[25] Geometric and abstract patterns using simple spot, stripe, and all-over forms have been continually produced, but the types of motif, scale, spacing, and structure have varied. For instance, in the 1960's, the interpretation of ethnic themes often resulted in simple striped tribal designs but, since then, a more sophisticated approach has been apparent which recognises the visual complexity of the source material.

Simple small-scale geometric designs have been a continual theme and their production, motivated by technological stimuli, has often been associated with utilitarian, scientific, or modern idioms (6.18). They have often been produced in reaction to previously ornate styles (4.12), and the repetitive nature of pattern was often stressed.

Complex forms of different scales have been fashionable in particular eras. For example, 19th century roller engraving techniques enabled the accurate production of small-scale geometric and optical effects. These geometrics and *excentrics* (8.16) were produced throughout the 19th century and were particularly fashionable for dress fabrics between 1820 and 1840. The Op Art designs of the 1960's also relied on precise geometric structures, but their impact was totally different because they were of a much larger scale. Whereas the 19th century designs derived from technical innovation, these 20th century prints drew from contemporary Fine Art influences. They were used for dress and furnishings.

The 'geometric structure of a visual design can never, by itself, allow us to predict the effect it will have on the beholder . . . structure is independent of scale while perception is not'.[26]

7.03. Scale

Small-scale, all-over non-directional designs have been continually important for fashion fabrics. 'The close setting and all-over distribution of the motifs help in "making-up", as the repeat and pattern direction has not to be considered'.[27] Many block prints of scattered motifs used a half drop or brick format format with a small

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[25] Heavily abstract elements may still appear as recognisable images because of the 'it looks like' nature of human perception (2.04).

[26] Gombrich, E.H., *The Sense of Order*, Oxford 1979, p.117.

[27] Wright, R.H., *Modern Textile Design and Production*, London, 1949, p.96.

repeat (8.09). Some 20th century scattered designs (8.16 and 8.25) may be superficially similar to these, but dissimilar in their structure and repeat size.

A distinction must be drawn between the scale of design and the size of repeat for, although designs composed of small individual motifs, or elements are termed small-scale, a small repeat is not automatically implied. They may have many elements and form a very large repeat. Alternatively, a large-scale design may rely on the simple repetition of one large element to create a bold effect. Scale of design relates to the size of these elements. Large elements are associated mostly with furnishings because their scale is more appropriate to larger expanses, and the relative coarseness of the fabrics would distort fine details.[28] Small-scale designs are printed on lighter, closely-woven fabrics which are suitable for clothing.

A further distinction must be made between the size of repeat and the size of design unit. The design unit is the element or group of elements which forms the basic building block of a design. When a pattern is made by the simple repetition of a unit, then the size of the repeat is the same as the unit. But the sizes of design unit and repeat are not always the same. If units containing single motifs are distanced from each other, the repeat is larger than the unit. When the simple drop or brick formats are used, the repeat is double the size of the unit.[29] The total repeat may, therefore, comprise of more than one design unit. The size of repeat can be increased further using variations in treatment of multiples of the unit (counterchange or hand-drawn irregularities), transformations (changes in the orientation or mirroring of multiples of the unit), and more complex formats. The building up of a pattern by sequential placements of copies of a design unit is the basis of extension methods of pattern construction (4.19 -22), and is covered in detail in Chapter 9.

The manipulation of design units to build up a larger repeat may take place at the design, engraving, or printing stage, and is linked to the size of impression associated with different printing processes. For example, when design units are printed as small individual impressions of a printing element, the complexity and scale of the total repeat is determined by their relative placements and orientations. The assembly of very large repeats using complex arrangements has occurred most frequently with small units, and has been influenced by engraving processes.

[28] Such irregularities have been exploited in 'tapestry' prints (6.05).

[29] The drop is generally used to increase visually the width of a design (4.17).

In some cases, multiples of the design unit were engraved on the printing element and, depending on the size and type of printing element, further manipulations may have taken place at the printing stage. These relationships between scale, repeat complexity, and technology are discussed more fully in Chapter 8.

The sizes and proportions of repeats have been affected by changes in sizes of impressions and fabric widths; vertical repeats relate to the size of impression and horizontal repeats to the fabric width. At the start of the 20th century, most fabrics were produced in widths up to 30" (760 mm) or 36" (900 mm). Long designs with selvedge to selvedge repeats were often designed to be dropped when lengths were sewn together, and this effectively doubled the design width. Designs of this width with a short repeat produced a banded effect (8.25). As potential vertical repeats have lengthened, fabric widths have also been increased.[30] In the 1950's, many long designs had repeats that covered the full width and, like earlier furnishing, were designed to repeat when lengths were joined.

Whereas some designs exploited increased vertical and horizontal dimensions to produce huge repeats, most fashion fabrics have used a smaller scale. The increased size of impression has been used for production economy by engraving multiple repeats in the horizontal and vertical directions. For example, a width of 45" could be divided into three repeats of 15", five of 9", nine of 5", or fifteen of 3". Unless a directional emphasis is intended, a similarly proportioned vertical repeat would be used. The narrowness of early fabrics limited the scale of complex repeats comprised of multiple units. For instance, the total repeat for an eighth-drop format, such as figure 8.07, is eight units wide. With a repeat covering a 36" width, the maximum size of each unit would be 4.5" wide. Increased fabric widths and sizes of impressions have had no significant impact on the scale of complex repeats. Most geometric and optical designs of the 1960's had simple repeats and, although some designers developed this geometrical trend by using mathematical progressions, complexity was uncommon in 1970's hard-edged designs.

[30] Fashion fabrics are now 36" (900 mm), 45" (1150 mm), or 60" (1520 mm) wide, and furnishings are 48" (1220 mm), 54" (1370 mm), or 60" (1520 mm) wide.

CHAPTER 8: THE COMPLEXITY OF REPEAT

In this chapter, the relationships between sizes of design unit, complexity of repeat, and sizes of impression are examined.[1] The following sections of the chapter are arranged using the categories of unit size, repeat complexity, and size of impression. Section 8.32 deals with the limitations of this classification method.

Repeat Complexity	**Small units 8.01.**			**Medium units 8.14.**		**Large units 8.23.**	
	impressions			**impressions**		**impressions**	
	small	medium	large	medium	large	medium	large
simple	**8.02.**	**8.03.**	**8.04.**	**8.15.**	**8.16.**	**8.24.**	**8.25.**
transformation	**8.05.**	**8.06.**	**8.07.**	**8.17.**	**8.18.**	**8.26.**	**8.27.**
composite	**8.08.**	**8.09.**	**8.10.**	**8.19.**	**8.20.**	**8.28.**	**8.29.**
combined	**8.11.**	**8.12.**	**8.13.**	**8.21.**	**8.22.**	**8.30.**	**8.31.**

Table 8.01. Categories according to unit size, repeat complexity, and size of impression.

The unit size refers to the basic design unit, and is denoted by:-

Small - up to 8" x 8" (200 mm square).

Medium - from 8" x 8" (200 mm square) up to 20" x 15" (500 mm x 380 mm).

Large - above 20" x 15" (500 mm x 380 mm).

Repeats may be assembled using various arrangements of design units. The repeat complexity is denoted by:-

Simple - block, drop, or brick format including spacing or counterchange.

Transformed - block, drop, or brick format, with single transformations.

Composite - complex format and/or multiple transformations.

Combined - any of the above applied to two or more units.

The size of impression is denoted by:-

Small, medium, and large (using the same dimensions as the design units).

The categories of medium units and medium impressions are based on the range of sizes used for woodblocks (5.04). Many traditional designs derive from

[1] This work is concerned with repeating patterns printed as lengths, but panel designs are included where their associated techniques are seen to have been influential. Panels are contained designs, and they may include repeating elements as filling patterns, often having borders and central motifs. They include designs for shawls, bedspreads, chair seats, handkerchiefs, and scarves.

simple block prints, and their continual reinterpretation has ensured the continuity of this scale. The unit size categories used in this classification could be produced by block printing; blocks could be engraved with multiple small units, used to print single medium units, or combined to build up large units. This range of sizes was, therefore, used in this classification method because it provided a simple standard with which to compare other technologies.

8.01. SMALL UNITS

There has been a continuous demand for designs with small-scale units, such as simple floral, geometric, or abstract forms. Spacing, counterchange, and transformations are used to achieve striped and scattered patterns. When viewed from a distance, the details are not seen but the repeated forms create linear or textural effects (2.12), and small-scale pictorial images may appear as abstract forms.[2]

They have been used mostly for dress fabrics and as linings for garments of expensive fabrics, although there has often been a cross-over of usage.[3] Frequently, there has been a relationship between design structure and garment shapes. For example, scatters have been used for full or bias-cut skirts, and stripes to emphasise vertical or horizontal lines (6.22). They have also been used as linings for curtains and bed-hangings and for furnishings with a nostalgic cottage look. These designs have generally been less affected by fashion changes than those with medium and large units, and there is a continuing market for traditional patterns.[4] Some have stayed in production for many years, being converted as new printing processes have evolved (6.16).[5] They have often been associated with idealistic objectives and modern design, in which their scale represented economy of production and served to emphasise the regularity of repeat and the propriety of the design. Many prints of the French and Russian revolutionary eras used small-scale designs in order to cut design and production costs to make

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[2] Many Russian Constructivist designs played on this effect with the use of images, such as tractors, spools, and *Young Pioneers*, which appeared as striped or diamond patterns, but revealed the revolutionary symbols when viewed closely.

[3] As in *Eyebright* (1883) which was 'one of three small scale designs made by Morris to be used for linings although later used for general purposes, including dress'. Parry, L., *William Morris and the Arts and Crafts Movement*, London, 1989, plate 16b.

[4] For example, Laura Ashley was founded on the revival of small-scale 19th century roller prints (6.15).

[5] The archives of David Evans & Co. hold pattern books dating back to the 1840's. 'Some of these patterns are still being used today with some modifications'. *Printing on Silk*, Screen Process, May 1990, vol.40, p.60.

textiles more affordable.[6] Modern movements have often rejected frivolous design and moved towards obvious repetition and geometric abstraction (6.18).

Unit size	repeat complexity		impression		text		figures
		----	small	----	8.02	----	8.01.a. b.
	simple	----	medium	----	8.03	----	8.02.
		----	large	----	8.04	----	8.03.a. b. c. d.
		----	small	----	8.05	----	8.04
	transformed	----	medium	----	8.06	----	8.05.a. b.
		----	large	----	8.07	----	8.06.
small							
		----	small	----	8.08	----	8.07 .
	composite	----	medium	----	8.09	----	8.08 .
		----	large	----	8.10	----	8.09.a. b. c. d.
		----	small	----	8.11	----	8.10.
	combined	----	medium	----	8.12	----	8.11.a. b.
		----	large	----	8.13	----	8.12 .

Table 8.02. Categories of small units and their associated figures.

8.02. Small units: simple repeats: small impressions

Designs under this heading are formed by regular translations of units without transformations. All-over patterns are formed by placing rows of directly adjacent units, linear patterns are made by introducing spacing between rows of impressions, and spot patterns by making spaces between all the units. When the units are adjacent, shapes may be formed by the unprinted spaces but, when the units are separated, these negative spaces appear as the ground (2.05). Different patterns are formed with drop and brick formats and spacing again would produce linear or spot versions (figures 3.01.a and b). Further variety can be added by applying counterchange to individual units.

The most basic form is the use of a stamp or stencil to hand print multiple impressions, although any variation in the orientation and pressure of each impression produces irregularities in the overall pattern. Such variations are easily noticed (2.11) and are imitated in pseudo-ethnic or naive designs (8.13).

[6] Production costs were important factors for British 18th century manufacturers, such as Peel (1.04). Their cheap prints were predominantly stripes, spots, florals, and running sprigs with small simple motifs. These were mostly copies of London designs with variations in the style, direction, and size of motifs, or with alterations made to the grounds.

Examples are ethnic prints with geometric or highly stylised imagery (figure 8.01.a) and early European designs, which were printed using small blocks to form rows of separate figurative images (figure 8.01.b).[7]

8.03. Small units: simple repeats: medium impressions

Designs built up from single impressions of small-scale units were expensive to block print. Therefore, multiple repeats were cut on one wood-block but, because each repeat was cut individually, there would be slight variations in each. This form was common for dress fabrics, such as sprigged or spot designs, and as filling patterns for shawls and furnishing fabrics (figure 8.02).

Stereotype cast plates provided accurate repetition and reduced engraving costs for these multiple repeats (5.09). They were used for intricate designs, such as small tie prints, tiny paisleys, and floral designs. These were often discharge printed on dark, dyed or printed grounds (5.07) and variations were produced by using alternative grounds.

Rainbow printing was sometimes combined with small-scale units, and this generally increased the size of the total printed repeat. In Europe, this effect was used extensively with perrotine printing to create variety in limited vertical repeats.

Multiple isolated motifs, like polka dots, presented difficulties for the block printer because they had 'a pronounced tendency to visually amplify repeat inaccuracy when joined together along the length of the fabric'.[8] The slightest degree of error would be progressively duplicated in both the horizontal and vertical directions.

8.04. Small units: simple repeats: large impressions

Rollers solved the printing problems formerly associated with these types of design and reduced costs further. The unit was repeated across the width and circumference to fill the roller's surface and, provided these were engraved precisely, the rotary printing action ensured repeat continuity. Roller printing generally increased the production of small-scale designs because they could be printed faster and more accurately. These economic factors and the political preference for utilitarian styles prompted the production of large numbers of small-scale geometric patterns in the French revolutionary period.

[7] Early European prints followed the dominant pattern forms of woven textiles and, therefore, did not exploit the patterning possibilities demonstrated by ethnic textiles (8.11). They were mostly figurative and rarely employed changes in orientation.

[8] Greenwood, J., *"Spotting the True Image": The Industrial Textile Printer,* The Textile Society Magazine, Vol.17, Spring 1992, pp.7 and 8.

The introduction of mechanical engraving methods reduced design and engraving costs and enabled the production of many types of design which had previously been impossible or prohibitively expensive to engrave by hand. The accuracy of mill engraving stimulated the production and demand for very small-scale designs, particularly all-over designs and fancy fine lines which repeated hundreds of times across the roller. Units were commonly less than 1" (25 mm) square, and multiple repeats were often engraved on a die in drop or brick formats (figure 8.03. a-c).

Engraved effects produced tonal variations and added visual interest to monochrome prints. Very small repeats, such as honeycomb and trellis patterns, were printed as fancy machine grounds. These were used for linings, but were also combined with larger scale block or roller printed motifs, giving a crowded effect. Engravers, such as Lockett, 'provided many printers with background rollers which could be used in conjunction with any roller or woodblock pattern'.[9]

Flat and rotary screen printing are now used to replicate block and roller printed designs. Screens cover the full width of the fabric and units can be repeated horizontally and vertically across them using step and repeat machines. Some manufacturers, such as David Evans, have found that an adaption of this process is more accurate and economical. A line of units is photographically reproduced for the screen width, and a step and repeat machine used to repeat this in the vertical direction. Laser engraving has now permitted the replacement of mill-engraved rollers by rotary screens for very small-scale continuous designs. The spiral engraving process solved the continuity problems produced earlier by joining long films (5.40).

In the 20th century, the structural perfection produced by mechanical engraving has often been rejected and, although utilising technical developments, the variations characteristic of hand processes have been simulated in small-scale repetitive patterns. This occurred frequently in modernist prints and many of the Omega Workshop's designs were printed by '. . . an undivulged special technical process aimed at preserving the "freedom and spontaneity of the original

[9] Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p. 307.

They were printed over block prints; the 'completed block work being over-printed with a protective paste before passage through the machine'. Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.76.

drawing".'[10] This approach has continually been applied to simple repetitive designs. It is used extensively to simulate the look of naive or ethnic prints and to provide visual interest in small-scale geometric designs (figure 8.03.d). Ascher's early geometric designs typified this look, using simple small-scale patterns with irregularities. Hand-drawn repetitions of small-scale units can create large repeats for rotary and flat screen printing, and the consequent irregularities give the appearance of hand production whilst retaining a regular structure.

Counterchange can add pattern variation to simple geometric patterns and will double or quadruple the size of the repeat. Simple counterchange was often combined with the use of hand-drawn irregularities in modernist designs, and a scattered form was often used in 1960's designs to produce irregular arrays of focal points within highly repetitive patterns.[11]

8.05. Small units: transformed repeats: small impressions

Alterations to simple repeats can be made by changing the orientation of individual units, and different formats, spacing, or counterchange can be used to produce varieties of all-over, linear, or spot patterns.

Stamps allow flexibility in the orientation of individual impressions, and small stencils can be turned over to produce mirrored units. Glass noted that the turn-over 'plan is largely used in weaving, where it enables the weaver to double the width of his pattern', but was also applicable to stencilling. 'If one half of a stencil pattern is designed and the paper folded in the middle, a double or turnover pattern will result, after cutting through both sheets'.[12] This method was used to create stencils of mirrored units. Slight deviations from symmetry were often introduced on the vertical axis (figure 8.04), and airbrushing could produce variations in the treatment of individual units.

8.06. Small units: transformed repeats: medium impressions

The engraving of multiple copies on one block allowed transformations to be applied to individual units for non-directional designs, such as sprig and small paisley patterns (figure 8.05.a). Such designs, 'when reduced in scale so that the motifs were closer to each other, also served as filling patterns for printed shawls and handkerchiefs'.[13]

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[10] Mendes, V., *The Victoria & Albert Museum's Textile Collection: British Textiles from 1900 to 1937*, London, 1992, p.11.

[11] The effect of irregularities in arrays was used in the Fine Arts (2.11).

[12] Glass, F. J., *Drawing Design and Craftwork*, London, 1920, p.129.

[13] Young, H., *Patterns for Textiles*, Victoria and Albert Museum, London, 1987, p.11.

An open brick format was often combined with the mirroring of units on alternate rows (9.27) for shawl and cashmere fillings. It gave a zig-zag movement across the pattern, especially when used with asymmetrical motifs. This arrangement was common to Persian printed florals, Kashmiri and Paisley shawl filling patterns (6.08), and many designs derived from 16th century silks (6.03). Gombrich suggested that it counteracted 'the directional pull of a row of these motifs . . . thus restoring a kind of symmetry productive of "repose".' [14] Stripes were produced by engraving linear arrangements of motifs, and the introduction of alternately mirrored or rotated units created serpentine lines and small ogee patterns (figure 4.17). Such linear arrangements made all-over patterns when placed adjacently, or definite stripes when spaced apart (figure 8.05.b). These striped and open brick arrangements are the most common transformed repeats and can be found in many different eras and cultures.

8.07. Small units: transformed repeats: large impressions

The unit variations used on blocks were also applied to roller prints. Early 19th century roller printed floral serpentine lines were finely engraved and frequently printed with fancy grounds (figure 8.06). The total vertical repeat was usually about 12" or 14" (305 x 356 mm), consisting of two units with one mirrored above the other.

The fashion for small-scale patterns grew as roller engraving techniques became more sophisticated, prompting the production of smaller and more detailed designs. Between 1820 and 1880, tiny florals, geometrics, stripes, and optical effects became popular. The pantograph enabled turn-over repeats to be generated from one repeat,[15] and the engraving of 'an endless variety of curious configurations, which can hardly be copied or even imitated by the hand engraver'.[16] Designs were drawn much larger than the final prints allowing extremely fine detail to be traced during the pantograph operation.[17]

Zig-zag and serpentine movements were used extensively in Art Nouveau roller prints, but these designs were given continuity by using trailing elements to link the

[14] Gombrich, E.H., *The Sense of Order*, Oxford, second edition 1984, p.139.

[15] '. . . the diamond points may be made to work in opposite directions to each other - a feature which allows for "turn-over" patterns being pantographed from one single repeat of the subject'. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing*, 3rd edition, London, 1936, p.83.

[16] Parnell, E.A., *Dyeing and Calico Printing,* London, 1849, pp. 123.

[17] The Victoria and Albert Museum have a collection of roller printed textile designs from the 1840's which were drawn six times larger than the final print. Victoria and Albert Museum, E1943 to 1980.

motifs and to emphasise the sinuous lines. Further variation was introduced by counterchanging alternate rows of motifs or elements. Many Art Nouveau and Art Deco designs used horizontally-mirrored units arranged in a diaper format (9.12) which, although slight deviations from symmetry were sometimes introduced on the vertical axes, emphasised the regularity of their stylised or geometric elements. This form could produce diamond or striped effects, depending on the directionality of the motifs. Art Nouveau designs used flowing directional movements, whereas Art Deco was generally more concerned with static symmetry.

8.08. Small units: composite repeats: small impressions

Complex arrangements of one unit can be combined with transformations of individual units to create a huge repeat.[18] Different formats can be used to produce scattered arrangements or linear movements (figure 8.07). Stamps and stencils provide flexibility in the placement and orientation of individual units.

8.09. Small units: composite repeats: medium impressions

Many late 18th and early 19th century designs were small non-directional patterns, discharge-printed on plain or patterned dark grounds (8.06). Copies of a motif could be engraved using various transformations in a brick or spot format to achieve a scattered effect. During engraving or printing, a larger repeat could be created by repeating the group of motifs using a drop or brick format (figure 8.08). Step or complex drop formats can simulate the zig-zag or diagonal effects of small-scale ikat and batik designs, such as figure 8.07.

8.10. Small units: composite repeats: large impressions

During the mid to late 19th century, scattered arrangements were often roller printed on fancy grounds to give an overall continuity (figure 8.09.a and b). Since then, these have been printed by flat and rotary screens and used with all types of small-scale design, including pictorial, cartoon, and abstract imagery. This form was a characteristic of many abstract patterns of the Memphis Group in the early 1980's. Modern technology provides facilities which could allow transformation to be specified during the engraving process, but these operations are often performed at the design stage (8.04). Most spot patterns have an organised structure, but their effectiveness, determined by the orientation of the units, is dependent on the designer's visual skill.

Geometric motifs, combined with rotational or four-way mirror formats, were used to produce interlocking forms and optical effects (figure 8.09.c and d). These

[18] The permutations from arrangements of just four transformations of one unit are enormous (4.20).

show the continuing exploitation of mechanised engraving techniques (8.07). The pantograph, using multiple engraving heads, was applicable to complex formats. Many abstract, ogee, and carpet designs exhibiting four-way symmetry were also printed in this scale, particularly in the second half of the 19th century. In the 20th century, rotational arrangements were often combined with pictorial imagery to create dynamic novelty prints for the expanding leisurewear market (6.22).

The movement or rotation of flat screens between impressions permits the overprinting or adjacent printing of multiple units. 'In this way a simple repeat can become part of a larger composite one'.[19] The addition of counterchange provides further variation. These effects, originating from hand screen printing in the late 1940's and early 1950's, were adopted for automatic and rotary screens and were exploited in many 1960's furnishing fabrics in which basic shapes 'creating more shapes by overprinting are used in simple repetition to achieve a flowing pattern'.[20]

8.11. Small units: combined repeats: small impressions

The combination of more than one unit with simple, transformed, or composite repeats can produce huge designs as in Adinkira cloths, which use ordered arrangements of many stamps to build up a large pattern. Some of these have no apparent repeat, and may be considered as panel designs (figure 8.10).

Owen Jones proposed that the 'secret of success in all ornament is the production of a broad general effect by the repetition of a few simple elements; variety should rather be sought in the arrangement of the several portions of a design, than in the multiplicity of varied forms'.[21] He illustrated this with a design which was built up by the rotational arrangement of impressions from simple stamps, such as triangles and diamonds. This approach, using found objects, is suggested in many 20th century screen printing manuals.[22]

8.12. Small units: combined repeats: medium impressions

Block printed all-over and spot designs (8.06 and 8.09) were varied further by the introduction of more units. Small floral patterns often had five or seven different motifs arranged in a spot-repeat format, or two, four, six, or more motifs arranged in a brick or block format. Transformations were usually applied to motifs that

[19] Searle,V., and Clayson, R., *Screen Printing on Fabric,* New York, 1968, p.16.

[20] Johnston, M.P. and Kaufman, G., *Design on Fabrics,* New York, 1967, p.43.

[21] Jones, O., *The Grammar of Ornament,* London 1856, reprinted London 1987, p.15.

[22] '. . . select a few that make interesting marks and arrange them on the paper in a variety of patterns'. Searle,V., and Clayson, R., *Screen Printing on Fabric,* New York, 1968, p.24.

occurred more than once in the total repeat.

Striped designs were combined during printing to produce double stripe patterns.[23] With this mix-and-match approach, blocks could be used in different combinations to produce new designs (figure 8.11.a). This example, from 1825, combined three patterns; an 'Indian shawl stripe' with medallions, 'needlework' flowers in bunches, and a small floral stripe. The needlework units were arranged in vertical stripes with mirroring on alternate placements, and were printed using a drop format. The small floral motifs were similarly arranged, but without a drop. Colour variations were applied to the medallions.[24]

Structures, like serpentine and straight, were often mixed with various motifs, allowing newly introduced types, such as lace, ribbon, and imitation chiné motifs, to be used with established forms. By combining traditional motifs with the newly fashionable, manufacturers produced saleable products whilst allowing customers to be slightly daring. This feature of block printing was exploited in the printing of handkerchiefs, en suite furnishings (8.21), and large panels, such as shawls (8.30).

Handkerchiefs usually had a border, detailed corners, and a central motif or filling pattern (figure 8.11.b).[25] In this example, the corner element is printed on two alternate corners.[26] Block and copperplate printing were sometimes combined, either to add colour to detailed engravings or to give flexibility in design changes. Copperplate printing was used for finely engraved borders, and the block printed motifs or filling patterns could be changed when required (5.13).

8.13. Small units: combined repeats: large impressions

Copperplate printed double and multi-stripe patterns were common in the 1770's and 1780's as the fashion for large-scale toiles (8.25) waned. Although many were similar in scale and structure to block printed versions, these monochrome prints exploited the detailed engraving process for intricate lace designs. They often combined four or five detailed stripes alternating with

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[23] During the 18th century, stripes were also printed 'to be cut apart and used for edgings and borders'. Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London, 1970, p.19. These were printed vertically, often two or more designs at the same time.

[24] The 'same medallions with a different alternate stripe' also appeared in another sample book. Hefford, W., *The Victoria & Albert Museum's Textile Collection: Designs for Printed Textiles in England from 1750 to 1850,* London, 1992, p.30.

[25] 'Usually, but not always, the corners receive the prime attention, because this portion not only displays well when seen in its entirety, but in shop display and in boxes attracts the would-be purchaser'. Wright, R.H., *Modern Textile Design and Production,* London, 1949, p.155.

[26] These are 'filled with a delicate, regular floral motif, edged by a wavy line, which recalls the treatment of corners in some Kashmir shawls'. Brédif, J., *Toiles de Jouy,* English translation London, 1989, p. 100.

scattered motifs, simple filling stripes, or trailing florals.[27]

Dies could be re-used to produce new designs for roller printing, and combined for tiny detailed monochrome stripes. Hefford illustrated a variety of 1820's designs intended for roller printing, many of which were floral, fern, and coral serpentine stripes, some shown in various combinations.[28] Mill engraving was particularly suited to this linear repetition. The pantograph may have been used to engrave patchwork patterns, which combined multiple small-scale patterns in a geometric structure to create a large repeat (figure 8.12). This example shows sixteen triangular units arranged to form a composite unit of 18.5" x 10.8" (470. x 274 mm), which was then doubled using a drop format. Some patchwork patterns used the hexagonal format.

Although utilising mechanised processes (6.13 and 8.04), many 20th century designs containing multiple repetitions of small elements employ irregularities to achieve a naive, spontaneous feel. Ethnic designs, such as figure 8.10, have been reinterpreted for screen printing, in which case the whole repeat contains multiple repetitions of many elements drawn irregularly to simulate hand processes.

Spot arrangements of multiple motifs (8.12), using many types of imagery, have continued with roller and screen printing. For example, English Eccentrics used classical motifs in similar arrangements for dress fabrics, such as *Heads and Diamonds* (1987). This had a repeat size of approximately 4" x 3" (100 x 75 mm). Similar arrangements of large-scale classical motifs can be seen in furnishing fabrics of this time (8.22).

The manipulation of flat screens during printing (8.10) can be further developed by combining different units. Alistair Morton 'showed the immense versatility from simple elements which was possible by screen printing' when, in 1946, he produced 'a series of fabrics from a group of basic screens: horizontal and vertical stripes, stars, flower-heads, polka-dots, rings - each being on the same module'.[29] Overprinting different sizes of unit may result in a mismatch of repeat, and this has been particularly apparent with motifs printed over ground effects.

[27] Hefford included examples that had similar full repeat sizes of 10' x 25" (254 x 635 mm), although many were larger. Hefford, W., *The Victoria & Albert Museum's Textile Collection: Designs for Printed Textiles in England from 1750 to 1850,* London, 1992, plates 29 and 30.

[28] Ibid, plates 161-172.

[29] Storey, J., *Textile Printing,* London, 1974, p.110.

(a) Stencilled resist-dyed cotton. Senegal, 20th century.

(b) Stamped linen. Germany, 14th century.

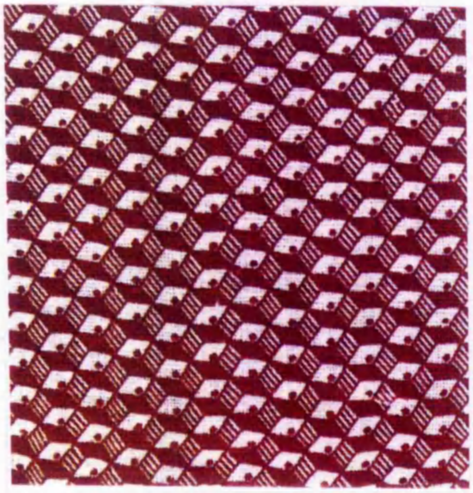
Figure 8.01. Small units: simple repeats: small impressions.

Block printed cashmere filling pattern from a curtain. The fabric was sewn in lengths and edged with a larger scale border pattern. England, 1804-10. Repeat $1^5/16$" (33 mm).

Figure 8.02. Small units: simple repeats: medium impressions.

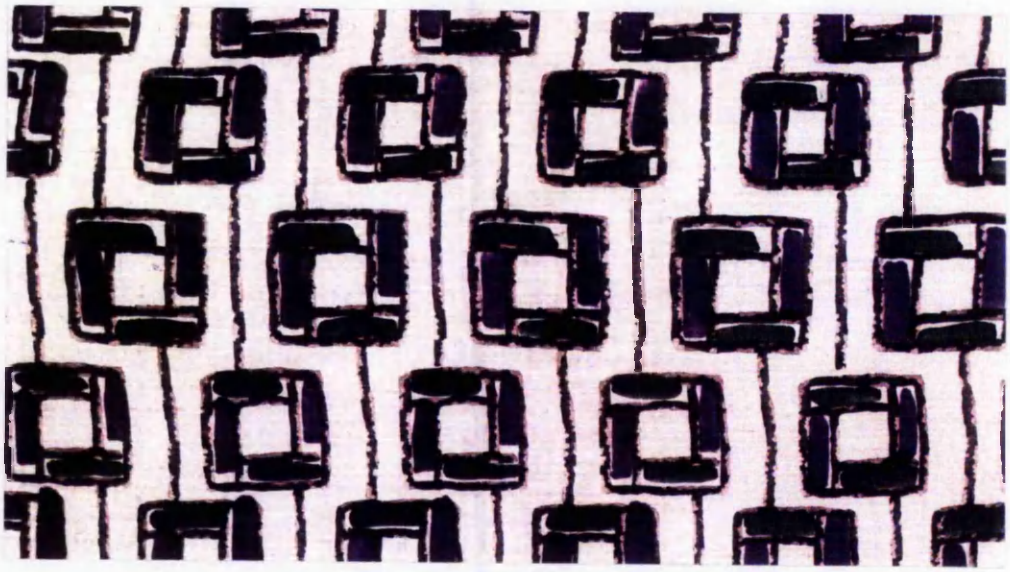
(a)

(b)



(c)

Roller prints produced by mill engraving. Actual size. (a) and (b) France, 1810-20. (c) England, 1824.



(d) *Mechtilde,* printed linen. Omega Workshops,1913. Small-scale geometric design with hand drawn units to produce irregularities in the overall pattern.

Figure 8.03. Small units: simple repeats: large impressions.

Stencil design using a mirrored unit with deviations from symmetry on the vertical axes.
Walter Crane, England, late 19th century.

Figure 8.04. Small units: transformed repeat: small impressions.

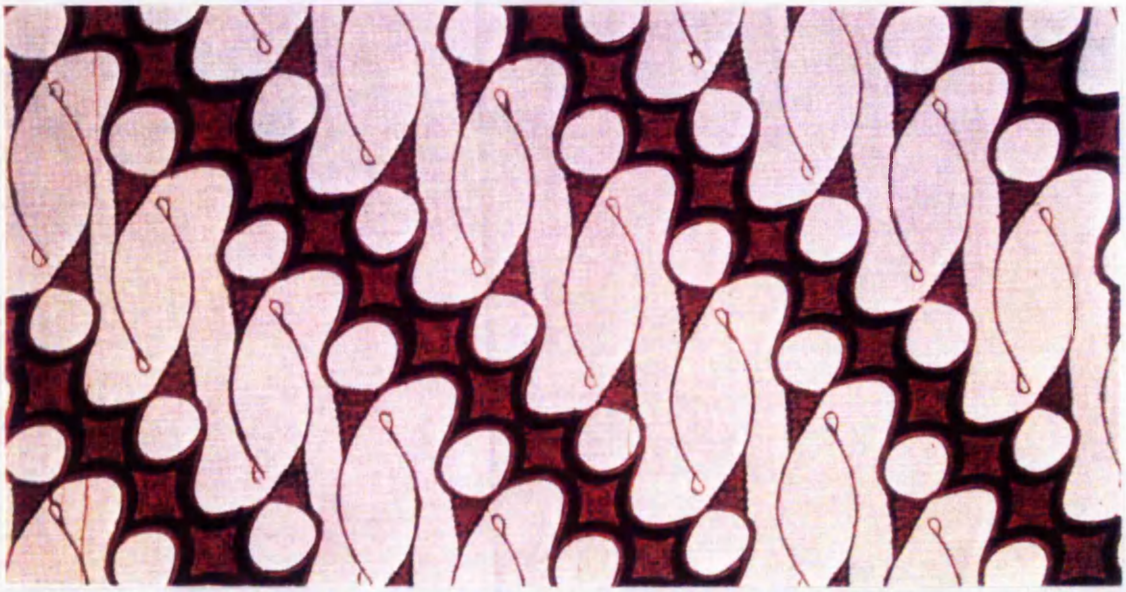
(a) Block printed paisley tie pattern using two orientations of one unit. England, 20th century. Actual size.

(b) Block print, indigo discharge technique. England, 1810-1820. Vertical lines of units with mirroring of alternate units. Repeat 2^{3}/16" x 1^{3}/16" (55 x 30 mm).

Figure 8.05. Small units: transformed repeat: medium impressions.

Roller printed serpentine pattern on a fancy ground. England, 1818.
Repeat 14" x 9.25" (356 x 235 mm) including alternate mirroring of the units.

Figure 8.06. Small units: transformed repeat: large impressions.



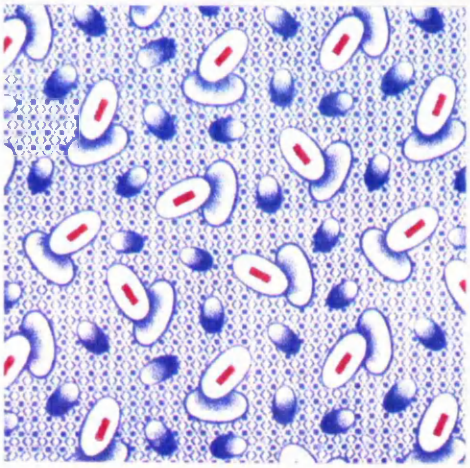
A Javanese batik using unit rotation and an eighth drop format to produce strong diagonal lines. Traditional.

Figure 8.07. Small units: composite repeats: small impressions.

Block printed design using indigo discharge technique. England, 1810-1820. Actual size.
Four variations of the motif are arranged, and this group is then dropped to create a larger repeat.

Figure 8.08. Small units: composite repeats: medium impressions.

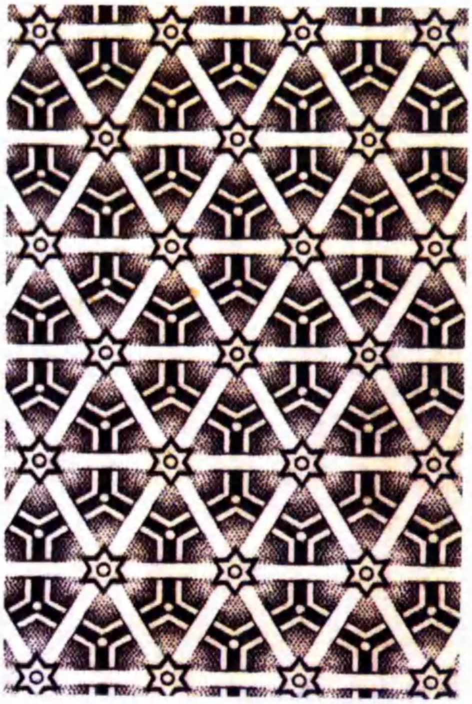
(a)



(b)

Roller prints. France, late 1880's. Actual size. (a): four variations of the unit are simply block repeated as a group. (b): eight variations are block repeated as a group on a fancy ground.

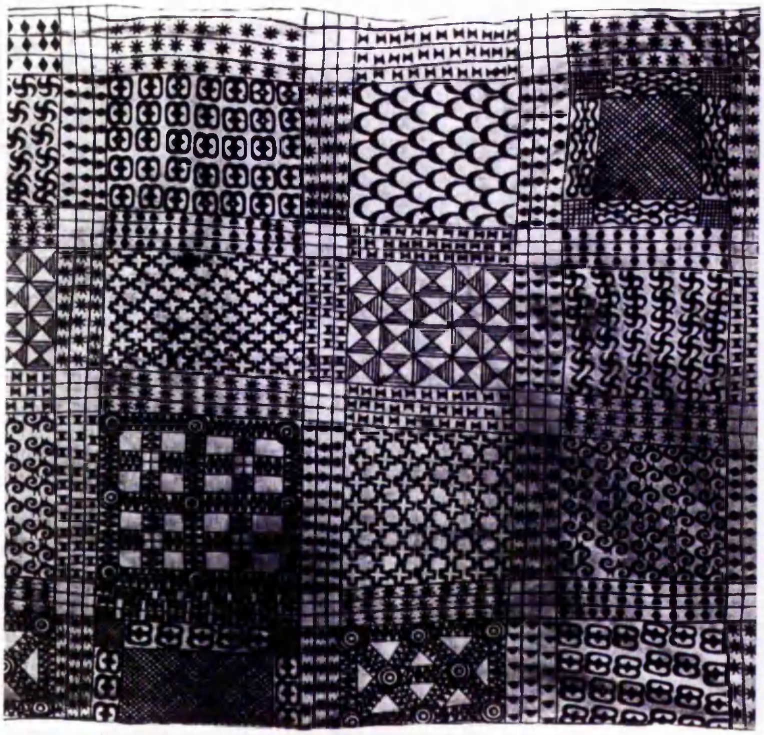
(c)



(d)

Roller prints. France. (c): four-way mirror format, 1900. Actual size.
(d): hexagonal format, 1880. 120% actual size.

Figure 8.09. Small units: composite repeats: large impressions.



Adinkira cloth. Ghana, early 20th century. Multiple impressions of various stamps are arranged within an overall geometric structure.

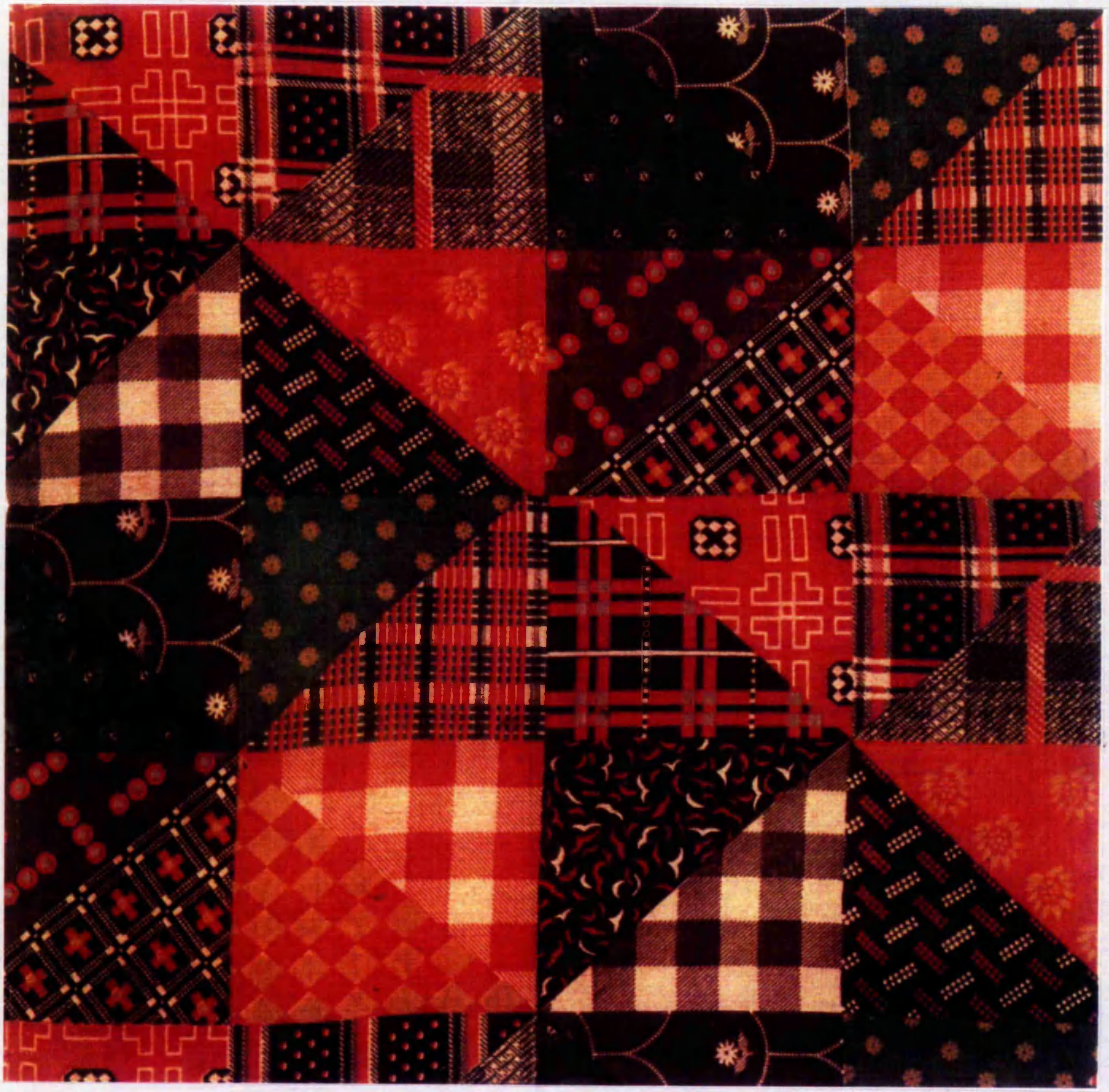
Figure 8.10. Small units: combined repeats: small impressions.

Block printed furnishing chintz. England, 1825. The full repeat was about 12" x 25" (305 x 635 mm) and combined three patterns.

Figure 8.11.a. Small units: combined repeats: medium impressions.

Block printed handkerchief. France, late 18th century. Border repeat approximately 5" x 2.5" (128 x 64 mm).

Figure 8.11.b. Small units: combined repeats: medium impressions.



Roller printed patchwork pattern. USA, 1880's. Full repeat 18.5" x 21.6" (470 x 549 mm) including a drop.

Figure 8.12. Small units: combined repeats: large impressions.

8.14. MEDIUM UNITS

Repeat can be used with medium-scale units either to stress or to hide the repetitive nature of pattern. It can produce highly repetitive or directional effects, especially when linked with relatively large elements. A large-scale element acts as a dominant visual accent and, when regularly repeated, tends to create linear effects across the whole pattern (2.12). The direction is determined by the repeat format used (9.05).

Complex formats are rarely used because the scale is large enough for arrangements of small scattered elements to show no apparent repeat, particularly with a drop format. Symmetrical designs are uncommon, except as underlying structures or where deviations from symmetry were introduced to diminish the impact of the vertical axes. This was usually done by modifying elements along the axes or adding directional elements. The four-way mirror format is particularly rare because its visual symmetry would be dominant at this scale. Such strictly symmetrical arrangements occur mostly on a smaller scale (8.10).

Unit size	repeat complexity	impression	text	figures
	simple	medium	8.15	8.13.a b.
		large	8.16	8.14.
	transformed	medium	8.17	8.15.
		large	8.18	8.16.a. b.
medium	composite	medium	8.19	8.17.
		large	8.20	8.18.
	combined	medium	8.21	8.19.
		large	8.22	8.20 .

Table 8.03. Categories of medium units and their associated figures.

8.15. Medium units: simple repeats: medium impressions

The simple repetition of a unit containing a single motif produces a highly repetitive pattern, and the use of a block or drop format can impose directional movements. Generally, the block format creates a static grid-like appearance (9.07), the drop a diagonal (9.14), and the brick a horizontal emphasis (9.21).

The drop and brick formats created the diamond and ogee forms of Gothic designs; 'block printing lent itself to the regular square and diamond patterns containing single motifs which were a feature of this style'.[30] These designs, with

[30] Phillips, B., *Fabrics and Wallpapers,* London, 1991, p.96.

their traditional association with craftsmanship, were revived by 19th century Gothic Revival designers, like Pugin. They had flat 'conventional' forms and they exhibited strong geometric structures (4.05), many using symmetrical motifs (8.17 and 8.19).

Copies of Indian prints introduced trailing stem designs which had more continuous elements than European designs and a less geometrically rigid appearance (6.09). Until the late 18th century, most were printed with blocks less than 12" by 10" (305 x 254 mm). Some had comparatively large-scale elements which, combined with continuity, meant that more engraving skill was needed to achieve an organic appearance, and the considered use of repeat was of prime importance in their design. The production of a continuous design by block printing is achieved by successive impressions. The pattern must be arranged so that each impression links up on each side with the surrounding impressions but, when 'a continuous pattern, embodying long unbroken lines or masses of colour, is executed by block printing, these joinings-up at the repeats are always more or less perceptible'.[31] Many European designs were based on geometric construction and design forms to achieve a regular distribution of elements (4.13 -15), and blocks were cut in irregular shapes to mask repeat joins (4.17).[32] The drop format could achieve a visually larger scale and a flowing natural effect. Counterchange could be applied to whole units, selected elements, or ground areas to create diaper or striped effects (figure 8.13.b).

Simple formats can impose a box-like structure which has been used in pictorial designs to form a succession of repeated pictures (figure 8.13.a). This has also been a dominant characteristic of many 20th century crafts-based and modern styles. Some designers, like Dufy, also applied traditional woodblock printing to achieve a spontaneous 'hand-crafted' look.[33] Simple repetition was an important characteristic, but he often used figurative and stylised elements to create continuity within a diamond structure derived from a drop or brick format. 1930's designers, such as Phyllis Barron and Dorothy Larcher, also exploited block

[31] This is due to the 'separate applications of the block for each fresh portion of the cloth printed, and the consequent difficulty of accurately adjusting the successive impressions to each other'. Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.20.

[32] 'The same rules that govern the repeats of patterns in block printing apply equally in stencilling, and similar means may be employed to mask the prominence of awkward repeats'. Ibid, 1936, p.42.

[33] He used 'a distinctive technique, involving an extra block covered with oil, to produce irregularities in the outlines'. Brédif, J., *Toiles de Jouy,* English translation London, 1989, p. 164.

printing's textural effects but with more emphasis on repetition.

Simple repeats also occur frequently in non-directional designs composed of similar small-scale elements which are arranged to create organic effects, such as vermicular grounds, marbling, animal prints, and scattered or packed florals. In these, the elements are usually continuous or link over the unit edges, and the repeat is not obvious because there is no defined design structure or dominant feature (4.01).

8.16. Medium units: simple repeats: large impressions

Many of the styles produced by woodblocks were adapted for plate and roller printing and, later, for flat and rotary printing, mostly using the same scales and formats. Although plates permitted huge repeats (8.25), from the 1770's they were used for detailed versions of smaller scale block printed designs, such as trailing floral or striped designs (8.13).

Some designs, like pillar prints in the 1830's, appeared as block or roller prints, and there was a general cross-fertilisation of techniques and styles between these two processes. The style of Arts and Crafts prints, derived from working within the limitations of the block printing process, was widely imitated in roller printed designs with smaller repeats (1.09).[34] The pantograph made the engraving of detailed designs of this scale easier and more accurate because the engraving heads could be set for the number of repeats across the width of the roller (5.18).

Jazz and floral designs of the late 1920's and early 1930's frequently used simple structures to produce directional movements. Furnishing fabrics often exhibited a strong horizontal bias which relied on the block or brick formats to create banding of elements (6.21). Many were surface printed to produce bold flat areas of colour (5.21) and this process was also used for Jacobean chintzes (6.16). Repetitive patterns of the early 20th century often employed counterchange of selected elements within units and hand-drawn irregularities.[35]

Directionality was also important to many 1950's screen prints, using motifs repeated in bands, with emphasis placed on the imagery and/or drawing and line quality. Horizontally striped abstract and banded motif designs, and printed plaids and checks cut on the bias were used to emphasise the full skirts of 1950's dresses. Directional designs for furnishings were also used with the new styles of

[34] Their block prints for furnishings were mostly of a larger scale (8.24, 8.26, and 8.28). A roller's vertical repeat was limited by its circumference and several repeats were engraved across the roller's width (7.03).

[35] For example, the Omega Workshop's abstract designs incorporated painted brush marks to add texture and variety to simply repeated 'Cubist' planes of colour.

home decor. Many abstract furnishing designs of this period had relatively small repeats, for example *Point on Point* (1955), which derived from a 1930's abstract painting, had a repeat of 14" x 12" (356 x 305 mm).[36]

The freely-drawn character of early screen prints was transferred to the roller prints of the 1930's. Photoengraving allowed the reproduction of water-colour and hand-drawn effects which were popular for non-directional fabrics for bias-cut dresses.[37] In these, loosely arranged elements were repeated using a simple format to create all-over designs with no obvious repeat (figure 8.14). Many 1930's floral prints are 'constantly revived, adapted and recoloured to suit current fashions'.[38] Designs of this type and scale have remained economically important in the fashion industry; 'it makes no difference which way they go when the cloth is sown into a garment'.[39]

8.17. Medium units: transformed repeats: medium impressions

Many Gothic prints had a flat, stencil-like appearance with gaps between individual elements.[40] Their repetitive nature was stressed by the isolation and symmetry of the units, which were engraved by turning over the design used for marking out the block.[41] These arrangements derive from the forms of woven textiles (6.03), and this symmetrical appearance was also an ingredient of designs derived from Islamic sources in the late 19th century (6.08). Similar arrangements were used by Arts and Crafts designers, but continuity was important and deviations from strict symmetry were frequently introduced (4.16). Many Art Nouveau and Art Deco designs relied on simple arrangements of symmetrical units, but often included continuous elements to create all-over patterns.

Many of the formats used for small-scale units (8.06) were also applied on this scale to create striped patterns and serpentine movements in trailing stem patterns.

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[36] Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.223.

[37] Early rotary screens were limited to non-continuous designs, 'it was possible to form a cylinder by soldering along a line that fell between the engraved motifs'. Wingrave, J., *Textile Printing - a Review of Technical Development in Australia,* Australasian Textiles, 1990, Vol.10, Part 5, p.42.

[38] Mendes, V., *The Victoria & Albert Museum's Textile Collection: British Textiles from 1900 to 1937,* London, 1992, p.15.

[39] '. . . this eases the work of the cutter, who can make more economical use of a bolt of cloth when shapes can be cut from it in any direction'. Meller, S. and Elffers, J., *Textile Designs,* London, 1991, p.29.

[40] These designs can be divided between those in which the motifs were printed and those in which the ground was printed. In the first, the gaps between elements made inaccurate registration tolerable. With the second, misregistration was a common problem and resulted in misalignment or overprinting.

[41] Simple arrangements of these composite units were used to build up patterns (8.19).

Designs were often cut on two blocks to create a larger total repeat and variations in detail were usually applied to the transformed unit (figure 8.15).

8.18. Medium units: transformed repeats: large impressions

The symmetrical forms of Gothic designs have been continually revived and converted for new printing processes, and revivalism has also ensured the endurance of most earlier design forms of this scale. Differences in treatment have been introduced with changes in printing processes and fashionable 'looks' (6.15 and 16). Roller printed Art Nouveau designs were often based on traditional scale and ogee forms using deviations from symmetry on the vertical axes (figure 8.16.a).

In the 1920's, batik and marbled effects were combined with loosely drawn abstract all-over patterns; 'roller-printing machinery could imitate the much more laborious hand resist-printing techniques'.[42] These often had a regular geometric base, but the combined variations of texture and irregular drawing produced an organic look and a larger total repeat (figure 8.16.b).

8.19. Medium units: composite repeats: medium impressions

The ogee form, based on a four-way mirrored unit repeated in a brick or drop format, was used extensively in Gothic designs. It has continued in the reinterpretation of damask and arabesque patterns and underlaid many Arts and Crafts prints. It was often used with deviations from symmetry introduced by adding directional elements to the basic structure (figure 8.17). Some prints, derived from panel designs for carpets and architectural features, such as ceiling patterns, also retain this underlying symmetry. Although blocks can be rotated between impressions for symmetrical patterns, rotational patterns rarely occur at this scale.

8.20. Medium units: composite repeats: large impressions

Designs of this type for roller, screen, and rotary printing usually derived from block prints and, again, symmetrical forms were used mostly as underlying structures. Composite formats on this scale appear more often in panel prints, such as scarves, where their symmetry relates to the overall balance of the contained pattern.

In the 1940's, bias, triangular, and square scarves were roller and screen printed.[43] Square scarves were normally 36" (914 mm) wide, and traditional

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[42] Mendes, V., *The Victoria & Albert Museum's Textile Collection: British Textiles from 1900 to 1937*, London, 1992, p.13. Warp printing was also used to give variation and blurred outlines to geometric patterns.

[43] Bias scarves were engraved spirally on the roller and the printed fabric was cut on the diagonal. Screen printed triangles were engraved as multiples of two or four units rotated to produce a square.

designs were usually symmetrical.[44]

The English Eccentrics screen printed scarves of the late 1980's were mostly 36" or 45" (914 or 1143 mm) square. These were made into garments which were cut individually and produced in limited quantities. The 'design had to work as a placement print, with the centre of a scarf acting as the shirt back and the border design as cuffs and pockets'.[45] Their collages of photographically reproduced motifs, although not always exhibiting strict symmetry, were often arranged in symmetrical forms (figure 8.18).

8.21. Medium units: combined repeats: medium impressions

The late 18th century en suite fashion for matching sets of curtains, borders, cushion covers, and chair seats exploited the mixing of elements attainable with block printing. Differing designs could be assembled by using selected blocks in a variety of combinations and spatial arrangements. This approach was exploited further in the printing of 19th century shawls and counterpanes (8.30).

Pattern books showed border patterns, which could also be printed as stripes, and pillar prints that could be printed either sequentially, as columns, or along the centre of the fabric with a choice of filling patterns (figure 8.19). Designs for chair seats and cushion covers, using symmetrical patterns or pictorial imagery, were mostly about 11" (280 mm) in diameter.[46]

8.22. Medium units: combined repeats: large impressions

Some monochrome furnishing prints of the 1980's used collages of classical motifs. For example, *Small Roman Heads* (figure 8.20) consisted of three similar units, each arranged in five different orientations to build up a design across the full width of the fabric. Similar classical motifs and arrangements were used, on a much smaller scale, by English Eccentrics (8.13). Timney-Fowler also combined classical architectural motifs in linear arrangements to compose pillar prints. Their scale, use of tone, and the engraved qualities of the imagery allude to 18th century toiles but, being designed to be draped, they differ drastically in their structural organisation.

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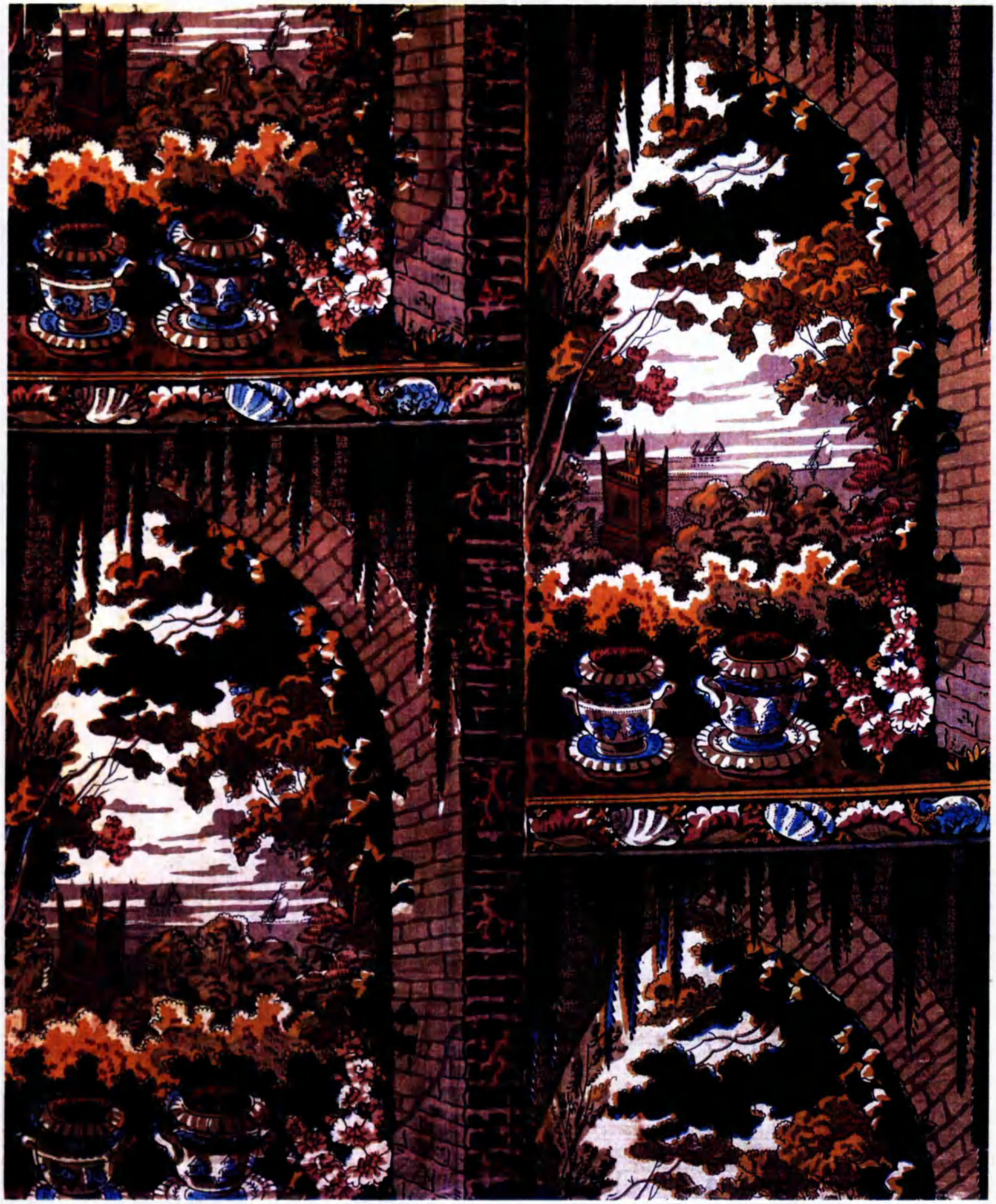
[44] Others, including many Ascher scarves, were one-way panels. These artists' designs were exhibited in frames, but also needed to look effective when draped or folded. Many required over ten screens, some as many as twenty.

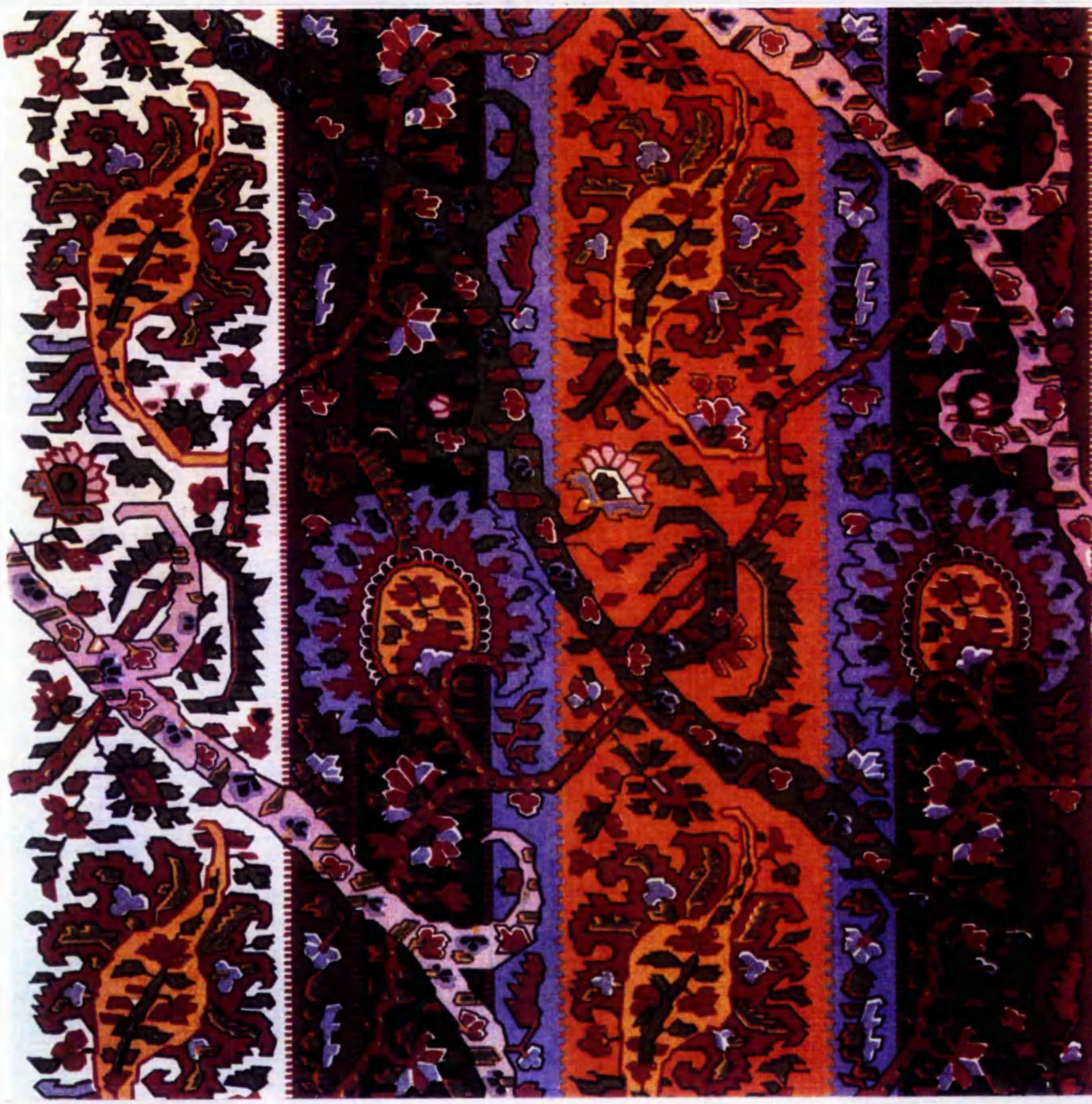
[45] McDermott, C., *English Eccentrics: The Textile Designs of Helen Littman,* London, 1992, p.8.

[46] These were designed to fit the shape of the seat, but were often also used as central designs for quilts. These and matching upholstery borders were also plate printed.



Block printed blind. England, 1830's. The repeat is 16.5" x 20" (420 x 508 mm) including the drop.

Figure 8.13.a. Medium units: simple repeats: medium impressions.



Block printed paisley pattern. France, mid-19th century. Counterchange has been applied on selected elements in vertical bands, but also on the diagonal stems. The unit size of 7.7" x 10.9" (196 x 277 mm) is thereby quadrupled in the total repeat.

Figure 8.13.b. Medium units: simple repeats: medium impressions.

Roller printed floral dress fabric. England, 1935.

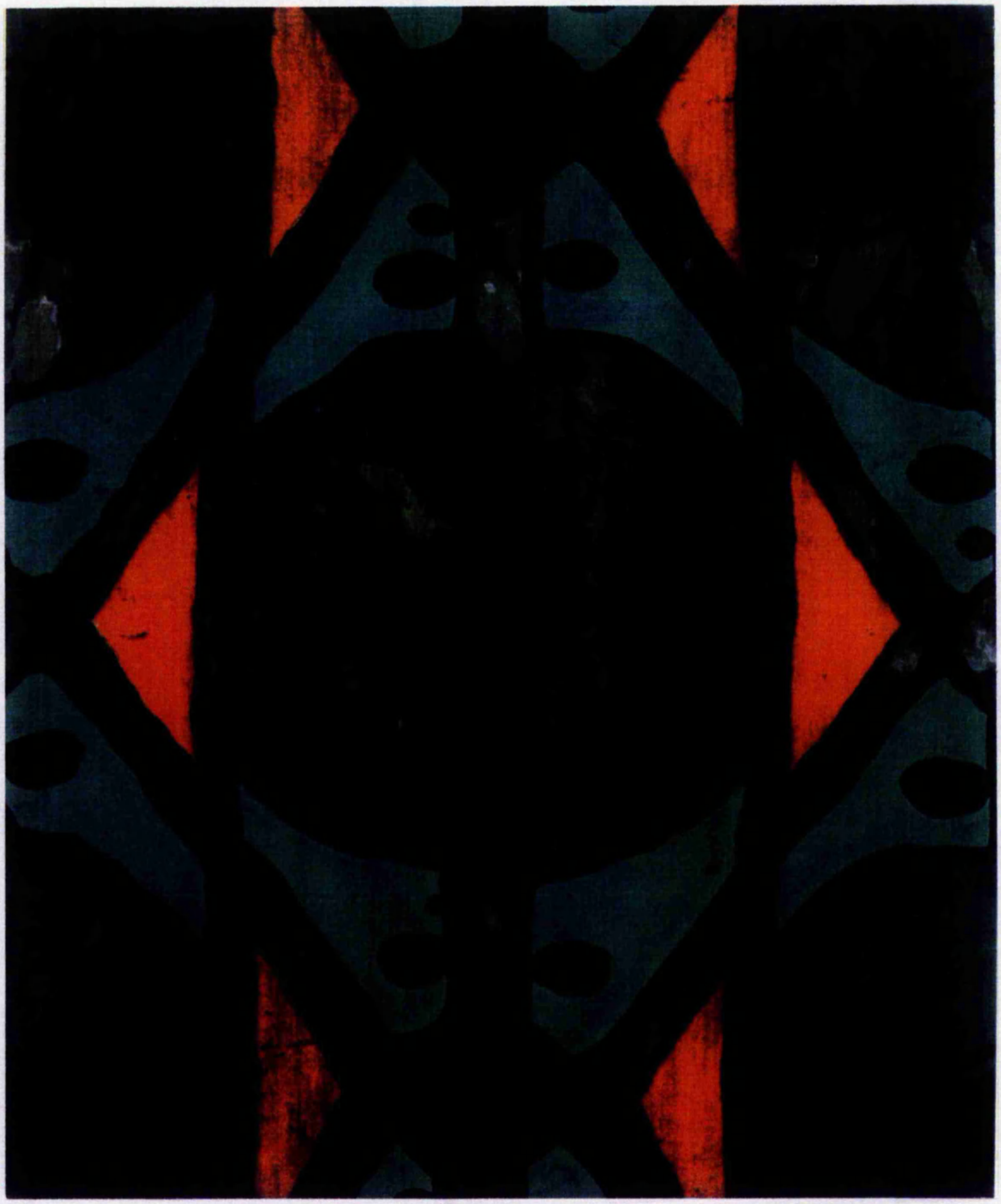
Figure 8.14. Medium units: simple repeats: large impressions.

Paper block-impression with additional colours by hand. England, 1770's or 1780's. Total repeat 22" x 16.75" (558 x 425 mm.) cut on two blocks. The unit was mirrored horizontally, and variations of detail were applied to each block.

Figure 8.15. Medium scale units: transformation: medium impressions.

Roller printed cotton velvet. France, 1897, designed by Félix Aubert. Total repeat 23" x 15". The units are arranged in a block/diaper/horizontal-mirror format with deviations from symmetry. The ground arranged in a brick format.

Figure 8.16.a. Medium units: transformation: large impressions.



Roller printed cotton. England, 1921. Textural effects and irregular drawing applied to a geometrically based design increased the total repeat size.

Figure 8.16.b. Medium units: transformation: large impressions.

Arabesque design for a printed textile. France, 1880. Four units of 12" x 14.5" (305 mm x 368 mm) combined with counterchange and transformations to form a total repeat of 24" x 29" (610 mm x 736 mm). The underlying structure exhibits four-way symmetry.

Figure 8.17. Medium units: composite repeats: medium impressions.

Screen printed scarf, *Angels*. English Eccentrics, 1988. 45" (1143 mm) square.

Figure 8.18. Medium units: composite: large impressions.

A group of designs comprising pillar prints, filling patterns, a chair seat, and a border (for edging seats or curtains). England, 1800.

Figure 8.19. Medium units: combined repeats: medium impressions.

Small Roman Heads. Timney-Fowler, 1986. Scattered arrangements of three units.

Figure 8.20. Medium units: combined repeats: large impressions.

8.23. LARGE UNITS

These have mostly been associated with furnishing fabrics but, from the 1950's, changes in fashion and the potentially larger repeat sizes provided by screen printing prompted their use in dress fabrics (6.22). Some of these employed the scale of design associated with furnishing fabrics, whilst others used small-scale scattered elements to form a large repeat.

Rotary screen printing 'greatly expanded the market for prints' and its ability to print wider widths 'catapulted bedding products into the thick of fashion rivalry'.[47] Flatbed is now considered the most practical method for printing bedding and other large-width designs, particularly those with long repeats.[48] Their size allows for symmetrical panel designs (8.29), similar in arrangement to shawl designs (8.28), to be printed. A mix-and-match approach is often adopted with the same, or similar, motifs being used on pillows and curtains.

Unit size	repeat complexity		impression		text		figures
	simple	----	medium	----	8.24	----	8.21.
		----	large	----	8.25	----	8.22.a. b.
	transformed	----	medium	----	8.26	----	8.23.
		----	large	----	8.27	----	8.24.
large							
	composite	----	medium	----	8.28		
		----	large	----	8.29	----	8.25.
	combined	----	medium	----	8.30	----	8.26.a. b.
		----	large	----	8.31	----	8.27.

Table 8.04. Categories of large units and their associated figures.

8.24. Large units: simple repeats: medium impressions

Large designs could be divided, cut on several blocks, and reassembled during printing. This method competed with woven fabrics and plate printing to produce large-scale furnishing fabrics, such as blue resist prints (figure 8.21).[49] These bold designs included large-scale elements, but most were rather crude and poorly registered. Many late 18th and 19th century furnishing prints were designed to be

[47] Fulmer, T.D., *In Prints With Style,* American Textiles International, 1989, Vol.18, No.2, p.28.

[48] With flat screens, the vertical repeat is only limited by handling. The largest vertical repeat is obtained with semi-automatic printing (5.26).

[49] Resist dyeing developed between 1730 and 1750, and the scale of these prints reflected the increased sizes of silk designs of that time. They became larger following the introduction of copperplate printing.

dropped when lengths were sown up, and the unit covered the width of the fabric. This arrangement allowed the printing of designs in which the total repeat was twice the width of the fabric. It was also 'used by copperplate printers, although in making up, many upholsterers did not bother to match the sideways repeat'.[50]

Combining blocks provided a large vertical repeat which, for furnishing prints, gave block printing an advantage over roller printing and ensured its continuity into the early 20th century. This technique was used extensively in the production of Arts and Crafts furnishing prints, such as William Morris's chintz designs, which were often of a grand scale with long repeats (8.26).[51]

Continuity and the harmonious distribution of elements in all-over designs was the aim of most Arts and Crafts designers and, although many designs had a directional emphasis, this was usually counterbalanced by secondary accents to produce repose, or balanced design (4.12). For example, in some designs, Morris achieved diagonal movements by the joining up of stems, but these were offset by visually linked elements in the horizontal direction. He based many designs on forms from historic and oriental woven textiles (6.03).[52]

8.25. Large units: simple repeats: large impressions

Plate printing introduced a new scale to printed textiles and the engraving techniques were applicable to pictorial imagery. These factors influenced the type of designs that were possible, and block prints were, in turn, influenced by their scale, detail, and linear effects (1.05). Early copperplate prints were mostly large, highly detailed illustrative scenes. Some were simply a series of printed pictures, while others were isolated islands of imagery (7.02). These made skillful use of interlocking areas lacking elements which needed to be joined during printing, and gave the impression of continuity whilst allowing for inexact registration. They 'show superbly how a designer can use the limitations and restrictions as well as the advantages and good qualities inherent in a technique to lead him into new ideas'.[53]

Their size was increased further using the drop format, or designs were built up

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[50] Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.48.

[51] His early chintzes were mostly two coloured designs with an emphasis on form which gave an uncluttered feel.

[52] The *Wey Chintz* (1883) 'almost certainly derives its structure from a fine piece of Italian cut velvet which Morris saw in the South Kensington Museum'. Gillow, N., *William Morris: Designs and Patterns,* London, 1988, pl.20.

[53] '. . . but they are also examples of a designer using purely literal drawings to create highly decorative fabrics'. Storey, J., *Textile Printing,* London, 1974, p.65.

from two or more plates (figure 8.22.a). Some prints combined images from four or six large plates to build up a huge design. '. . . in some of these the individual figures are a foot high or more, the individual scenes may be three or four feet square, and the whole repeat over six feet tall'.[54] These extremely large-scale prints would have been used for 'hangings' or wall-coverings.[55]

Many early roller print designs followed those of plate prints, but tended to be crowded and compressed because a similar amount of detail was included within a shorter vertical repeat. Their horizontal repeats were often the whole width of the roller, and this produced a banded effect.

Screen printing also permitted the production of repeats which filled the cloth from selvedge to selvedge. 'Many 1930's screen prints had a short wide pattern . . . since this made the screen a convenient size for the printers'.[56] Large screens, up to 72" x 48" (1829 mm x 1219 mm), were used for 'special styles of decorative fabrics - such as the large printed panels which consist of a design complete in itself (without repeats) and enclosed within an ornamental border'.[57] In the 1950's, Ascher printed large panel designs by artists, such as Henri Matisse and Henry Moore, most of which were non-repeating and one-directional.

In the 1950's, following the introduction of automatic screen printing and wider fabrics, larger repeats were printed, for instance, Lucienne Day's *Calyx* (1951) with a repeat of 24" wide x 27" (610 mm x 686 mm) on a 48" (1220 mm) width. This was 'unusually large for the time . . . to be fully effective, a drop of at least two and a half yards was required'.[58] Later in the decade, many designs with longer vertical repeats were produced. These 'could only be seen to advantage when at least two widths of cloth were hung side by side' and 'became, in effect, large vertical stripe designs'.[59] The expanding market for contact furnishings and changes in domestic interiors fuelled the production of this scale of design and modified versions were printed for smaller scale domestic furnishings.

[54] Floud, P., *English printed textiles: Copperplate pictorials,* Antiques, 1957, vol. LXXI, pp.238-41.

[55] Early wallpapers were assembled from sections in a similar manner. They were made in sheets of about 12" x 15" (305 x 381 mm), and large designs were printed in sections and assembled on the wall.

[56] Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.197. They gave an example of a furnishing print with a repeat 35.5" x 17.75" (902 x 450 mm).

[57] Knecht, E. and Fothergill, J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London, 1936, p.50.

[58] Harris, J., *Lucienne Day: a career in design,* Manchester, 1993, p.23.

[59] Ibid, p.42. Semi-automated screen printing facilitated easier screen handling and registration (5.27).

They were influenced by the scale of Scandinavian prints, some of which had huge simple motifs,[60] while others used small-scale elements in geometric arrangements (figure 8.22.b). This example (1956) had a repeat of 47" x 48" (1194 x 1219 mm). It was based on a small triangular grid structure which created 'a multifaceted surface composition'.[61] It was the forerunner of many late 1950's Swedish designs and later geometric patterns.

This scale of repeat was popularised in the early 1960's with the advent of large geometric and Op Art screen prints for furnishings and dress. These broke with previous conventions concerning the use of geometric patterns with upholstery (6.21). The use of this scale for dress fabrics developed from fashion changes in the 1950's (6.22). 'Bold and dazzling, these geometrics suited the prevailing, rather aggressive, clean-cut youthful styles'.[62]

Flat and rotary screen printing have prompted the production of designs with small-scale elements arranged to form a large repeat. A large area printed by one impression can be totally covered with scattered motifs. In fashion fabrics, the repeat size may be larger than the garment pieces and, with furnishings, the drape and scattered effect usually hide any obvious repetition. This method was exploited in stylised and abstract designs of the Memphis Group in the early 1980's. These combined a variety of motifs with abstract grounds but, because the motifs were similar, many of these designs give the appearance of a smaller repeat.[63] Large scattered designs were also used in the collages of graphic images and text which appeared as a major design theme in the late 1980's.

The quadricolour printing method can be used to print photographic images, and comparisons can be drawn with the scale and figurative imagery of early plate-prints. In 1991, this technique was used to produce 'some large designs in which photographs are placed across the cloth with no seeming repeat'.[64]

8.26. Large units: transformed repeats: medium impressions

The technique of combining blocks to produce long vertical repeats was also applied by Arts and Crafts designers to print horizontally-mirrored designs, many

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[60] In the 1960's, designs derived from the paintings of Maija Isola were used for huge scale prints of simple geometric motifs that covered the width of the fabric.

[61] Eidelberg, M., *Design 1935-65: What Modern Was,* New York, 1991, p.219.

[62] Mendes,V.D. and Hinchcliffe,F.M., *Ascher,* London, 1987, p.234.

[63] This group also produced many designs based on irregular arrangements and transformations of one motif to create medium sized units (8.10).

[64] These were being used for men's shirting. Watkins, P., *Première Vision - Sping/Summer 1992,* Textile Horizons, May 1991, p.17.

derived from Gothic ogee patterns. Many of Morris's designs of 1876, such as *Honeysuckle*, used this scale and format, with deviations from symmetry usually applied to elements on the vertical axes (figure 8.23). This had a repeat 30" x 36" (762 x 914 mm), but others of this period had tall narrow repeats, for example *Iris* had a repeat of 88" x 19.25" (2230 x 490 mm).

8.27. Large units: transformed repeats: large impressions

The large-scale of mid- to late 1950's screen prints was continued in the hard-edged and geometric designs of the 1960's. Patterns were often the width of the fabric and were designed to repeat when lengths were hung together. These designs commonly used symmetrical units in regular grid or stripe arrangements. They were of a much larger scale, but less complex, than the 19th century optical patterns and eccentrics (8.07 and 8.10). Many produced horizontal bands in repeat (figure 8.24). In the late 1960's, mirror formats were also used with figurative imagery, especially in space-age designs, such as *Space Walk* by Sue Palmer and *Lunar Rocket* by Eddie Squires for Warners.

8.28. Large units: composite repeats: medium impressions

Most large-scale furnishing prints were directional. Exceptions were panel prints where strictly symmetrical arrangements related to the overall balance of the contained pattern (8.30). Composite formats are therefore rare in block-prints of this scale and occur mostly with small design units (8.08 to 8.10).

8.29. Large units: composite repeats: large impressions

Large-scale designs of the 1960's using composite formats, such as four-way mirror symmetry, were geometric, Op art, and derivative Art Nouveau patterns. These were mostly bold screen-printed fabrics having just one or two total repeats across the width of the fabric. Some designs were commissioned from artists, such as Victor Vasarely (figure 8.25).

8.30. Large units: combined repeats: medium impressions

A repeat could be doubled by inserting two different filling motifs in a repeating pattern and, by dropping this combined unit, the size could be doubled again. This technique was often used in block-printed designs containing cartouches or rococo frames (figure 8.26.a).

Victorian shawls exemplified the flexibility of block printing for panel designs; many included border, corner, filling, and central patterns (figure 8.26.b). 'This is a pattern layout borrowed directly from the original Kashmir shawls imported during the first decade of the nineteenth century. It proved popular and was frequently used over the next fifty years'.[65] Placements for border patterns would involve rotating the block by 90 degrees for each edge. Border patterns often had similar unit arrangements as stripes (8.06), for example serpentine borders were printed by rotating the block by 180 degrees between each sequential linear impression. They were sometimes quite deep and would require more than one block. Corner elements were also turned by 90 degrees for each corner, and could be used as central medallions by placing four impressions of 90 degree rotations. Filling patterns were usually small-scale units in a brick repeat arrangement or larger continuous patterns. A mix-and-match approach was often adopted whereby customers could select various design elements from pattern books, allowing existing blocks to be re-used in new combinations.

A set of blocks was required for each colour, therefore a minimum of twelve blocks would be needed for a four colour design with three design elements. 'Printed shawls were sometimes costly items and the most elaborate examples . . . could require more than 500 printing blocks'.[66] Some, such as one designed by George Haité for the Great Exhibition of 1851, would not have been in commercial production, being produced only as examples of printing expertise.

Various elements were similarly combined to build up other contained designs, such as bedspreads. Schoeser and Rufey illustrated a late 18th century counterpane which was built up from approximately fifteen elements arranged to form an asymmetrical design within a square.[67]

8.31. Large units: combined repeats: large impressions

Screen printing prompted experiments with the overprinting of different design units (8.13), and these techniques were adapted for roller printing. In the late 1950's and early 1960's, Lucienne Day produced a number of designs by superimposing monoprinted acetate sheets on flat-coloured designs to introduce a smudgy texture. An adaption of this method can also be seen in her designs where blocks of colour are overprinted with sketchy line drawn designs, the two units having a different repeat size (figure 8.27).

[65] Reilly, V., *Paisley Patterns,* London, 1989, p.19.

[66] Exhibition guide to *Designs for British Dress and Furnishing Fabrics,* Victoria & Albert Museum, London, 1986, p.38.

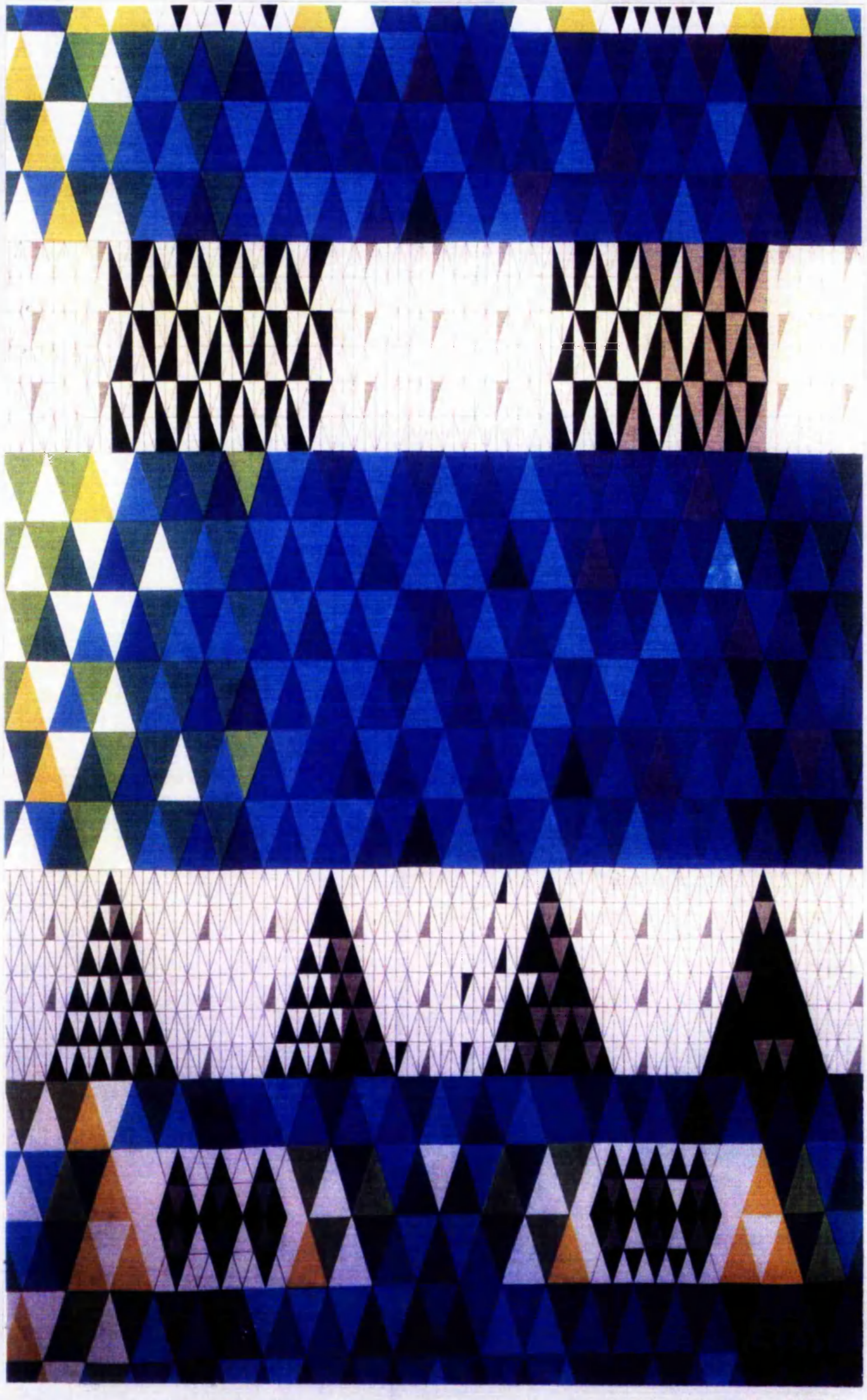
[67] These included inner and outer border patterns, a central motif, various large motifs at 45 and 90 degree rotations, with smaller motifs placed around them. Schoeser, M. and Rufey, C., *English and American Textiles: from 1790 to the present,* London, 1989, p.31.

Block printed blue resist furnishing fabric. England, second half of the 18th century. Repeat 28" x 40" (711 x 1016 mm) including the drop.

Figure 8.21. Large units: simple repeats: medium impressions.

Plate printed cotton. England, 1761. Repeat 34" x 80" (864 x 203 mm). This was printed using two plates. Only a section is shown here.

Figure 8.22. a. Large units: simple repeats: large impressions.

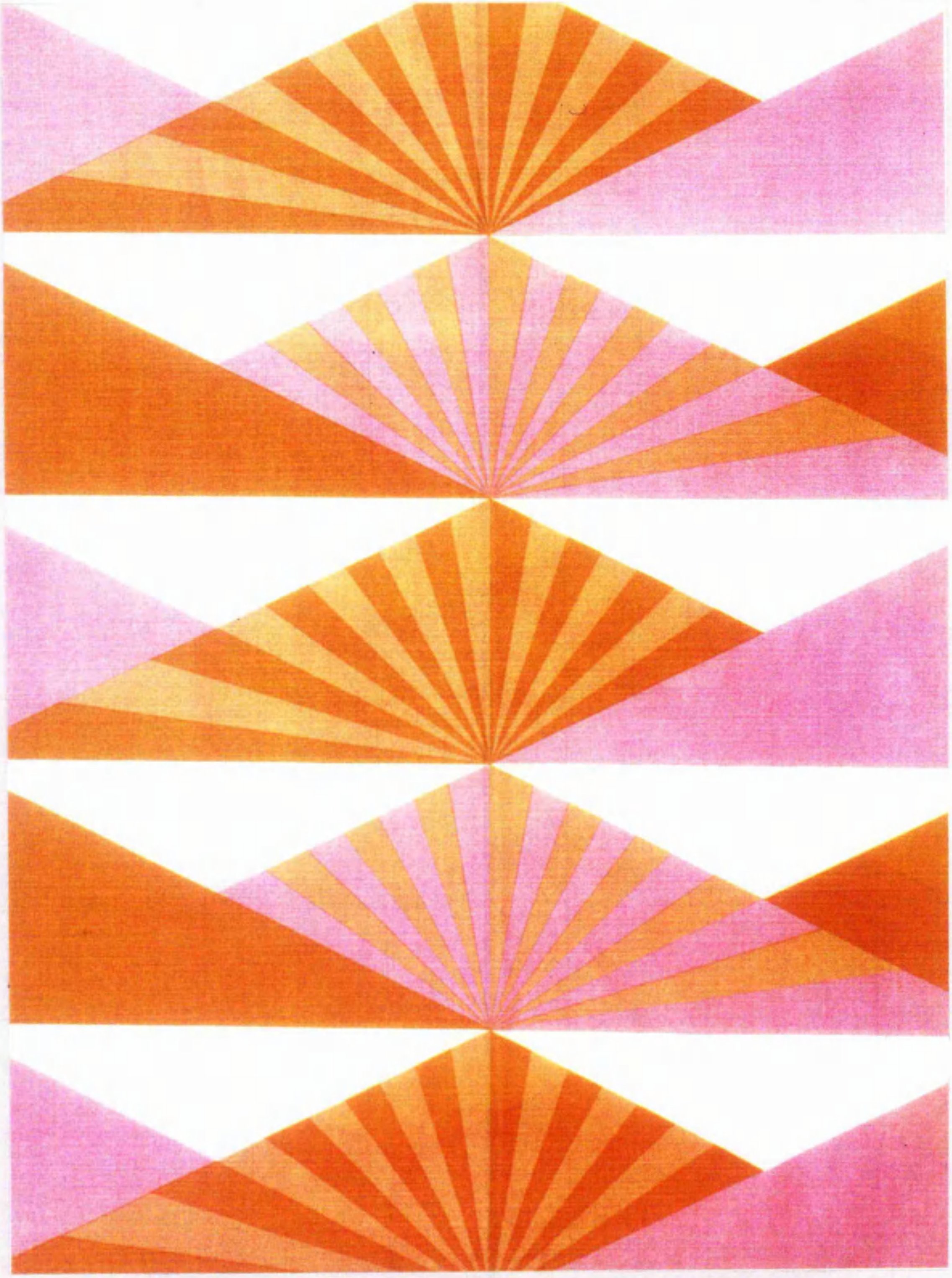


Pythagoras, screen printed furnishing fabric. Sven Markelius, Sweden, 1955. Repeat 47" x 48" (1194 x 1219 mm).

Figure 8.22.b. Large units: simple repeats: large impressions.

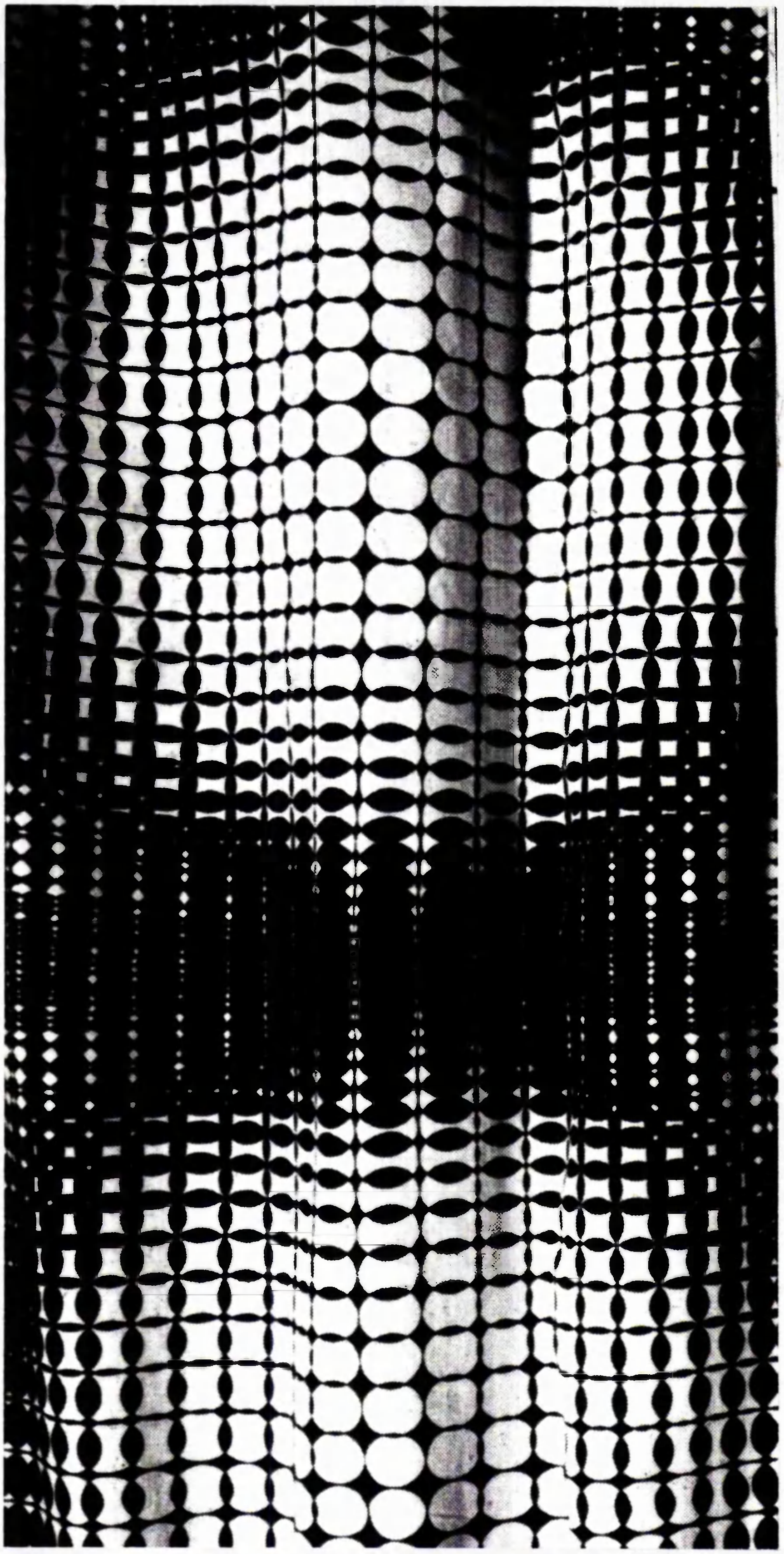
Honeysuckle, block-printed furnishing fabric. William Morris, England, 1876.
Repeat 30" x 36" (762 x 914 mm).

Figure 8.23. Large units: transformed repeats: medium impressions.



Sunrise, screen-printed furnishing fabric. Lucienne Day, England, 1969.
Repeat 48" x 27" (1220 x 686 mm). Two units mirrored horizontally with counterchange.

Figure 8.24. Large units: transformed repeats: large impressions.



Kernoo, screen-printed Op art furnishing fabric. Victor Vasarely, England, 1963. Repeat 48" x 48" (1220 mm). Four-way mirrored units.

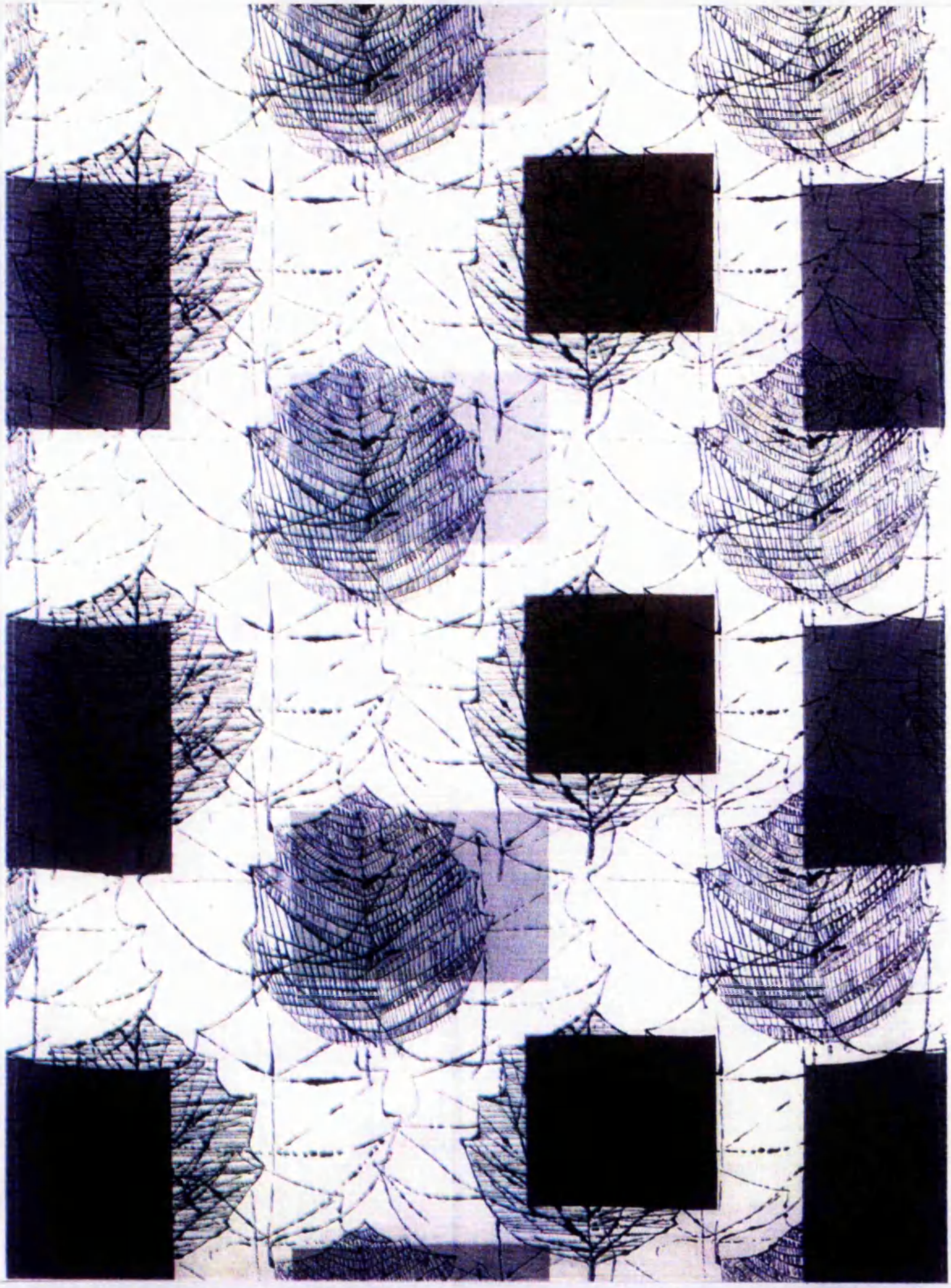
Figure 8.25. Large units: composite repeats: large impressions.

Block printed furnishing chintz. England, about 1750. Repeat about 70" x 36" (1780 x 914 mm) including alternate filling motifs of heads and urns.

Figure 8.26.a. Large units: combined repeats: medium impressions.

Part of a block-printed paisley shawl design showing a medallion corner, narrow border, and some of the centre pattern. Paisley, about 1830.

Figure 8.26.b. Large units: combined repeats: medium impressions.



Linden, roller-printed furnishing. Lucienne Day, England, 1960. Repeat 48" x 24" (1220 x 610 mm). The repeat of the leaf design is doubled by being combined with the wider repeat of the rectangles.

Figure 8.27. Large units: combined repeats: large impressions.

8.32. THE LIMITATIONS OF CLASSIFICATION

This classification method was intended to provide a practical framework within which the effects of technological and stylistic changes on repeat could be examined. A more rigorous categorisation could have been made. For example, a greater range of unit sizes may have included a separate category for the scale of units used with extremely small mill-engraved units. But it was found that there were general characteristics associated with the broad categories selected, and a stricter classification would have been too fragmentary for any general conclusions to be formed.

Many designs may fit into more than one category according to how the classification is applied. This is particularly apparent in designs where units are used to build up a symmetrical pattern to which additions and alterations are then made. These can be viewed as complex structures with variations or as simple, larger repeats. Hand drawn repetitions of small motifs can also be considered as simple repeats of small units with variations or as large units comprised of many elements.

When considering the size of unit as a primary category, it was found that, by disregarding variations, many designs from different eras exhibited the same structural characteristics. The emphasis placed on precise or irregular repetition was affected by technological developments, but also by changes in attitudes towards the visual effects of mechanised and hand-crafted renditions. The repeat structure forms a design's skeleton but the visual effects, characteristic of different styles, are provided by its scale and the treatment of units within it.

It was found that complex repeats occurred most with small units and least with large units. Complexity has often been used to add visual interest to small-scale patterns, but earlier technical limitations also restricted the scale of complex designs. The size of impression provided by contemporary printing has been used for large-scale designs with relatively simple structures. Although this scale and the manipulation facilities provided by modern technology give the opportunity to create complex repeats with medium and large units, they have not been exploited in this way to any appreciable extent. This can be seen as a result of the emphasis placed on imagery and tactile qualities in 20th century design coupled with the disinterest in structure as a design ingredient, but it also reflects the current lack of technological exploitation for design innovation.

CHAPTER 9: REPEAT FORMATS

9.01. CLASSIFICATION

A method of pattern construction was developed from a collection of repeat formats assembled by Peter Phillips and his colleagues over the last twenty years.[1] These included commonly used formats, such as block, brick, drop, and spot repeats, and variations formed using transformations and spacing. But, as they had no coherent labelling and structural organisation, a systematic approach was adopted for their classification which extended the existing range.

Examples were sought for each type, and some of these were included in *Repeat Patterns.*[2] It was found that some formats were more common than others and that a few appeared more frequently in particular styles or periods of history. It was also found that complex repeats were mostly confined to small scale designs. In general the larger the design, the less complex the repeat tended to be (8.32). Although it is not suggested that this method was used for the construction of the original designs, it can be used for the reconstruction of these and structurally similar designs.[3]

A repeat format may be just a starting point for the design development. It can be used to arrange the main motifs which may then be altered or added to individually.[4] Variations can also be introduced by adding filling details or printing designs on patterned grounds. In these cases, a different much larger final repeat is created.

9.02. Design units

The design unit is the basic building block of the design. Design elements may extend beyond the boundaries of the unit, enabling them to overlap adjacent units.[5] Most formats use rectangular units, although triangular and rhombic forms occur in composites.[6] The rectangle is the easiest form to use because translation (the

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[1] These were to teach repeat theory to textile design students, using exercises involving the manipulation of photocopied geometric units by cut and paste techniques. They originated from methods used before the 1950's (4.20).

[2] Phillips, P., and Bunce, G., *Repeat Patterns: a manual for designers, artists and architects,* London, 1993, ISBN 0 500 27687 0. The examples in this publication are taken from a range of applied designs.

[3] Classification of a design does not always indicate how the design was constructed (3.15).

[4] The repeat may form the skeleton of the design, and deviations can be introduced to extend designs or diminish symmetrical dominance (9.10). This is similar to the use of design forms and secondary construction lines (4.14).

[5] This allows the planning of design continuity (4.22).

[6] Composites comprise three or more copies of the unit grouped together, using more than one transformation. These are repeated in one of the simple formats. Triangular and rhombic units occur in formats, such as the block/composite/90 degree rotated mirror (9.13) and hexagonal composites (9.21).

distance moved in the horizontal or vertical direction when placing copies of the unit) always relates directly to the unit dimensions.[7]

9.03. Simple formats

The unit is repeated using six simple formats; block, drop, brick, irregular, woodblock, and spot (table 9.01).[8] Variations of drop, brick, and irregular formats can be specified using the distance by which units are translated on the horizontal and vertical axes. Variations of the spot format relate to the number of motifs in the repeat, and variations of the woodblock format relate to the unit proportions.

Simple formats provide a basic structure to which secondary organisations and transformations are applied.

9.04. Secondary organisations

The use of the secondary organisations of spacing and counterchange varies according to the characteristics of the simple format. The introduction of regular spacing between units on the horizontal and/or vertical axes produces pillar, stripe, diaper, diagonal, or open arrangements. These names are descriptive of the visual effects that they produce. For example, pillar arrangements produce vertical columns, and stripe arrangements, horizontal rows of units. Counterchange is applied to alternate units in the horizontal and/or vertical directions to produce pillar, stripe, diaper, or diagonal arrangements.[9]

9.05. Transformations

Subgroups are defined by single transformations (vertical-mirror, horizontal-mirror, and rotation)[10] and arrangements (pillar, stripe, diaper, and diagonal) which determine the positions of transformed units within the basic format. The axes of transformation lie through the centre of the units, so that transformed units retain their positions in the basic structure.[11]

The visual effects produced by particular formats differ according to the scale, proportions, and internal organisation of the unit which may, perhaps, have a strongly directional emphasis, created by linear effects or the visual linkage of

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[7] The rectangle has relevance to computer-aided design, particularly for raster graphics in which image manipulation facilities involve the specification of a rectangular matrix of pixels (10.04).

[8] These names were retained because they are an accepted part of the textile vocabulary and have strong visual associations. Other terms, such as *pillar* and *stripe,* were also chosen for the same reasons.

[9] Counterchange is also used irregularly, for example, to add random focal points in regular arrays of small motifs (8.04).

[10] 180 degree rotation is used in all the examples unless stated otherwise.

[11] If elements extend over the unit's boundaries, it is the centre of the unit, not the centre of the group of elements, that is used for the transformation. Sometimes the same pattern can be constructed using a different basic format and a different selection of elements in the design unit (9.39).

Simple format	BLOCK	DROP	BRICK	IRREGULAR	WOODBLOCK	SPOT
Simple variations	none	displacement on vertical axis	displacement on horizontal axis	displacement on horizontal and vertical axis	unit dimensions	number of units

SECONDARY ORGANISATIONS

	pillar	stripe	diaper or diagonal	open	diagonal	stepped	regular or irregular
	spacing	spacing	spacing	spacing			count number
	counterchange	counterchange	counterchange		counterchange		variable

TRANSFORMED ARRANGEMENTS

	pillar	stripe	diaper or diagonal	diagonal	stepped	variable and combined
Single transformations	horizontal mirror	horizontal mirror	horizontal mirror	horizontal mirror	horizontal mirror	horizontal mirror
	vertical mirror	vertical mirror	vertical mirror	vertical mirror	vertical mirror	vertical mirror
	rotation	rotation	rotation	180 deg. rotation	180 deg. rotation	rotation

Table 9.01. Repeat formats, secondary organisations, and transformations. These can be applied to single units or composites.

elements.[12] This emphasis may be accentuated or diminished by the selected format.[13] Visually cohesive groups may be formed by elements that are linked by mirror transformations.[14]

9.06. Total repeat

Any format contains a rectangular unit which can be translated in two directions, using the simple block format, to form the specified pattern. The total repeat is the smallest arrangement of units which can be used in this way. For instance, the total repeat for the simple half drop format is comprised of two units (figure 9.09) and for the one-third drop, three units (figure 9.10). The size of the total repeat is altered by secondary organisations and transformations.[15]

BLOCK FORMATS

9.07. Block: simple format

This is constructed by the regular translation of the design unit by its width along the horizontal axis, and by its height on the vertical axis. The total repeat consists of one design unit (figure 9.01). Any directional emphasis in the unit may be accentuated to give a vertical, horizontal, or diagonal movement in the pattern (figure 9.02. a-d),[16] and this may be stressed further by the proportions of the unit (figure 9.02. e-h). Units lacking directional emphasis may form stable grid-like patterns.

The visual effect depends on the proportionate scales of unit and elements, which emphasise or hide the repeat. Dominant accents can produce highly repetitive patterns (figures 8.01.a. and 8.01.b)[17] and, alternatively, the repeat can be camouflaged using small-scale 'organic' or geometric elements (figure 8.22.b).[18]

9.08. Block: secondary organisations

The introduction of pillar, stripe, open, or diaper spacing between units in a block format produces linear or isolated patterns (figure 9.03).[19] Pillar, stripe, and

[12] Elements may be linked perceptually to create lines or shapes (2.06).

[13] Elements all 'pointing' in the same direction can produce a feeling of directional movement (2.18).

[14] Such cohesive units emphasise the pattern's regularity (2.14).

[15] Appendix 5 illustrates their combined effects on the block format.

[16] Such directional movement can be offset by regularly occurring elements on the horizontal axes (8.24).

[17] The simplicity of this repeat can emphasise the imagery (8.15), and simple pattern structures are often used in radical styles with novel or stylised images (6.18).

[18] Although this design was constructed by filling in sections of a triangular network (4.13), its scale and complexity produced an overall non-repetitive effect. Simple block repeats were also common in organic patterns, such as vermicular grounds (8.15).

[19] Diaper spacing creates diagonal bands of units, pillar spacing forms vertical columns, and open spacing can produce horizontal, vertical, or diagonal lines according to the directionality of the motifs.

diaper arrangements are also used to apply counterchange to selected elements[20] or whole units (figure 9.04).

Secondary organisations can accentuate the directional movements in linear arrangements or the isolation of units in diaper arrangements.[21] The total repeat size is increased, and may be increased further if secondary organisations are combined (figure 9.04.d).

9.09. Block: transformations

Horizontal-mirror, vertical-mirror, and rotational transformations are applied using pillar, stripe, and diaper arrangements to produce nine basic pattern types with different visual characteristics (figure 9.05). The three horizontal-mirror arrangements (figure 9.05. a, d, and g) are the most commonly used transformed block formats for printed textiles, occurring with most styles and imagery.

The effect of the patterns will vary according to the internal organisation of the units. For example, the diaper format with horizontal or vertical mirroring gives a diamond effect when used with diagonally biased units, or a linear emphasis with horizontally biased units. These effects are illustrated diagrammatically in Appendix 4. These figures show transformations applied to the simple block format. They can be combined with secondary organisations to produce further permutations (figure 9.07). The range of total repeat units is illustrated fully in Appendix 5.

9.10. Block: pillar arrangements

In pillar arrangements, transformations are applied to units in alternate vertical columns of the block repeat, doubling the total repeat size. Pillar spacing or counterchange emphasises the vertical columns, whereas striped arrangements will accentuate horizontal bands of paired units.

The <u>block/pillar/horizontal-mirror format</u> (figure 9.05.a) gives vertical axes with columns of paired units displaying bilateral symmetry. Its symmetrical character is highlighted by units with vertical, diagonal, or curved emphases (figures 9.05.a, c, and d), especially if the units form cohesive groups. Units with an all-over or horizontal bias diminish the dominance of the vertical axis, particularly if elements are joined to form banded effects (figure 9.06.b).

[20] For example, in figure 8.13.b, a vertically striped effect was produced by selective pillar counterchange.

[21] The simplest form of secondary organisation is the checkerboard pattern which can be made either by diaper spacing of black squares on a white ground or by diaper counterchange. This anomaly confounds most classification systems (3.11). Detail added to one set of squares would distinguish it as having diaper spacing.

This format is seen in simple geometric patterns, such as chevrons and many ethnic and naive designs.[22] It was frequently used in Arts and Crafts (figure 4.13) and Art Nouveau designs (figure 4.14).[23] The potentially dominant symmetry is often reduced by deviations on the vertical axis (figure 8.23),[24] or by asymmetrical additions to the paired units (figure 8.26.a).[25]

The block/pillar/vertical-mirror format (figure 9.05.d) creates up and down movements which, if combined with diagonal bias or curved elements, produce horizontal zig-zags or undulating lines (figure 9.53). This format is rarely used in floral designs because it gives a strong bidirectional effect. It occurs in some stylised designs, such as paisleys, but more usually in vertical geometric banded patterns.

The block/pillar/rotation format (figure 9.05.g) produces similar bidirectional movements but, with diagonal bias, may show a linear slant. Unit elements linked across the vertical axis can form cohesive groups which appear to gyrate. This format is found in some geometric and textured bands where rotation is used to introduce visual dynamism with simple elements.[26]

9.11. Block: stripe arrangements

In stripe arrangements, transformations are applied to units in alternate horizontal rows of the block repeat. The total repeat size is doubled.

The block/stripe/horizontal-mirror format (figure 9.05.b) generally gives a vertical zig-zag, or serpentine effect, which can be underlined by directional bias (figure 4.17.b) and/or pillar spacing (figure 8.05.b).[27] Filling details or fancy ground effects were often added to pillar spaced arrangements to create continuous patterns which retained a strong vertical character (figure 8.06). This format is also seen in all-over floral designs in which less dominant serpentine movements were produced using units containing diagonal or curved elements.[28] It often appears as

[22] It is common in Egyptian and tribal striped designs.

[23] In this design the vertical axis was emphasised by strict symmetry, but offset by strong horizontal bands.

[24] 'Asymmetrical symmetry' was commonly used in mirror, or turn-over, designs (4.16).

[25] The final repeat was altered when different filling motifs were added (8.30). In this case, although most elements were organised in the block/pillar/horizontal-mirror format, the total repeat was changed to the simple block format.

[26] This produces more visual interest than other pillar formats. It is quite rare, but is occasionally found in printed ikats.

[27] Serpentine effects were common in 19th century stripe and double-stripe patterns (8.06 and 8.07).

[28] This format was particularly common to Arts and Crafts floral designs in which flower stems were used to produce the effect of upward growth. In Art Nouveau designs, the structure was more visually defined and the serpentine effect was often stressed by pillar counterchange. It can be found in some modern geometric designs (figure 8.24) and was used to create dynamic movement in Russian constructivist designs (6.14).

as an underlying structure for these designs, with variations applied to individual elements (figure 8.15).

The block/stripe/vertical-mirror format (figure 9.05.e) produces a horizontal axis of symmetry, but units linking across the axes can create horizontal or vertical bands, according to their directional bias. It can be found in some examples of vertically banded linear, geometric, and moiré patterns.[29]

The block/stripe/rotation format (figure 9.05.h) produces horizontal bands of units with alternating directions, and diagonal bias gives a slanted effect. It is occasionally found in vertically banded patterns[30] and as an alternative to the stripe/horizontal-mirror format for serpentine patterns.

9.12. Block: diaper arrangements

In diaper arrangements, transformations are applied to alternate units in the horizontal and vertical directions.[31] The total repeat size is quadrupled.

The block/diaper/horizontal-mirror format (figure 9.05.c) gives an alternating arrangement of symmetrical paired units (figure 4.17.c). This format appears in symmetrical designs, such as ogee and arabesque patterns (figure 8.17).[32] Slight variations were sometimes introduced to lessen the visual dominance of the vertical axes of symmetry (figure 8.16.a). It was often used as a framework to which further asymmetrical elements were added. For example, its structure underlies scale patterns (figure 4.08) which appear in strictly symmetrical forms (figure 4.10), or with deviations (figure 4.12).[33]

The block/diaper/vertical-mirror format (figure 9.05.f) produces an alternating arrangement of vertically symmetrical paired units. It appears mostly in fret and geometric patterns, where elements are linked to make continuous lines.[34] It was a common feature of Chinese floral designs with variations applied to individual

[29] More often symmetry on the horizontal axis is combined with symmetry on the vertical axis to form a four-way mirror unit (9.13).

[30] This format was found in fairly simple vertically linear patterns, such as columns of bamboo. Slight differences in lines showed where the units met on the horizontal axes.

[31] Block/diaper formats may also be constructed with paired units in a simple drop or brick format (9.39).

[32] This is common to styles that used a structured approach for the design of all-over patterns, and appears particularly in Islamic, Gothic, Arts and Crafts, and Art Nouveau designs.

[33] This example also has striped counterchange. The scale pattern has been used in many forms, from strictly symmetrical patterns to underlying organisational design forms (4.15).

[34] Such as the arrangement of blocks of vertically graduated tone for banded ombré effects.

units.[35]

The block/diaper/rotation format gives the strongest diagonal slant of the rotational formats (figure 9.05.i). A rotation of 90 degrees was often used to create an alternate over-and-under effect for simple lattice patterns and this was also used with open spacing for small paisley and foulard patterns (figure 8.05.a).

9.13. Block: composites

A composite is formed by four or more units with combined transformations, repeated as a group using the simple block format. Only five of the most commonly occurring composites have been illustrated (figure 9.08) because the possible permutations are practically unlimited. Composites with more units and other combinations of transformations can be made and secondary organisations can be applied to the composites (figure 2.10.b) or individual units within them.

The four-way mirror (figure 9.08.a) and 90 degree rotated mirror (figure 9.08.e)[36] units make stable non-directional patterns, and their inherent regularity is exploited in geometric patterns (figures 8.09.c and 8.25) and others which depend on a grid-like structure, such as carpet patterns.[37] These and 90 degree rotated units (figure 9.08.d) have often been used with open spacing to form small regular designs, such as foulard and tie patterns.

The 90 degree rotated unit gives a spinning effect which produces the illusion of diagonal movements. It is found in Celtic knot and fret patterns and in small-scale geometric patterns, such as simulated houndstooth. Counterchange and variation of detail are often used to provide visual interest.

The alternating four-way mirror unit (figure 9.08.b) is used mainly to create undulating horizontal bands or interlocking bidirectional patterns.[38] Many examples can be found in Islamic and Egyptian patterns. The rotated vertical-mirror unit (figure 9.08.c) is often combined with counterchange. It is mostly associated with ethnic designs and can produce visual complexity with simple geometric units.

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[35] An example is shown in Phillips, P., and Bunce, G., *Repeat Patterns: a manual for designers, artists and architects,* London, 1993, p.53.

[36] This is a variant of either the four-way mirror unit, in which the individual units in the composite are symmetrical about a diagonal axis, or the 90 degree rotated unit, where a unit is mirrored horizontally and then rotated. The pattern is defined in international notation as having symmetry **p4m** (Appendix 2). An example of this format can be seen in figure 4.03.

[37] It has been used extensively in a non-repeating form for panel prints (8.30).

[38] The international notation for this pattern is **pmg** (Appendix 2).

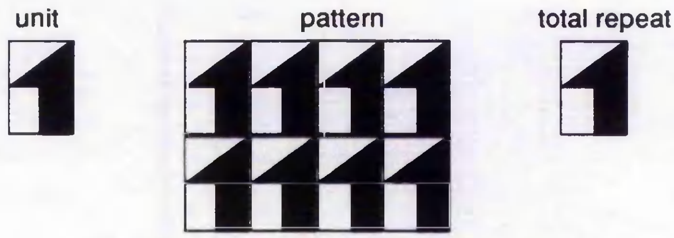


Figure 9.01. Block repeat/simple format.

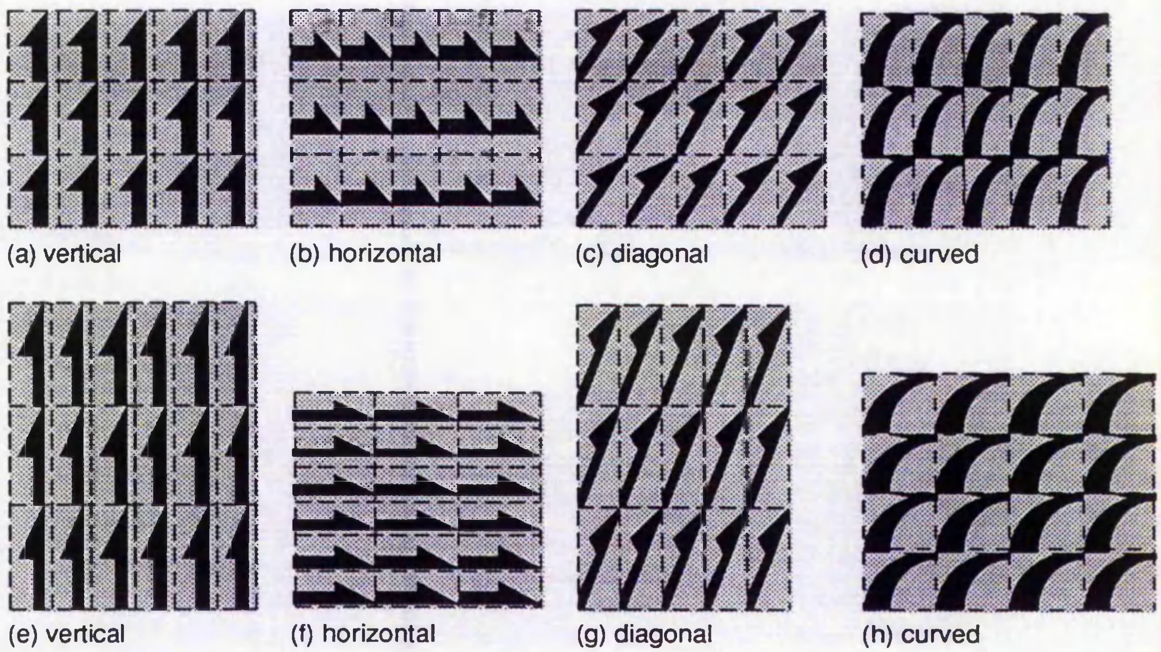


Figure 9.02. The directional emphasis of a design unit can be accentuated by the simple block repeat format (a - d). Directionality is also affected by the proportions of the unit (e - h).

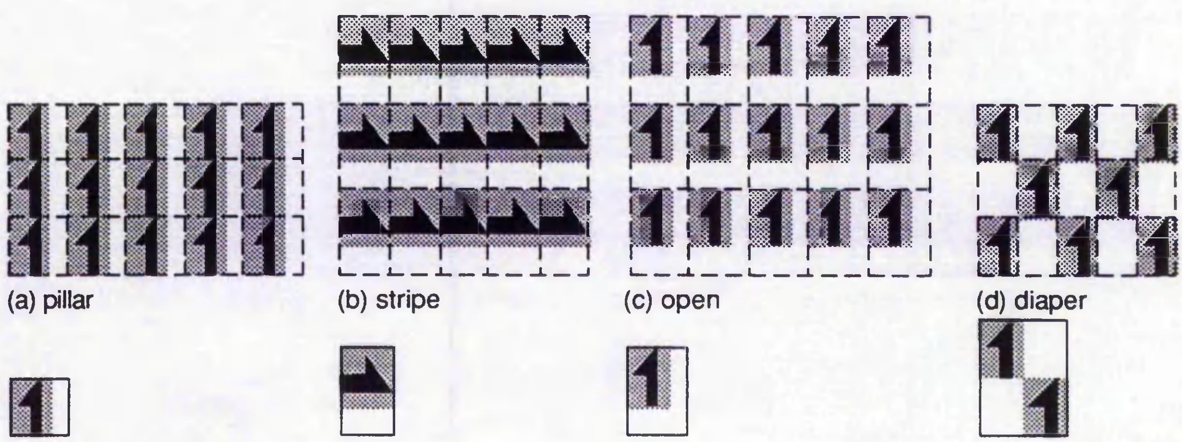
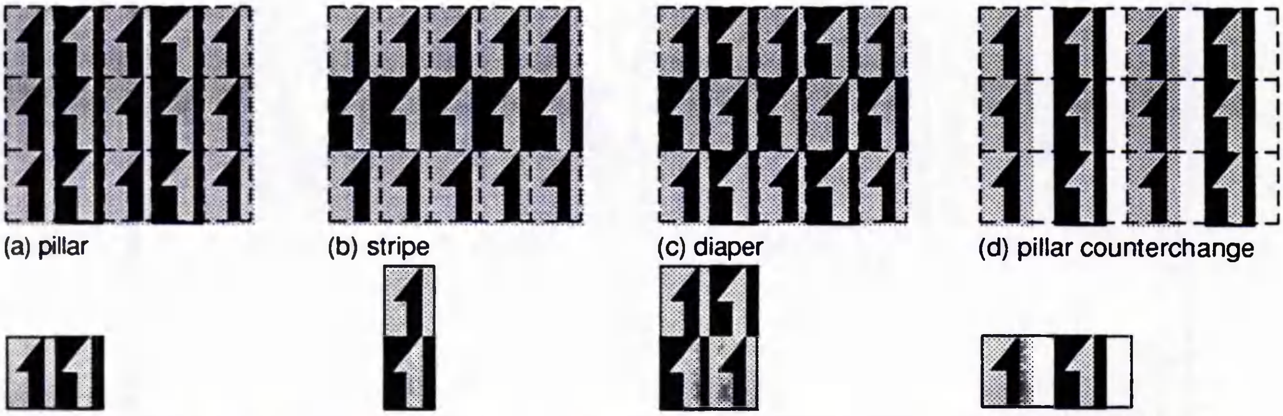
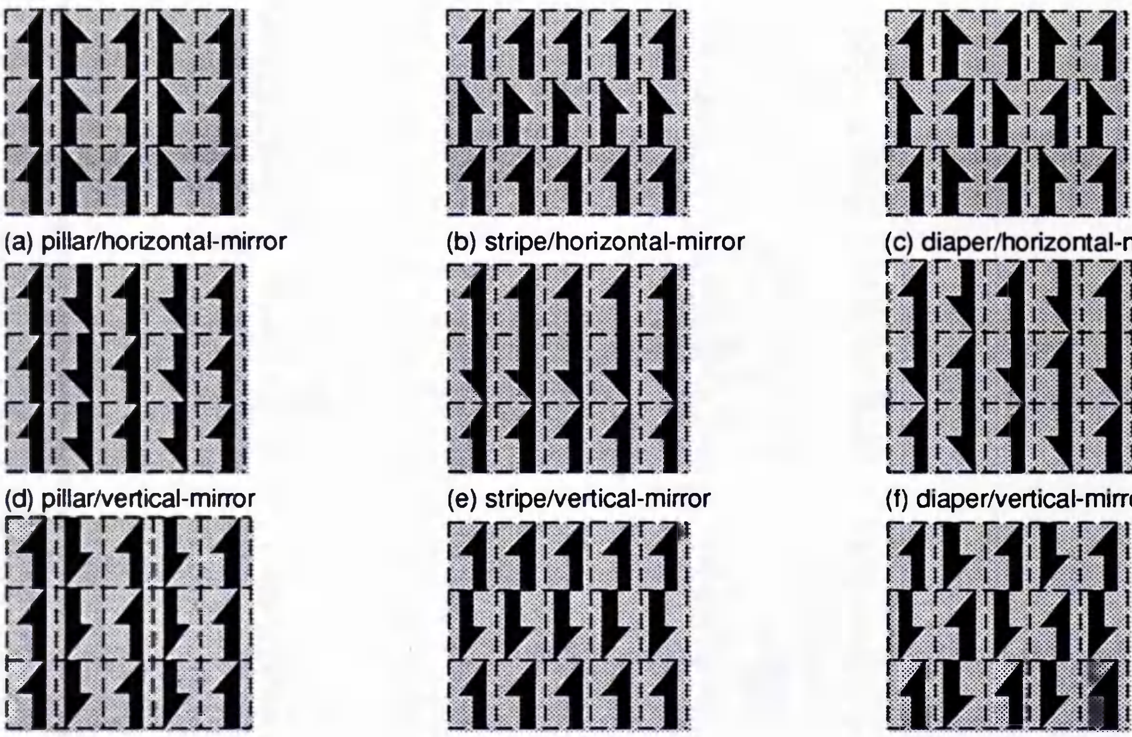


Figure 9.03. Spacing used with the simple block repeat produces linear or isolated arrangements of units. This can add further emphasis to directional units. The total repeat size is increased by spacing.



(a) pillar (b) stripe (c) diaper (d) pillar counterchange

Figure 9.04. Counterchange applied to simple block formats in pillar, stripe, and diaper arrangements. The total repeat size is increased by counterchange and when combined with spacing (d).



(a) pillar/horizontal-mirror (b) stripe/horizontal-mirror (c) diaper/horizontal-mirror

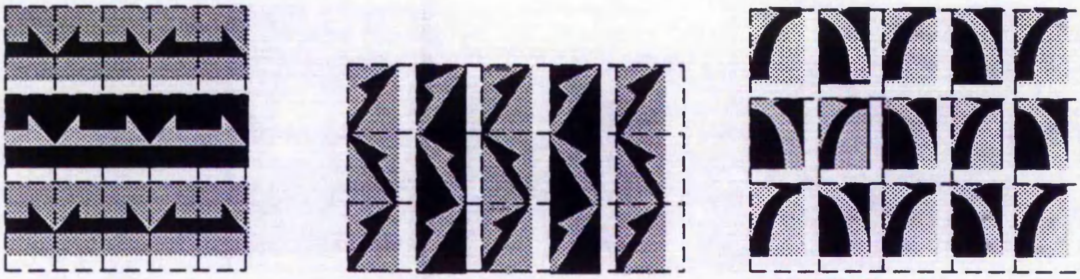
(d) pillar/vertical-mirror (e) stripe/vertical-mirror (f) diaper/vertical-mirror

(g) pillar/rotation (h) stripe/rotation (i) diaper/rotation

Figure 9.05. Transformations applied to the simple block format.

(a) vertical emphasis (b) horizontal emphasis (c) diagonal emphasis (d) curved elements

Figure 9.06. Block/pillar/horizontal-mirror format using units with different directional emphases. The visual effects are accentuated if paired units form cohesive groups.

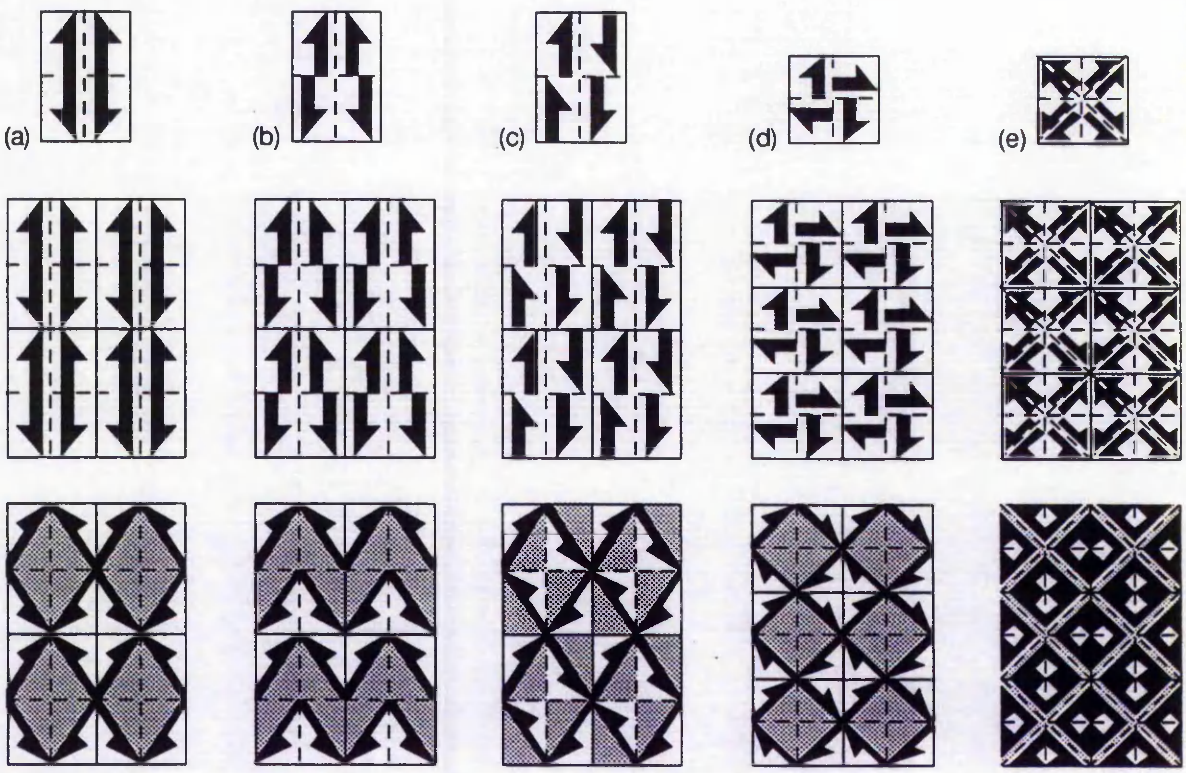


(a) pillar transformation, stripe spacing and counterchange counterchange

(b) stripe transformation, pillar spacing and counterchange

(c) diaper transformation, open spacing, and diaper

Figure 9.07. Secondary organisations applied to transformed repeats can accentuate directional movements (a) and (b), or the isolation of the units (c).



(a) Four-way mirror, (b) alternating four-way mirror, (c) rotated vertical-mirror, (d) 90 degree rotation, and (e) 90 degree rotated mirror.

Figure 9.08. Composites repeated with the simple block format.

DROP FORMATS

9.14. Drop: simple format

The most widely used drop format is the half drop (figure 9.09). Units are translated by the unit height on the vertical axis, but on the horizontal axis they are translated by the unit width, and then moved downwards (dropped) by half the unit height. This produces staggered columns of units with alternate columns being horizontally aligned. The total repeat is two units.

The half-drop is commonly used to double the design width (figure 8.21)[39] and to mask regularity with scattered and all-over designs (figure 8.14).[40] These designs were often constructed on a diamond net, allowing interlocking forms to be drawn outside the confines of a rectangular unit.[41] Design units with dominant visual accents can create diaper effects (figure 8.16.b), boxed images (figure 8.13.a), or diagonal lines (figure 8.03.c).

9.15. Drop: simple variations

Other drops produce steep (figure 9.10) or gradual (figure 9.11) diagonal movements, with larger drops generally forming steeper gradients.[42] Different drops emphasise the diagonal to the left or right. The figures show drops operating towards the right, but these also create proportionate drops to the left. For example, the two-thirds-drop (figure 9.10) gives a one-third drop to the left.[43]

Using a division of the unit height for the drop will ensure that the column of units will be aligned regularly in the horizontal direction. For instance, with the one-third drop, the alignment will occur on every third column, and on every fourth column with the quarter-drop. The total repeat size is increased proportionately, being three units wide for the one-third drop, four units for the quarter drop, and so on.

To produce the step drop, alternate columns are dropped by a specified amount, such as one-third (figure 9.12). Like the half-drop, the total repeat is two units, and alternate columns are aligned. It can produce undulating or strong zig-

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[39] This device was commonly used for designs on narrow widths (4.17).

[40] Other examples can be seen in figures 4.11 (small-scale elements based on a geometric structure), 4.16 (all-over directional floral), and 8.03.a (small-scale motif).

[41] This permitted the design to be drawn in a diamond unit, and then the design elements could be contained within a rectangular unit for printing (Appendix 3). This method was used for all types of design. Some retained the diamond structure in linear form (figure 8.08). Designs constructed using a regular structure (figure 8.12) can usually be repeated in a drop or brick format (9.21).

[42] This also depends on the proportions of the unit. For example, tall narrow units produce steep gradients with relatively small drops.

[43] This is exploited with directional bias to create strong diagonal emphasis.

zag effects according to the amount of the drop and the internal organisation of the unit.

The column structure of drop formats is accentuated by units having vertical emphasis (figure 9.13.a), but in those with horizontal or diagonal bias, the directionality can be disrupted (figure 9.13. b and c). The drop can be exploited to create strong diagonal movements to the right or left by joining the elements. For example, the third-drop can be used to form a steep downward movement to the left and a less acute diagonal to the right (figure 9.14.a).[44] The continuity of linear elements depends on the relationship between their vertical positions on the edge of the unit and the drop used. For example, this same unit in a two-thirds drop creates a broken diagonal (figure 9.14.b).

Drop formats were often used with units containing ordered arrangements of various small motifs. figure 9.15 shows the quarter drop used in this way. The unit has six motifs arranged in four horizontal bands. The total repeat is four units wide and each motif occurs only once in every horizontal row of the repeat.[45]

9.16. Drop: secondary organisations

As with block formats, secondary organisations are used to stress directionality in the pattern. Spacing is applied using pillar, stripe, open, and diagonal arrangements (figure 9.16). Pillar spacing stresses the column structure, and the stripe arrangement makes and accentuates horizontal zig-zags. Open spacing was commonly used for filling patterns (figures 8.02 and 8.03.b),[46] and the effect, although ordered, can be perceptually unstable.[47] Diagonal spacing can be introduced to the right (figure 9.16.d) or to the left (figure 9.16.e), and produces linked bands of units. Counterchange can be applied in pillar, stripe, and diagonal arrangements (figure 9.17).

9.17. Drop: transformations

Pillar, stripe, and diagonal arrangements are used to apply the transformations

[44] Such diagonal banding is found in many Art Deco designs.

[45] These arrangements were common in small floral designs which used individual flower motifs linked by trailing stems and designed to join over the unit edges. They also provided an underlying structure for more detailed designs (4.15). Figure 8.09.a shows an arrangement of four transformed motifs repeated in a simple half drop format. Spot formats were used to add more variety to this type of design (9.35).

[46] This produces an anomaly when units are spaced far apart, being seen as both open drop and open brick formats.

[47] These arrangements can display alternative emphases because the regularly appearing accents can be linked either diagonally or vertically (2.18).

of horizontal-mirror, vertical-mirror, and rotation (figure 9.18). Their visual effects will vary according to the directionality of the units (Appendix 6) and the drop format used. The most common format is the half-drop/pillar/horizontal-mirror.

9.18. Drop: pillar arrangements

In pillar arrangements, transformations are applied to units in alternate vertical columns of the drop structure. Without secondary organisations, there is no change in the total repeat size for the half drop and other even drops (figure 9.19.a), but with uneven drops the size is double that of the simple format (figure 9.20).

The drop/pillar/horizontal-mirror format (figure 9.18.a) gives a vertical zig-zag effect and is found in many paisley patterns in which curved motifs created undulating upward movements. It was used with vertical emphasis, often with spacing or linear filling elements, for striped and double striped serpentine patterns. Geometrically based examples can be found in modernist prints in which diagonal emphasis gave a dynamic effect.

The drop/pillar/vertical-mirror format (figure 9.18.d) produces bidirectional columns, and is similar to the block format except that units are offset on the vertical axes. With simple geometric shapes, this forms an undulating effect.[48]

The drop/pillar/rotation format (figure 9.18.g) is occasionally seen with pillar spacing in geometric or stylised vertically lined patterns. It can also be seen in some ikat and batik designs (figure 8.07),[49] but these complex forms have rarely been interpreted in European textiles.

9.19. Drop: stripe arrangements

In stripe arrangements, transformations are applied to units in alternate horizontal rows of the drop structure. The total repeat size for the half and other even drops is double that of the simple format (figure 9.19.b). The drop/stripe/horizontal-mirror format (figure 9.18.b) forms alternating horizontal zig-zag lines of units facing in two directions, which can be emphasised by striped spacing or counterchange.[50] This is sometimes used to add directional variety to novelty designs of motifs on patterned grounds.

Undulating effects can be achieved with the drop/stripe/vertical-mirror format

[48] The structure is easily seen in geometric designs or those with stripe spacing, but some examples can be classified as either the drop or block format according to the position of the mirror axis (9.39).

[49] This example is an eighth-drop/pillar/rotation format.

[50] This format can be seen in the arrangement of the main motifs in figure 8.11.a. In this, the motifs form vertical columns which are separated by other elements to form a vertically striped design.

(figure 9.18.e), especially if vertically paired units are joined and are seen as a complete motif. When the drop/stripe/rotation format (figure 9.18.h) is used, paired units create spinning S-shaped effects with curved linear motifs. With a slightly more vertical emphasis, it is also found in some serpentine patterns.

9.20. Drop: diagonal arrangements

Diagonal arrangements can emphasise the diagonal movements made by drop formats. They are more often used with drops other than the half drop. As with secondary organisations the direction of this movement can be to the left or right, and its gradient will depend on the drop used. The total repeat size for the half and other even drops is quadruple that of the simple format. For example, the quarter-drop forms a total repeat of sixteen units (figure 9.21).

The drop/diagonal/horizontal-mirror format used with units having a diagonal bias can produce a diamond lattice appearance. The drop/diagonal/vertical-mirror and rotation formats can emphasise the diagonal lines when vertically paired units exhibit cohesion, especially when combined with a small drop.

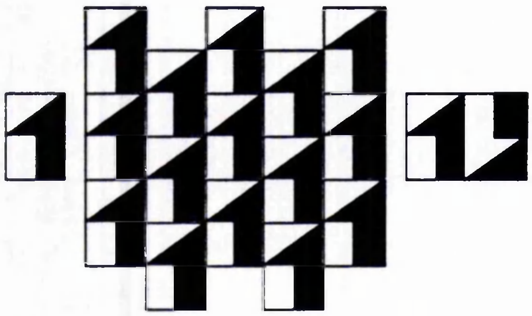
9.21. Drop: composites

Composites are usually repeated using the simple drop format, although variations can be used to make more complex patterns. As with block formats, secondary organisations can be applied to the constituent units of composites or to them as a whole. The same units illustrated in figure 9.08 can be used in the drop format; the drop being half of the composite unit height (figure 9.22).[51] In designs based on the diamond structure, a group of four rhombic units, using a variety of different transformations, may also be contained within a rectangular unit to be repeated in the drop format (figure 9.23). This was a common device for small floral designs (figure 8.08).

Hexagonal composites (figure 9.24), when used in the drop format, are translated by less than the unit width, so that the units interlock (figure 8.09.d). These patterns can be broken down into rectangular units (figure 9.24.d) and, as with the diamond form, are easier to construct using a geometric grid.[52]

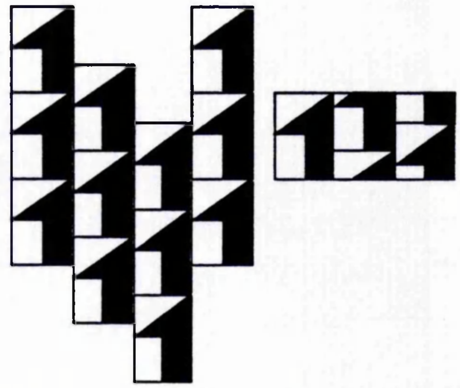
[51] Most of these patterns can also be formed using the same units in a different combination in the brick format.

[52] This form can be based on the equilateral triangle network (Appendix 3).



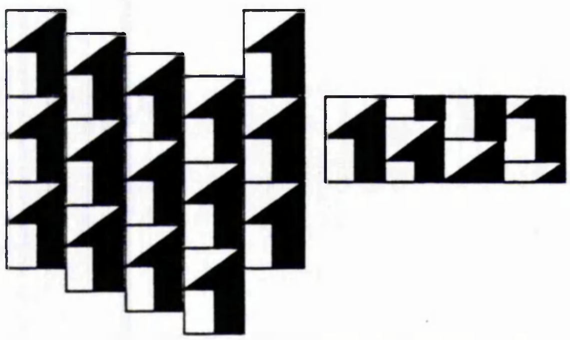
unit pattern total repeat 2 units

Figure 9.09. Drop format/half-drop.



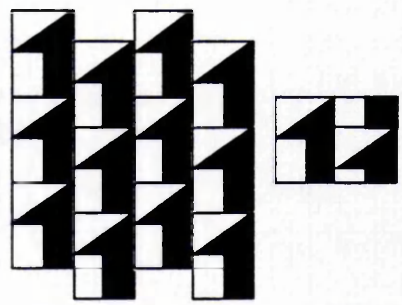
pattern total repeat 3 units

Figure 9.10. Drop format/two-thirds drop.



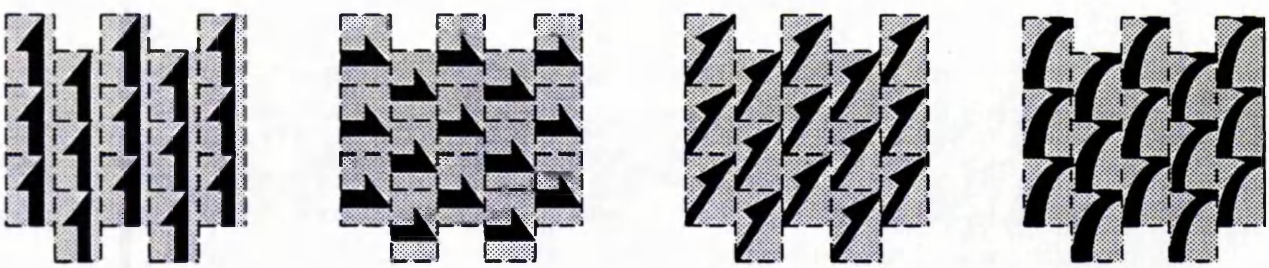
pattern total repeat 4 units

Figure 9.11. Drop format/quarter drop.



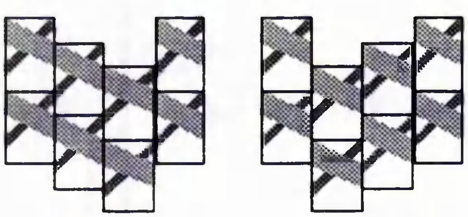
pattern total repeat 2 units

Figure 9.12. Drop format/one-third step.



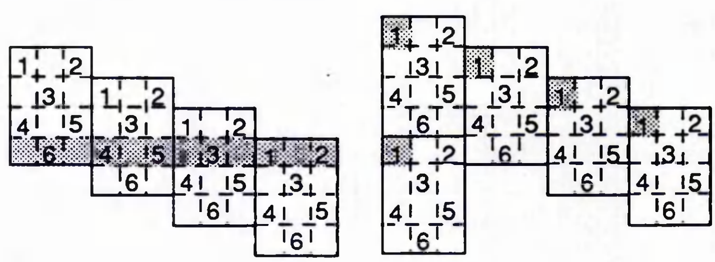
(a) vertical (b) horizontal (c) diagonal (d) curved

Figure 9.13. Half drop format showing the effect of units with different directional emphases.



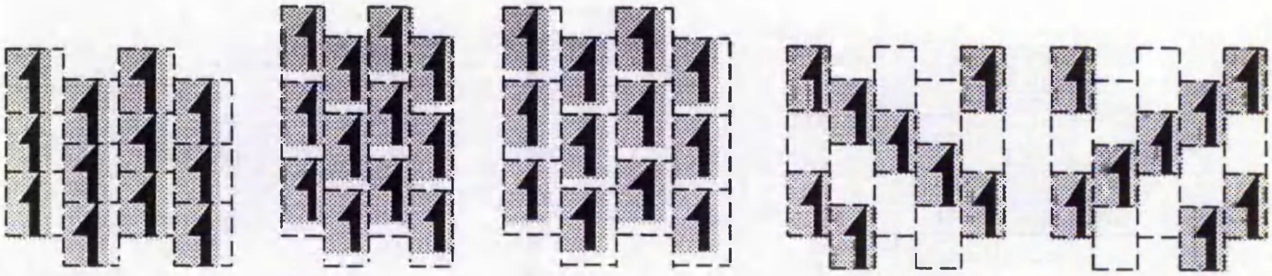
(a) one-third drop (b) two-thirds drop

Figure 9.14. The same unit in different drop formats giving continuous (a) and broken (b) lines in the pattern.



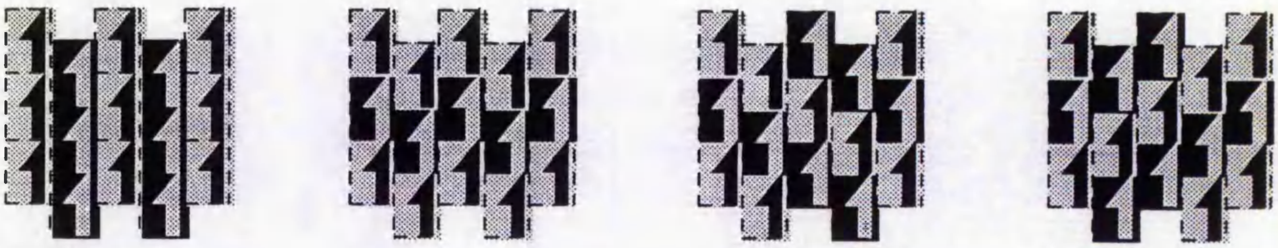
(a) (b)

Figure 9.15. Quarter drop applied to a unit containing a diaper arrangement of six different motifs. Width of the total repeat is quadrupled (a). Motifs recur in diagonal lines (b).



(a) pillar (b) stripe (c) open (d) diagonal right (e) diagonal left

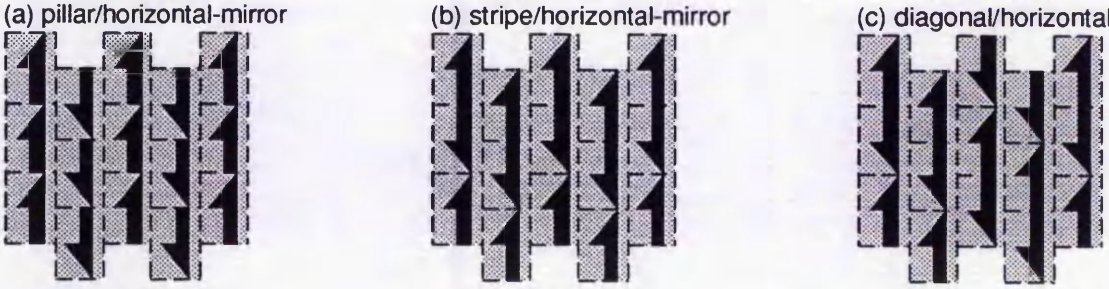
Figure 9.16. Half drop format with spacing.



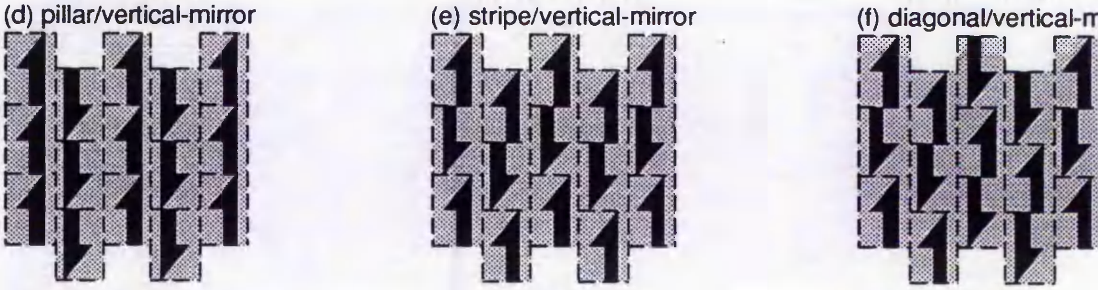
(a) pillar (b) stripe (c) diagonal right (d) diagonal left

Figure 9.17. Half drop format with counterchange.

(a) pillar/horizontal-mirror (b) stripe/horizontal-mirror (c) diagonal/horizontal-mirror

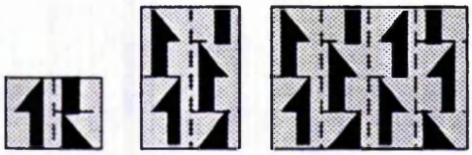


(d) pillar/vertical-mirror (e) stripe/vertical-mirror (f) diagonal/vertical-mirror



(g) pillar/rotation (h) stripe/rotation (i) diagonal/rotation

Figure 9.18. Half drop format with transformations. These may also be used with the diagonal left arrangement, as shown in figure 9.17.d.



(a) pillar (b) stripe (c) diagonal

Figure 9.19. Half drop format with horizontal-mirror. Total repeat sizes:- (a) 2 units. (b) 4 units. (c) 8 units.

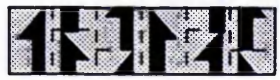


Figure 9.20. One-third drop/pillar/horizontal-mirror. The total repeat is 6 units

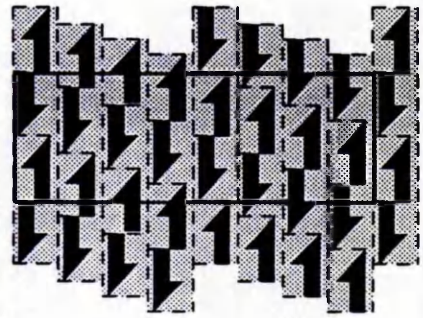
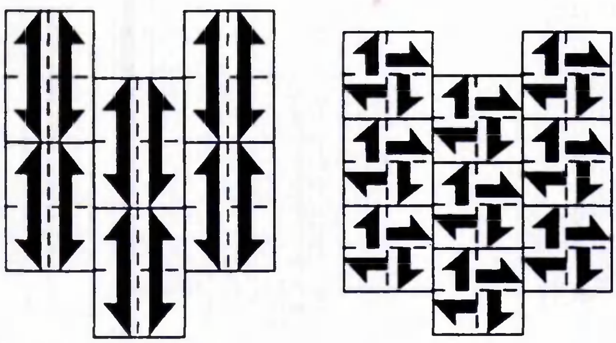


Figure 9.21. Quarter drop /diagonal/rotation. The total repeat is 16 units.



(a) Four-way mirror. (b) 90 degree rotation.

Figure 9.22. Half drop format/ composites.

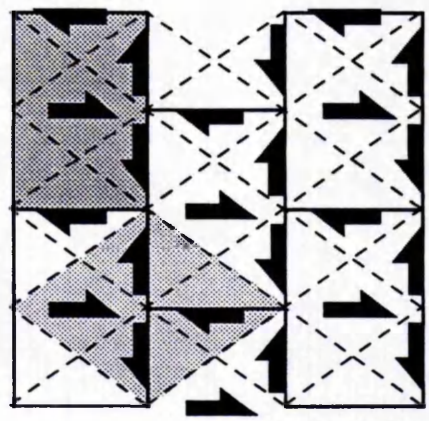
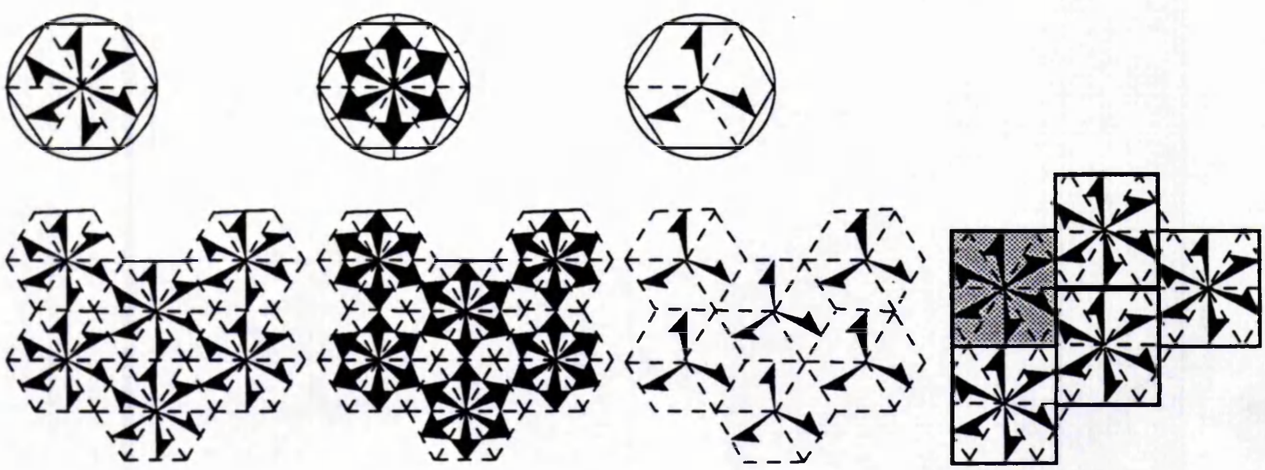


Figure 9.23. Four transformed motifs in a diamond net structure. They can be repeated in a drop format (shaded rectangle).



(a) 60 degree rotation. (b) 60 degree rotated mirror. (c) 120 degree rotation. (d) construction of (a) using a rectangular unit.

Figure 9.24. Half drop format with interlocking hexagonal composite units.

BRICK FORMATS

9.22. Brick: simple format

The brick format is constructed by the translation of units by the unit width on the horizontal axes and by the unit height on the vertical axes. It is then displaced horizontally by half the unit width (figure 9.25).[53] The total repeat is two units high. In fact, the brick format is the same as the drop format turned though 90 degrees (figure 9.26).

This format produces strong horizontal emphases with directional bias and, as with the drop, gives diagonal movements which are increased or diminished by the internal organisation of units (figure 9.27). This movement has often been exploited in floral designs where diagonal linear stems connect flower heads arranged in horizontal bands.[54] The grid structure engenders perceptual stability if it is used as an element in the design or, as with non-symmetrical scale patterns,[55] if elements within the unit appear as a cohesive group.

Many all-over designs using the simple drop format can also be constructed with the brick format, but the brick tends to be used mostly when a definite horizontal bias or the brick grid appearance is required.

9.23. Brick: simple variations

Variations are formed in the same way as with the drop format, but here they are made by changes in the displacement along horizontal, rather than vertical, axes (figure 9.28). This displacement should be a division of the unit width to form regular vertical alignments of units which produce one-third brick, quarter brick, and so on. The displacement proportion affects the diagonal gradient, with smaller divisions, such as one-third (figure 9.28.a), giving steeper diagonals than larger ones, such as two-thirds (figure 9.28.b). As with drop formats, continuous or broken diagonal lines can be made by taking into account where elements join on the edges of units.[56]

[53] The name is derived from the similarity to a brick wall.

[54] The simple brick format was used in many 16th century Italian velvets. William Morris adapted this form for printed textiles in the late 19th century (6.03). He produced similar strong diagonal patterns using the simple block format in which the flower heads are aligned in vertical and horizontal directions. This format was also often used as an underlying structure for this type of pattern which was then developed using slightly different motifs in alternate horizontal bands.

[55] The symmetrical design form (9.12) can be used as structure, and the units can be filled with asymmetrical motifs (4.15).

[56] As with the drop format (9.15), the gradient is also affected by the proportions of the unit.

Brick formats occur as underlying structures in many Art Deco and early 20th century modernist designs (figure 8.03.d), often with alterations made to individual units.[57]

9.24. Brick: secondary organisations

Spacing can be applied in pillar, stripe, open, or diagonal arrangements (figure 9.29). Diagonal spacing forms lines of units which rise and fall to the right (figure 9.29.d) or left (figure 9.29.e).[58] The stripe arrangement stresses the inherent horizontality of the format, whereas the pillar arrangement can create a vertical zig-zag.[59] Open brick arrangements usually exhibit definite horizontal banding.[60] This format is common to designs derived from Persian and Indian florals.[61]

Counterchange can be used in pillar, stripe, or diagonal arrangements (figure 9.30). Diagonal arrangements form linear movements to the right (figure 9.30.c) or left (figure 9.30.d).

9.25. Brick: transformations

Pillar, stripe, and diagonal arrangements are used to apply the transformations of horizontal-mirror, vertical-mirror, and rotation (figure 9.31). As with secondary organisations, the diagonal arrangement can be directed to the left or right. Effects will vary according to the directionality of the units (Appendix 7) and the simple brick format used, but any horizontal bias will generally be emphasised. As with block and drop formats, horizontal-mirror transformations occur most often, the most common being the brick/stripe arrangement.

9.26. Brick: pillar arrangements

Pillar arrangements form vertical zigzags of paired units, disrupting the diagonal movement usually produced by the brick format. This is most apparent with the <u>brick/pillar/horizontal-mirror format</u> (figure 9.31.a) which, when used with diagonal or vertical emphasis gives an undulating shift on the vertical axes,[62] but this effect is diminished with units having horizontal emphasis. Here, the banded character is accentuated, particularly if elements are joined to create a cohesive group.

The <u>brick/pillar/vertical-mirror format</u> (figure 9.31.d) is most effective when

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[57] This example was based on a two-thirds brick with differences in drawing of individual units (8.04).

[58] This can be seen in figure 3.01.a.

[59] This is particularly noticeable when combined with striped transformations (9.27).

[60] Whereas the drop organisation produces a vertical bias (9.16)

[61] The isolated motifs often had a slightly curved asymmetrical appearance which gave a diagonal bias in the pattern (6.08 and 6.09). This form was developed in paisley patterns (9.27).

[62] Examples can occasionally be found in Art Deco geometric patterns, providing a variation to the more formal symmetrical patterns.

combined with diagonal bias, especially with geometric motifs (figure 9.32.c). It is used to make complex patterns from simple elements. With horizontal emphasis, this can be used to form undulating bands.[63]

The brick/pillar/rotation format (figure 9.31.g) forms horizontally paired units in undulating vertical columns. If the units form cohesive groups, their spinning appearance can increase this undulating motion.

9.27. Brick: stripe arrangements

Stripe arrangements can be used to stress the inherent horizontal bias of the brick format by creating alternate rows of transformed units. This is demonstrated by the brick/stripe/horizontal-mirror format (figure 9.31.b), in which bands of units face alternately to right and left. This bidirectional effect can be strengthened by diagonal bias (figure 9.32.a), and was often combined with pillar spacing or counterchange for serpentine patterns (figure 3.04). It gave a more defined zig-zag than the block version (9.11), but still had a strong upward movement.[64] It was frequently used with open spacing (figure 9.32.b) to form small shawl patterns.[65] Elaborated forms, such as isolated motifs in diamond-shaped cartouches and paisley motifs on patterned grounds, are seen as developments of this basic pattern type. A box-like effect is a characteristic of many small-scale Art Nouveau designs in this format.[66]

By turning alternate rows of motifs upside-down, the brick/stripe/vertical-mirror format (figure 9.31.e) further emphasises the horizontal. Diagonal bias can produce a horizontal herringbone effect but, because attention is concentrated on the axes, this does not have the upward movement associated with the horizontal-mirror format. This format occurs in some Russian constructivist and modernist designs to create dynamic movements. This transformation is sometimes found in patterns which use the cartouche form mentioned above.

Dynamic effects can be accentuated by the brick/stripe/rotation format (figure 9.31.h) to give a spinning movement about the horizontal axes. It can also be seen

[63] This is similar to the block/pillar/vertical-mirror format (9.10), but the displacement of alternate rows of units induces more visual interest.

[64] This form was used with the usual serpentine motifs, such as floral and arborescent trails, but frequently with single leaf or feather elements, especially for small-scale mill engravings (8.04).

[65] This was also a common format in 16th and 17th century woven silk designs, particularly for small florals and 'lace' patterns (6.03), and was transferred to prints (8.06).

[66] These often contained pictorial motifs, such as peacocks or apples.

with 90 degree rotation in small-scale diagonal lattice patterns.[67] This angle of rotation was also used for variations on patterns which normally used the stripe/horizontal-mirror format.

9.28. Brick: diagonal arrangements

Diagonal arrangements strengthen the inherent diagonal movements of the brick format, especially when combined with directional emphasis. This can be developed further using brick variations, such as the quarter or third brick format.

The brick/diagonal/horizontal-mirror format (figure 9.31.c) forms symmetrically paired units which, if joined to make cohesive groups, accentuate the diagonal movement. This directionality may be alleviated using units with a horizontal bias, because the banded effect becomes more pronounced.

The brick/diagonal/vertical-mirror format (figure 9.31.f) gives bidirectional diagonal lines of units. It forms undulating horizontal bands which, with brick variations, are used to create wave effects (figure 9.32.d).[68]

The brick/diagonal/rotation format (figure 9.31.i) produces similar bidirectional effects and bands. Elements that link across the vertical axes may form spinning motifs arranged in diagonal lines.

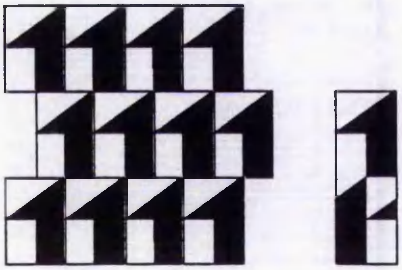
9.29. Brick: composites

The examples of composites described for block and drop formats (9.13 and 9.21) can be repeated in the simple or varied brick formats (figure 9.33). The diamond net structure can also be repeated using a brick format (figure 9.34).

Hexagonal units form patterns like drop formats, but rotated by 90 degrees (figure 9.35). In this form, more emphasis is placed on the horizontal and the pattern can also be constructed using a rectangular unit (figure 9.35.c). Units formed by 60 degree rotation are common in Islamic design (figures 4.04-4.06), but also occur in designs based on scientific imagery (figure 4.02).

[67] Especially in late 19th century mill engravings (8.07).

[68] These horizontal bands of units are the same as those described for the block/pillar/vertical-mirror and block/pillar/rotation formats (9.10), but the progressive shift of successive rows produces a diagonal pattern movement.



pattern total repeat

Figure 9.25. Brick/simple format.

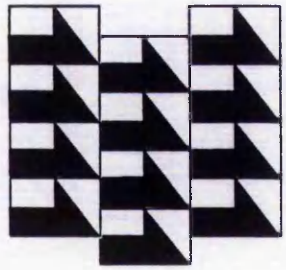
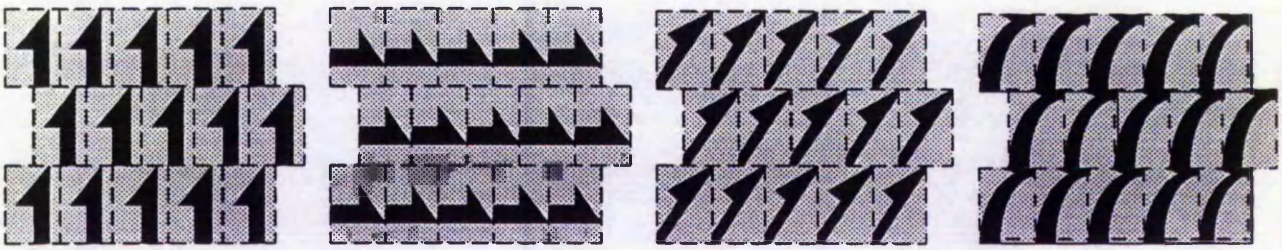
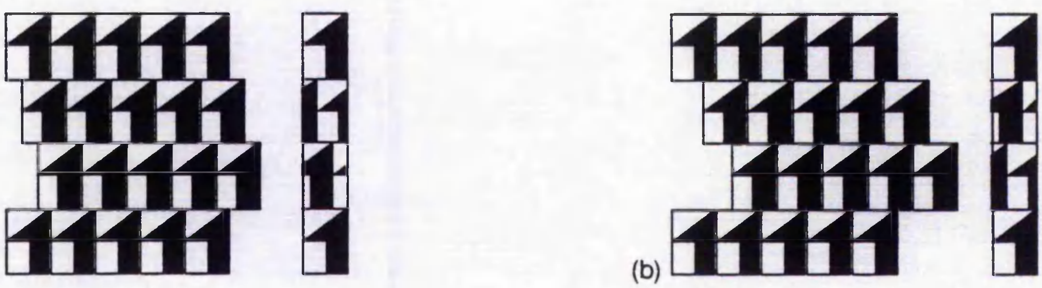


Figure 9.26. The brick format rotated 90 degrees forms the drop format.



(a) vertical (b) horizontal (c) diagonal (d) curved

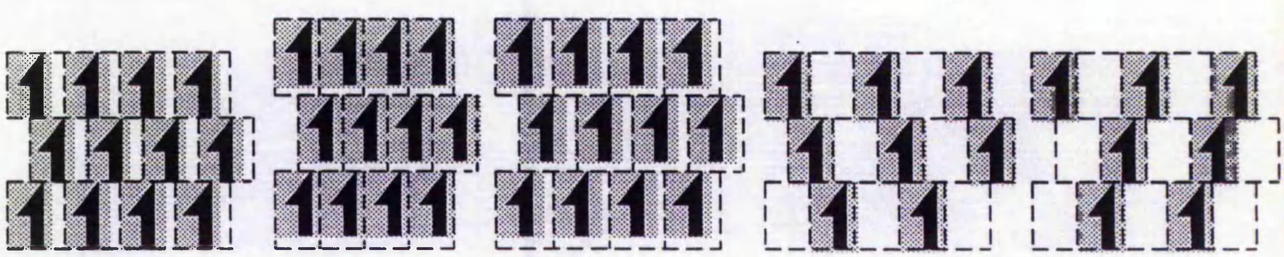
Figure 9.27. The brick repeat constructed with units having different directional emphases.



(a) pattern total repeat

(b) pattern total repeat

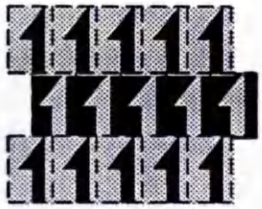
Figure 9.28. Brick variations (a) One-third brick format. (b) Two-thirds brick format.



(a) pillar (b) stripe (c) open (d) diagonal right (e) diagonal left

Figure 9.29. Brick format spacing organisations.


(a) pillar


(b) stripe


(c) diagonal right

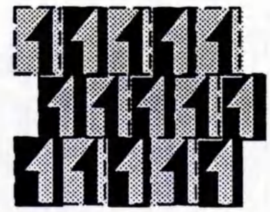
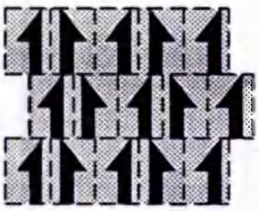
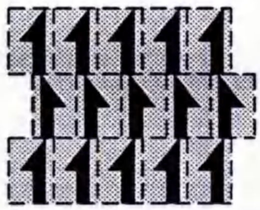
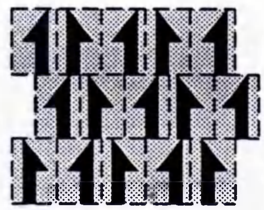
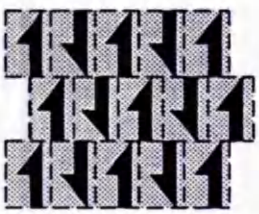

(d) diagonal left

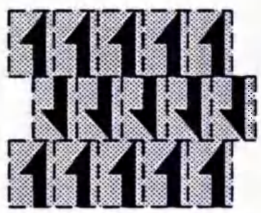
Figure 9.30. Brick format counterchange organisations.

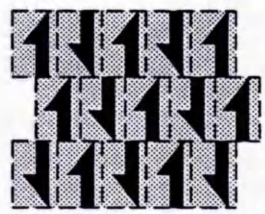

(a) pillar/horizontal-mirror

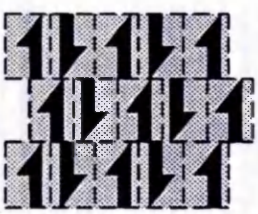

(b) stripe/horizontal-mirror

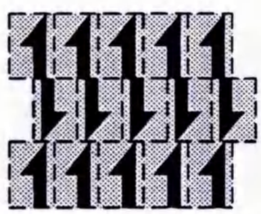

(c) diagonal/horizontal-mirror


(d) pillar/vertical-mirror


(e) stripe/vertical-mirror


(f) diagonal/vertical-mirror


(g) pillar/rotation


(h) stripe/rotation

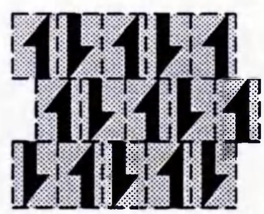
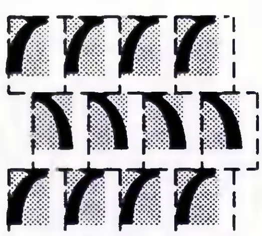
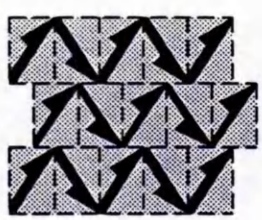

(i) diagonal right/rotation

Figure 9.31. Transformations applied to the simple brick format. A diagonal left arrangement may also be used (as shown in figure 9.30.d).

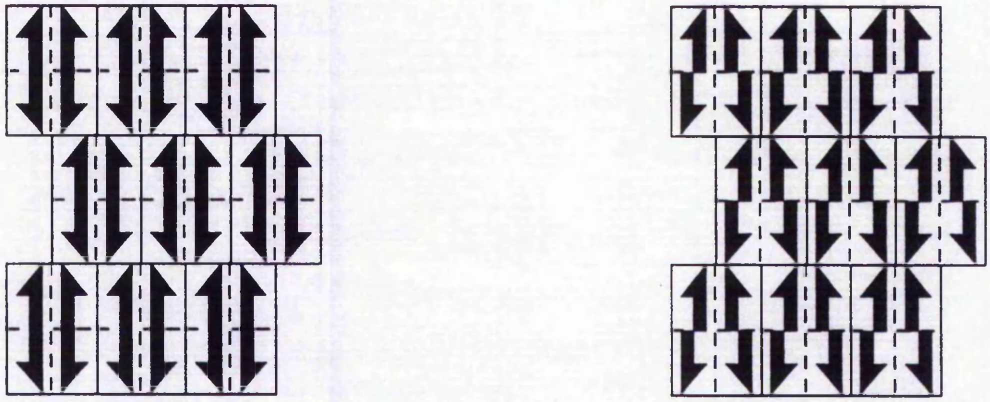

(a) brick/stripe/ horizontal-mirror


(b) open brick/stripe/ horizontal-mirror


(c) brick/pillar/vertical-mirror


(d) quarter brick/diagonal/ vertical-mirror

Figure 9.32. Transformed brick formats using units with diagonal and curved emphases.



(a) Four-way mirror (b) Alternating four-way mirror.

Figure 9.33. Brick formats with composite repeats

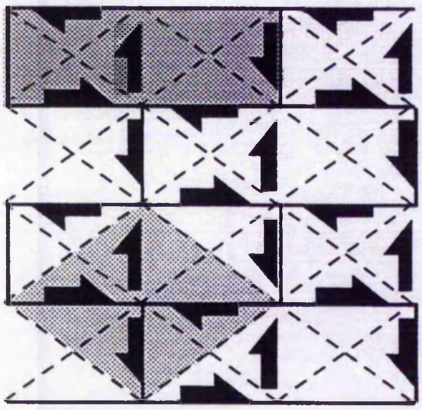
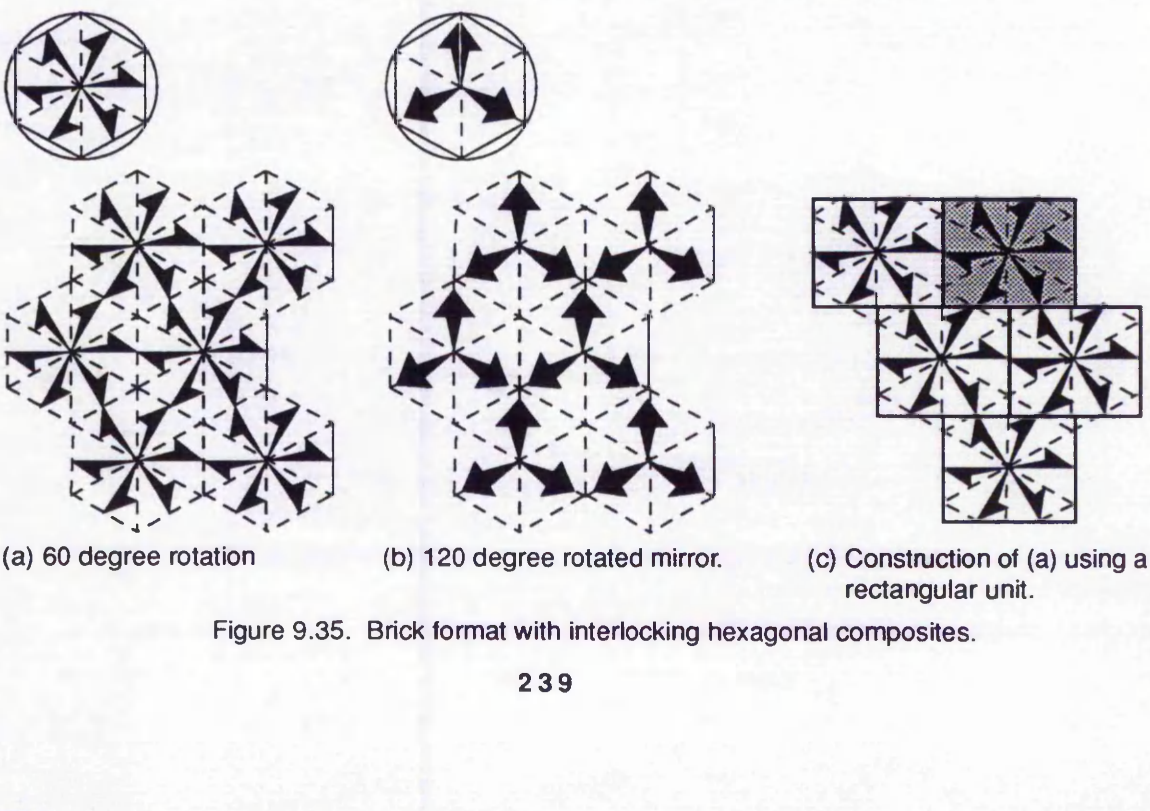


Figure 9.34. Four transformed motifs in a diamond net structure. These can be repeated in a brick format (shaded rectangle).



(a) 60 degree rotation (b) 120 degree rotated mirror. (c) Construction of (a) using a rectangular unit.

Figure 9.35. Brick format with interlocking hexagonal composites.

9.30. IRREGULAR FORMATS

Irregular, or sliding repeats, are further variations of drop and brick formats. Countless variations can be made using three types of arrangement. Secondary organisations and transformations are applied to form further permutations.

9.31. Irregular: combined drop and brick formats

Drop and brick formats can be combined so that units are offset on the vertical and horizontal axes (figure 9.36). These examples show a combined one-third drop and one-third brick (a) which has a total repeat (b) of $3^1/_3$ units square,[69] and a combined half drop and quarter brick (c) which has a total repeat of $2^1/_4$ units wide and $4^1/_2$ units high (d). These formats remove the vertical and horizontal linearity associated with the drop and brick formats, and can engender a less rigid structure in designs with small units. They can be found in Art Deco geometric and floral designs. In the first, they are used to form bidirectional diagonal movements and in the second, for an organic appearance.

Transformations can be applied to these formats, the most common arrangement being the diagonal (figure 9.39), which can be used to accentuate the inherent diagonal movements.

9.32. Irregular: reversed formats

Drops operating down to the right are, at intervals, reversed to operate upwards. If this happens on the unit alignments a zig-zag effect can be formed (figure 9.37). Similar arrangements can be used with brick formats.

Transformations can be applied in pillar arrangements. If changes in orientation are made at the point where the drop is reversed, wide columns of transformed units are produced (figure 9.40). In this example, an extra column has been introduced on the unit alignment so that columns of paired mirrored units recur regularly in the pattern. This format was found in many examples of ikat weaving. Striped arrangements of transformations, counterchange, and spacing can stress zig-zag movements (figure 9.41). More complex arrangements can be explored (figure 9.42).

9.33. Irregular: sliding step formats

These can be produced by repeating columns of step-repeated units in another step format (figure 9.38). This example shows three columns of units in a one-third step format, which is then repeated as a group in a two-thirds step format.

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[69] The pattern will fit into an oblique network (figure 9.54.d). It has the same international symmetry notation as the simple block, drop, and brick formats **p1** (9.39).

Secondary organisations and transformations can be applied in pillar arrangements to emphasise the column structure, or in striped arrangements to bring out the zig-zag character (figure 9.43). This example shows a stripe/vertical-mirror transformation applied to figure 9.38, and the joining of motifs in such repeats can be used to further develop directional movements.

9.34. WOODBLOCK FORMATS

These formats are very specific arrangements of rectangular units. Two orientations of the unit are used, one being rotated by 90 or 270 degrees to form an L-shape with the other. The structure and the size of the total repeat is altered by the proportions of the basic unit (figure 9.44).

Counterchange and transformations can be used, the most obvious arrangement being the diagonal. These can be applied to individual units (figure 9.45.a) and groups of two units (figure 9.45.b), and can be combined to form more complex patterns (figure 9.45.c).

9.35. SPOT FORMATS

Spot formats[70] are used to organise groups of individual units on a plain or patterned ground.[71] Units are arranged in a grid which is the number of units squared. For example, the grid for the five-spot format is five by five squares.[72] No unit is placed in the same vertical or horizontal column as any other. Larger numbers of units generally result in the units being spaced further apart.

Although the permutations of unit placements in each grid is large, there are only a limited number of patterns that can be formed. For example, with four-spot formats there are twenty-four possible arrangements of units but, in repeat, these give just three different patterns, two of which are regular and one irregular (Appendix 8).

Spot patterns are most effective when their structure is not noticed. The spacing of the motifs, the amount of ground between them, is affected by the relationship

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[70] The spot formats were derived from sateen patterns used in weaving. Day proposed these methods for organising small repeats. Day, L.F., *Pattern Design*, London, 1903, reprinted 1915, pp.128-133.

[71] In some designs the details of the patterned ground also fit into the spot format. Two examples of this type can be seen in Phillips, P., and Bunce, G., *Repeat Patterns: a manual for designers, artists and architects,* London, 1993, ISBN 0 500 27687 0, p.134.

[72] A three-spot format has a three by three grid, a five-spot format has a five by five grid, and so on (Appendix 8).

between the sizes of the motifs and the grid. Although motifs can be arranged in a grid in a methodical manner, the judgment of their relative proportions is based on perceptual skill (2.02).

9.36. Regular spot formats

In regular formats, a single numerical sequence is used to place the units. The first unit is placed in the bottom left corner of the grid, and a count (sequential increment) is the number of grid squares in the horizontal direction before the second unit is placed in the row above. For example, with a count of two (figure 9.46.a), the unit is moved up one square and right two squares, and for a count of three (figure 9.46.b), the displacement is one square up and three squares right. The sequence is continued for the placement of each unit.[73]

A count of one always produces diagonal lines of units (figure 9.47.a). A count which is the number of units minus one produces a diagonal line which is the reverse of count one (figure 9.47.b). Other counts produce less pronounced diagonal arrangements of units because the units are separated from each other (figure 9.47.c and d). These examples of five-spot formats show count two (c) producing the reverse diagonal of count three (d).

The counts used vary with the different formats (Appendix 8). To prevent units occurring more than once in each column, the unit number must not be divisible by, nor have the same divisor as, the count. Formats based on prime numbers produce the greatest numbers of usable counts (the number of units minus one). Each count has a reverse, as in figure 9.47.

When the same count is used in different formats, the patterns differ in the spacing between the diagonal lines of units. The larger the number of units in the spot pattern, the more spaced out the lines of units will be, and this can emphasise the linearity of these arrangements. For example, the counts two and three used with the seven-spot format (figures 9.49. a and b) produce a more defined diagonal line compared to the five-spot format (figures 9.47.c and d).

9.37. Irregular spot formats

Irregular formats can be used to give 'random' arrangements with four or more units. They are produced using a variable count. For example, a six-spot format can be constructed using a sequence of 1,3,5,2,6,4 for the placement of units in the grid, this has a count of 2,2,3,4,4,3 (figure 9.48). With six or more units, irregular

[73] If the unit is moved out of the grid during the sequence of moves, then the count should continue from the equivalent square on the left of the grid.

counts can be used to form patterns that consist of separated units, whereas clusters of units always occur with five or four spot formats.

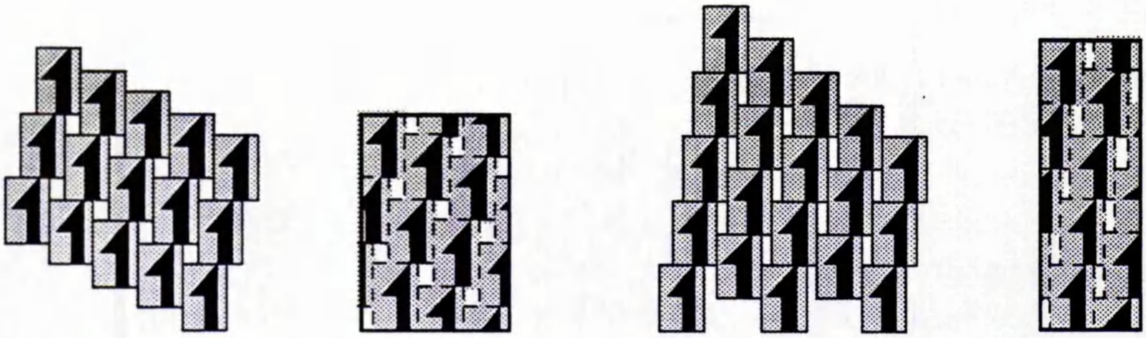
The number of possible irregular arrangements increases with the number of units (Appendix 8). They are of two types; arrangements of grouped units and scatters of separated units (figure 9.49.c). Although the units are not placed in a regular manner, they can in repeat tend to form noticeable clusters of units.

9.38. Transformed spot formats

Random effects can be achieved most successfully by applying transformations to individual units within a regular spot format which has a count other than one or its reverse (figure 9.50). The units are evenly spaced to prevent any visual grouping, and the transformations disrupt the linear character. The most frequent formats used with transformations are the five-spots. Even though these formats produce diagonal lines, especially with directional motifs, slight changes in the orientation of individual motifs will alleviate their visual effects.

90, 270, and 180 degree rotations are easily noticed (2.11) and, as visual accents, they may emphasise a pattern's regular structure. Therefore other degrees of rotation, often combined with mirroring, are more effective (figure 9.51).[74] As with spacing (9.35), perceptual skill and experience are important for judging which transformations look best with different motifs and formats.

[74] The eight-spot/count three format shown in figure 9.51 can be seen in the arrangement of motifs on a patterned ground in figure 8.09.b. Figure 8.09.a is not a spot format because units in the group of four are aligned on the vertical axis.



(a) one-third drop and one-third brick

(b) total repeat of (a) $3\frac{1}{3} \times 3\frac{1}{3}$ units

(c) half drop and quarter brick

(d) total repeat of (c) $2\frac{1}{4} \times 4\frac{1}{2}$ units

Figure 9.36. Irregular format/combined drop and brick.

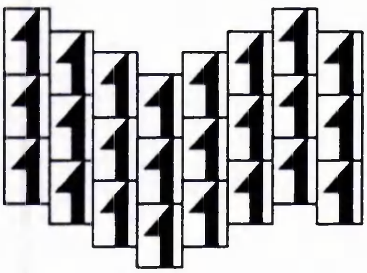


Figure 9.37. Irregular format/one-third drop reversed on unit alignments.

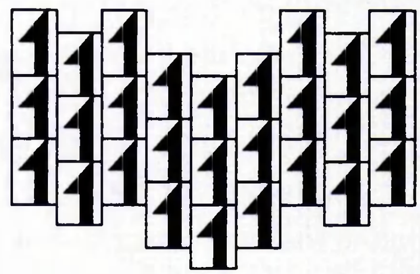


Figure 9.38. Irregular format/sliding step repeat using one- third and two-thirds drops.

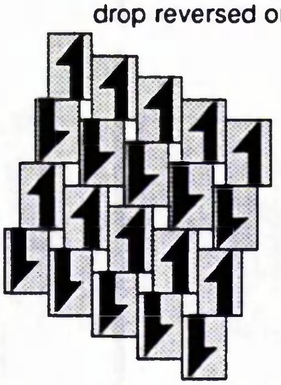


Figure 9.39. Diagonal/rotation transformation applied to figure 9.36.a.

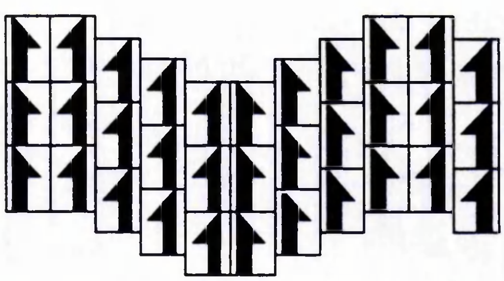


Figure 9.40. Pillar/horizontal-mirror transformation applied to a variation of figure 9.37.

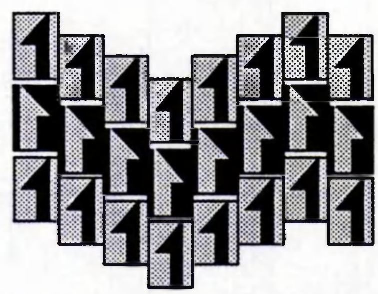


Figure 9.41. Stripe/horizontal-mirror, counterchange, and spacing applied to figure 9.37.

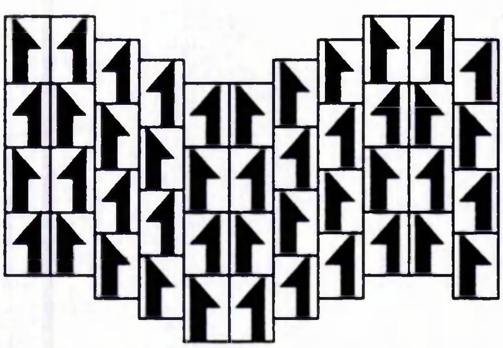


Figure 9.42. A complex arrangement of transformations applied to a variation of figure 9.37.

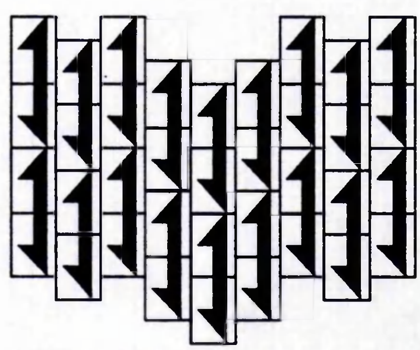
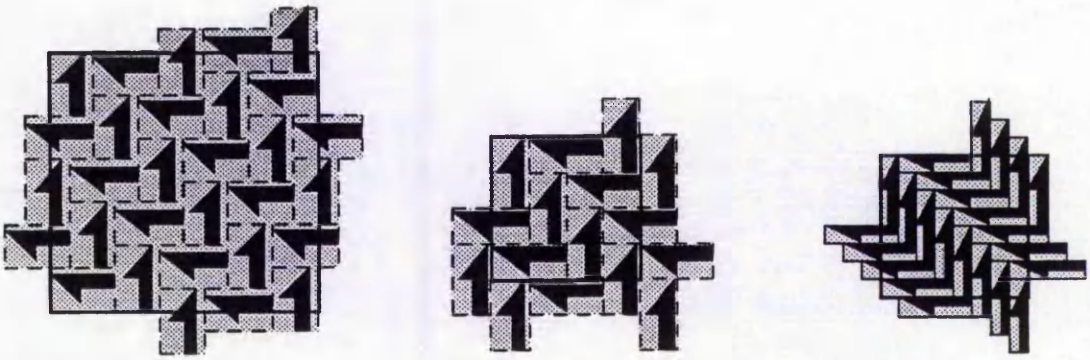
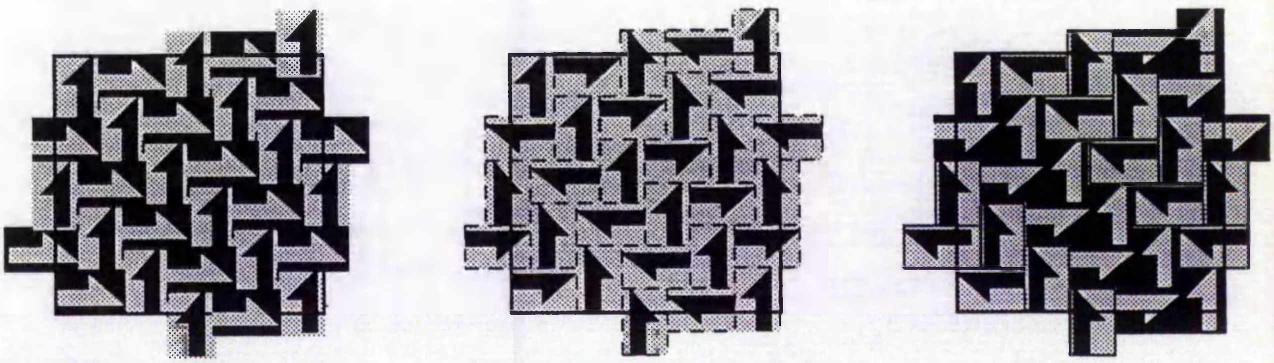


Figure 9.43. Stripe/vertical-mirror transformation applied to figure 9.38.



(a) 2:3 unit (b) 1:2 unit (c) 1:4 unit

Figure 9.44. Woodblock formats with different unit proportions. The squares indicate the full repeats.



(a) diagonal/counterchange (b) diagonal/horizontal-mirror (c) diagonal/horizontal-mirror with counterchange

Figure 9.45. Woodblock formats. Counterchange and transformations.

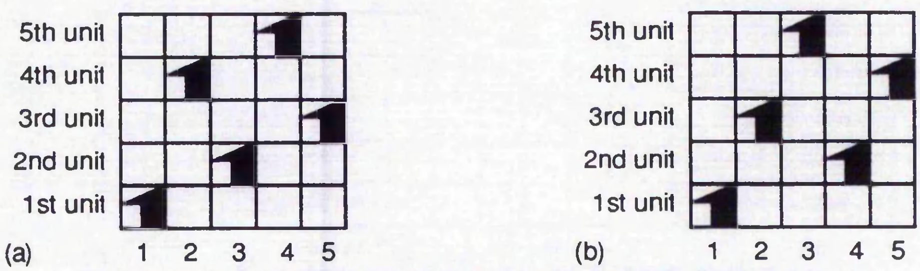
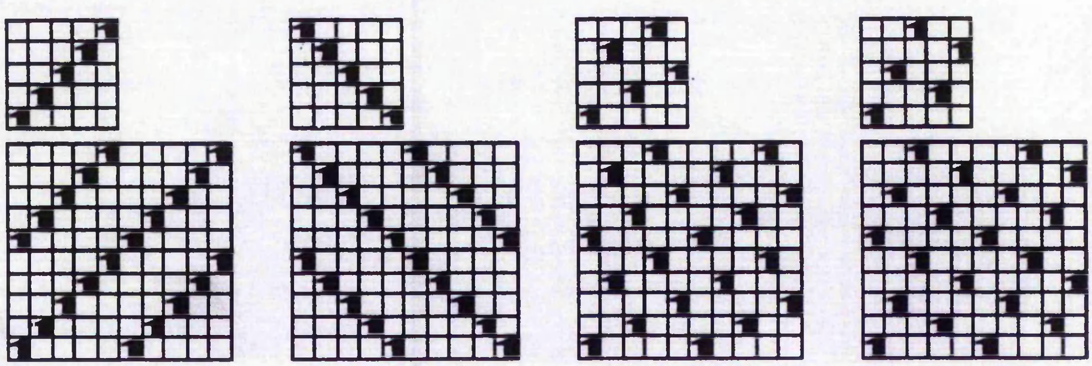


Figure 9.46. Regular five-spot formats. (a) count 2. (b) count 3.



(a) count 1 (b) count 4 (5-1) (c) count 2 (d) count 3 (5-2)

Figure 9.47. Regular five-spot formats.

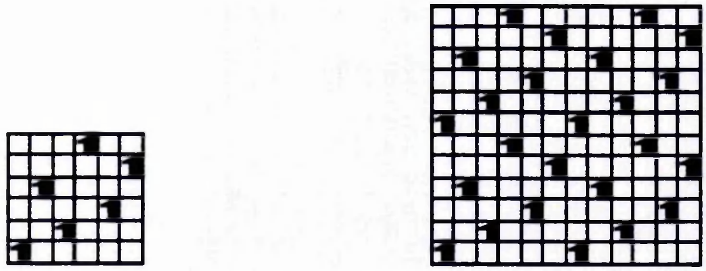
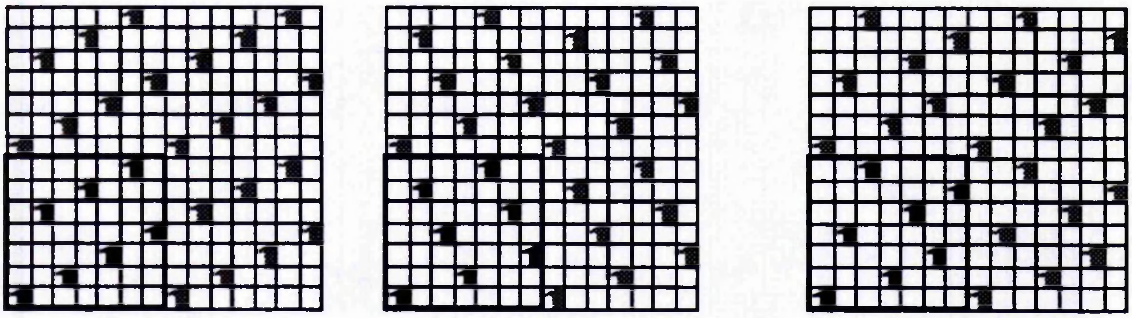


Figure 9.48. Irregular six-spot format. Count 2,2,3,4,4,3.

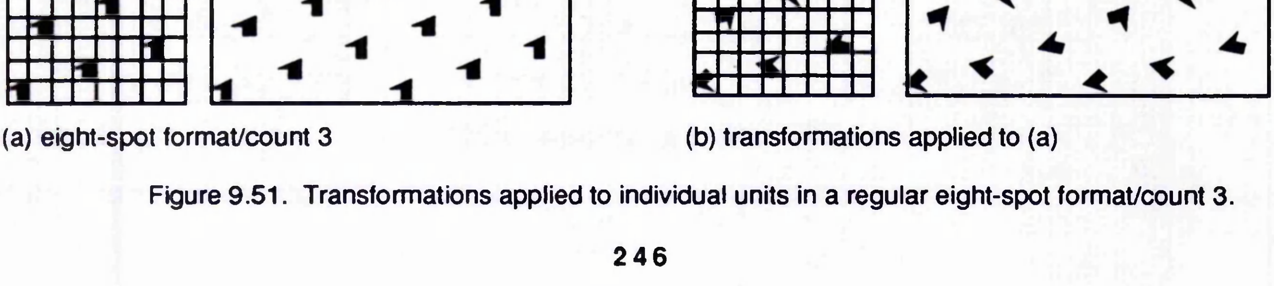


(a) count of 2 (b) count of 3 (c) count of 3,2,3,3,2,3,5

Figure 9.49. Seven-spot formats. Regular: (a) and (b). Irregular: (c).

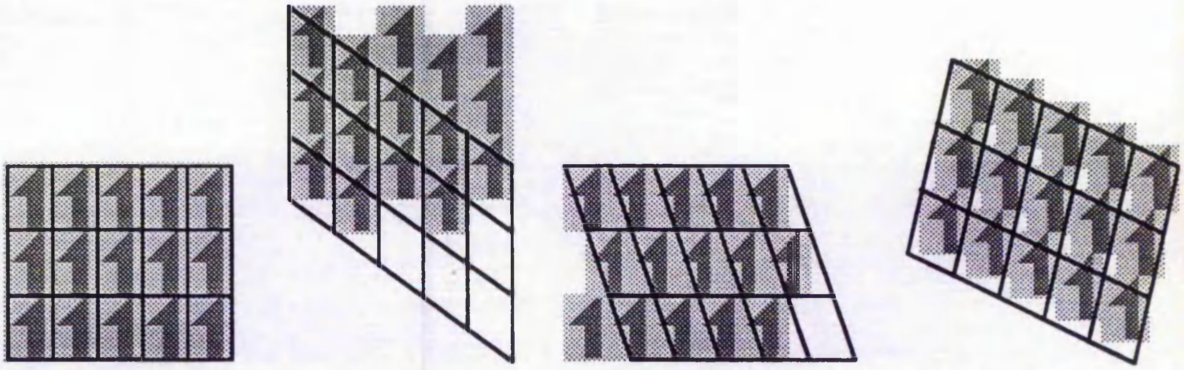
(a) five-spot format/ count 3 (b) transformations applied to (a)

Figure 9.50. Transformations applied to individual units in a regular five-spot format/count 3.



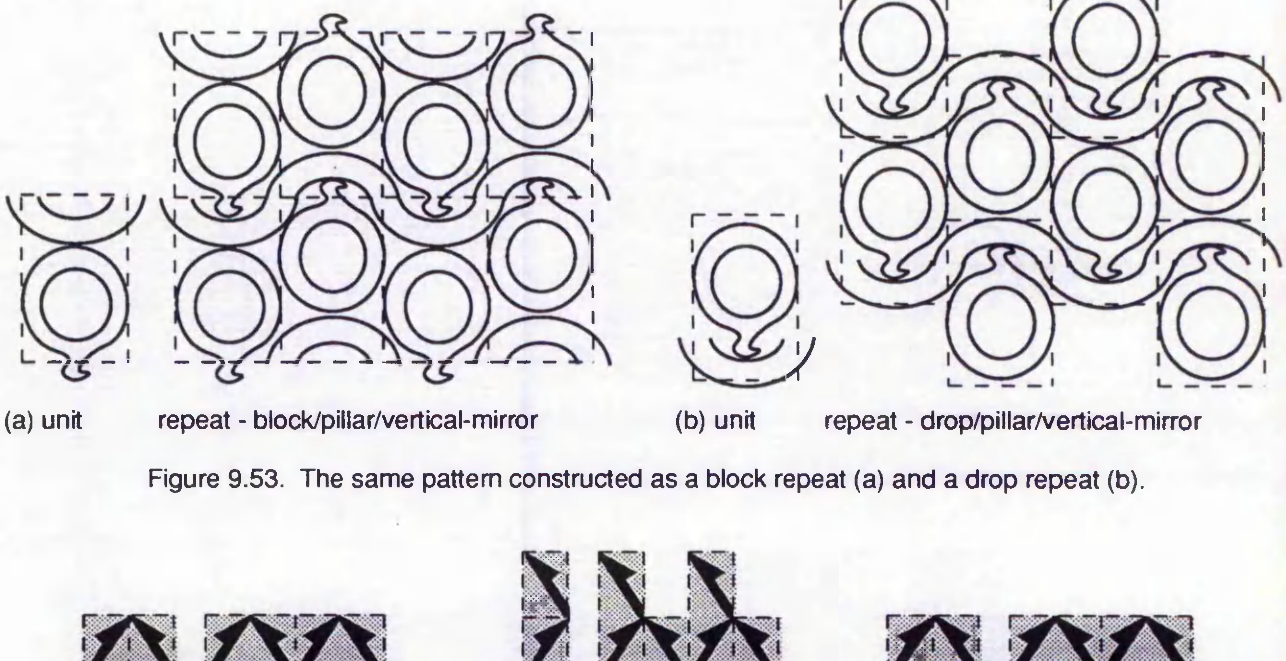
(a) eight-spot format/count 3 (b) transformations applied to (a)

Figure 9.51. Transformations applied to individual units in a regular eight-spot format/count 3.



(a) simple block format (b) simple half drop format (c) simple brick format (d) irregular format/ drop/brick

Figure 9.52. These four simple repeat formats have the same pattern symmetry notation (**p 1**) based on different networks (Appendix 2).



(a) unit repeat - block/pillar/vertical-mirror (b) unit repeat - drop/pillar/vertical-mirror

Figure 9.53. The same pattern constructed as a block repeat (a) and a drop repeat (b).

(a) block format (b) half drop format (c) brick format

Figure 9.54. A pattern formed by the block/diaper/horizontal-mirror format (a) can also be constructed by using paired units in a simple half drop (b) or brick format (c).

9.39. THE LIMITATIONS OF CLASSIFICATION

This method differs from that of symmetrical pattern classification (Appendix 2) which defines seventeen classes of all-over pattern, but takes no account of the orientation of the design unit. In symmetrical classification, patterns constructed from the same basic unit and having the same notation may look different according to the positions of the axes of reflection and rotation. Visually distinct patterns formed by the simple formats, block, drop, brick, and irregular/combined block and drop are classified as having the same symmetry **p1** using rectangular and oblique networks with different orientations (figure 9.52).

Although the brick format, when rotated by 90 degrees, is the same as the drop format, in this method both formats were retained because directionality is crucial to textile design, and the orientation of motifs is an integral part of the design process.[75] Formats relating to orientation are useful for planning the effect of a repeated pattern. For example, a designer wishing to achieve a horizontal emphasis may use a brick arrangement because it is a characteristic of that format.

Anomalies were found in this system because some patterns could be constructed and, therefore, classified in more than one way. For instance, figure 9.53 illustrates the same pattern formed by a pillar arrangement of vertical-mirror transformations applied to the block (a) and the drop format (b), using different arrangements of elements for the design unit. Patterns constructed using block/diaper formats can also be formed by repeating paired units in a simple brick or drop format (figure 9.54).[76] The block/diaper/horizontal-mirror format is the underlying structure of scale and ogee patterns (9.12) but, with asymmetrical additions, the final design may be seen to have a brick format (9.22).

This produces an anomaly between pattern construction and classification in that, although the underlying structure of a pattern may be based on one format, additions and alterations might produce a finished design with a different classification. The method described in this chapter is, therefore, proposed as a system for pattern construction, rather than for classification. It could form the basis of a new approach to implementing design structuring facilities with CAD, but any system based on this would have to provide flexibility so that variations in treatment of units and additions could be easily applied when required.

[75] Directionality has been an important stylistic factor in dress and furnishing fabrics at different periods (6.21 and 6.22).

[76] Figure 4.17 shows paired units (a) printed in a block format (b) and a drop format (c).

CHAPTER 10: PATTERN CONSTRUCTION USING COMPUTER GRAPHICS

10.01. Computer graphics: the media

An economic impetus to replicate existing media and processes has directed the development and application of computer technology.[1] In the fashion and textiles industries, this has produced two fundamentally different types of computer graphics media which are applicable, generally, to either technical or image-based design processes. Early random-scan display technology was object-orientated and its vector methods related directly to technical design applications. The screen image was a representation of the design, and the output was predominantly in the form of production data for manufacturing processes.[2] The greater immediacy and interactivity provided by raster graphics opened up a new range of applications for computer technology and created a divergence in its use.[3] For two-dimensional image-based applications, a direct relationship existed between the screen image and final product. Raster-scan displays are now used for most computer graphics applications by raster or vector techniques.[4]

Methods of image storage and display produce important distinctions between raster and vector-based software. Ashby noted that in design terms 'it is important to understand the differences, and the benefits and restrictions of each, otherwise confusion and frustration can result because certain creative operations are difficult or impossible using one or other type of display'.[5] Also, because the use of CAD for textile printing relies on computer generated designs being reproduced at an adequate size and resolution, other differences occur with the associated types of output device and the resultant image qualities.

Raster graphics addresses individual or rectangular matrixes of pixels (rasters)

[1] The effects of economic incentives and restrictions on technological developments are discussed in a wider context by Rosenburg, N., *Inside the Black Box: Technology and Economics,* Cambridge, 1982.

[2] The computer's mechanistic capabilities and mathematical accuracy were exploited to provide precise measurement for drawings, replication of elements, and storage and retrieval of data. Such facilities were seen as direct benefits to these design processes and as improvements on traditional methods.

[3] Raster graphics developed from VDUs in the late 1960s. The aesthetic qualities of the screen image became of prime importance. Developments were 'concerned with achieving more realism in images, manipulating pictures faster and reducing the cost in hardware or computer time to obtain given effects'. Jankel, A. and Morton, R., *Creative Computer Graphics,* London, 1984, p.21.

[4] Vector displays are now only used for specialised applications. They 'are not nearly as versatile as raster systems' and 'because of the tremendous drop in prices for memory and logic, raster systems are not only intrinsically more versatile, they're cheaper'. Andries Van Dam quoted by Emmett, A., *The Vanishing Vector,* Computer Graphics World, April 1988, p.55.

[5] Ashby, C., in *CAD in Clothing and Textiles: A Collection of Expert Views,* edited by Aldrich, W., Oxford, 1992, p.28.

and designs are stored as bitmaps. Applications are generally termed *paint software* and include simple monochrome applications,[6] general-use colour paintbox systems,[7] and software or systems for specialist applications. To store and display high resolution images requires a large computer memory and fast processing power. This limits the range of computers which are suitable for commercial printing applications and, although hardware costs have dropped, viable production systems are still expensive and, consequently, are directed mostly to cost effective applications.

Resolution is defined in two ways: virtual resolution is the number of pixels in the design area, and screen resolution, the amount of pixels displayable on the computer monitor. The size of raster images is limited by the virtual resolution of the system. This varies dramatically between production systems, using mainframe computers,[8] and design systems, based on PCs with graphics cards.[9] But, even 'though a large memory is capable of storing a high-resolution image, current display technology cannot provide a cost-effective monitor for viewing it'.[10] Because most print designs are too large to be viewed at full resolution on a monitor, panning and zoom techniques must be employed during the design process. Seeing the effects produced on the whole design whilst working on temporarily enlarged details necessitates continual and disruptive changes of viewing mode.

The data output from a raster system is taken from the individual pixels comprising an image. A line, being represented by a series of pixels, can produce

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[6] These are used mostly in desktop publishing for the creation or editing of illustrations for documents. For example, MacPaint® is described as providing 'the freedom to experiment, try new effects, undo what you don't like, create several versions of an idea, combine images from several different sources, and finally, put your work on paper when it's just right'. *MacPaint®*, California, 1987, p.xiii.

[7] These range from software providing 16 colours through to 32 bit systems giving 16.7 million colours and complex masking facilities.

[8] Since the 1970's, Scitex have produced high resolution conversion and production systems. In 1976, the Response System 200 was 'capable of scanning a sketch or a pattern of up to 12 colours in about 8 to 10 minutes in sizes up to 36 x 36 inches'. Suchecki, S.M., *Fast Film Service*, Textile Industries, December 1976, Vol. 140, part 12, p.104.

In 1992, the IAM system running on a DEC VAX 4000 had '24 MByte of mainframe memory, 200 Mbyte of system disk memory, 381 MByte of user disk memory (nearly 200 designs in A3 format), and 300 MByte of streamer tape capacity for stored data'. It could output high resolution designs up to 1.2 metres square. *Top Design CAD/CAM System for Textile Printing*, Institute for Applied Mikroelectronics Ltd. (IAM), Braunschweig, August 1992.

[9] Increased virtual resolution is a feature of most PC-based systems using the newest graphics cards.

[10] Vince, J., *Computer Graphics*, London, 1992, p.31. In 1986 the 'state-of-the-art for resolution in raster-scan devices' was 1280 x 1024 pixels for colour applications. Siebers, G.R., *An Introduction to Computer Graphics*, Computer-aided Design, vol.18, no.3, April 1986, pp.161.

a stepped effect, and this is a recognised disadvantage in designs incorporating detailed work.[11] Output from cheap, low resolution systems can be scaled up to produce larger scale designs, but these have an unacceptable jagged appearance. This effect can be lost to a certain extent when printing on heavily textured fabric or with a coarse screen mesh,[12] but it is unsuitable for commercial printing unless a computer generated appearance is integral to the design style.

Vector-based applications are generally called *drawing software.* These are object-orientated and designs are composed of lines, circles, and other mathematically defined objects, which are stored as vector data.[13] Vector-based software is used predominantly when a superior line quality is required, and is used mainly for pattern cutting systems. Pen plotters can be used to output line drawings, thereby producing continuous, smooth lines. Vector data can also be output to laser printers or imagesetters by using RIP technology. Here, the quality of the final image is dependent on the resolution of the output device, and designs can be scaled with no deterioration of line quality.

Raster and vector techniques are now combined in software applications which need the resolution-independence, mathematical accuracy, and line quality of drawing software, plus the bitmapped qualities and scanned imagery provided by paint software. This approach evolved from pre-press systems for the publishing industry, and is now being used with some printed textile systems.[14]

Printing is concerned with the placing of a design on an existing substrate and, allowing that the design has to fit within certain dimensions determined by the fabric width and the size of printing elements, there are no intrinsic structural considerations. In this respect, printed textile design can be seen to have stronger

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[11] Raster graphics uses scan conversion to display vector information for plotting lines, circles, and other geometric shapes, which are then stored as raster data.

[12] It is 'necessary for a digital image to have a resolution that relates to the type of screen mesh being used to print the design in the production process and also that an out-put printer attached to a CAD system is of sufficient resolution to reproduce this level of quality'. Holmes, J., *CAD in Production Proofing,* Manufacturing Clothier, June 1993, p.16.

[13] A 'draw system stores individual graphics instructions in a linear sequence so that every vector that you add to the screen is stored as a vector call'. Hutzel, I., *Trends in PC Paint System Development,* Computer Graphics World, March 1985, p.47.

[14] Such as CDI's U4ia®, which provides an 'extensive array of vector and raster based drawing tools'. This system also allows images to be sent 'directly to pre-press systems for catalogs and other promotional pieces'. *U4ia®,* Computer Design, Inc., Grand Rapids, September 1993.

links with the publishing industry than with structural textiles.[15] Continual technical transferences occurred between the developing publishing and textiles industries (6.19). Manufacturers, such as Scitex and Dainippon Screen, produce systems for both industries, and future developments may strengthen these links further.

10.02. Pattern construction

The related programming techniques of raster and vector-based software engender differences in the drawing and manipulating of images and, therefore, conduce different approaches to pattern construction, inclining them to either extension or holistic methods.

Generally, paint software facilitates direct, painterly design methods. But a design element, once drawn, ceases to be an individual item and becomes part of an array. The image manipulation techniques are concerned with arrays of pixels, and offer 'an opportunity to deal with images in ways that differ dramatically from the geometric approach'.[16] Dealing with images in rectangular sections makes raster graphics directly applicable to extension methods of pattern construction, with repeat often being used as a post-design operation for extending a design's coverage.

Drawing software provides mathematical accuracy and flexibility in design modification. Design elements or groups of elements can be manipulated individually because they are stored as separate objects in a display list. Basic functions, such as copy and paste, are applicable to extension methods, but specific functions provided by some software make it suitable for methods based on a structured holistic approach.

There is an almost universal adoption of the latest facilities for computer graphics systems, and many basic functions are found in similar applications, although the specific terminology and operation may differ. In the following sections of this chapter, these functions are described generally, with reference to specific systems or software when unusual or novel approaches are noted. Specific applications and descriptions of construction methods are covered in more depth in the appendices. Due to the rapid development of computer technology,

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[15] In structural textiles, most output is to machine controls, and design must relate to their technical limitations. Rasters are used to represent both the structural formation of the design and its imagery. Historically, there has been a transference of technical developments between the two industries (6.19).

[16] 'The raster is a simple, intuitive, natural representation of an image. . . Composing a raster image using such operations as moving existing parts of the image to new locations or erasing parts of the image is as natural as composing a page by cutting, pasting, and erasing'. Newman, W.M. and Sproull, R., *Principles of Interactive Computer Graphics: International Student Edition*, Tokyo, 1981, pp.265-266.

software can be quickly outdated but, although some of the products mentioned in this thesis have already have been discontinued or changed, the basic techniques remain in use.

10.03. PAINT SOFTWARE

As raster graphics systems have become more widely available and powerful, greater emphasis has been placed on ease of use and the painterly aspects of image making. Facilities that emulate conventional media have been introduced, such as pressure sensitive pens,[17] varieties of brushes,[18] and choices of 'paper'.[19] New effects have also arisen from the technology.[20] These tools, combined with image manipulation techniques and the incorporation of scanned imagery, have produced a flexible new medium which provides a greater range of mark-making and image creation effects than any other. It has its own character and range of grades related to factors, such as resolution, number of colours, and output devices, as well as functions provided by specialist software.

Most paint software provides similar functions with which designers can establish sequences of operations to suit their individual methods. An advantage is that designers are not constrained by software writers' conceptions of the design process. This allows flexibility and individuality in its use although, because specific textile operations are not automated, designers need to learn more about each function.

The application of computer technology to image-based design processes has met with a degree of distrust, and has often been criticised as an attempt to mechanise and restrict a creative and individualistic activity. Because effects are all created using the same devices, their selection and operation requires an overtly intellectual approach which, in comparison with the traditional, more physical involvement of the designer with materials and processes, is seen to distance the designer from the medium. The selection and use of media always

[17] These translate changes in hand pressure into varying thicknesses of line or density of colour.

[18] These simulate a range of effects, such as chalk, charcoal, and airbrush.

[19] Their selection affects how the brushes operate. Documentation for *Fractal Design Painter®* stated that *Painter's* 'tools interact with textures just as their natural-media cousins do on drawing paper, water-colour paper or canvas', so that 'the eye actually sees the striated surface of oil paint, the saturated bleed of felt markers and the nubby richness of charcoal.' *Painter,* Fractal Design Corporation, California, 1992.

[20] Scott Gross, director of research and development at Time Arts was quoted as saying that 'the tools are becoming exotic. Our fade cell tool, for example, is like no tool available in any other media'. Robertson, B., *Paint Systems,* Computer Graphics World, April 1988, pp.66-8.

involves a high, but unquantifiable, degree of experiential skill, and designers, as they gain CAD experience, usually overcome this perceived separation.

The emulation of conventional media also led to direct comparisons between the aesthetic qualities of computer images and those produced using tactile media.[21] This was exacerbated in early CAD/CAM systems for printed textiles in which, being production-orientated,[22] emphasis was placed on technical functions, such as quartering and colour separation. Because the industry is still heavily biased towards scanning and conversion, systems have continued to be mostly raster-based.[23]

The perception of printed textile design as an essentially artistic process has reinforced the use of raster systems, and more painterly design facilities have gradually been added. General developments in raster graphics have been adapted for CAD when they have been seen to be relevant to the contemporary design ethos and viable for established production methods. Design is concerned ultimately with production processes, therefore new tools, developed for general paint applications, are only relevant if the resultant image can be converted for textile production.[24] Changes in production processes will continue to affect the computer graphics facilities that are provided by CAD systems.[25]

10.04. Raster operations

The following functions are found in most paint applications. They are performed on specified rasters, which are usually defined by indicating two points on the screen image as opposing corners of a rectangle.[26] This direct approach makes raster graphics particularly suitable to extension methods of pattern construction. Many systems provide *grid* facilities to aid the precise definition and

[21] Because there is no direct contact between the drawing medium and the substrate, there is a loss of tactile quality. Using conventional media, such as pastels or paints, results in different qualities in the image due to the physical differences in the way the medium is applied and its interaction with the substrate.

[22] Problems in the early days of CAD/CAM were associated with 'a lack of willingness from designers to work with computers, which would in their opinion restrict the ability to be creative, which at that time wasn't completely outside the truth'. *Development of CAD Systems for Textiles,* Textile Month, May 1991, p.31.

[23] Because print systems were designed for design conversion, development was concentrated on scanning and output. Facilities for editing and interactive design were added later (5.37).

[24] For example, on a computer display, a colour graduation or wash is represented by many different colours, and these must be translated into tint values of the same colour for use with a half-tone screen.

[25] At present, ink-jet printers are being increasingly used for design sampling but, unless production employs similar methods, there is a danger that the sample could not be printed by conventional means.

[26] In some software, the sequence of point specification is used to select transformed copies (10.08). Some software allows the defining of polygonal areas so that irregular shapes can be cut and pasted.

placement of rasters.[27]

Rasters can be increased or decreased in size using *scale* functions. Increasing produces a coarsening of the image quality, and decreasing results in a loss of image detail. This is especially evident with line-work, although some applications now provide scaling down facilities which allow lines of one pixel width to be retained. Provision is usually made for scaling to be proportionate or variable on the horizontal and vertical axes so that images can be squashed or stretched (figure 10.01).[28]

Copy functions replicate the pixel information from a source raster into a temporary raster, which can then be *pasted* on to another part of the screen. Multiple copies of a design unit can be pasted to build up a pattern. These can be placed by eye, which may produce irregularities in the repeated pattern, or positioned accurately using a grid. Continuous patterns are created by units placed adjacently (figure 10.02.a) and isolated arrangements when they are spaced out (figure 10.02.b). The use of a *transparent colour*[29] enables units to be overlapped (figure 10.02.c)[30] or pasted on a patterned ground.

Mirror functions allow a raster to be mirrored across its horizontal or vertical axis.[31] *Rotate* functions turn a raster by a specified degree.[32] The specific operation of these functions differ. In some software, the specified raster is transformed and, in others, transformation is combined with a copy function, allowing transformed copies to be pasted. This provides two alternative methods of pattern construction. The pattern unit can be repeated in a simple format using

[27] Specification of grids varies with different software. Some require numerical inputs for the number of pixels between grid lines, or for the number of lines, horizontally and vertically, across the screen. With others, the unit size is defined by marking out a rectangle on the screen.

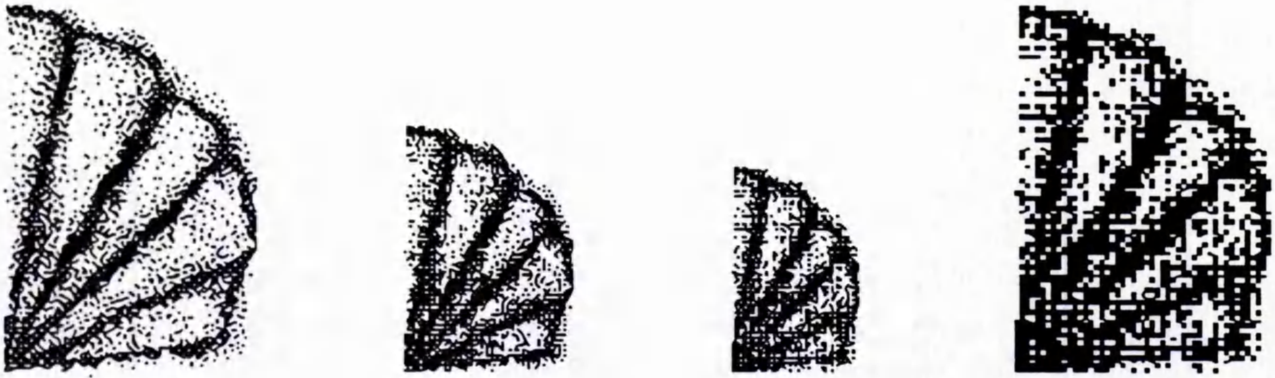
[28] This illustrates a motif scaled down proportionately (b) and disproportionately (c). In (d), the motif has been scaled up, producing a characteristic blocky raster image. These examples were scaled using a grid of 16 x 16 pixels, which was then used to control the placements of the scaled units for building up repeat patterns.

[29] Usually one colour or a range of colours can be defined as transparent. This allows a raster to be manipulated without the background colour, so that design units can be overlapped and elements can extend over the boundaries of the repeat units. Isolated motifs can also be placed on coloured or patterned grounds.

[30] Grid proportions can be equal to, or factors of, the unit dimensions. The unit size in these examples is 48 x 80 pixels. A 16 x 16 pixel grid was used in the placement of copies. Translation for (a) was 48 pixels (3 grid divisions) horizontally and 80 pixels (5 grid divisions) vertically, for (b) 64 x 96 pixels, and for (c) 32 x 64 pixels.

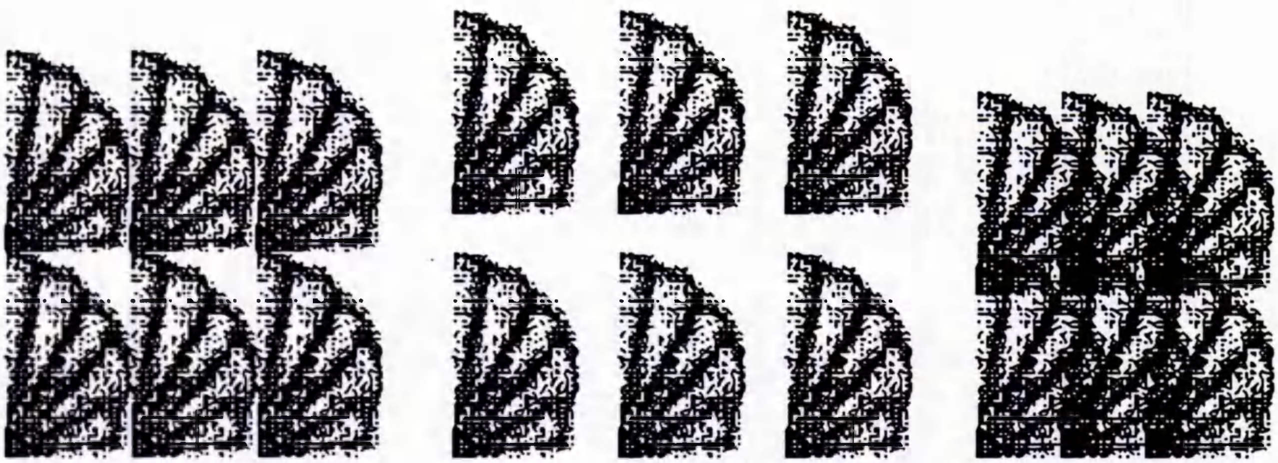
[31] A number of systems also provide this function to operate over a 45 degree axis.

[32] Some systems are limited to 90 degree rotations, others allow single degrees by numerical input or by interactive display.



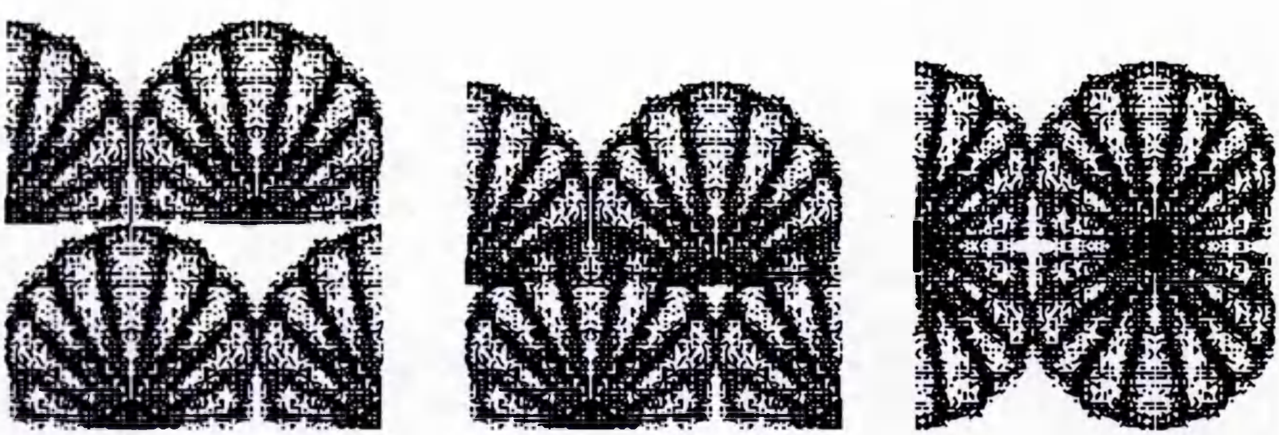
(a) (b) (c) (d)

Figure 10.01. A motif drawn using paint software and scaled resulting in loss of image detail. Unit sizes (a) 144 x 96 pixels, (b) 96 x 64 pixels, (c) 80 x 48 pixels, and (d) 144 x 96 pixels (c scaled up to the same size as a). *MacPaint®.*



(a) (b) (c)

Figure 10.02. The repeated unit in (a) a simple block format, (b) open block format, and (c) block format with overlapping units using white as a 'transparent' colour (c). *MacPaint®.*



(a) (b) (c)

Figure 10.03. The unit repeated in (a) a block/diaper/horizontal-mirror format, (b) in the same format with units overlapping on the vertical axis, and in (c) a block/four-way mirror format. *MacPaint®.*

copy and paste, and selected units can be transformed *in situ* (figure 10.03.a).[33] Thus variations on a simple repeat can be made empirically. Alternatively, transformed and simple copies of the pattern unit can be pasted to construct a composite unit which can then be copied and pasted to build up a repeat (figures 10.03.b and c).[34]

10.05. Symmetry tools

Sometimes facilities are provided for direct drawing of symmetrical units. For example, some allow the user to select up to four axes of symmetry for use with a brush tool. Each brush mark is reflected immediately about the selected axes to create symmetrical units. The unit can then be copied and pasted to form a pattern.[35] Others provide different symmetry modes, such as mirror or rotational symmetry about a specified point using a selected number of axes, and the facility to draw in simple block repeat format having first defined the size of unit.[36] Similar, but more sophisticated facilities, are provided by some textile systems (10.08).

10.06. Predefined Pattern fill

Low level software often provides a simple, small-scale pattern fill for textural or tonal effects.[37] The pattern unit, usually a matrix of 8 by 8 pixels, is repeated in a block format to fill selected bounded areas. This is sometimes combined with a brush function enabling the repeated pattern to be painted. Facilities to change individual pixels within the matrix are usually provided for editing or creating new pattern units.

10.07. User-defined pattern fill

A user-defined raster is used in a repeated form to fill a specified bounded area. A repeat of isolated motifs can be produced by selecting a rectangular area that is larger than the motif, their spacing being determined by the size of the raster.[38] The

[33] This figure illustrates selected block repeated units mirrored to form a block/diaper/horizontal-mirror format.

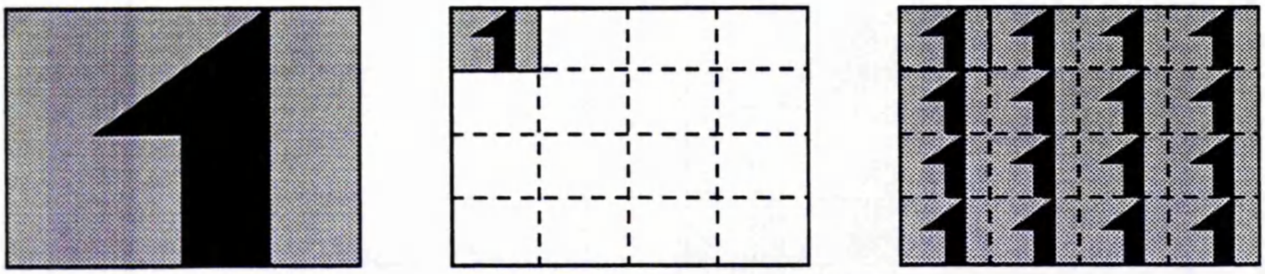
[34] In (b), a horizontal row of units has been overlapped and, in (c), mirrored vertically to create a block/four-way mirror format.

[35] MacPaint® provides such a function, called *Brush Mirrors*. The manual suggests that this 'is useful for creating interesting patterns, such as snowflakes, or creating kaleidoscopic effects'. *MacPaint® Reference Manual*, CLARIS Corporation, California, 1987, p.133.

[36] In Deluxe Paint III® these are called *point* mode and *tile* mode.

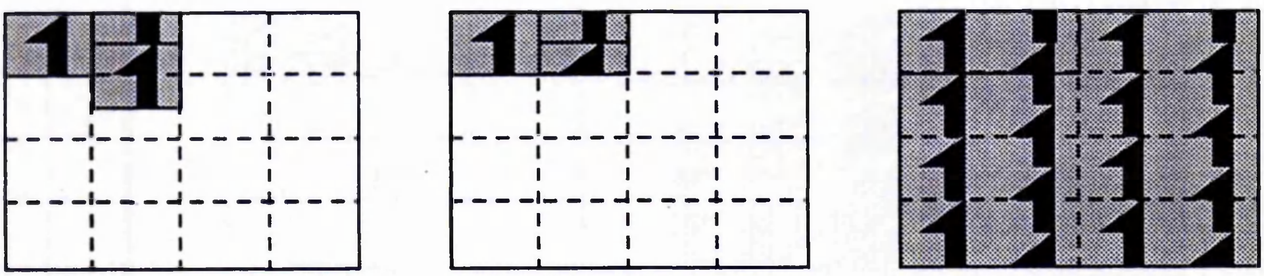
[37] Predefined patterns are usually of three basic types; linear, dot, and geometric which produce effects such as basketwork and bricks.

[38] All the pixels within the raster are duplicated, therefore patterns of isolated motifs can be made by specifying an area which exceeds the size of the original motif.



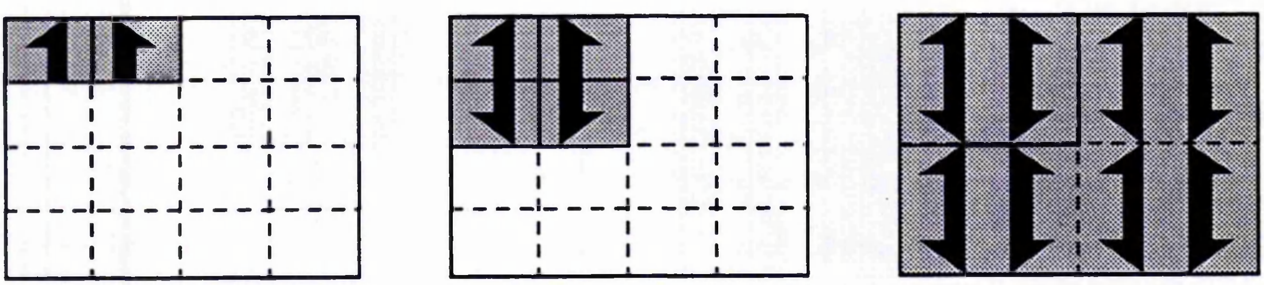
(a) Whole screen image (b) Reduced to 25% on both axes (c) Pattern fill of (b)

Figure 10.04. Pattern fill used to form a simple block format.



(a) Copies in half drop format (b) Half drop pattern unit (c) Pattern fill of (b)

Figure 10.05. Pattern fill used to form a simple half drop format.



(a) Horizontally-mirrored copy (b) Vertically-mirrored copy of (a) (c) Pattern fill of (b)

Figure 10.06. Pattern fill used to form a block/four-way mirror format.

definition of different sized rasters provides variability in the scale and application of this function.[39]

Small-scale patterns can be used for textural and tonal effects, as with the predefined pattern fill (10.06).[40] Large or full screen images, scanned or created on the computer, can be scaled down and repeated in drawings at an appropriate scale to provide a simple form of design visualisation in two-dimensional fashion or furnishing drawings.[41] Any pattern with a definite stripe or check will appear flat,[42] but patterns with a less geometric or directional emphasis appear more convincing, especially if airbrushing is applied to simulate shading.[43]

This function can also be used during the development stages of a design to obtain an impression of lines of movement in the repeated pattern. A large design can be scaled down and, by selecting a raster encompassing this pattern unit, viewed in a simple block format (figure 10.04). Only a block repeat can be used directly, but other formats can be constructed by placing copies of the pattern unit in drop or brick positions, and a raster containing the total repeat unit can then be repeated using a pattern fill (figure 10.05).

Transformed repeat formats can be constructed and repeated in a similar manner (figure 10.06). This method can be applied to most of the formats detailed in Chapter 9. If the software provides mirror and rotation functions that operate on rasters *in situ*, an alternative method can be used by repeating the unit, using pattern fill, and then transforming individual units. Grid functions can be useful to define the units accurately.

10.08. Pattern repeats

Textile applications of all levels have more comprehensive provisions for pattern repeats, but the virtual resolution of the system is always a limiting factor on

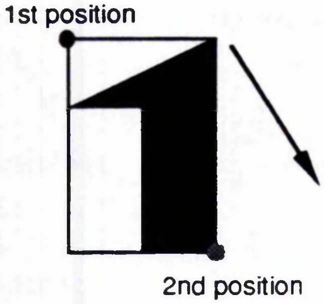
[39] Often there is no restriction on the size of the area, although there are some exceptions with lower resolution software. For example, *DrawMouse®* permits a maximum of 32 x 32 pixels with a brush facility allowing patterns to be painted in repeat.

[40] Pattern units taken from painted or scanned designs can be used for the simulation of effects in fashion and interior illustrations. Illustrations can be drawn on the screen or scanned in from photographs or drawings.

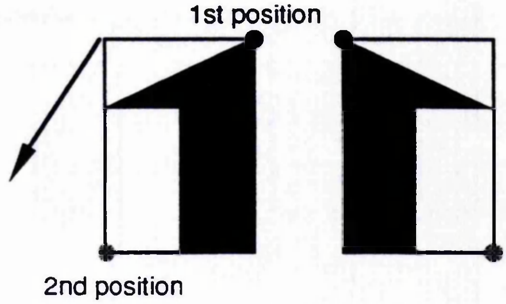
[41] Scaling down of raster images usually results in image degradation due to the loss of pixel data (10.04).

[42] Image distortion techniques can be applied to squash patterns and alter their orientation in order to change their flat and regular appearance.

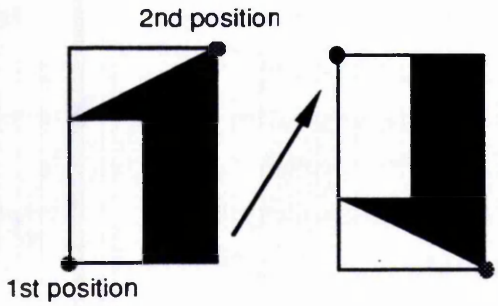
[43] Much research and development has been devoted to the visual simulation of textile designs in fashion illustrations. This attempts to achieve realistic drape by the use of texture mapping techniques but, in many cases, with the exceptions of strongly directional effects, the first visual impression is usually no more effective than using a simple pattern fill with the addition of painterly effects.



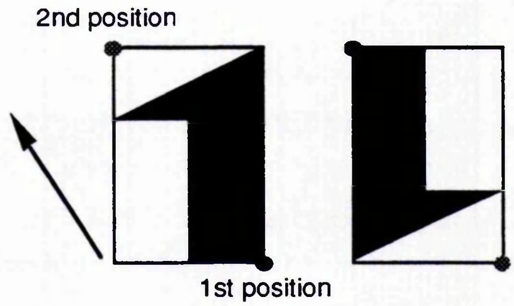
(a) Copy in the same orientation



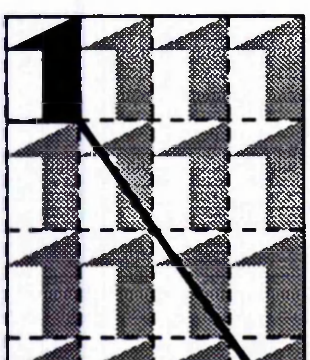
(b) Copy: horizontal-mirror



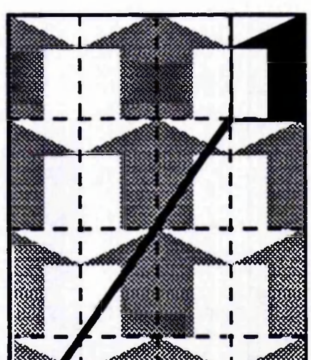
(c) Copy: vertical-mirror



(d) Copy: 180 degrees rotation



(e) Simple block format



(f) Block/pillar/horizontal-mirror format

Figure 10.07. Directional indications used by the *HCS IGOS* system for unit orientations. (a) to (d) point specification for copying, (e) and (f) directional indications for repeats.

the possible scale and complexity of the repeat.[44] The low resolution *DrawMouse®* (Appendix 10) provides zero drop (block), brick, drops (1/4, 1/3, 1/2, 2/3 and 3/4), and unit drop (an alternation of unit and background). The pattern unit is defined by the selection of a raster, which is then repeated in the selected format over the whole screen. Individual units within the repeated pattern can be transformed *in situ* using mirror or rotate functions. An *undo* function allows the original image to be recovered. This method allows for small units to be tested easily in different formats using a try-it-and-see approach. Motifs within the repeat can be altered to add variety to a structured pattern by changing colours or painting additional details.

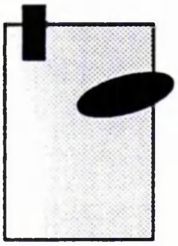
A similar range of repeats are provided by most textile systems, usually block, drop, and brick formats. Specification of drop and brick variations is made using a variety of methods on different systems: by fractions, for example, 1/4 brick and 1/2 drop, or by a numerical input for the offsetting of consecutive units, such as a distance in millimetres or number of pixels. Transformed repeats can be dealt with by creating a composite unit, which is then repeated. In practice, transformations are used mostly for producing symmetrical motifs or varying the orientation of elements within a design, but rarely for repeat structure.

Some systems use a modular approach to repeat specification, and require numerical inputs for the repeat type and the transformation to be applied, such as a half drop repeat with horizontal mirroring. The defined raster is repeated in the selected format and an editing window is provided to enable modifications to be made to the unit. The display must be refreshed periodically to apply such changes to all the units in the repeat. This method is found in some PC-based knitwear applications in which, because repeat units are relatively small, complex repeats can be constructed and displayed quickly.

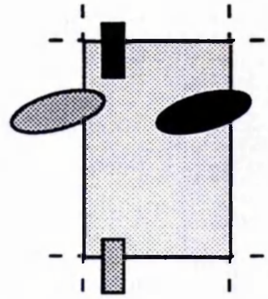
The *IGOS* system uses an opposing-points method of raster specification in the copy function for orientation selection (figures 10.07.a to d).[45] This is also used to a

[44] But, because standard paint systems have low virtual resolutions in comparison with most printed textile applications, the possible size of repeat is limited. For example Niesewand, writing about the use of *Painter®* on a *Quadra 700* for textile printing at the RCA, commented that, the 'only limitation to designing on computer is the size - it can't handle the big repeats'. Niesewand, N., *Live wires . . . computers byte back*, Vogue, November 1993, p.101.

[45] Specifying the top left corner first, followed by lower right, will give a copy of the same orientation. Top right, followed by lower left, will give a horizontally-mirrored copy, lower left, followed by top right, a vertical-mirror, and lower right, followed by top left, will give a copy rotated by 180 degrees. *IGOS: Interactive Graphic Computer Systems,* HCS Computer Graphics, Utrecht, 1990.

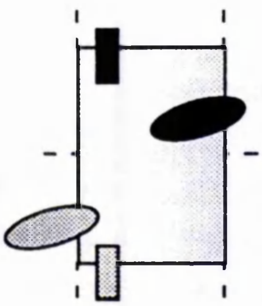


(a) Elements drawn outside the unit boundaries.

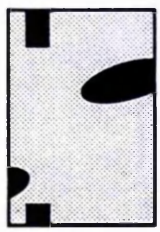


(b) Placement of elements which overlap the unit boundaries in a simple block format.

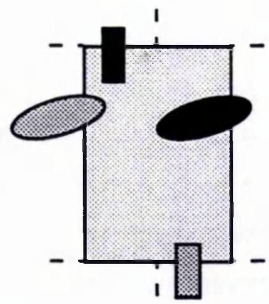
(c) Clipped unit



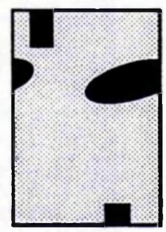
(d) Placement of elements which overlap the unit boundaries in a simple half- drop format.



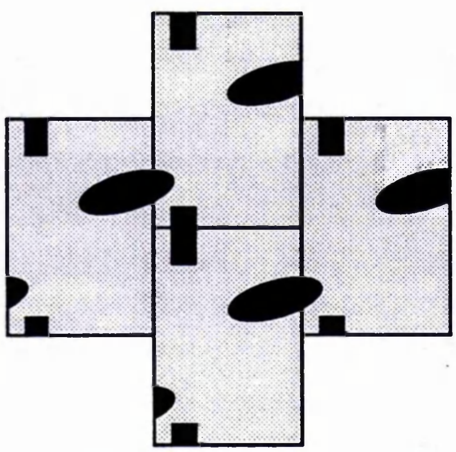
(e) Clipped unit



(f) Placement of elements which overlap the unit boundaries in a simple brick format



(g) Clipped unit



(h) The clipped unit (e) repeated in a half-drop format showing continuity over the unit boundaries.

Figure 10.08. Drawing in repeat.
Elements exceeding the boundaries of the design unit are redrawn in the relevant positions according to the selected repeat format.

limited extent in repeat specification. A raster is marked out by two points, and the relationship between them indicates the required orientation of the units in the repeat. A third point specifies the size of the repeated pattern, including the original unit (figures 10.07.e and f).

10.09. Avoidance of rectangularity in pattern repeats

Because of the rectangularity of the pattern unit, one of the drawbacks of raster graphics is the danger of creating patterns with a strong grid like appearance. The traditional method for avoiding this requires the design to exceed the boundaries of the unit rectangle (4.22). An adaption of this approach is found in some systems which provide facilities for designing in repeat.[46] These apply a selected simple repeat format (drop and brick with specified offset, or block) to a rectangular unit of a specified size. Parts of any elements drawn over the unit boundaries are redrawn within the unit, according to the selected format (figure 10.08). For example, with a block repeat, elements drawn over the top edge of the unit are redrawn in the bottom of the unit. Elements outside the boundaries are clipped so that the final design unit contains only those parts within the unit boundaries.

When repeating existing units, the avoidance of rectangularity has been approached by software designers in two different ways, both of which depend on background colour transparency. One method is demonstrated by the *repeat over* function used in *DrawMouse®*. A motif is drawn on the background colour (figure 10.09.a), the repeat format is selected, and the repeat unit defined. This unit need not include all of the motif because it is used for setting up the repeat grid dimensions (figure 10.09.b). The repeat pattern is then undone. The second stage is the selection of the *repeat over* command and the definition of a rectangle containing the whole unit. The resultant pattern combines the first selection of repeat format and unit size with the raster selected for the second unit. Any parts of the motif that exceed the limits of the first unit will overlap adjacent units (figure 10.09.c).

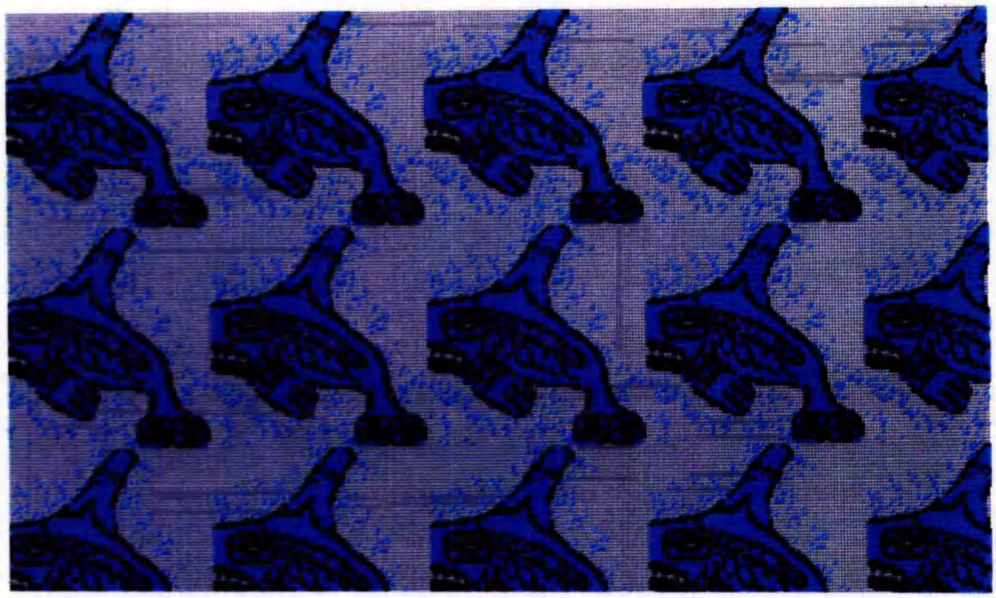
Another method is to define the whole motif and the repeat, and then specify a distance for 'butting up' on the vertical and/or horizontal axis so that the units overlap each other without the background colour.[47] The main difference between

[46] For example, TCS and CDI's U4ia®.

[47] This was included in the Eikonix system in 1987. *Eikonix ® Designmaster® 9000: Delivers quick response and reduces costs,* Eikonix Corporation, Bedford, MA, 1987.

(a)

(b)



(c)

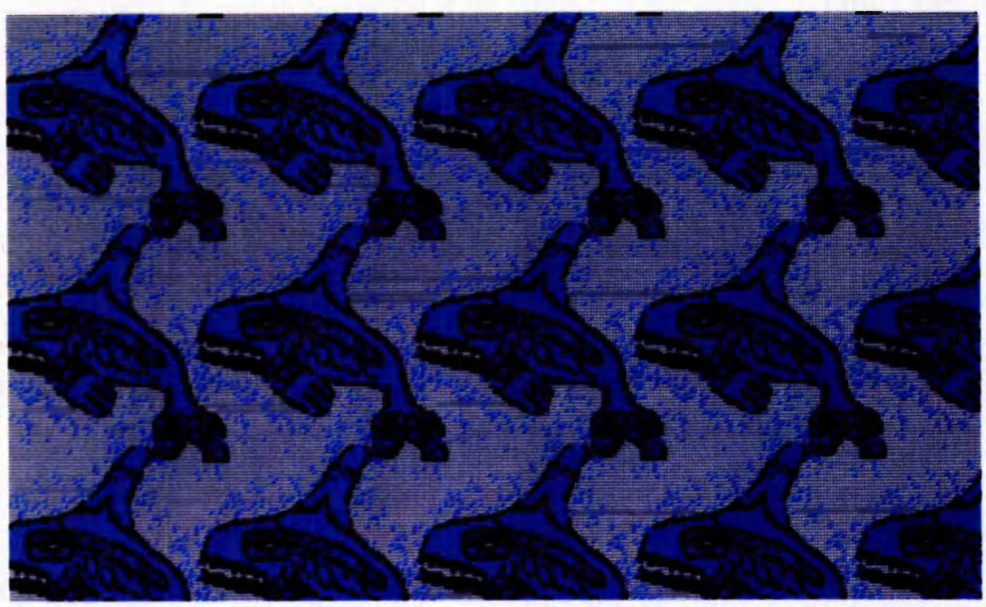


Figure 10.09. Examples using *repeat over*.
(a) Single motif drawn on the background colour. (b) Block repeat (zero drop) using a cropped area of the motif. (c) Final repeat, using the same format as (b) and the whole motif. *DrawMouse*.

these two approaches is that the first is grid-based and the second unit-based. The grid-based method derives from traditional design methods which require a fixed grid relating the repeat size to divisions of the fabric width. As with designing in repeat, motifs may exceed the grid boundaries to create continuity in the design. The unit-based method allows flexibility in the distancing of the motifs, which can be adjusted until the repeat 'looks right'. Units encompassing the whole motif are overlapped, and the repeat is the size of unit minus the amount of overlap. The design can be scaled to the required dimensions on output, and this ability has reduced the reliance on the grid as a controlling mechanism for design size.

10.10. Quartering

Most dedicated textile systems include an automatic quartering facility. This is an adaption of a conventional technique, and is especially relevant to large designs when the repeat format has already been decided. The rectangular area containing the design is divided into four sections and rearranged on the computer screen in a format relating to a specified repeat. The outside edges are placed adjacent to each other. The design can be modified so that elements link across these boundaries, and noticeable joins in the design are eliminated. The method can be used on general paint systems, using copy and paste techniques (Appendix 9). This function is essential to the design conversion process as it allows large scanned designs to be corrected prior to output. The step and repeat facilities, provided on laser engravers and film plotters, can be used to repeat the corrected unit on output.

10.11. DRAWING SOFTWARE

Most drawing software has been developed for technical applications, such as architecture and engineering. It has been used in the fashion and textiles industries for applications with a predominantly mathematical or technical emphasis, such as pattern cutting and lay planning. Some software, such as the *Textile Graphics System* in the 1960's [48] and *Ormus Fashion®* (Appendix 11), were developed for printed textile design to provide line and fill facilities.

Drawing software records each design element as a separate object, therefore elements and groups of elements can be moved or manipulated individually.

[48] The *Textile Graphics System* was developed for design conversion for the engraving of copper rollers, which was a line process (5.37).

Specifications, such as size, line width, and fill,[49] can usually be altered at any time, allowing for greater scope in design modification than with raster systems. Mathematical precision provides smooth lines of specific width and enables designs to be accurately scaled to required dimensions without image degradation. This is especially useful for placement prints or engineered prints (designs to fit into garment shapes) because designs can be scaled to fit various sizes. Because the design size is not resolution dependent, very large designs with intricate detail can be created on relatively inexpensive computers and output to high resolution plotters.

Some packages provide stacking or overlay functions that allow the position of elements in an list of overlay priorities to be specified.[50] Most have a system of layers that can be worked on individually and made visible or invisible when required. These facilities enable complex designs to be created, using different layers, so that grouped elements can be worked on separately, but viewed together.[51]

The disadvantages are a lack of the painterly techniques and loose textural effects that are characteristic of contemporary textile design. They provide less direct design methods than paint software, and can impose a mechanistic approach to the design process. Drawing software 'is considered to be a bit more difficult to master because of having to manage a database instead of just drawing on the screen'.[52]

10.12. Extension methods of pattern construction

Drawing software, by allowing individual design elements to be replicated and manipulated separately from the background or surrounding elements, does not impose the rectangular dominance associated with raster techniques. The distance between copies can be numerically specified, and the unit size is determined by the distance between equivalent points on the copies, therefore elements can be positioned to interlock without using any confusing or specialist techniques.

[49] Some packages include a similar simple pattern fill to paint software (10.06). Others provide a simpler version of a line fill, with horizontal, vertical, diagonal, or cross-hatched lines.

[50] This controls which elements are in front or behind others. Some packages employ simple 'bring to front' or 'move to back" commands.

[51] Designs that contain a lot of detail often take a long time to redraw after modifications have been made or the viewing mode changed. Working on layers allows sections of the design to be 'turned off', thus cutting down on the redraw time.

[52] Hutzel, I., *Trends in PC Paint System Development*, Computer Graphics World, March 1985, p.47.

Copy and paste operations can often be duplicated, allowing multiple copies to be made with exact distancing in a specified direction.[53] To produce a repeat in two directions will usually require the formation of multiple copies in one direction, followed by the selection of these copies, and the formation of copies in another direction.

The provision of rotation and mirroring allows for symmetrical patterns to be constructed. This usually gives more control of degrees of rotation than with raster graphics, and no image degradation. The manipulation of elements also provides a greater degree of control and subtlety over the variation of individual motifs in a repeated pattern. Variations on a basic repeat can be produced by changing the size, orientation, and spacing of individual units, or by altering elements within them. Such design modification is directly applicable to the reinterpretation of naive or ethnic prints.[54]

10.13. Designing in repeat

Although some raster-based systems provide facilities for painting in repeat (10.09), the mathematical accuracy, control, and resolution-independence of vector techniques can allow the drawing of larger and more complex repeats. Specific functions, provided by *Ormus Fashion,* were investigated for the setting up of files so that designs could be drawn in predetermined repeat formats (Appendix 11).

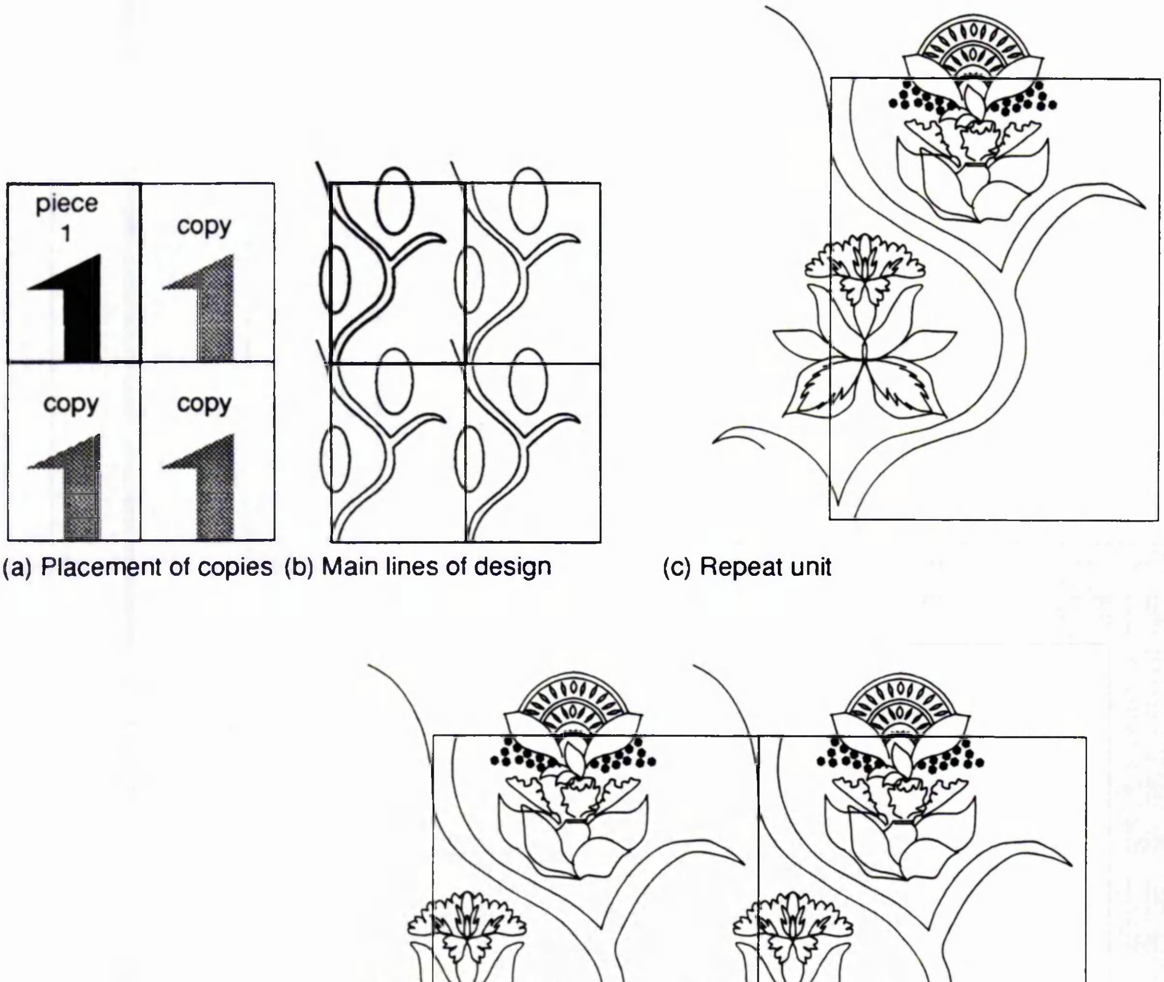
Pieces (multiple layers) can be selected to be visible or invisible whilst work is carried out on another piece.[55] *Copy piece* allows all the elements of a piece to be copied to another piece, using scaling, mirroring, and rotation if required. Individual elements of the copy cannot be changed directly, but any modifications or additions to the original piece will be carried through to the copy.

These facilities permit drawing, using a complex repeat format, and viewing the repeated pattern during the design process. The format and size of repeat unit are decided at the start of the design process, and a rectangle of the unit dimensions is

[53] The distance moved is usually specified by units (centimetres, inches, etc.) in the horizontal (x) and vertical (y) directions.

[54] A characteristic of these sources is that, although they give the appearance of simple repeats due to repeated elements, the variations of individual units, induced by hand processes, produce a much larger repeat (8.11).

[55] *Items* (individual elements) or *blocks* (groups of items) can be copied and pasted within pieces. Movement can be specified by the numerical input of a displacement distance (positive or negative value) on the x and y axes. Items or blocks can be scaled, rotated, or mirrored (horizontally or vertically) by keyboard input before placement.



(a) Placement of copies (b) Main lines of design (c) Repeat unit

(d) Repeat

Figure 10.10. Construction of a pattern using a block format. *Ormus Fashion.*

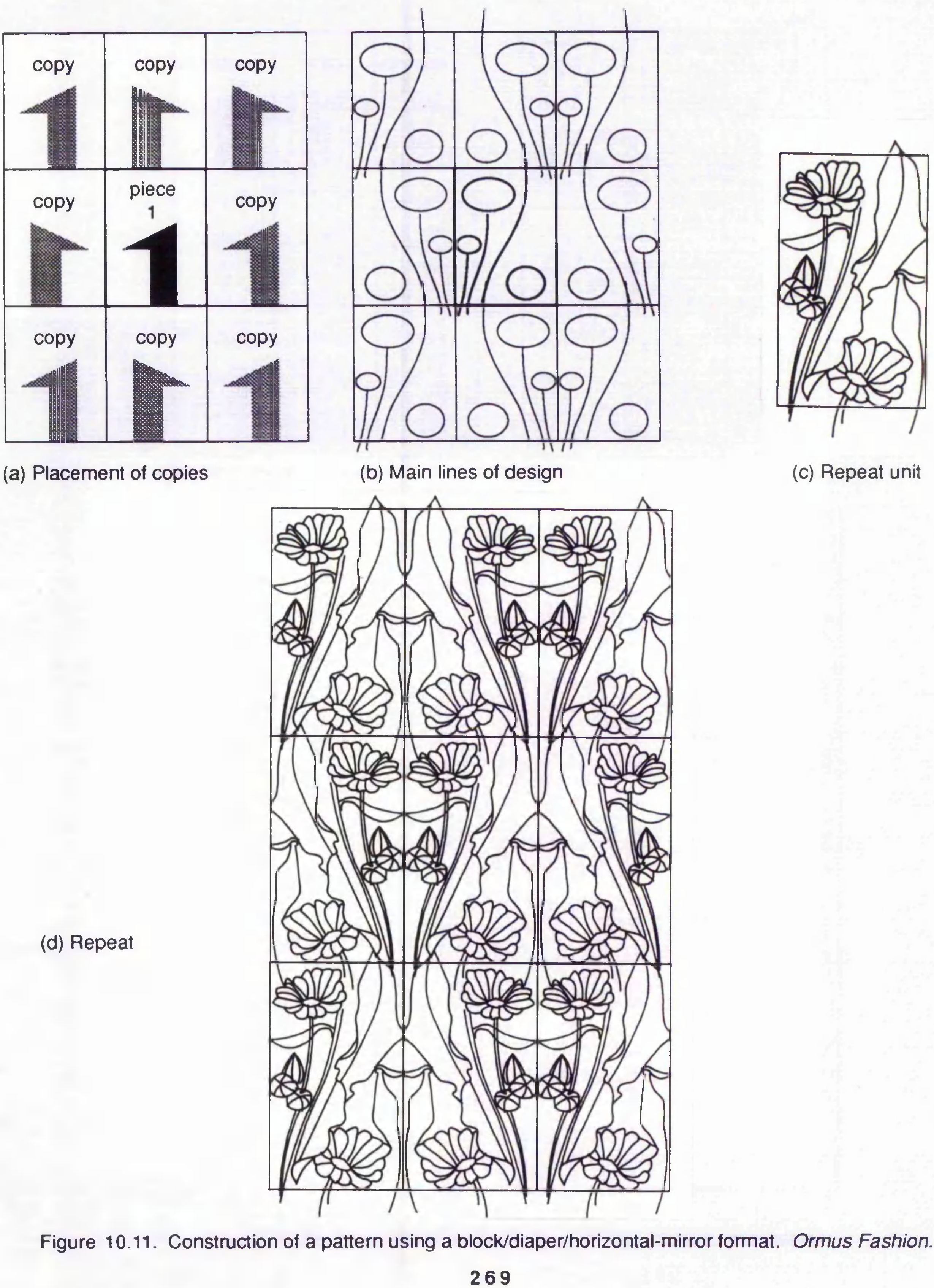
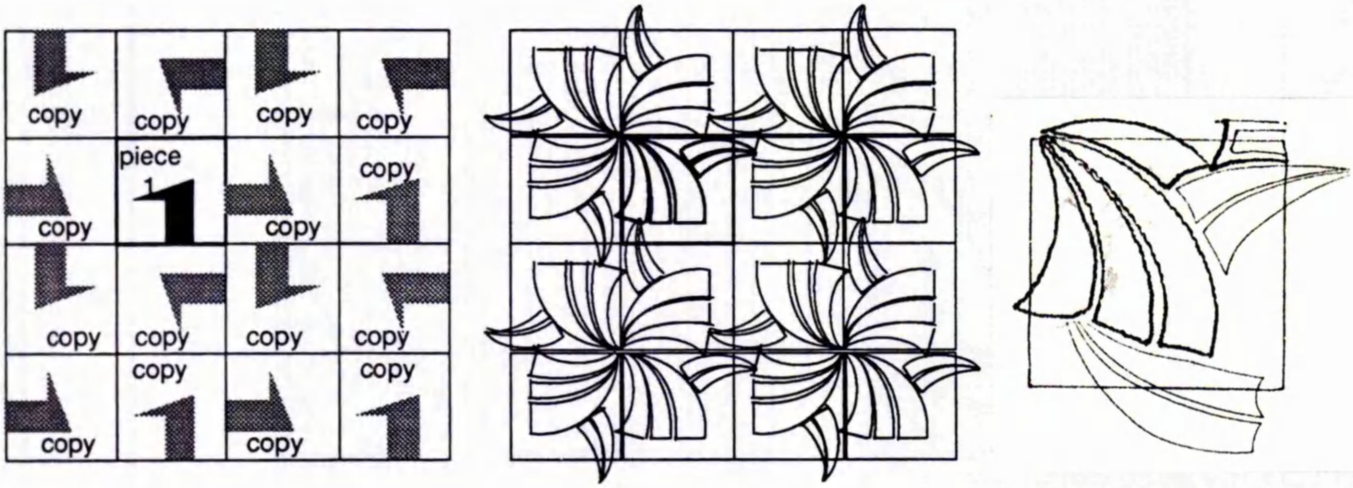
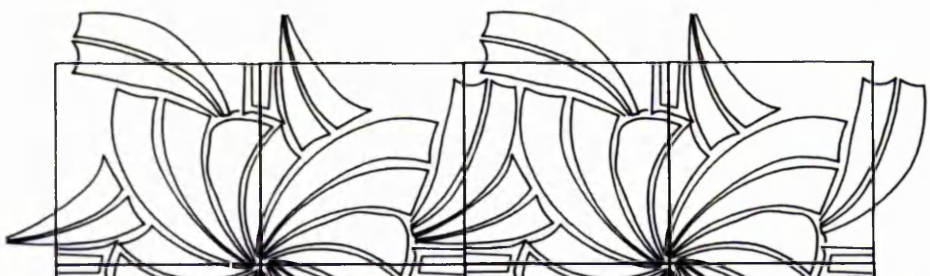


Figure 10.11. Construction of a pattern using a block/diaper/horizontal-mirror format. *Ormus Fashion.*



(a) Placement of copies (b) Main lines of design (c) Repeat unit



(d) Repeat

Figure 10.12. Construction of a pattern using a block/90 degree rotation format. *Ormus Fashion.*

constructed as the basic design unit in one piece.[56] Copies of this can be positioned using mathematically precise placements and transformations to construct the required repeat format in a second piece. By drawing in the original piece whilst keeping visible the second piece and constantly updating the display, a design can be viewed in repeat as it is drawn (figure 10.10). Variations on the basic method can be used to build up different simple and transformed repeats (figure 10.11). More complex formats, such as repeated hexagonal units requiring angled copies, are particularly effective, especially where design elements are required to interlock (figure 10.12).[57]

This approach is particularly useful in the initial design stages because elements exceeding the boundaries of the unit rectangle overlap on to adjacent copies. The user can ensure that there is no discontinuity on edges of the repeat and that the main lines of the design are visually effective. The relationship between the elements in each unit is always apparent, no matter how complex the repeat format. Modifications can be made and the effect over the whole design viewed quickly. A drawback is that 'real-time' pattern construction cannot be achieved because the copies are not updated automatically.[58]

10.14. COMBINED RASTER AND VECTOR TECHNIQUES

Combined raster-vector graphics techniques offer two approaches; the incorporation of bitmapped images into vector software and the transference of vector data into paint applications. These have, so far, been little used for textile design, but current developments in printing technology and output devices may provide an opportunity for their development.

10.15. Raster data into vector software

This combination of techniques has been developed mainly for the publishing industry to exploit the use of scanned and drawn imagery by the importation of bitmapped graphics into object-orientated software. This has been described as 'vaster' technology, in that it combines 'vector-based object-orientation and resolution-independent draw features with raster-based, artist-orientated paint

[56] Ideally, its size on the x axis should be a division of the fabric width.

[57] This technique was found to be effective with Escher type repeats involving interlocking shapes.

[58] An equivalent to 'brush mirrors' in MacPaint® (10.05) which worked in real time would be ideal. Also, with detailed designs, the redraw time was long, and it was found necessary to make the copies invisible whilst working, and make them visible periodically in order to view the repeated design.

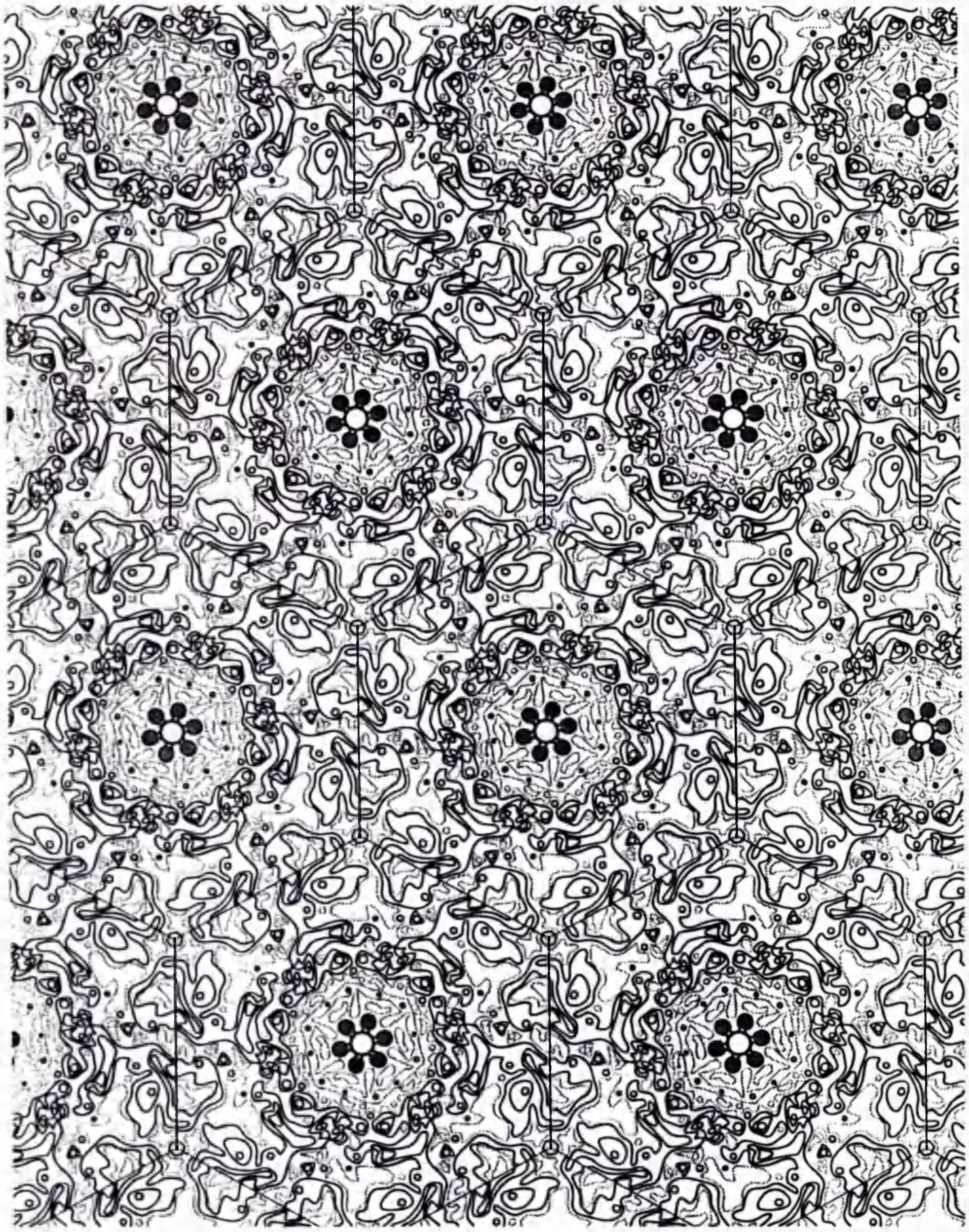


Figure 10.13. Hexagonal pattern constructed using *Aldus Freehand®*.
60 degree rotations about a central point were used to build up the hexagonal unit, which was then repeated using copy and paste techniques (Appendix 12).

functions . . any part of a raster image, whether input or created on the system, can be isolated and manipulated as an object'.[59]

Creating patterns generally involves the same techniques of copy and paste documented in drawing software (10.12), although various packages include different combinations of functions. All the illustrations in *Repeat Patterns*[60] were drawn, repeated, colour separated, and output using Aldus FreeHand® (Appendix 12).[61] With this, elements can be grouped together and transformed as a whole which enables design units containing multiple elements to be copied, moved, and transformed accurately. *Cloning* produces a copy of the original in exactly the same position, and movement can be specified numerically on the horizontal and vertical axes. *Duplication* permits a repetition of clone and move sequences so that multiple copies can be created with equal spacing. Transformations can be applied about a specified point. Duplication sequences can be combined with rotation to produce rotational composite units around a central specified axis.[62]

The most suitable method for using Aldus FreeHand® was found to be grid-based. The unit size is decided, and a rectangle constructed of these dimensions. Design elements can exceed the boundaries of the rectangle, and movement of copies is specified in relation to the unit dimensions so that such elements overlap on to adjacent units. Transformations are applied about the central axes of the rectangles so that units remain in a regular grid structure.[63] Hexagonal units can be constructed by applying rotation or mirroring to triangular sections, using the unit centre as a control point. The unit can then be repeated using the hexagonal grid dimensions to specify movement (figure 10.13). Bitmapped images can be scaled, rotated, sheared, etc. as whole objects, and can also be pasted into other elements. This allows scanned imagery to be repeated by copy and paste

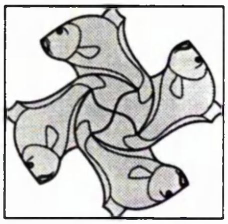
[59] Haimes, R., *Graphic Design Technology Matures,* Computer Graphics World, February 1988, pp. 50.

[60] Phillips, P. and Bunce, G., *Repeat Patterns: a manual for designers, artists and architects,* London, 1992.

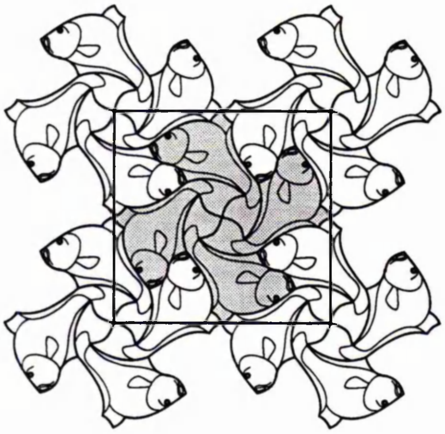
[61] This is a drawing package for graphic design that allows the importation of bitmapped images, such as scanned images and designs from compatible paint applications. The page or design size can be as large as 1,016 mm square and can be output to a variety of printers and typesetting equipment. Designs can also be scaled on output.

[62] There is not the same degree of control of orientation as there is with Ormus Fashion (Appendix 11).

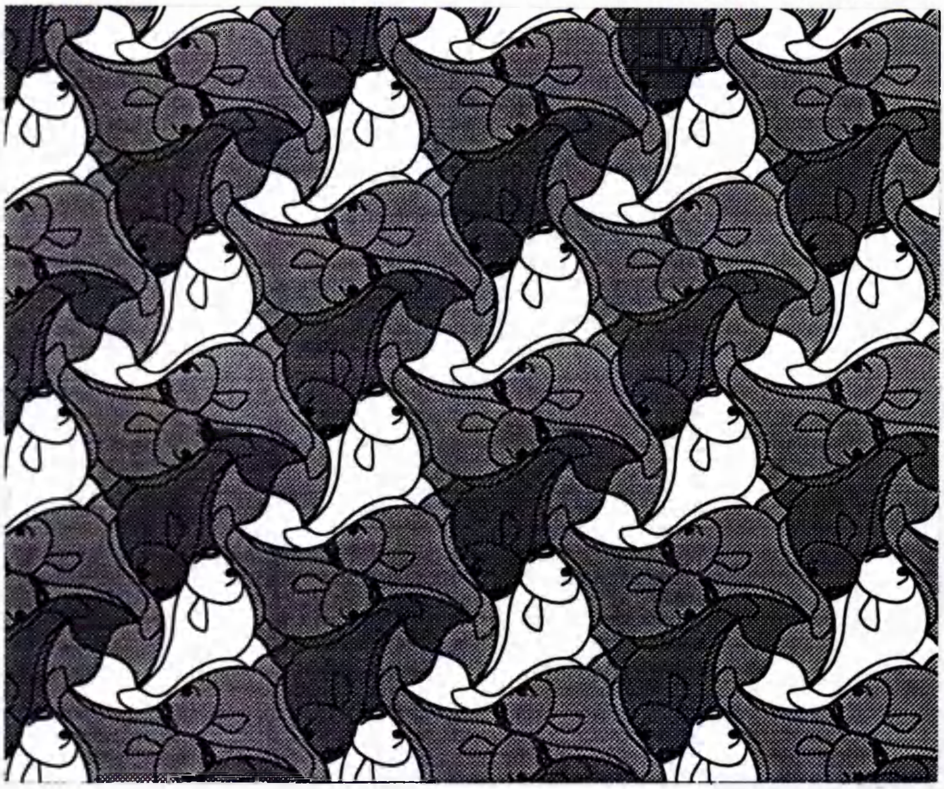
[63] It was necessary to reconstruct the repeat continually, as elements were added, to see how the overall design worked and elements interlocked. The main lines were drawn in, the repeat constructed, modifications made, and the repeat reconstructed.



(a) 4 design elements using 90 degree rotation



(b) The repeat unit built up using copy and paste techniques. The square indicates the area to be tiled.



(c) The unit shown in the square in (b) tiled into a rectangle to produce the repeated pattern.

Figure 10.14. Rotational design constructed using *Aldus Freehand®*.

techniques.[64]

Design stations for the publishing industry allow images to be scanned or imported from paint applications, manipulated, and combined with drawn and painted elements. In order to get a high quality output of photographic images at the production stage, the originals are re-scanned at high resolution on a pre-press system, and combined with the data on their location and manipulation plus the additional data from the design system.[65] Full colour photographic images can now be printed onto fabric but, as yet, their use in design has not been explored fully. Images are usually simply block repeated, and the effect is that of multiple pictures, rather than pattern. Perhaps, once the novelty aspect of this type of imagery has decreased, the potential of powerful design systems may be used to exploit it more creatively.

Jet printing, by eliminating the intermediate stages of screen production, may be the ideal printing process for such designs using process colours. It is used extensively for sampling but not, as yet, for production. If it becomes an economically viable production process, then the limitations of what is printable will drastically alter, and the image processing facilities provided on pre-press systems may be transferred to printed textiles.

10.16. Tiled fill

This vector equivalent of the raster pattern fill (10.07) is found in some graphic design applications. A selected element or group of elements can be tiled into a bounded area to give a block repeated pattern. Spacing is determined by the overall width and height of the elements. A total repeat unit can be constructed (figures 10.14.a and b), pasted inside a rectangle, and then tiled into another element in block repeated form (figure 10.14.c).[66] All of the formats catalogued in Chapter 9 could be constructed by using tiled fills and/or copy and paste techniques (Appendix 12).

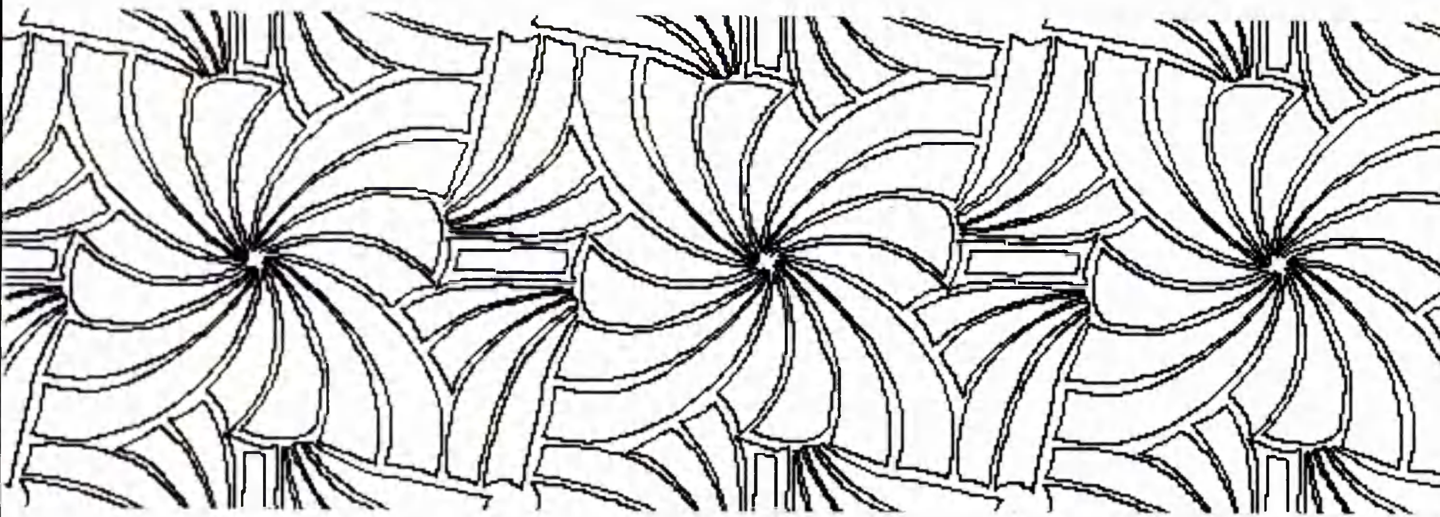
10.17. Vector data into raster software

Vector data can usually be imported into paint software in bitmapped form. On

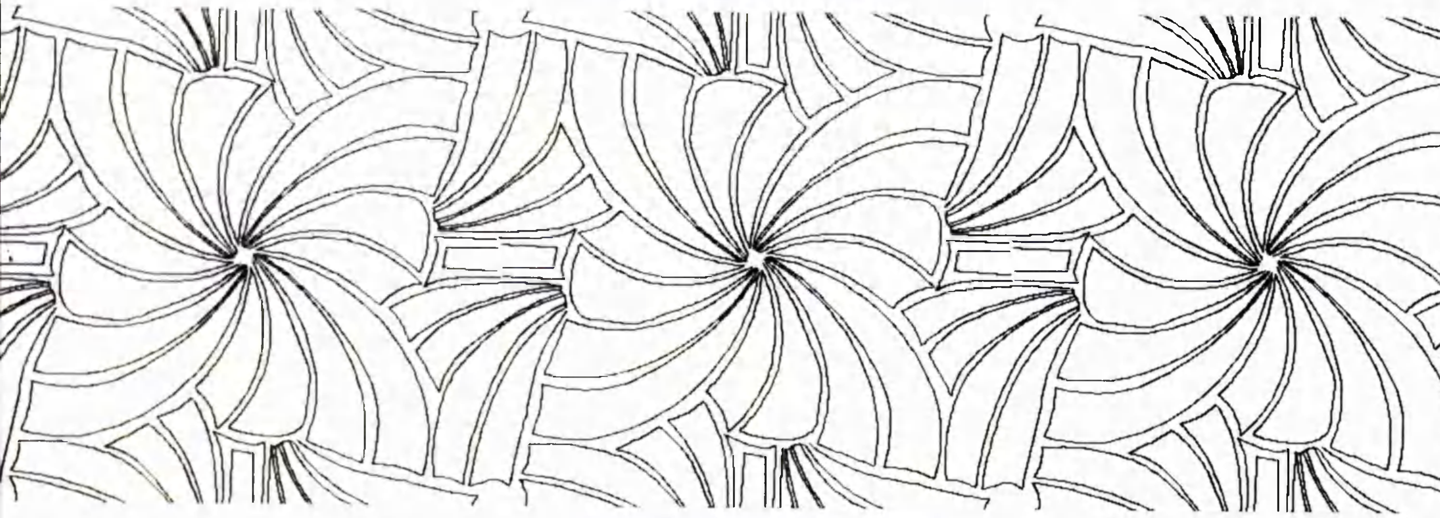
[64] Simple black and white bitmapped images can be 'traced' to produce an outline of the shape, which can then be manipulated as a drawn object.

[65] CDI's *U4ia®* software uses a similar approach, allowing scanned and painted images to be manipulated as objects, but it also includes repeat facilities which are similar to those of raster systems, such as designing in repeat (10.09).

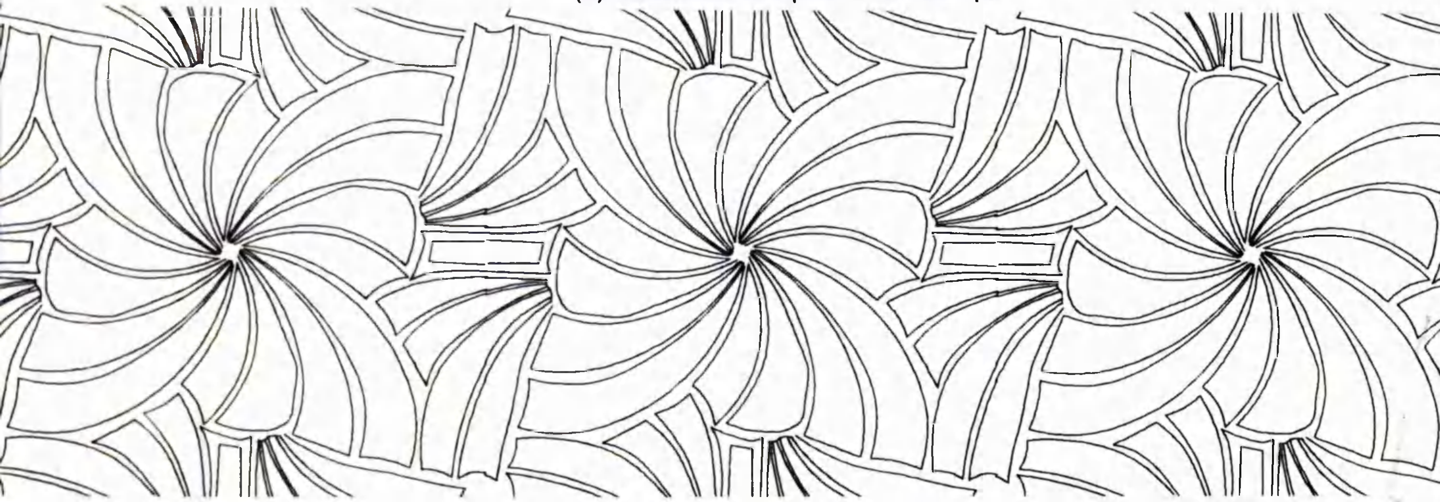
[66] Aldus FreeHand® provides a tiled fill option that permits the unit to be scaled, rotated, and offset. This also allows for the filling pattern to be transformed with the element it fills.



(a) Converted and printed at 75 dpi.



(b) Converted and printed at 150 dpi.



(c) Converted and printed at 300 dpi.

Figure 10.15. A vector file (figure 10.12) from *Ormus Fashion* converted to a bitmapped image at three different resolutions in *Ormus Hi-Res*.

Figure 10.16. A converted vector file (figure 10.15.a) with flood and pattern fills in bounded areas using *Ormus Hi-Res*.

low resolution systems, this will result in a reduction of line quality, but it can be useful when a mathematically accurate construction is needed. *Hi-Res®*, a PC application developed for the fashion and textiles industries, is a basic paint package with a high virtual resolution (Appendix 13). It allows the importation of object-orientated files from *Ormus Fashion* (10.13), which are then converted to high resolution bitmapped images at a specified resolution (figure 10.15). This results in a larger design size and finer quality of line output than most raster systems.

Hi-Res® provides basic paint functions, such as pixel editing and pattern fills, and is being developed further to include more sophisticated paint functions. It also permits the importation of data from various raster file formats. Bitmapped imagery can be added, using copy and paste functions, or repeated into bounded areas, using a pattern fill. Designs can be transferred from lower resolution paint systems, to be repeated and modified prior to output. The repeat function provides simple formats (block or drop and brick with specified offset). The repeated design can then be developed, and additions made to individual units.

Although *Hi-Res®* does not yet have the sophisticated facilities of general paint software, its high resolution makes it a useful tool for the addition of painterly qualities and scanned imagery to vector-generated designs. This allows mathematically accurate line drawing to be combined with loose painterly qualities (figure 10.16) and scanned imagery. The design construction, or skeleton, can be drawn, using vector techniques, and painted into, using raster techniques.

10.18. THE FUTURE

Aldrich proposed that 'CAD technology has . . . to offer some extension of the design purpose itself'.[67] Vince argued that computers were 'mechanistic and mathematical, and, on the other hand, design is associated with creativity and artistic activities' . . but might become . . 'the most influential design tool ever used by artists and designers'.[68] Ways of exploiting these mechanistic qualities within the design process have been proposed, but not developed. Hearle suggested in 1971, that 'the computer will not only get rid of the tedium of drawing the same elements many times, but will open up the possibility of using much more complicated repeat patterns than could otherwise be handled'.[69] Also, in 1984, he

[67] Aldrich, W., PhD Thesis, *New Technology and Clothing Design*, Nottingham Polytechnic, 1991, p.227.
[68] Vince, J., *Computer Graphics for Graphic Designers*, London, 1985, p.22.
[69] Hearle, J.W.S., *Function and Form: Computing as a Tool in Textile Design*, Advance, 1971, vol.11, p.37.

wrote; 'a floral design, with an underlying regularity of form, could be modified by a random number generator so that no two elements were identical'.[70]

Facilities for the creative exploitation of computer graphics exist, but economic and design climates have not encouraged their use or further development. There has been a bias towards practical technological applications which has stifled the development of such potential uses. It is only recently that new techniques and approaches have been slowly introduced. The future development for computer-aided pattern construction depends on underlying attitudes toward structured design. These attitudes are changing, and there is an apparent rekindling of interest in structural organisation, as long as it is not too overt. If computer facilities were developed in a design-orientated manner, their use could stimulate design innovation. Development could take different forms according to the bias towards either raster or vector techniques, and it could involve further progress with combined techniques.

The limitation of size on raster images has restricted the use of repeat. The greatest use of CAD for repeats usually occurs with low-resolution applications dealing with small repeats, such as knitwear, where the fast display of the repeated design encourages a try-it-and-see approach (10.08). To handle complex repeats and the large files produced by most print designs, a computer needs very high resolution but, also, fast processing speed so that the repeat and subsequent modifications can be displayed quickly. The expectancy of computers' speed and reliability is not fulfilled when dealing with large detailed images. Designers may have to delay making aesthetic judgments about design decisions whilst the computer performs an apparently simple task, such as displaying a repeat.[71]

Trial and error methods of pattern construction (4.06) are, therefore, only really appropriate for small-scale designs. However, these methods can be extended by using repeat functions to create simple or complex patterns which can then be varied to produce less mechanised effects and larger repeats. Hearle's suggested use of computer-generated random variations could extend this approach further.

The use of bitmapped data in object-orientated software may provide an

[70] Hearle, J.W.S., Newton, A., and Grigg, P.J., *Computer-aided Design: A Liberating Prospect,* Proceedings of the Textile Institute Conference - Computers in the World of Textiles, 1984, p.6

[71] Cooley suggested the high speed of data processing could be stressful. Cooley, M.J.E., *Impact of CAD on the designer and the design function,* Computer-Aided Design, vol. 9, no. 4, October 1977, p.239. The reverse is often true with large raster files.

opportunity to exploit photographic imagery within a structured environment, but its full exploitation depends upon the provision of extremely high virtual resolution, fast processing power, and adequate output technology. Although printing technology can handle large repeats, few CAD systems can match it.[72] These technical restraints are limiting factors on design, as were fabrics widths and the vertical repeats of rollers in the early 19th century (7.03). Then, engraving techniques and design styles were developed to exploit the technology within its limitations, whereas today, CAD is decried as inadequate for every industrial application, although its potential for innovation has not been exploited.

An alternative planning-based approach is the method suggested for *Ormus Fashion* (10.13) in conjunction with *Hi-Res* (10.17). This uses the mathematical capabilities of vector software and the painterly techniques of raster graphics at different times during the design process. It relates to holistic pattern construction methods, in that repeat is considered at the start of the design process and the *bones* of the design are drawn in first. Once the skeleton of the design has been drawn, using vector techniques, and the repeat judged to be effective, the file can be transferred to a high resolution paint system for detailed painterly work. This degree of interactivity has not been possible before, but any practical application would rely on an easily understandable method of repeat specification.

10.19. THE INTERFACE

The classification system described in Chapter 9, being based on a modular approach, could provide a suitable step-by-step method for selecting repeat formats by specifying the following factors :-

1. Unit dimensions.
2. Basic format.
3. Variation (displacements for drop and brick repeats).
4. Secondary organisation (spacing).
5. Transformation.

The same unit used in different formats creates different sizes of total repeat (9.06). The user could be provided with this information in respect to the specified unit size and selected format, thus ensuring that the final design would be suitable for the available output media and production processes. During the design

[72] In 1977, the repeat length possible using the Millitron machine was said to be 'only governed by the computer size and could go up to, say, 200 ft in length'. Charnock, R.E., *The Significance of Millitron,* International Dyer & Textile Printer, March 18, 1977, p. 277.

process, the total repeat could be displayed, with one unit identified as the design area. An option to view the repeat over a wider area, as required, would be essential.

The repeat unit or total repeat unit could be clipped, and the file transferred for painterly applications. The repeat facilities provided by the raster software to be used should be considered at this stage. For simple repeats, such as block and half-drop, the single design unit could be transferred to the paint software. Following paint applications, the design could be quartered (10.10) to check the repeat edges and repeated in the required format for output. This would be particularly relevant to large-scale designs. For complex formats, the total repeat could be transferred and treated as a block format for quartering and output. Such a modular approach exploits the inherent capabilities of both types of computer graphics.

A flexible system allows individual designers, once they understand the basic functions, to create their own methods of working that accord either with their usual design methods or are tailored to solve or explore particular design problems. 'It is not uncommon that the user . . . develops some special skills after long practice and makes the system much more productive than originally anticipated'.[73]

CAD can be useful, not only for practical and economic reasons, but also for design innovation. Although some systems provide a flexible design environment, their potential can only be exploited by allowing designers to experiment and develop individually. Aldrich, following research into students' design methods, noted that when 'given a choice each student's understanding and use of CAD was different'.[74] However, the teaching of CAD to large groups of design students often imposes a rigid methodology which can negate this inherent flexibility.[75]

[73] Cheung, M.L., *Dyeing Automation for Hong Kong,* Textile Asia, March 1991, p.76.

[74] 'There were startling contrasts between students who produced immediate realisations of ideas, students who worked structurally, and students who endlessly refined work'. Aldrich, W., in the introduction to *CAD in Clothing and Textiles: A Collection of Expert Views,* Oxford, 1992, p.xi.

[75] Hadrian Pigott, at the RCA, said, 'I came to see software as a landscape; a motorway which was only interesting when you turned off it. So when people say that a lot of stuff they see generated by Computer Aided Design looks similar, it seems that designers haven't gone off the motorway to explore'. Quoted by Niesewand, N., *Live wires . . . computers byte back,* Vogue, November 1993, p.104.

CHAPTER 11: SUMMARY AND CONCLUSIONS

11.01. The history of printed textiles has seen a continual cross-fertilisation of stylistic influences which, by being copied, adapted, or gradually absorbed into current trends, have prompted changes in design characteristics. In hindsight, it is often easy to see similarities between the designs of an era or culture. Within their overall homogeneity, slight differences in visual characteristics appear as variations of a dominant style and, due to this collective individuality, designs can be classified according to provenance. A retrospective assessment of stylistic changes shows major historical styles, slight variations in fashion which fit in a stylistic framework, transitional developments between styles, and isolated developments that, although appearing out of tune, might be precursors of later styles or transitions.

Adair defined the current postmodern style as a transitional period 'when modernism's earnest principles and preoccupations have ceased to function but have not yet been replaced by a totally new system of values', and proposed that the present rampant eclecticism 'represents a moment of suspension before the batteries are recharged for the new millennium'.[1] During such periods of eclecticism, stylistic influences are actively sought, with a multitude of historical and cultural sources being recycled at a faster rate. Particular visual characteristics which, at that time, are considered to be definitive of such sources, are often directly copied. A superficial incorporation of diverse imagery becomes a major stylistic characteristic, with novelty of imagery taking precedence over other components of the visual vocabulary. Structure, as a considered design component, generally decreases in importance, with repeat being mostly used simply to extend the imagery.

The recycling of imagery takes two main forms; individual motifs are used in contemporary arrangements or the structural organisation is also retained to recreate the feel of the original, as with document and revival fabrics. However, recycled imagery becomes familiar in new forms, and many designs are known from reproductions in which they are divorced from their original scale. For instance, William Morris's prints are generally seen as small-scale reproductions in which their visual effect is diminished. In many sources, structural organisation was an integral part of the design process, but when originals, designed for a particular scale, are reduced their structural organisation is often visually

[1] Adair, G., *The postmodernist always rings twice,* The Guardian, August 20, 1992, p.30.

ineffective. This can be seen in isolated island arrangements of large-scale toiles which, when reproduced as small-scale fashion fabrics, exhibit patchy appearances. The increasing use of CAD/CAM and eclectic uses of scanned sources may reinforce these anomalies, but the reuse of such designs could re-kindle an awareness of the importance of structure to their overall appearance. Eclecticism may be a necessary method of re-evaluating the past which may instigate a reassessment of currently neglected components of the visual vocabulary, and this, combined with present technical influences, may lead to the evolution of new styles.

It is difficult to predict, contemporaneously, whether stylistic differences represent slight variations in eclectic trends or are major developments. Many styles, which are now seen to be of great importance, often only represented a fraction of the total market, and their retrospective importance is greater than their market share indicated. The beginnings of a new style may, therefore, be hidden amongst a plethora of superficially novel designs, and the future importance that will be placed on some current design developments is uncertain.

Collage designs, such as those by English Eccentrics (8.13 and 8.20) and Timney Fowler (8.22), may be seen as part of, or a transition to, a new style. Such designs have their roots in early 20th century art, and collages, as 'emblems of modernity based on industrial mass production',[2] have often been associated with radical changes of imagery. Their eclectic use of found imagery, copy and paste techniques, and multi-layered associations demonstrate a commonality of style which is also shown in contemporary graphics, television, and multi-media. The use of CD-Rom databases may increase such uses, and mixing of diverse sources of imagery and the applicability of computer technology to copy and paste techniques could provide an aesthetic impetus for the creative exploitation of CAD.

11.02. Structural trends

The current emphasis on historical and cultural references has determined the classification and presentation of designs in publications. Provenance has been the major factor used for classification. This separation of designs into styles defined by era has overshadowed an important connecting theme of European design which has been the fluctuating uses of structural and repetitive order. A classification of designs according to scale and complexity reveals structural design trends which transcend the boundaries of historical styles.

[2] Hughes, R., *The Shock of the New*, London, 1980, p.32.

Chapter 11: Summary and Conclusions

The current progression can be traced to the mid-19th century when reactions against rampant eclecticism and mechanisation ushered a return of the craftsman/designer and a divergence in attitudes to order. Ruskinite attitudes rejected structural order as a mechanistic imposition on creativity. But, at the same time, the reductionist ambience prompted the introduction of new design laws. This overwhelming drive to create rational conceptual frameworks also influenced the formulation of pattern classification systems. Design theorists and practitioners, such as Owen Jones and William Morris, analysed the structural organisation of historic and Eastern designs and, in their formulation of rules, they relied heavily on the holistic use of geometric structure for design planning. Such uses of underlying structural organisations became major components in the design concepts of the Arts and Crafts Movement.

This analytical approach affected the perception of other design sources and, therefore, their manner of interpretation. The structural characteristics of new sources, such as Japanese art, became as influential as their imagery. This structural emphasis developed, with Art Nouveau, into the moulding of design elements to strict frameworks using, what now appears as, an overt and rigid control.

Most Art Deco designs were also highly structured, but the influences of Egyptian, Russian, and naive art prompted changes from the asymmetry and linearity of Art Nouveau towards static symmetry (8.07), and placed greater emphasis on the use of texture and colour (8.18). Modernist designs also had ordered, often highly repetitive, structures but exhibited concerns with dynamic movement and a resultant rejection of bilateral symmetry. Designers often introduced hand-drawn irregularities and textural effects to counter the appearance of mechanical repetition (8.04).

These developments in structural design aspects ran parallel with the technical influences of screen printing which developed from the early stencil-like use of flat colour, with defined outlines, to a textural interpretation of painterly effects. Following the introduction of commercial screen printing in the 1950's, these effects became major stylistic characteristics, and structure became a less important component, with simple repeats being commonly used to produce striped or banded patterns.

The geometric and Op Art designs of the mid-1960's can be attributed to a continuance of 1930's modernist concepts of functionality combined with fine art's optical influences. Vasarely's modular approach was particularly influential on the use of repetition and progressions (8.29). This theme continued in the hard-edged designs of the late 1960s and 1970s, many of which were strongly repetitive, employing visual accents or progressions within simple arrays of motifs (8.04). Some of these themes were developed in experiments with flat screen printing, which involved the manipulation and successive printing of screens containing multiple units (8.10 and 8.13).

The interpretation of ethnic themes has tended to follow these changes in structural emphasis. Since the 1960s, they have moved from regular repetitive patterns towards subtler interpretations of the effects of hand-crafted designs, using small repetitive units with variations of drawing, orientation, or colour applied to individual motifs (8.13). This approach was also common to 1980's abstract and stylised designs, such as those of the Memphis group, with scattered arrangements of the same (8.10) or similar motifs (8.25).

Occasional resurgences in the use of structural complexity can be seen as variations within this main trend. These occurred in designs in which structure was integral to the designs' appearance, and are associated mostly with novelty prints (8.10), scientific influences (6.18), particular ethnic (8.18) or historic trends (8.19), and revivals of interest in Islamic design.

There has also been continual production of all-over designs which, although being structurally simple, have no obvious repeat (8.16). These and spot patterns (8.10) are economically important to the fashion industry, particularly when fashion trends preclude directional or ethnic influences.

11.03. Repeat formats

Most designs are produced for specific markets and must be appropriate for their end use. Their effectiveness depends on the visual effects produced when they are seen from a distance in repeat and applied to three-dimensional forms. Design is concerned with the internal dynamics of an image, that is the spatial organisation of elements within a single repeat unit, but, in order to produce controlled directional or non-directional effects, consideration must be given to the patterns that are produced when that image is repeated over a larger area.

The dynamics, or structural characteristics, of a pattern are determined by the use of repeat and, if this is considered at the start of the design process, an organisational framework can be established. Such repeat formats are important stylistic characteristics which influence a design's overall appearance (9.01).

During this research, it was found that various repeat formats have been used in different historical periods and cultures. Some are characteristic of many design types and have occurred regularly. Many such common formats derived from contemporary or traditional woven textiles at times when structural characteristics were important components for design interpretation. These include the block/pillar/horizontal-mirror (9.10) and brick/stripe/horizontal-mirror (9.27) formats found in turn-over patterns (8.05 and 8.17).

Some are associated with specific styles. For example, the brick/stripe/vertical-mirror format (9.27) appeared most often with Russian constructivist and modernist designs in which, combined with directional motifs, it was used for patterns with dynamic movements. Others were rarely used and, although a few, such as irregular (9.32) and drop/pillar/rotation (9.18) formats, occur frequently in authentic ethnic designs, like ikats and batiks (8.09), these structural characteristics have mostly been disregarded in European printed interpretations. Often the structures are simplified with emphasis placed on the sources' characteristic textures and imagery.

Historically, some formats were used to add variety to prints whilst using small repeats and narrow fabrics. Designers developed formats to maximise the design potential of particular printing and engraving processes whilst working within the limitations imposed by them. Regularly used formats were employed because the designer, understanding the link between structure and design forms, would know what visual effects to expect and could confidently work within established plans. Many recurring design types were based on particular structural arrangements. For example, the block/stripe/horizontal-mirror format (9.11) is common to most serpentine patterns (8.06), and the block/diaper/horizontal-mirror format (9.12) often underlays ogee patterns (8.17).

Technological changes have altered and, now, removed many practical restraints. Increases in the potential size of repeat, provided by larger printing elements and wider fabrics, have eliminated the dependency on structural methods of design planning within a small repeat. Large units are possible in modern printing but, although some 1960's large-scale designs, particularly opticals and geometrics, made use of transformed (8.27) and composite (8.29) formats to create highly structured appearances, they have been used mostly with simple repeats

(8.25). The technical potential of creating large-scale complex repeats has not been developed (8.32), and the variety and complexity found, historically, in small-scale units (8.07 and 8.10) has never been exploited at this scale.

The current emphasis in design innovation centres on different types or treatments of imagery which are usually combined with simple or familiar structural formats. Repeat is now used mostly to create design continuity, rather than for design organisation, but the formats associated with previous technologies are still relevant. The visual language of the contemporary designer has evolved from past designs, and repeat formats are an important part of that vocabulary.

11.04. CAD

Since the introduction of screen printing, designers have increasingly worked with mixed media. This evolved from a general emphasis on tactile qualities in the arts and the increased technical ability to interpret and engrave painterly effects. Computer graphics may increase the designer's creative use of mixed media, but many generally available facilities are not yet included on CAD systems (10.03). Statements, such as 'CAD was not just a tool, an electronic drawing board, but it could be used to extend the design creativity of designers',[3] will not be realised until the industry actively exploits systems for their design potential.

In 1990, Moore, writing about desktop publishing, proposed that designers 'must continue to open their minds to the prospect of utilising technology not only as as an automation tool but as a process which expands their very ability to innovate'.[4] Developments in this field have moved towards designer-orientated systems which are fully compatible with production systems. Their introduction was not without problems and, in 1984, Pipes suggested that interactive CAD design was construed, by printers, as allowing designers to change their minds.[5] These systems now include facilities, such as separation specification which 'provides more control over how the job will look, but also means the designer becomes responsible for more of the problems of production'.[6]

Such compatibility between design and production systems could be a way of increasing creative CAD use for printed textiles. If files are transferable and adaptable for production, more creative tools can be provided at the design level.

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[3] *The Increasing Influence of the Computer,* Textile Month, May 1986, p.39.

[4] Moore, D., *Innovate & Automate,* Aldus News, vol.1 issue 3, Autumn 1990, p.7.

[5] Pipes, A., *The cad cover-up,* Design, no 432, December 1984, p.54.

[6] Haimes, R., *Colour on the Desktop: Pioneering users are changing the way we print,* Computer Graphics World, May 1988, pp.38-9.

Computer-literate designers, when transferring files to a production system, could discuss special effects or production requirements with a skilled operator. In this way, designers could increase their knowledge of CAD/CAM's potential without being directly responsible for its implementation. This would eliminate the scanning and correction processes involved with conversion, and the role of the engraver could become more that of intermediary than interpreter.

The Quick Response ethos has already prompted the introduction of modular, integrated fashion and textiles systems which are 'aimed at addressing all aspects of the design cycle from concept to manufacture' and allow 'designers to take concepts through to fabric design and finished garments'.[7] These provide visualisation facilities to 'contour map from a painting, sketch or fabric sample onto either a photographed or hand-drawn model'.[8]

At present, visualisation is promoted as a marketing aid but, used during the early stage of the design process, could provide feedback for design decisions based on an assessment of a design's potential effectiveness on a garment or furnishing form. This may engender a greater awareness of how repeated patterns interact with three-dimensional forms when affected by drape and cut. Rather than patterns being treated as surface effects, more consideration might be placed on how their structural characteristics can enhance forms. This association could be further developed with engineered prints in which integrated garment pieces and textile patterns can be printed as lay plans (10.11). Although this approach is directly applicable to fashion fabrics, it could be an interesting development in other areas, such as customised upholstery fabrics.

11.05. A structural use of CAD

Owen Jones argued that 'the modifications and developments which have taken place from one style to another have been caused by a sudden throwing off of some fixed trammel, which set thought free for a time, till the new idea, like the old, became again fixed, to give birth in its turn to fresh inventions'.[9] New technologies have often instigated such sudden changes, but their exploitation in design terms has depended upon the receptiveness of the industrial and aesthetic climate to technical innovation. If the role of designers continues to be seen as

[7] *Dedicated Followers of Fashion,* CADCAM International, October 1989, p.36.
[8] Masters, N., *CAD in Fashion,* Computer Images International, April 1989, p.16.
[9] Jones, O., *The Grammar of Ornament*, London 1856, reprinted London 1987, p.2.

primarily artistic and technology considered a necessary evil, a neutral intermediary between design and production processes, CAD will not have an impact on style. Designers' lack of involvement with technology could prevent the development of CAD's creative potential.

In 1977, Cooley commented on the 'significant gap between that which technology could provide (its potential) and that which it does provide (its reality)', and he suggested that there is a tendency 'to make value judgements about given technologies based on what they might achieve rather than that which they have already achieved and are likely to continue to achieve within a given economic, political and social framework'.[10] This mismatch makes it difficult to predict how technology may be exploited. In 1993, Hearle commented on his personal experience of this; 'I was optimistic about the prospects for textile CAD 25 years ago. The ideas put forward then still seem relevant today, but they have been slower in implementation than I had expected'.[11]

Although the development of CAD facilities relating to repeat formats has the potential to stimulate a more considered and innovative use of structure, this might not happen because there is, at present, no perceived economic or aesthetic need. Structural considerations are largely absent from contemporary design methodology and education, consequently, existing repeat facilities have been used in an unsophisticated manner. Watkins suggested that early users of CAD were 'Beguiled by its astonishing capabilities, systems were quickly used for their reproductive facility in terms of repeat, . . . often with very banal results. Repeats were too symmetrical, . . . and the ease with which a motif could be put into repeat produced problems with tracking'.[12] She continued; 'the computer itself was not responsible for these results', but these could be attributed to the ease with which the facilities could be used 'without first acquiring design skills and experience'.

A creative approach necessitates a reappraisal of the role of structure in contemporary design and education. Unless designers become more aware of structural considerations, repeat facilities will continue to be used for mundane designs. This would encourage the perception of computers as mechanistic inhibitors to the design process, and delay the development of more sophisticated

[10] Cooley, M.J.E., *Impact of CAD on the designer and the design function,* Computer-Aided Design, vol. 9, no. 4, October 1977, p.238.

[11] Hearle, J.W.S., *Computer-aided textile design: The problem of three cultures,* Textile Horizons, vol. 13, no.5, October 1993, p.19.

[12] Watkins, P., in the *World Review of Textile Design,* 1991, quoted by Hearle, J.W.S., *Computer-aided textile design: The problem of three cultures,* Textile Horizons, vol. 13, no.5, October 1993, p.15.

facilities.

The development of repeat facilities could involve re-evaluating the use of structure in historic designs and adapting earlier manual methods for current technology. Alternatively, an evaluation of the role of structural trends and on-going changes in attitudes to order could be used to predict the future role of structure if technology is exploited for new design possibilities. A pro-active approach should consider how computer graphics can facilitate methods of pattern construction that would previously have been difficult, time-consuming, or impossible to apply manually. It should also exploit current and future printing and engraving developments.

The scale and complexity of designs has been determined, to some extent, by technical and economic factors. The current dominance of rotary screen printing has produced a bias towards simple blotch and textured designs (8.25). Roller printing was suited to very small-scale intricate designs (8.07), but this process, being uneconomic for short runs, has made such designs unsuitable in the climate of Quick Response. Laser engraving now 'makes it possible to engrave typical copper roller designs directly onto the screen',[13] and this, combined with increased engraving speeds, may allow the production of detailed and complex designs for the fashion market. The scale of 19th century roller prints was determined by the vertical repeat which, 'while being reasonable for dress fabrics, greatly curtailed the inventiveness of furnishings'.[14] Now, the comparable quality of laser-engraved detail, combined with the increased size of repeat obtainable by rotary screens, could be applied to new furnishing designs having large-scale complex structures.

The impact of further jet printing developments on textile design could be enormous, and may follow the carpet printing industry's experience where, by removing the intermediary stages associated with screen production, it has dramatically speeded up design changeover times, producing faster responses to market trends for short runs. A demonstration of the Millitron system by Shaw Carpets, in 1986, showed '1000 different designs were dye injected in less than 75 minutes, a task that using rotary screens would have taken 6 months'.[15] This has parallells in the publishing industry, where digital printing 'is set to revolutionise the

[13] Berfelo, K., *Laser engraver enables finer detailing of designs,* Textile Horizons, September 1990, p.32.
[14] Storey, J., *Textile Printing,* revised edition, London,1992, p.173.
[15] Textile Month, *The Increasing Influence of the Computer,* May 1986, p.40.

production of magazines and newspapers by the end of the decade' . . . because it . . . 'will do away with costly printing plates and allow changes to be made without stopping the presses'.[16]

Jet printing might produce characteristic qualities which may restrict its range of applications, but economic and quick response factors ensure that any commercial applications will soon be exploited. This may be especially relevant to the fashion market in which short runs are increasingly important. The direct digital link could facilitate the printing of full-colour scanned imagery. This would fit in with current eclectic trends (11.01), but could also stimulate experimentation with photographic sources and computer-aided image-manipulation techniques.

Taking all this into account, there are two approaches that could be made in the development of repeat facilities. Extension methods, which can be seen as a continuation of 20th century structural trends, could be developed to exploit the future use of jet printing. Holistic methods, based on contemporary reinterpretation themes, may lead to more complexly structured designs which would be suited to laser engraving techniques. In each case, the repeat is essential to the character of the finished design, but differences occur in the emphasis placed on the uses of repetition or structural organisation, and the time at which repeat is considered in the design process.

11.06. Extension methods

At present most textile CAD systems allow drawn or scanned design units to be repeated for proofing (10.08) and correction (10.10). Most of the formats described in Chapter 9 can be constructed using standard raster graphics operations with extension methods (10.04). These methods are used to create continuity with existing design units. Structural experimentation is a form of trial and error in which, by selecting different formats, the effects on a given unit can be investigated.

The provision of a greater range of repeat formats at this stage could stimulate an awareness of pattern's potential but, due to the lack of continuity of design elements over the unit boundaries, designs may be limited to spot or box-like patterns. Also, when repeating scanned images which have been designed to be continuous in a particular format, any slight miscalculation in the original drawing or error in its orientation during scanning will cause a lack of continuity in the repeat.

Hearle's suggested use of computer technology for randomly changing

[16] Rubens, P., *Digital presses cut cost of printing,* Sunday Times, 31 October 1993, section 3, p.11.

elements within a repeated design (10.18) has not been taken up, although it follows a major 20th century theme. Aspects of this are being exploited for knitwear designs which cover the whole garment shape. Computer controlled machines for this application were used for bold large-scale designs or single images, but the emphasis has now changed. This technology is being used for designs that appear to be repeated patterns, but do not actually repeat, and randomness can also be applied to make individual garments of a given design subtly different.

Computer generated randomness could be used with designs having regular grid structures, such as simple arrays (8.04) or spot patterns (9.38). Random effects from a range of variables could be applied to individual motifs within such arrangements to create a non-mechanised appearance. Depending on the selection of characteristics to be affected and the parameters within which the variables operated, subtle or obvious differences between the motifs could be achieved. These might appear as slight irregularities or strong visual accents in the overall pattern.

Raster graphics would be directly applicable to variations of orientation, size, and colour (10.04). Vector graphics, by generally allowing more control of individual design elements (10.11), could provide a greater choice of characteristics, such as line thickness, tint value, filling pattern, and overprinting. With motifs formed of groups of elements, variations could be applied to selected elements and to their overlay priorities. By retaining the characteristics of some elements within a repeated design whilst randomising others, such variations could be applied to other types of design. Selectivity could be used to retain any continuous elements that join across unit boundaries in repeat, with variability only applied to elements contained within the unit. An essential requirement for such CAD applications would be a facility for interactive changes, allowing the perceptual skill of the designer (9.38) to be used in the identification and alteration of any awkward effects or visually intrusive elements created by randomisation.

Screen printing allows the full width of the fabric to be printed, although the vertical repeat is limited by screen length or circumference. Production-quality jet printing may remove this restriction and allow the production of designs that have no vertical repeat at all. In 1993, Hearle stated that, although the limitation of a vertical repeat had been eliminated in computer-controlled jacquard weaving and knitting, 'designers have not exploited this opportunity. At most, there have been experiments with computer-generated random patterns. What is wanted is creative control by the designer, blending order and variability'.[17]

Jet printing's direct digital control could allow the data for one design unit to be continually affected by randomly generated variables from a selected range. A printed array pattern may have a total repeat containing many units, each being slightly different. Individual units, therefore, recur along the printed length and the total repeat must be considered in matching the sideways repeat. With applied randomness, the recurrence of identical groupings of motifs would be remote. The height of the unit could be used to match the repeat, providing less wastage. The use of these types of designs for furnishings could create a completely new style of interior design.

Randomness applied to small-scale spot patterns could aid the production of non-directional fashion fabrics in which each length would be different, although superficially similar. The present production climate of short runs, fast changing designs, and individuality may be conducive to this type of design innovation. Such designs would have an underlying organisation, but continuous variations would alleviate their repetitive character and create more *natural* appearances, in keeping with changing attitudes to order.

11.07. Holistic methods

Contemporary revivalist trends reflect consumer demands for fabrics that can co-exist with a variety of other styles, forming a slow eclecticism of traditional and ethnic themes as opposed to the complete new looks popular in prosperous times. A considered approach to the use of structure would allow a more sophisticated interpretation of such sources. Rather than simply copying the originals, their formats could be combined with contemporary imagery for new designs that, although evoking another time or place, do not rely on the nostalgic recreation of the past or the superficial imitation of other cultures.

With holistic methods, the structure is an integral and considered part of the design process. The internal dynamics of the design and the repeat are integral to the design concept, and the relationships between the repeated units are considered as the design is developed. Different formats have inherent structural characteristics which can be accentuated or diminished by the scale, proportions, and internal organisation of the repeat unit (9.05). These can be used to produce

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[17] Hearle, J.W.S., *Computer-aided textile design: The problem of three cultures,* Textile Horizons, vol. 13, no.5, October 1993, p.19.

symmetrical, directional, bidirectional, or nondirectional effects, which can be related to the fabric's end use.

Facilities for drawing in simple repeat are provided by some CAD/CAM systems (10.09), but developing this for more complex and transformed repeats could usher in a new era of pattern experimentation in which the computer would play a definitive role (10.18). The functions of repetition, rotation, and mirroring, which are required to build up complex patterns, are standard computer facilities. By using these in a modular pattern classification system, a complex repeat format could be specified at the start of the design process. A unit of a chosen size could be repeated using the selected format, and each addition drawn in it could be repeated in accordance with this format. This could allow the designer to see how the repeated and/or transformed units mesh together as the design develops. An immediate visualisation of the design over a wider area could provide feedback on its overall effects. This would allow informed decisions to be made throughout the design process and provide a more natural environment for the designer who 'learns about a problem by posing tentative solutions to it'.[18]

A greater understanding of the characteristics of repeat formats, combined with this use of computer facilities, could open out the neglected area of the controlled use of the dynamics of pattern. This implies a considered use of the inherent characteristics of repeat formats to produce visual effects which relate to the design's end use, rather than the mere avoidance of unintended bands or focal points on a surface covering. The combination of recycled themes and CAD's technical stimulus could prompt a synthesis similar to that of the Arts and Crafts Movement, in the late 19th century, where the structural formats of historic and oriental designs were re-worked using contemporary imagery.

The present design climate generally precludes an overt use of structure, and many earlier designs were based on underlying structures to which alterations and additions were made (9.39). Design is a dynamic process, consequently, any system for pattern construction must be designed to cope with different eventualities, and would need to work on micro and macro levels to retain a flexible approach. This might entail a provision for the designer to work on a repeat unit to initiate an overall design structure, and then switch to working on the total repeat to include alterations and additions (9.06).

[18] Cross, N., *Styles of learning, designing and computing,* Design Studies, vol.6, no.3, July 1985, p.157.

Such a development depends on devising a system of classifying complex repeat structures using a method that is easy to understand, but also refers to existing terminology. Terms, such as drop and brick, are a part of the textile designer's vocabulary, and any new system for pattern specification must include these in order not to alienate potential users.

There are many variables to be considered in the design of a CAD system for this application, and the user interface would be a prime consideration (10.19). The provision of more options increases the complexity of organisation and documentation. But systems that are complex or unwieldy to operate become counter-productive. Canter commented, 'If computing engineers, designers, and researchers do not learn a new way of thinking about their products, we will increasingly be confronted by "well designed" computers which are harder and harder to use'.[19]

Technological development is usually based on existing methodology. Computer technology for printed textiles has been developed in an era in which there has been little use made of repeat, and it has relied heavily on an interpretative use of technology. It takes time for the character and potential of a new process to be realised, and there is a time lag in which it is used solely for the efficient replication of existing techniques and their related design styles.

In 1983, Grigg predicted that the increased productivity of CAD would give the designer 'more time to explore creatively and to develop more designs, which could not have been considered using earlier methods'.[20] There has not been any appreciable evidence of this happening in industry. Designers and design students must explore the potential of new technology, and develop relevant techniques, design styles, and visual vocabulary, rather than just adapting their existing methods.

A comprehensively new approach to the use of repeat could stimulate such experimentation. Machines which have been derided for their imposition of mechanical repetition may, using different approaches, actually help to create designs that are sympathetic to contemporary and, possibly, future attitudes to order. But technology's potential as a catalyst for design innovation depends on the provision of suitable CAD facilities and their creative exploration during the design process.

[19] Canter, D., *From knobs and dials to knowledge,* Design, no.428, August 1984, pp.31-33.

[20] Grigg, P.J., *A CAD interface for textile design,* Computer Aided Design, vol.15, no.1, January 1983, p.38.

11.08. CONCLUSIONS

1. Styles continually evolve from combined technical, cultural, and historical influences within particular soci-economic frameworks. Structure is an important visual characteristic of different styles but, historically and culturally, variations have occurred in the degree of emphasis placed on its use in design processes.

2. The importance of structure as a considered design component has generally diminished when stylistic emphasis has been placed on other elements of the visual vocabulary, such as imagery or printed effects. Eclecticism increases the superficial incorporation of diverse forms of imagery but, at the same time, introduces a renewed awareness of designs from other periods and cultures.

3. Changes in structural emphases have reflected differing philosophical attitudes towards mathematical explanations and representations of the natural world. These have influenced reactions to the use of structural order in design, and have also affected the classification and interpretation of current design sources.

4. Classification systems group items together according to the factors chosen as meaningful similarities, and these differ according to the use for which the system is intended. Design classification systems tend to reflect current stylistic pre-occupations. Most contemporary publications group design sources according to provenance or imagery, but other methods of classification will group them together differently, and allow other information to be derived.

5. The classification of designs according to their scale and complexity shows relationships between printed textiles and the printing and engraving techniques of different eras. This classification reveals structural design trends which transcend the boundaries of period styles. It also indicates classes of design which have not been used because the relevant technical, economic, and aesthetic factors have never co-existed.

6. New technologies have mostly been used first within existing stylistic parameters, but have produced unique characteristics which then contributed to

the development of new styles. The delay between the introduction of technologies and their impact on design styles has varied according to how conducive the economic and aesthetic conditions have been to technical innovation.

7. The combined effects of CAD/CAM and current textile printing and engraving developments have the potential to initiate new design styles, but their impact on them has been retarded by a bias towards production applications.

8. The exploitation of CAD for creative design applications has been hindered by the association of mechanisation with an overt use of order. Banal uses of existing computer repeat facilities have exacerbated these perceptions. This lack of sophistication reflects the current inexperience with structural aspects of design which has resulted from its diminishing use in 20th century design and neglect in textile design curricula.

9. The repeat format classification system classes designs according to their structural organisations. It shows that there are relationships between a design's repeat format and its overall visual effect, such as direction or stability. It identifies commonly used formats; some have occurred continuously in history, but others are associated with specific cultures or periods. This classification also highlights formats that have not been used.

10. This research identified two potential methods for using CAD repeat facilities in relation to current printing and engraving developments. Further research is required to determine the range of designs that are applicable to each approach.

11. The extension method is a continuance of 20th century structural trends. The proposed application suggests the modification of individual units within array or spot patterns by the application of random transformations and variations. This method is seen to be particularly relevant to the future development of jet printing.

12. The holistic method could be exploited for design reinterpretation trends. It demands a greater understanding of the effects of repeat formats, and would involve pre-planning and consideration of structure as an integral part of the design process. Due to the potential complexity of designs, this would be most suited to

laser engraving for rotary printing. Combined with visualisation, this may prompt innovative approaches to the interactions of pattern and 3D forms.

13. The provision of CAD facilities for complex repeat formats depends on creating a practical computer user interface. This would need an easily understood method of specifying formats, but should allow design flexibility to prevent overtly mechanised appearances.

14. The proposed repeat format classification system provides a suitable modular method for repeat specification which can be applied to extension or holistic methods of pattern construction. The creative exploitation of such facilities requires a change of emphasis in design education. Designers need to be aware of the potential effects of different types of repeat in order to use them to advantage. This should prompt more sophisticated interpretations of design sources which, combined with contemporary trends, would lead to new styles in which computers play a vital role.

APPENDIX 1: DEVELOPMENTS IN EUROPEAN TEXTILE PRINTING

12th-14th centuries	Wood block printing, German prints with small stamps. International prints with larger blocks.
1440	Stencilled playing cards and cloth bale markers.
1550	Peter Klock travels to Turkey and the East to research resist printing. Dutch production of resist printed fabrics.
1597	Dutch East India Company. Imported eastern wood blocked calico.
1600	British East India Company.
1616	Danish East India Company.
1619	George Wood, patent for 21 years for sole printing and staining of linen in colours in England and Wales.
1654	European woodblock printing using Indian processes. Benois Gant, Marseilles. Armenian refugees as work-force using Indian printing processes. Monochrome prints with colours 'pencilled' in. Madder prints, colours - reds, browns, purples, black.
1664	French East India Company.
1667	Wood block mordant printing in Avignon.
1675	Thomas Togood, English patent for 'tingeing' by way of impression.
1676	William Sherman, English patent for block printing with mordants.
1678	Nimes block printing.
1685	Revocation of the edict of Nantes. Emigration of French Hugenot craftsmen.
1686	French edict forbidding the printing of textiles.
1688	Swiss wood block printing in Biel, and Pourtales, set up by emigre French Huguenots.
1689	Augsburg printworks, German resist printing, Jeremias Neuhofer.
1690	Wood block printing, Richmond, Cabanne, emigre French Huguenot.
1701	British Government Act prohibiting import of Indian printed calicoes.
1712	British Government impose taxes on printed linen and calico.
1721	British Government Act prohibiting the use of printed and dyed calicoes.
1730 - 50	Resist printing with indigo, pencil-blue techniques.
1743	First patent for a roller engraving machine, Keen and Platt.
1750	China-blue printing technique for block prints and, later copperplate prints.
1752	Engraved plate printing on cotton, Robert Nixon, Ireland. Paris Bureau de Commerce allow production of resist printed fabrics.
1759	French authorise textile printing.
1774	Repeal of the British 1721 Act.

1783	Bell's Copper roller 6 colour printing machine.
1785	Development of brass and copper for pins and strips for pinning or picotage effects, 'stormont' grounds, and fine lines.
	Quercitron dye, a fast yellow allowed a new range of colours which became fashionable as 'styles' in the early 19th century.
	French ban on imported calico.
1790's	Development of discharge printing. Introduction of Turkey red.
1800	Ebinger surface printing machine.
	Discovery of resist mordants.
1805	Burch improvements to surface printing.
	Union or mule combined roller and surface printing machine.
1808	Mill engraving.
1810	Roller prints competing with block prints. Flat colour added using block or surface printing.
1815	Roller printed fancy machined grounds produced by mill engraving.
1816	Niepce experiments with photo-engraving.
1820	Mill engraving commonly used.
	Roller printed stipple effects by hammered punches and dies.
	Block printed rainbow stripes. Toby printing.
1826	Development of aniline dyes.
1830	Motifs discharge printed on roller printed rainbow stripes.
	Roller prints, same motifs on different grounds (mill engraved).
	Grounds imitating watered or striped silk.
	Lithographic printing.
1834	Pantograph engraving.
	Perrotine printing.
1837	Mechanised warp printing.
1840	Roller printed fancy ground effects.
1842	90% of British printed textiles are roller printed.
1845-55	Roller prints. Impressionistic drawing and shading of floral motifs, dots to create shading around motifs.
1854	Improved pantograph engraving, Rigby curved-table pantograph.
1856-60	Increased range of aniline dyes, benzine purple, French mauveine, and magenta.
1857	Shields flat-table pantograph.

Appendix 1: Developments in European Textile Printing

1862	Experimental stencil printing.
1893	Experiments with photo-engraving of copper rollers.
1894	Sharps stencil printing machine.
1907	Samuel Simon silk screen patent.
1910	Fortuny continuous stencilling machine.
1915	Pilsworth commercial silk screening of American army flags.
1920's	Experimental silk screened textiles, small workshops.
1920-30	First commercial use of photo-engraving of copper rollers.
1929	First patent for transfer printing.
1930's	First commercial use of hand screen printing.
1940's	First fully automated flat bed printer, Fritz Buser.
	Block printing only used for document prints.
1950	Commercial screen printing.
	Man-made fibres.
1954	Hell Klischograph machine.
Late 50's	Photo-engraving of copper rollers widely used.
1960's	Block printing no longer commercially viable.
	Transfer printing.
1961	Galvano screens, Zimmer.
1963	Automatic rotary screen printing machine and lacquer screens, Stork Brabant.
1967	Textile Graphics System with output to CRT plotter for long films.
1970's	Resurgence of interest in block printing on craft level.
	Increase in transfer printing.
1971	Scitex Chroma-Scan, first shown at ITMA, scanning of designs drawn on Mylar sheets with felt-tip pens or watercolour in up to 6 colours.
1972	Scitex Response System for electronic pattern preparation and knitting machine control.
1974	Kurt Scliessmann machine, 3 and 4 colour separation for engraved roller production.
	Experimental CAD system for textiles developed at F.I.T. New York.
1975	Computex colour separation system, the first specialised colour separation system as opposed to tri-colour separation.
	Scitex Response 200 System, for the conversion of paper designs into colour separated films for the preparation of Galvano and lacquer rotary screens, and

	rotogravure and roller printing cylinders. Output to CRT plotter.
	Quadricolour panel prints.
1976	Laser film plotter, fine detail, exact registration, evenness of exposure.
	Scitex Response 200 System with output to laser plotter.
	Hell Chromagraph CTX 330 colour scanner for the preparation of large colour separations on film for printed textiles, no editing possible. Developed from a 4-colour scanner.
	Dainippon Scanagraph, similar to the Hell Chromagraph CTX 330.
1977	Hell Textile Data Processing System 500, automatic preparation of colour separated films for gravure or screen printing from a paper design.
	Laser engraving of rubber coated cylinders for the flexographic printing of transfer papers.
1978	First patent for ink-jet printing by Milliken, used in carpet production, but too coarse for other textile printing (10 dpi.)
	Titan Mark 4B ink-jet printer for carpet production, Godfrey Hirst.
	Rotamac computer controlled rotary screen printer, Buser. Followed by similar machines by Reggiani and Stork in 1979.
1979	Chromatronic ink-jet printer by Zimmer.
1980's	Decreased demand for man-made fibres, less transfer printing.
	Resurgence of flatbed screen printing for short runs and specialist prints.
1982	Quadricolour placement prints.
1986	Laser engraving of lacquer rotary screens.
1989	Stork Excelerator A0 size jet printer for water based and reactive dyes.
1990	Developments in cotton warp transfer printing, Stork.
	Increased speeds and finer detail by laser engraving of rotary screens.
1993	Increased use of A0 jet printers for sampling.

APPENDIX 2: SYMMETRICAL ANALYSIS

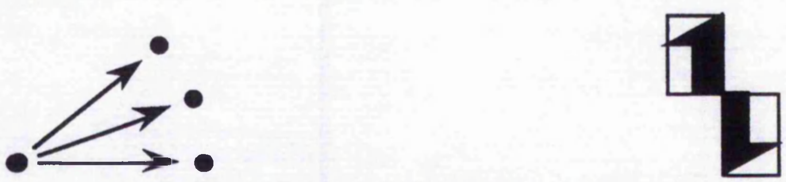
Notation

Four types of operation are used in the construction of symmetrical patterns; translation, rotation, mirror reflection and glide reflection. The following describes how these are used in band symmetry.

1. **Translation** - the carrying over of a given distance between points, from one place to another along a line. The translation of a unit along one axis produces a regular rhythmic row.

In diagrammatic form, translation is denoted by a straight line.

2. **Rotation** - the turning of a unit about a point, rotations of order 2 (180 degrees) are used for band symmetry.



In diagrammatic form, rotation is denoted by an ellipse. Its notation is **:2**.

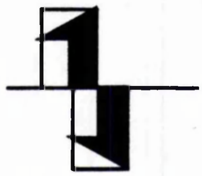
3. **Reflection** - two types of reflection are used. In **mirror reflection** the unit is 'turned over' an axis. This can be either the main axis of the band or an axis perpendicular to the main axis.

(a) (b)

In diagrammatic form, mirror reflection across the axis of the band (a) is denoted by a thick straight line. Its notation is **.m**.

Mirror reflection across the perpendicular axis (b) is denoted by a straight line crossed by perpendicular lines. Its notation is **:m.**

The other type of reflection is **glide reflection**. This is a combination of translation and reflection where the unit is translated (glided) along the axis, and then reflected over the same axis.



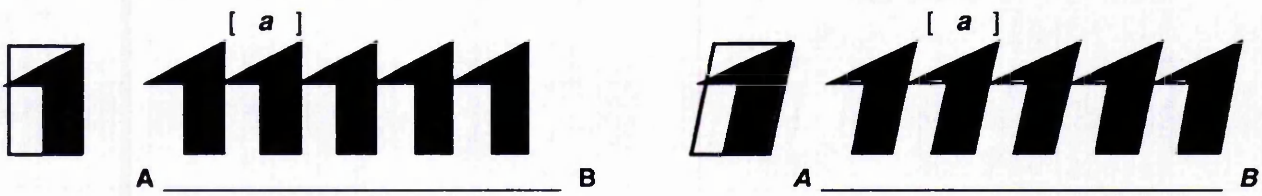
In diagrammatic form glide reflection is denoted by a dashed line. Its notation is **ã**.

The seven band symmetries

Seven classes of symmetry for one-sided bands can be constructed using these operations.

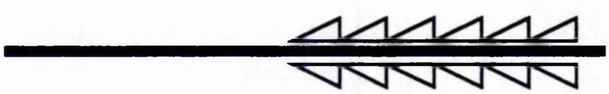
1. Symmetry (a)

This is the simplest transformation. An asymmetrical unit is translated by a distance **a** along an axis **AB.** The translation axis can be any line parallel to **AB**. It is the orientation of the line in space that is important, not the line itself. The shortest distance **a** through which the unit can be translated so that each consecutive unit touches the previous unit, is called the **elementary translation**, or **period**. In the following illustration, this distance is the same as the width of the unit.

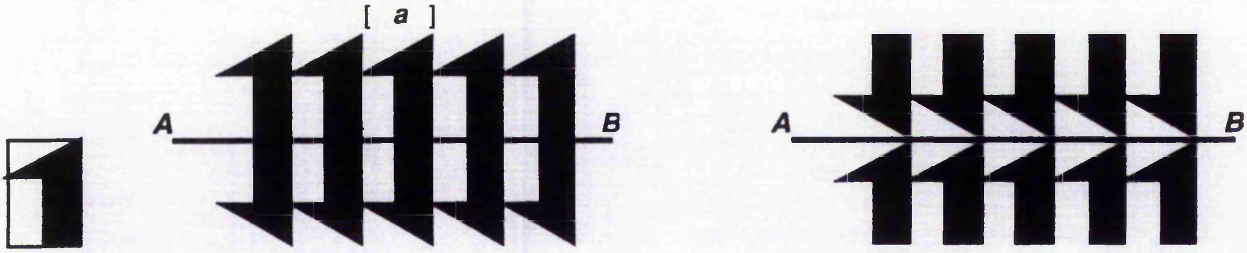


In the illustration on the right, the unit is contained within an oblique cell. The **elementary translation (a)** is the width of the cell, and therefore the units are butted up together.

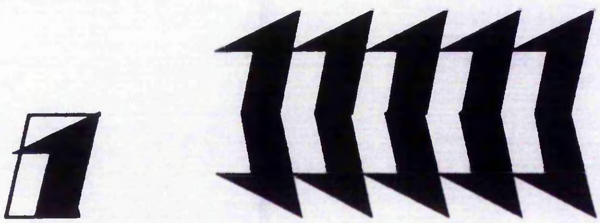
2. Symmetry (a).m



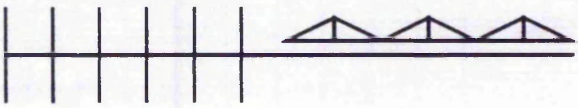
In this class of symmetry, the unit is mirrored over the axis **AB** and translated along the same axis. In the first example, the axis is at the bottom of the unit and in the second, it is at the top. The two patterns are visually different, although they have the same units and notation. In this class, unlike **symmetry (a)**, the position of the axis in relation to the unit has an importance.



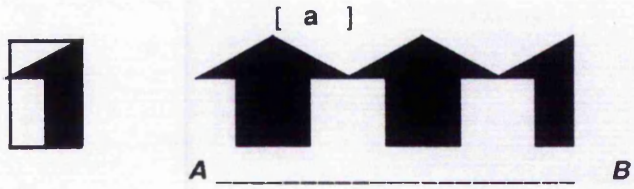
An oblique cell can also be used in this class of symmetry patterns. When the cells are juxtaposed, they do not overlap or form spaces between them.



3. Symmetry (a):m

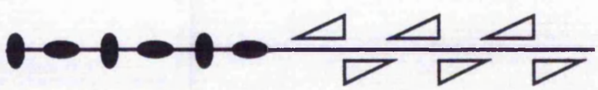


As in **symmetry (a).m**, the unit is mirrored, but this time across an axis perpendicular to **AB**.

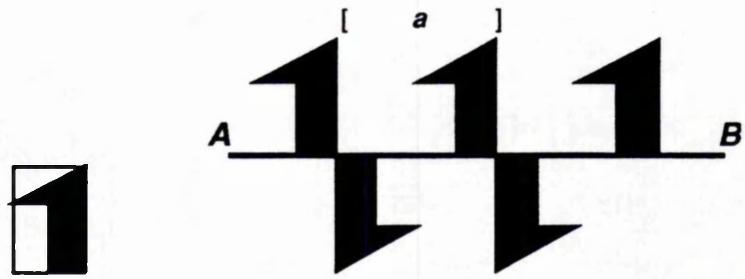


In this class, the position of the axis has no importance. An oblique cell cannot be used because, when it is mirrored, either spaces are formed between the cells, or the cells are overlapped.

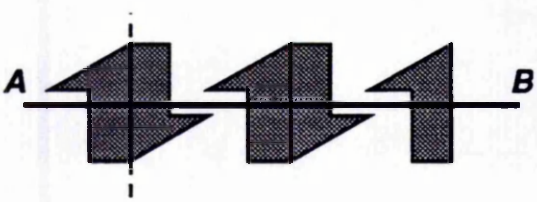
4. Symmetry (a):2

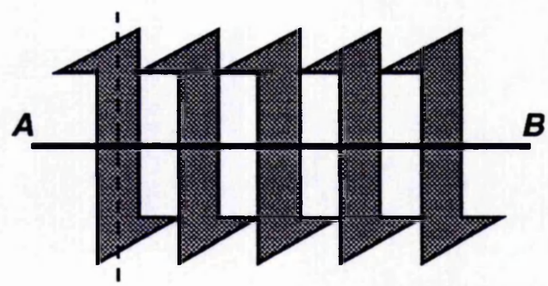


The unit is transformed by a rotation of 180 degrees around an axis perpendicular to the axis **AB**. The position of both axes in relation to the units is important to the visual character of the pattern.

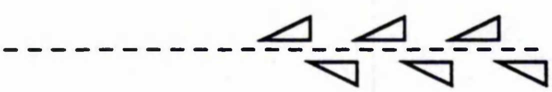


In the example below left, the axis **AB** is positioned so that it passes through the centre of the unit, and the rotated unit also straddles the axis. In the example to the right, the perpendicular axis runs through the unit, so that the rotated copy is positioned below the original unit. All three of these examples exhibit **symmetry (a):2**, even though they differ visually.

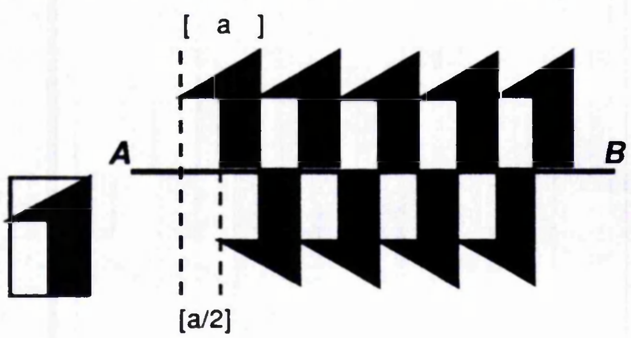


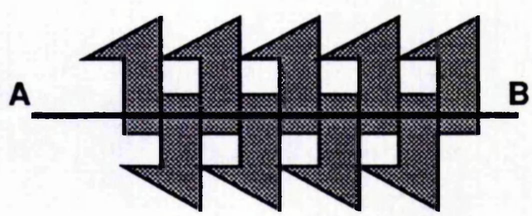


5. Symmetry (a).å

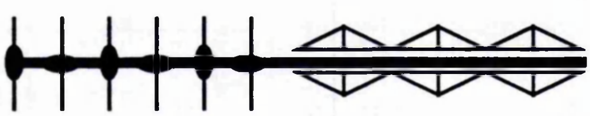


Symmetry (a).å uses glide-reflection. This involves a translation along the axis **AB** by a distance **a/2**, followed by reflection across the axis.

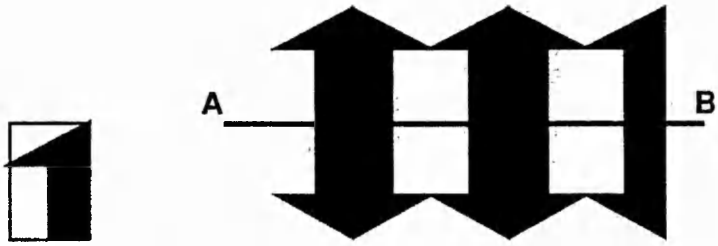


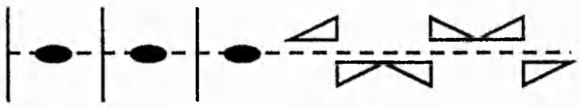


6. Symmetry (a):2.m

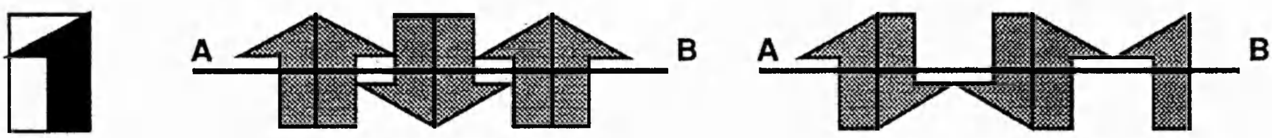


This class of symmetry is formed by combining reflection across axis **AB** with a reflection across an axis perpendicular to the axis **AB**.



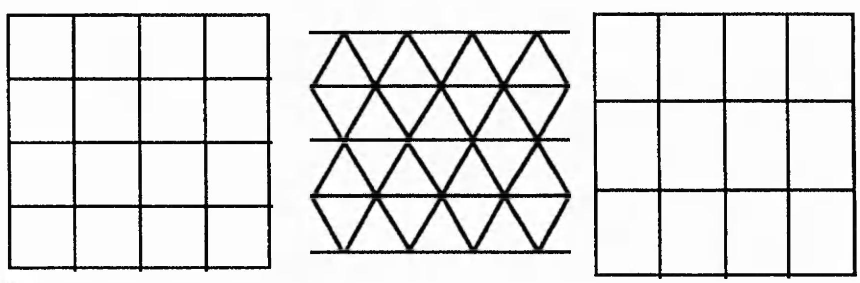
7. **Symmetry (a):2.å** 

Symmetry (a):2.å is a combination of a glide-reflection and two-fold symmetry.

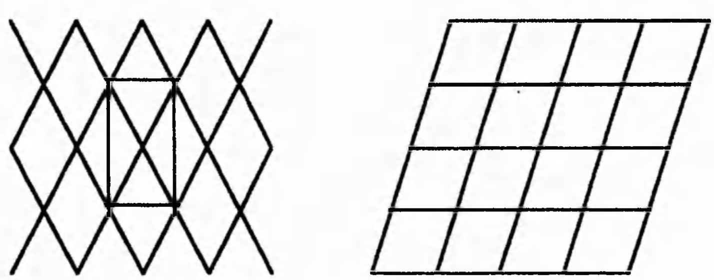


The symmetry of network patterns

In network patterns, units are repositioned both in the x and y directions. Five possible networks can be used to ensure that the units fit together with no overlaps or spaces formed between them:



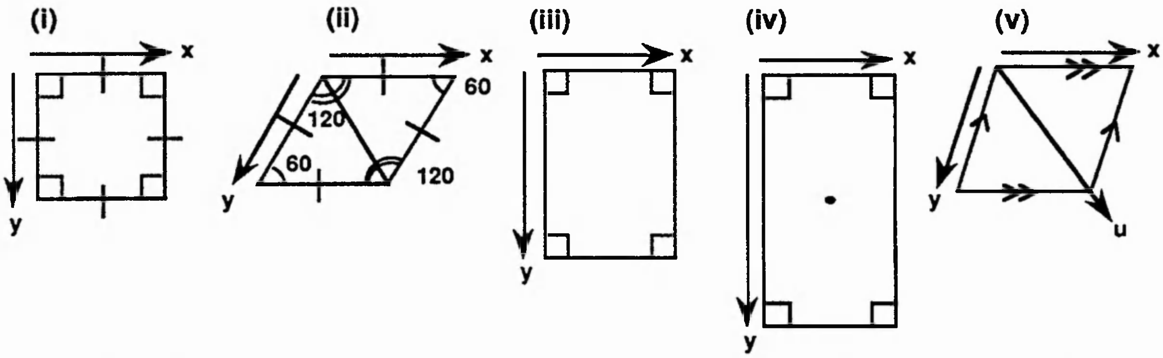
(i) (ii) (iii)



(iv) (v)

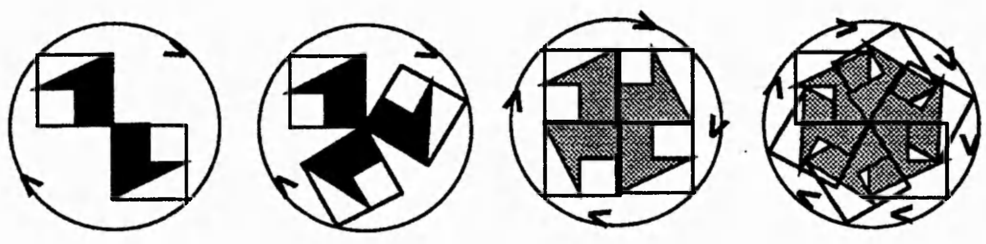
These are :- (i) square, (ii) rhombic or hexagonal, (iii) rectangular, (iv) centred, based on a diamond network, and (v) oblique.

The cells used to build up these networks are :-



(i) Square: the sides **a** (x direction) and **b** (y direction) are equal and the angle between them is 90 degrees.
(ii) Rhombic or hexagonal: this is formed by two equilateral triangles. Therefore **b=a** and the angles are 60 degrees and 120 degrees.
(iii) Rectangular: **b** does not equal **a** and the angle is 90 degrees.
(iv) Centred: in the basic diamond network **b=a** and the angles are not 90 degrees or 60 degrees. The centred rectangular cell contains a centre point on the intersections of the diamond network.
(v) Oblique: **b** does not equal **a**, and the angle is not 90 degrees.

The four types of transformation used to reposition units when constructing symmetrical network patterns are the same as for band patterns, except that translation is performed in two directions.
Rotations can be of order 2 (180 degrees), 3 (120 degrees), 4 (90 degrees), or 6 (60 degrees). These are the only rotations which allow for the units to fit together within a network.



The possible orders of rotation differ for each type of network:-

oblique	rectangular	centred	square	rhombic
2	2	2	2, 4	2, 3, 6

There are seventeen possible classes of pattern that can be constructed using these networks and transformations. A repeat is constructed in a network cell by repositioning the unit using any of the possible transformations for that network. The pattern is then built up by translating this repeat in two dimensions.

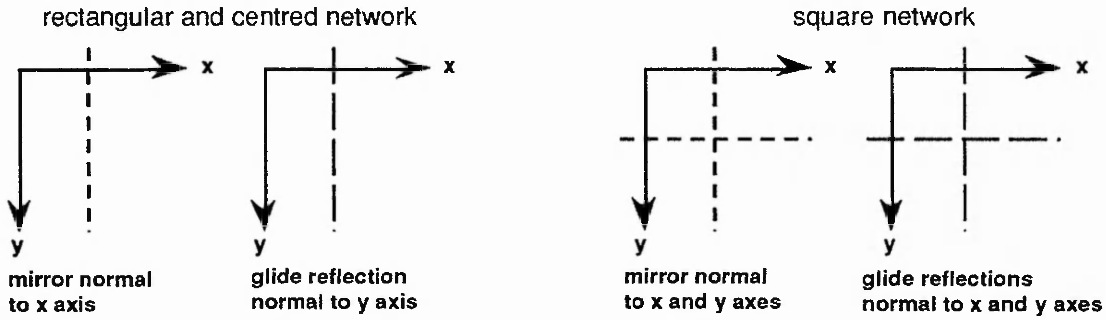
Notation

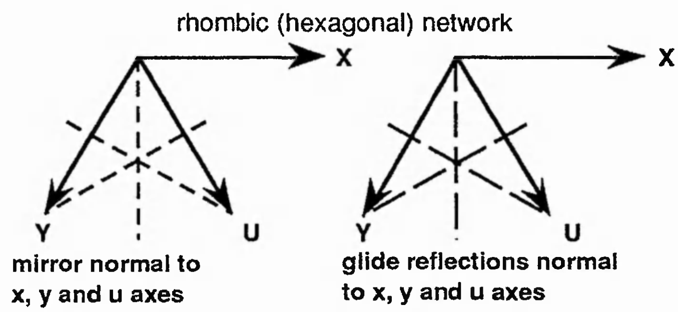
The notation uses four symbols to denote the structure of the cell:-

preface- this is a **p** to indicate a primitive cell or **c** if the cell is centred.

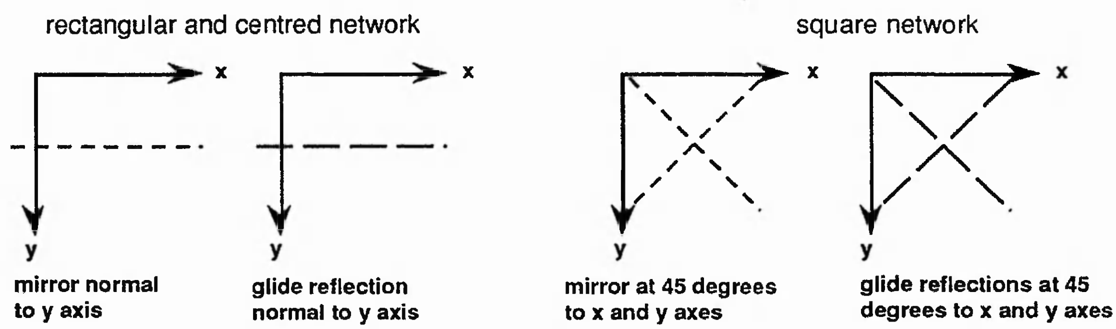
1st - a number is used to indicate the highest order of unit rotations in the repeat. It can be 1, 2, 3, 4, or 6. 1 indicates no rotations.

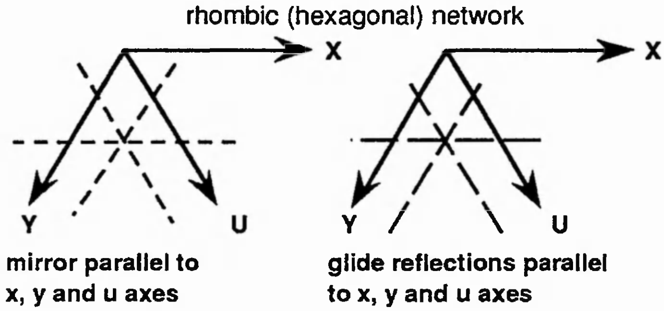
2nd- **m** is used to indicate a mirror reflection or **g** to indicate a glide reflection. The direction of the reflection depends on the type of network, as shown below.





3rd- **m** is used to indicate a mirror reflection, or **g** to indicate a glide reflection. The direction of the reflection depends on the type of network. They differ from the axes for the 2nd position as shown below.



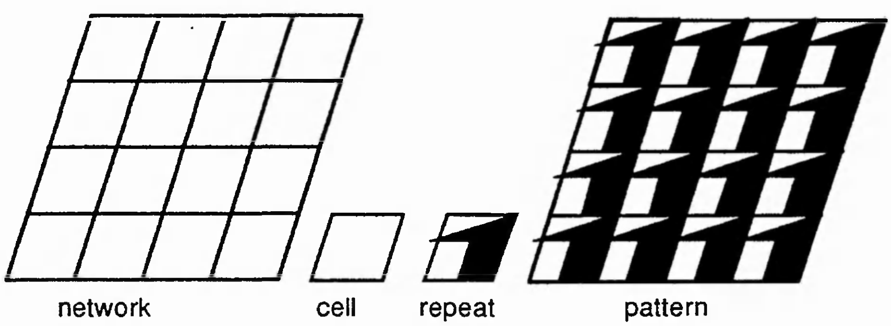


Oblique network

There are two classes of pattern that apply to oblique networks. They use translation and rotation of order 2. No other transformations will map an oblique cell onto itself.

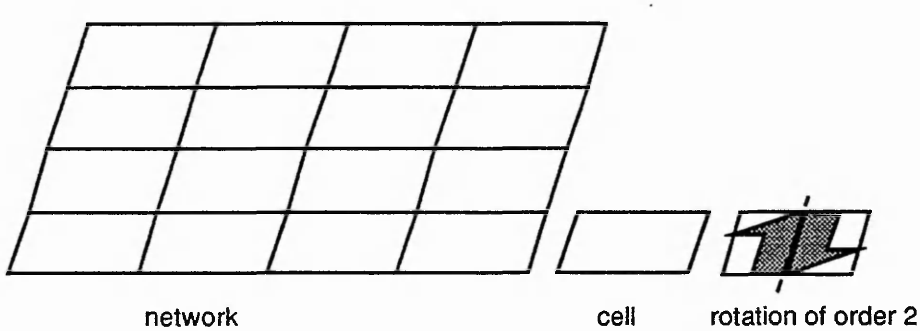
1. Pattern p1

The notation indicates a primitive cell and no rotations. Construction: this is the simplest pattern and involves translations only. The cell containing the unit is the repeat, and this is translated in two dimensions:



2. Pattern p2 (p211)

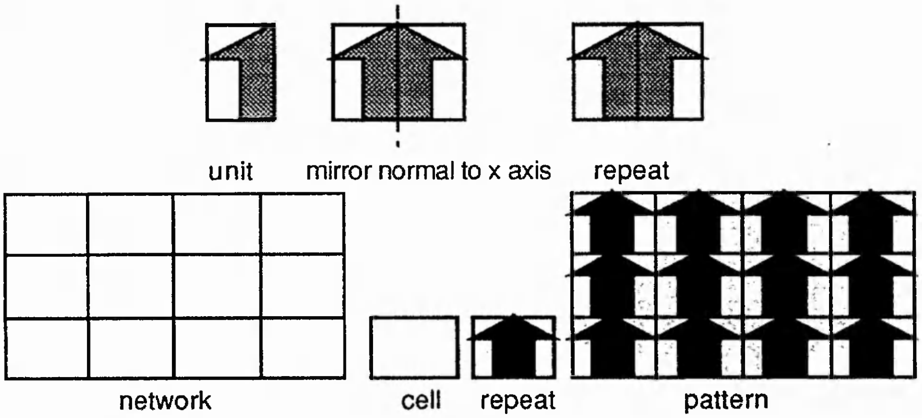
The full notation is **p211**, indicating a primitive cell, rotations of order 2, and no reflections. Construction: the cell containing the unit is rotated through 180 degrees about the centre of rotation to construct the repeat. This is then translated in two dimensions:



Rectangular network

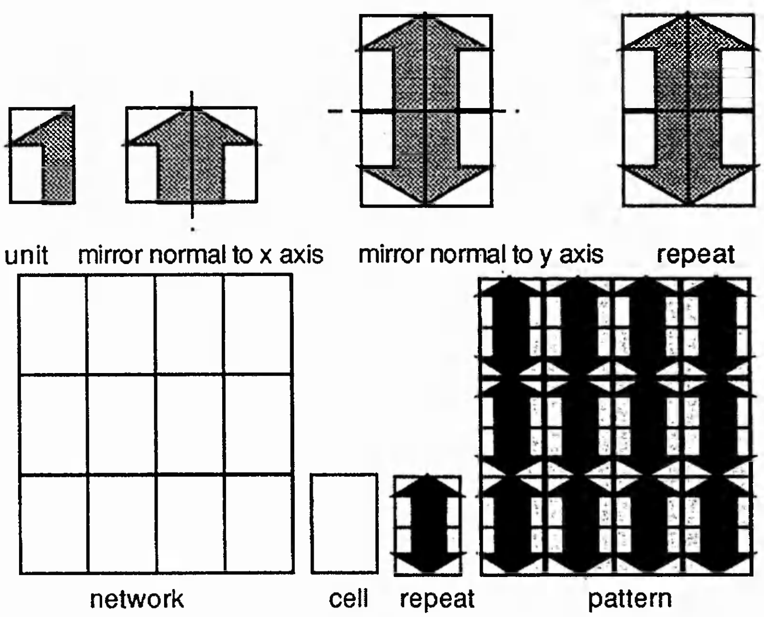
3. Pattern pm (p1m1)

The full notation is **p1m1**, indicating a primitive cell, no rotations, mirror reflection normal to the x axis, and no reflection to the y axis. Construction: the unit is reflected normal to the x axis, producing a rectangular cell containing two units. This repeat is then translated in two dimensions:



4. Pattern pmm (p2mm)

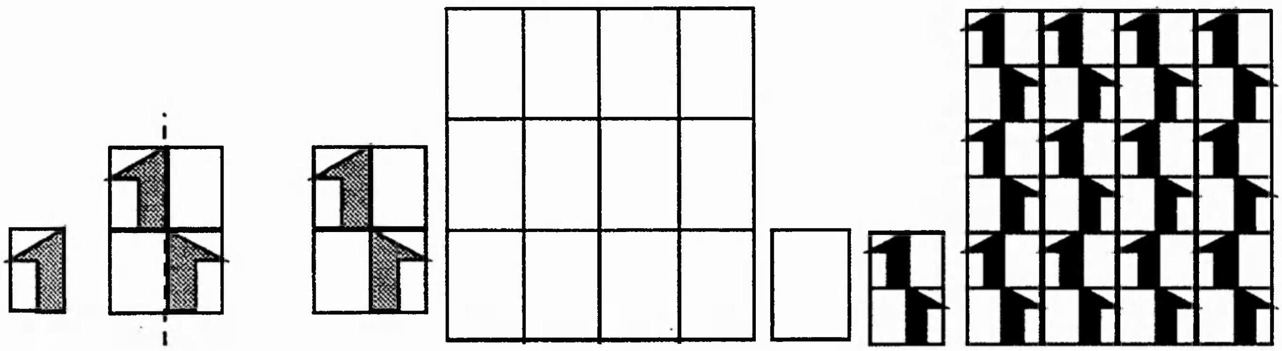
The full notation is **p2mm**, indicating a primitive cell, rotations of order 2, and mirror reflections normal both to the x axis and to the y axis. Construction: the unit is reflected normal to the x axis, producing a rectangle containing two units. This is then reflected normal to the y axis, producing a rectangular cell containing four units, which is then translated in two dimensions:



The series of operations does not included performing a rotation, but it can be seen that the unit at the bottom right of the repeat has been rotated by order 2 with its reflection on both axes. Patterns **p1mm** and **p2mm** are in fact the same. The minimum information needed to construct this pattern is **p1mm**, which is shortened to **pmm**.

5. Pattern pg (p1g1)

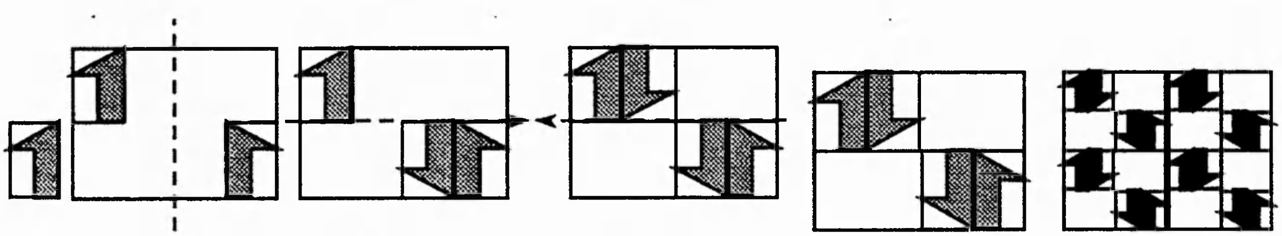
The full notation is **p1g1**, indicating a primitive cell, no rotations, glide reflection normal to the x axis, and no operations normal to the y axis. The notation is shortened to **pg**. Construction: the unit is glide reflected normal to the x axis, producing a rectangle of four network cells containing two units. This repeat is then translated in two dimensions:



unit | glide reflection normal to x axis | repeat | network | cell | repeat | pattern

6. Pattern pgg (p2gg)

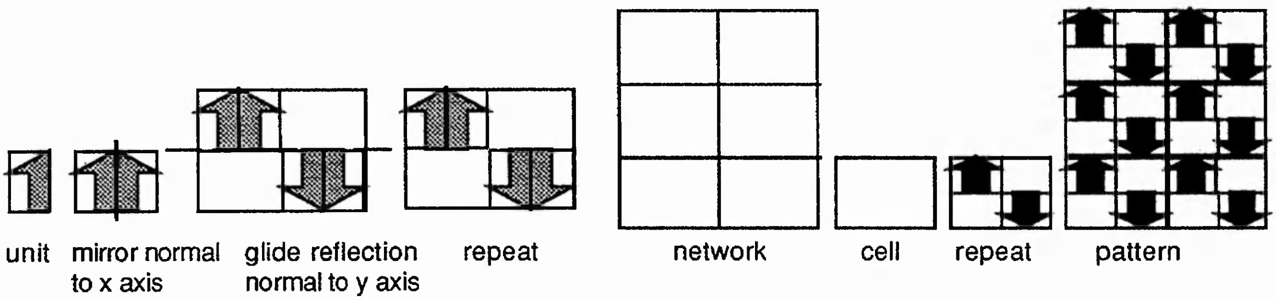
The full notation is **p2gg**, indicating a primitive cell, rotations of order 2, and glide reflections normal to both the x axis and the y axis. The notation is shortened to **pgg**. Construction: the unit is glide reflected normal to the x axis, producing a rectangle containing two units. These two units are then glide reflected normal to the y axis, which bisects the rectangle. The two glide reflections are in opposite directions. The repeat is made of four units, and then translated in two dimensions:



unit | glide reflection normal to x axis | glide reflection normal to y axis | glide reflection normal to x and y axes | repeat | pattern showing construction

7. Pattern pmg (p2mg)

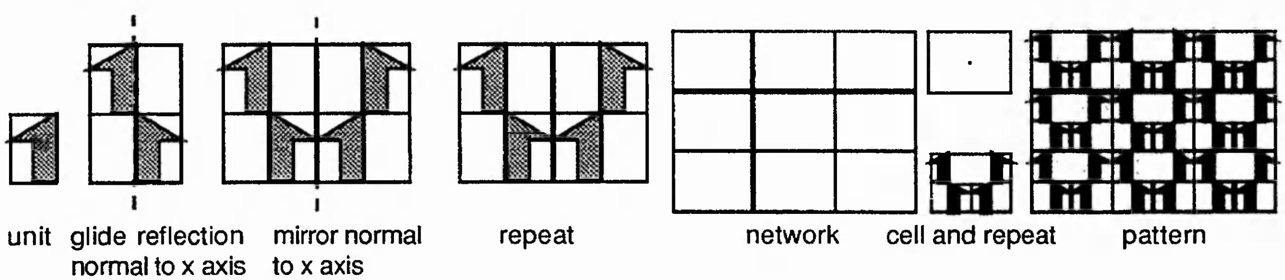
The full notation is **p2mg**, indicating a primitive cell, rotations of order 2, mirror reflection normal to the x axis, and glide reflection normal to the y axis. The notation is shortened to **pmg**. Construction: the unit is glide reflected normal to the x axis, producing a rectangle containing two units. This rectangle is glide reflected normal to the y axis. The repeat contains four units in a rectangle built up from eight network cells. This is then translated in two dimensions:



Centred network

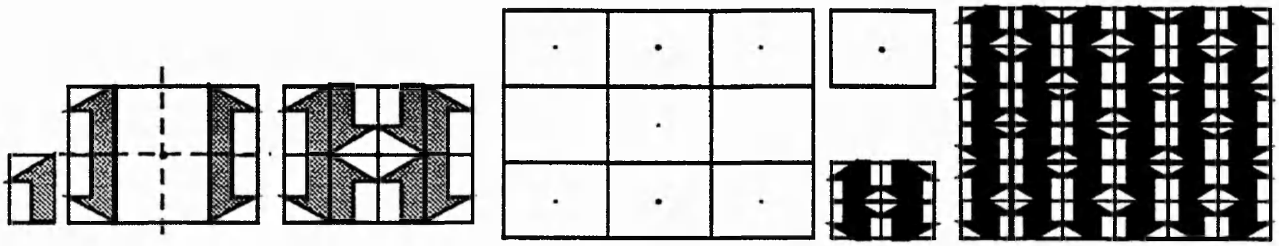
8. Pattern cm (c1m1)

The full notation is **c1m1**, indicating a centred cell, no rotations, mirror reflection normal to the x axis, and no operations normal to the y axis. The notation is shortened to **cm**. Construction: the unit is glide reflected normal to the x axis, producing a rectangle containing two units. This rectangle is mirror reflected normal to the x axis. The repeat contains four units in a rectangle built up from eight network cells. This is then translated in two dimensions:



9. Pattern cmm (c2mm)

The full notation is **c1m1**, indicating a centred cell, rotations of order 2, and mirror reflections normal to both the x axis and the y axis. The notation is shortened to **cmm**. Construction: the repeat used for **pmm** is centred, giving a repeat containing eight units in a rectangle built up from eight network cells. This is then translated in two dimensions:



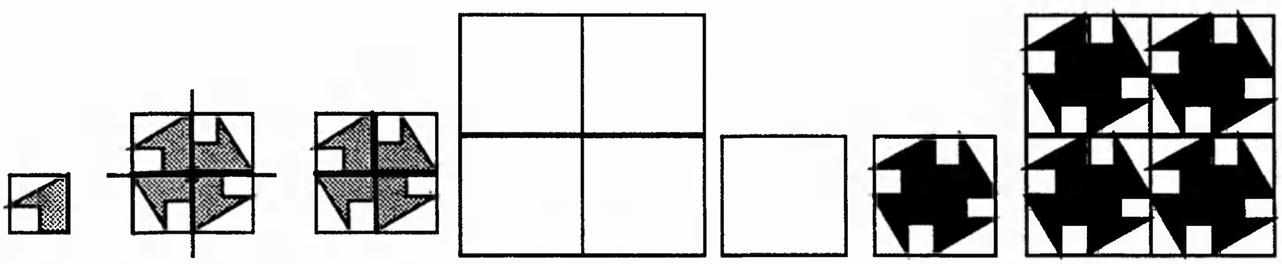
unit pmm repeat centred repeat network cell and repeat pattern

Square network

All the preceding patterns can also be constructed using a square network.

10. Pattern p4 (p411)

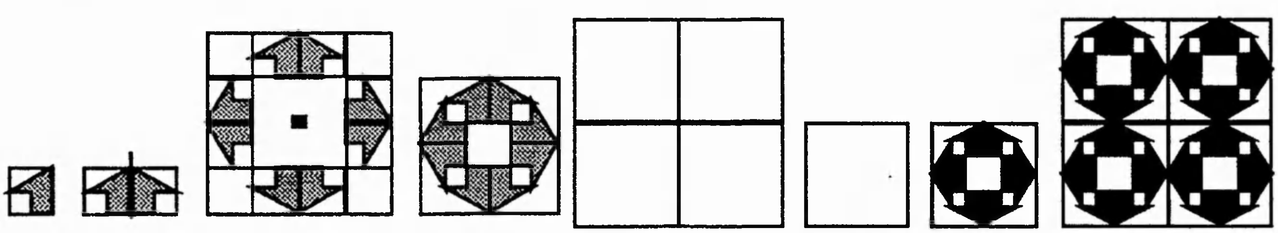
The full notation is **p411**, indicating a primitive cell, rotations of order 4, and no operations normal the axes or at 45 degrees to the axes. The notation is shortened to **p4**:



unit rotation order of 4 repeat network cell repeat pattern

11. Pattern p4m (p4mm)

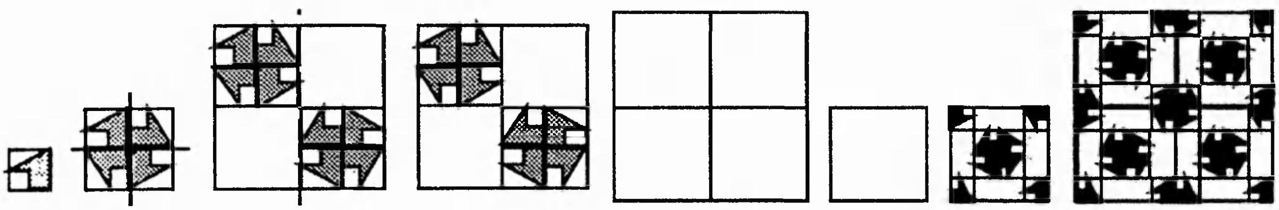
The full notation is **p4mm**, indicating a primitive cell, rotations of order 4, reflections normal the x and y axes, and reflections at 45 degrees to the x and y axes. The notation is shortened to **p4m**:



unit mirror reflection normal to x axis rotation order of 4 network cell repeat pattern

12. Pattern p4g (p4gm)

The full notation is **p4gm**, indicating a primitive cell, rotations of order 4, glide reflections normal to the x and y axes, and glide reflections at 45 degrees to the x and y axes. The notation is shortened to **p4g**:

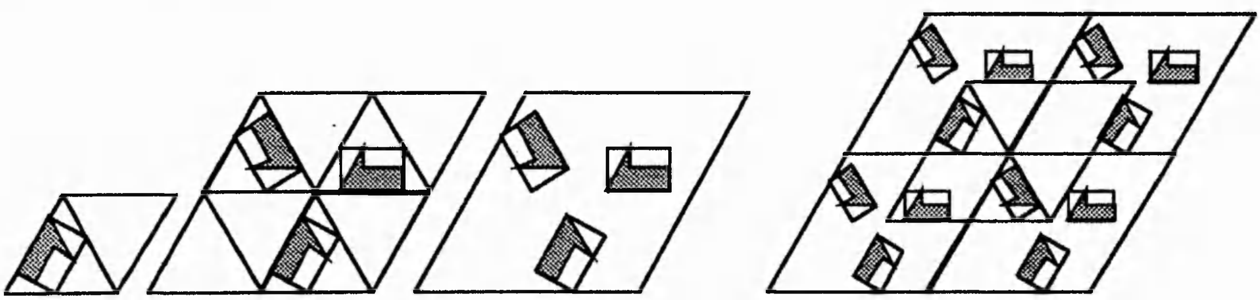


unit | rotation order of 4 | glide reflection normal to x axis | repeat | network | cell | repeat | pattern

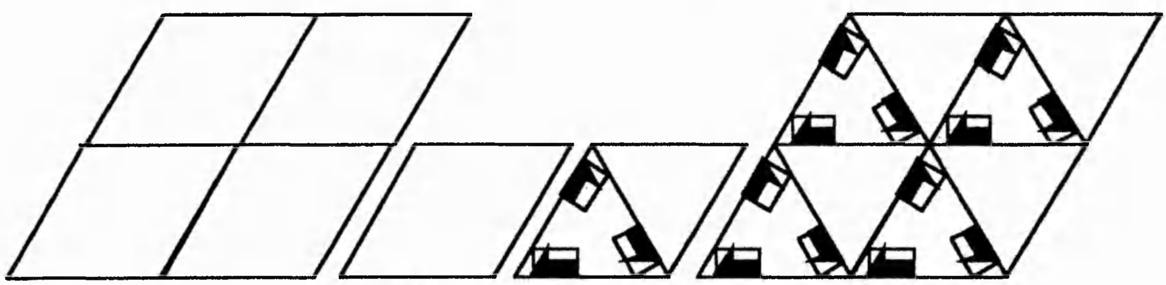
Rhombic network

13. Pattern p3 (p311)

The full notation is **p311**, indicating a primitive cell, rotations of order 3, no operations normal to the axes, and no operations along the axes. The notation is shortened to **p3**:



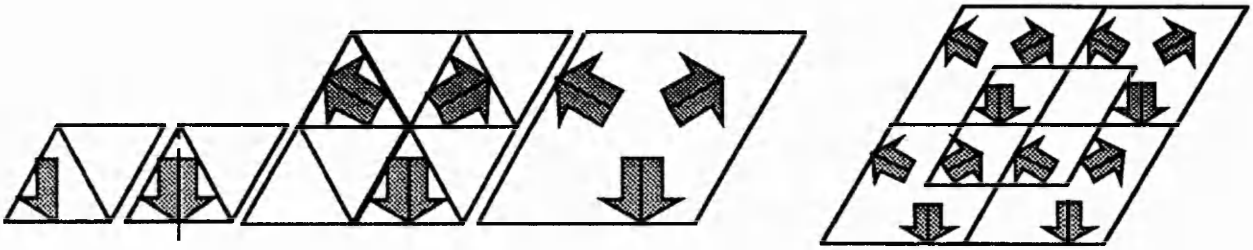
unit | rotation order of 3 | repeat | pattern showing construction



network | cell | repeat | pattern

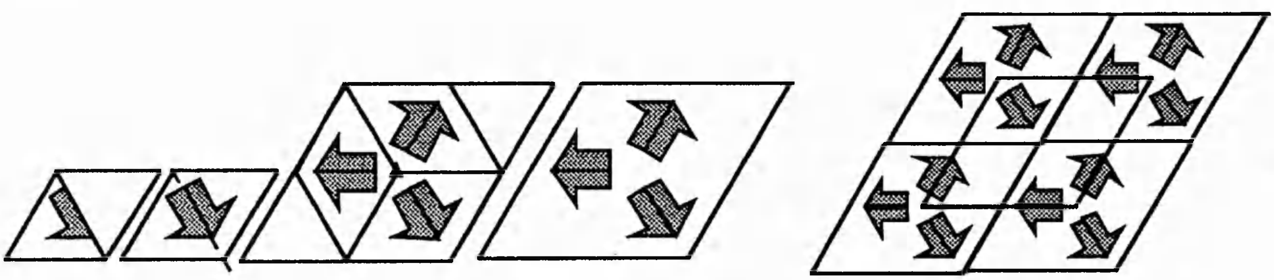
14. Pattern p3m1

The notation is **p3m1**, indicating a primitive cell, rotations of order 3, reflections normal to the x, y, and u axes, and no operations along the axes. The notation is not shortened:



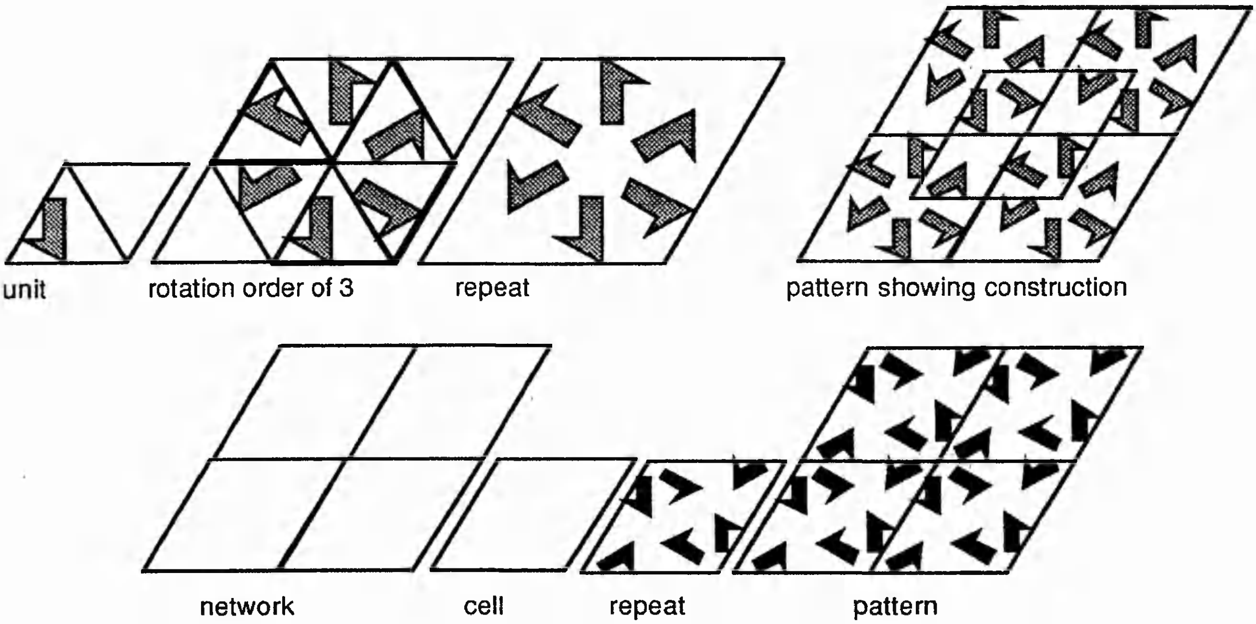
15. Pattern p31m

The notation is **p31m**, indicating a primitive cell, rotations of order 3, no operations normal to the x, y, and u axes, and reflections parallel to the x, y, and u axes. The notation is not shortened:



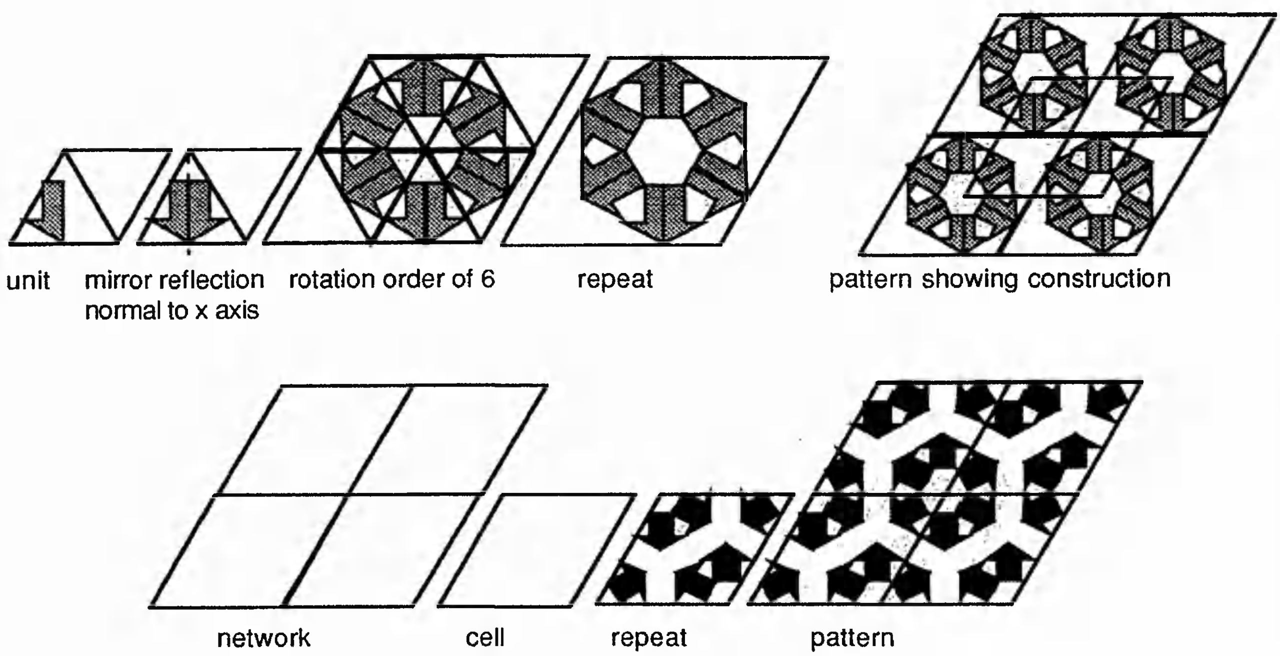
16. Pattern p6 (p611)

The notation is **p611**, indicating a primitive cell, rotations of order 6, no operations normal *or* parallel to the x, y, and u axes. The notation is shortened to **p6**:



17. Pattern p6m (p6mm)

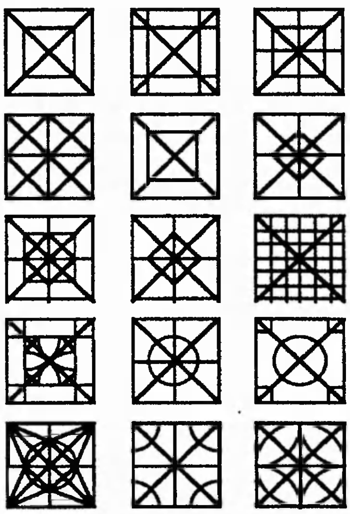
The notation is **p6mm**, indicating a primitive cell, rotations of order 6, reflections normal *and* parallel to the x, y, and u axes. The notation is shortened to **p6m**:



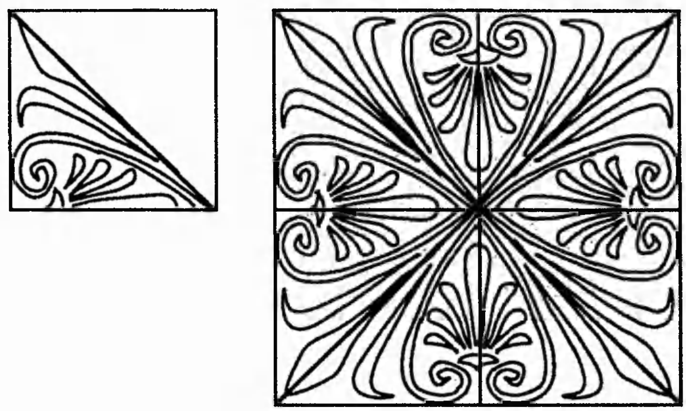
APPENDIX 3: EUROPEAN PATTERN NETWORKS

Construction methods based on network systems distinguish between designs for panels, bands, and repeating patterns.

Panel patterns are designed for bounded spaces. Constructions are usually symmetrical, and emphasis is placed on the design being complete and self-contained. Various constructions have been proposed for the geometrical division of regular polygons, such as the square, circle, oblong, ellipse, and diamond.

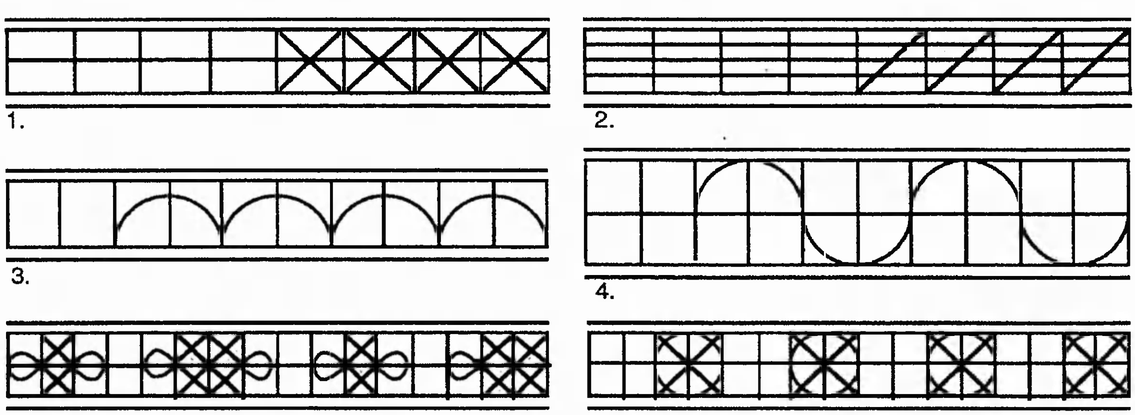


Simple divisions of the square panel.

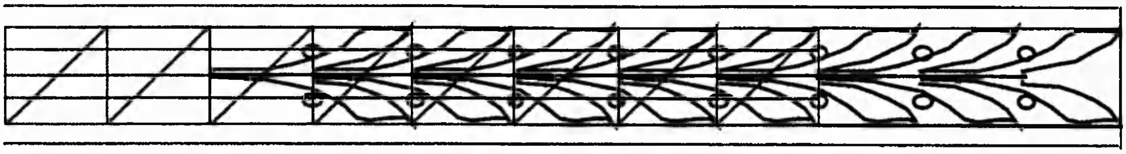


Symmetrical pattern based on the division of the square.

Band patterns are designed to repeat in one direction. Networks are formed by joining regularly placed points with lines. The addition of secondary construction lines or arcs creates further variations. Meyer illustrated forty-six band constructions. According to the use of secondary constructions, these were grouped in three main classes: straight lines, arcs, or combined lines and arcs.

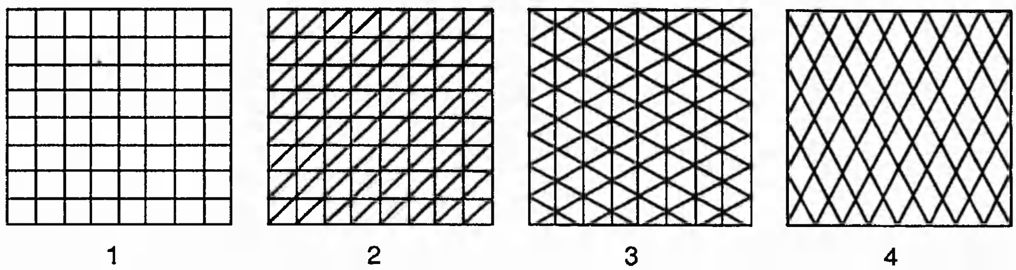


Examples of band networks based on simple grids with secondary constructions.
1 and 2: straight lines. 3 and 4: arcs. 5 and 6: lines and arcs.



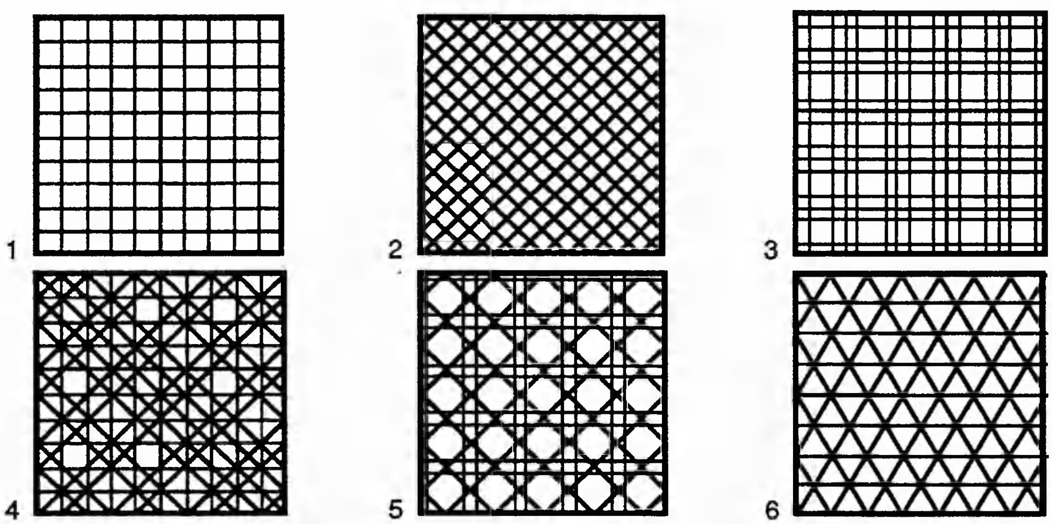
A band pattern constructed on network 2 illustrated above.

Repeating patterns are designed to repeat in two directions. Basic networks are based on square and triangular grids. Varieties of network have been illustrated by different authors. The following are the most common:



1. Square net.
2. Triangular net based on a square net.
3. Triangular net based on equilateral triangles.
4. Diamond (rhomboid) net.

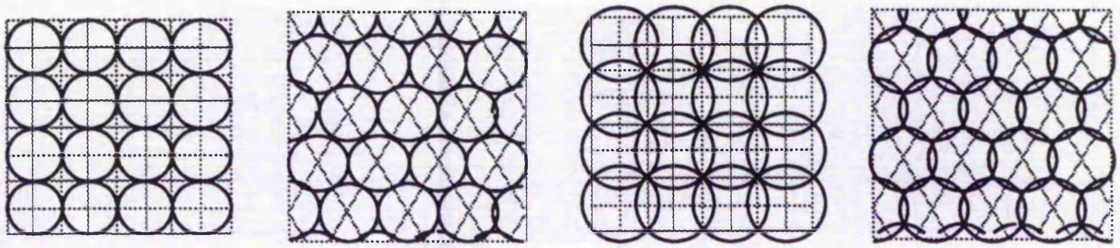
Variations, such as a rectangular network, can be produced by alterations to basic types. Others can be formed by combining networks. Meyer illustrated six types:



1. Ordinary quadrangular.
2. Oblique quadrangular.
3. Straight with alternate divisions.
4. Oblique quadrangular with alternate divisions.
5. Moorish diapers.
6. Triangular net.

Secondary constructions, such circles, can be added. Below, these are positioned using the network intersections.

Appendix 3: European Pattern Networks

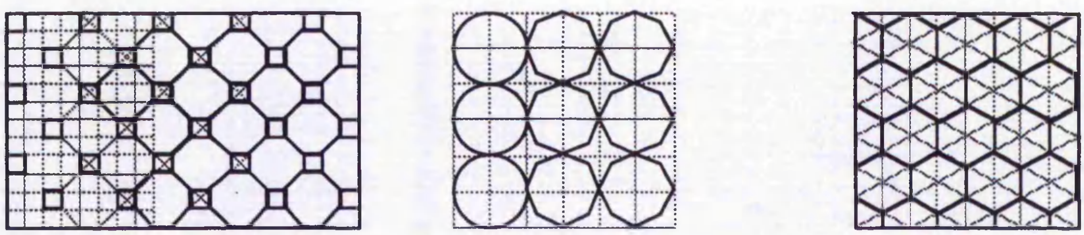


1. 2. 3. 4.

1. Circle network based on a square net. 2. Circle network based on a diamond net.

3. and 4. Variations of 1 and 2, using larger circles to create interlacement patterns.

Octagonal and hexagonal networks can be constructed on square, triangular, and circle nets.

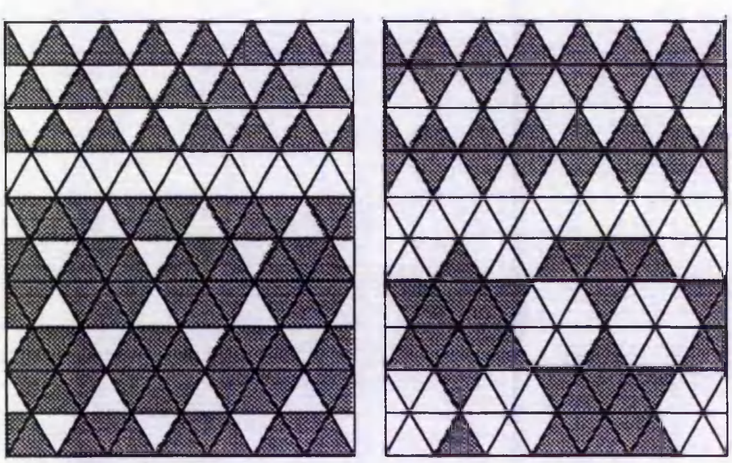


1. 2. 3.

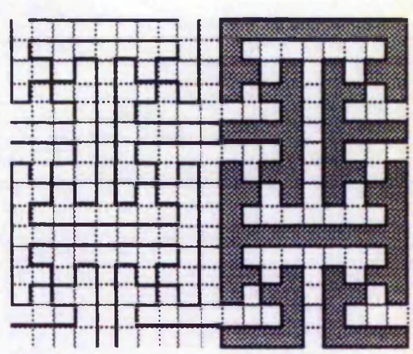
1. Octagonal net based on a square net. 2. Octagonal net based on a square/circle net.

3. Hexagonal network based on the equilateral triangle.

Geometric patterns can be created by filling in sections of a network, and linear patterns, by emphasising lines of the basic grid.

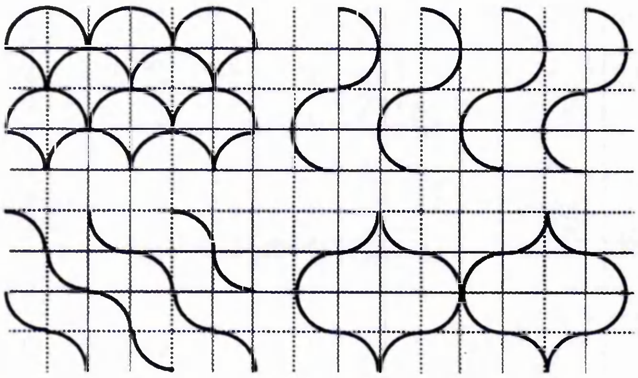


Geometric patterns created by filling in sections of an equilateral triangle network.

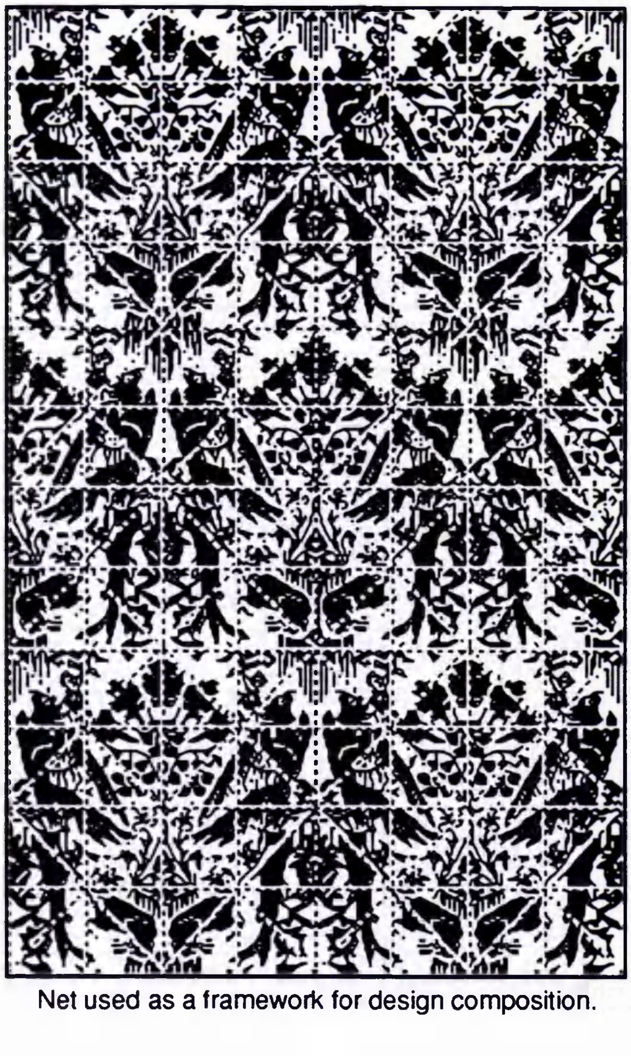


Linear fret pattern drawn on a square network.

Design forms can be created by adding secondary construction lines. These have been used as the basis of geometric patterns and as frameworks to arrange elements within a larger repeat.

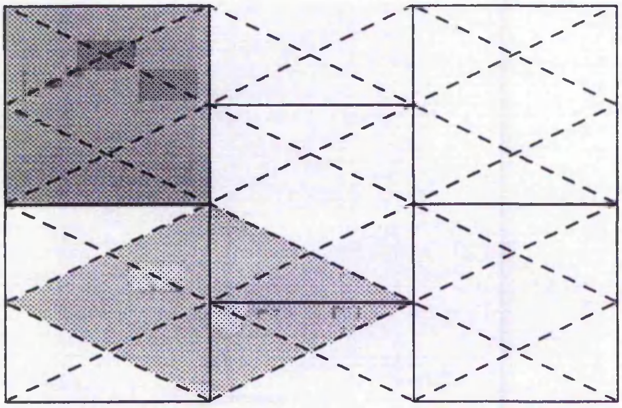


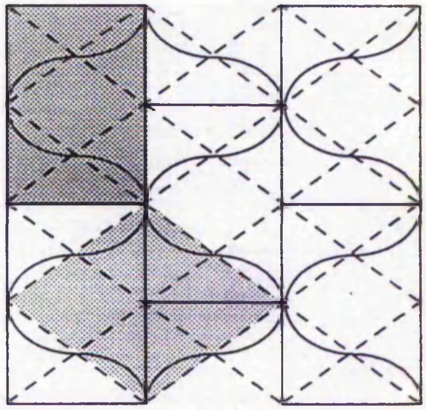
Various design forms created by combining arcs with a square net.
Scale, serpentine line, diagonal serpentine line, and ogee.



Net used as a framework for design composition.

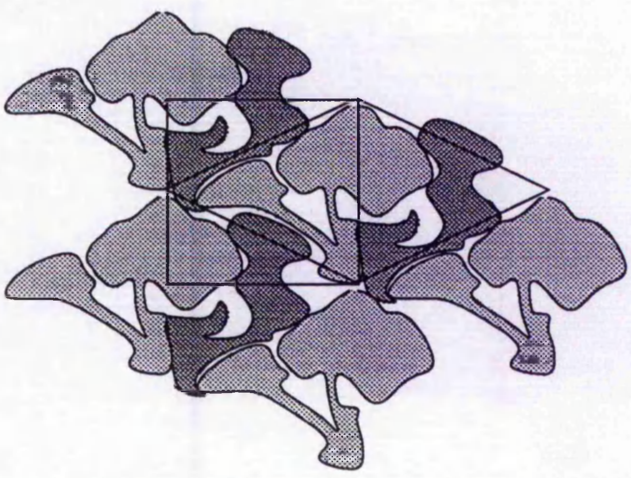
Design forms can be used as units which are filled with elements to form patterns which can also be repeated using rectangular units. This is particularly relevant to half drop repeats.

1


2


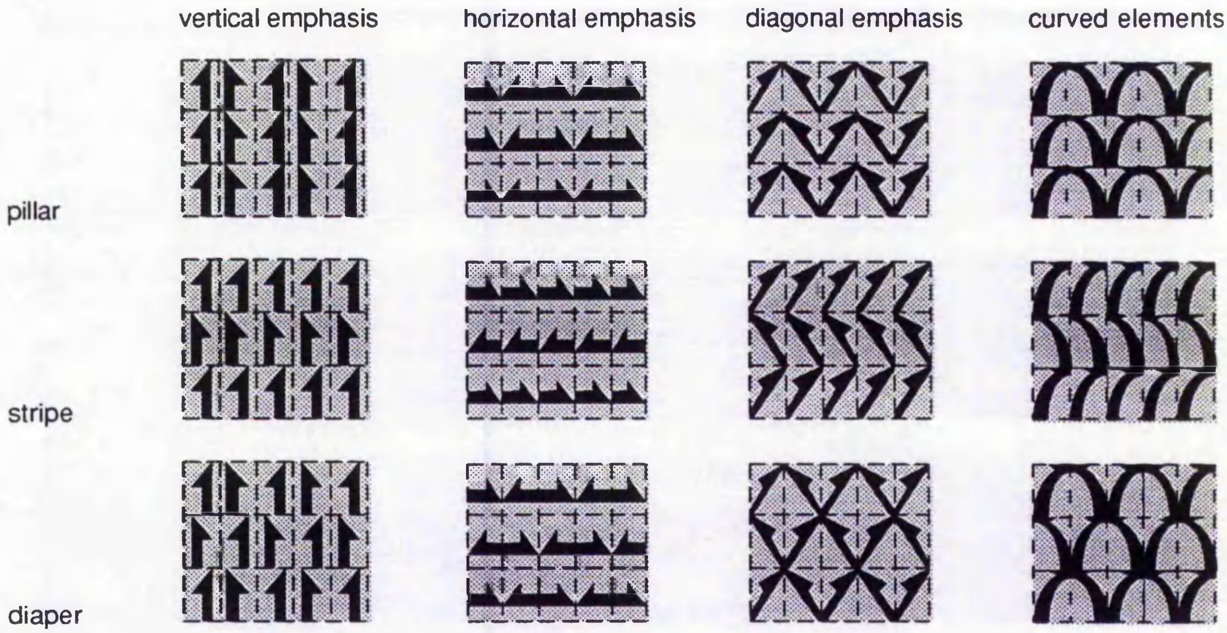
A half drop repeats constructed on diamond nets. 1: diamond design unit. 2: ogee design unit.

The traditional use of these nets has been to decrease the tendency to a grid-like appearance produced by using a rectangular repeat. Although designs can be repeated using a rectangular base, the design can be produced within a less rigid form. With the half drop, this effectively doubles the design width. For example, the following illustration, drawn within a diamond unit, can be repeated using a square unit.

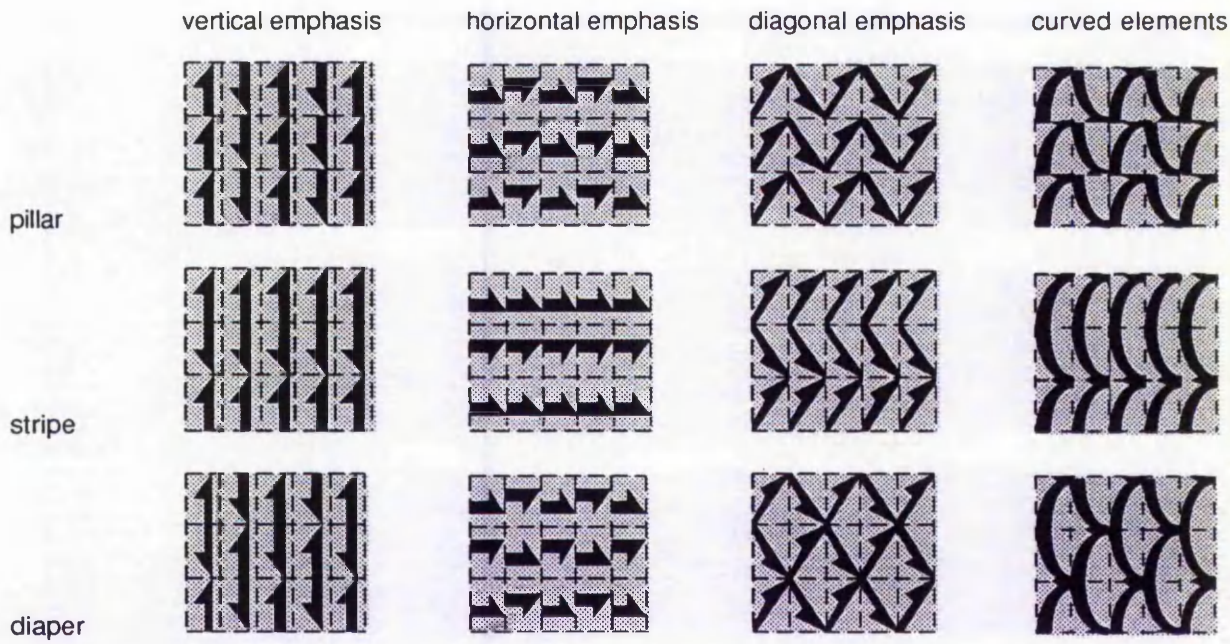


Design based on a diamond net which can be repeated in a half drop format using a square unit.

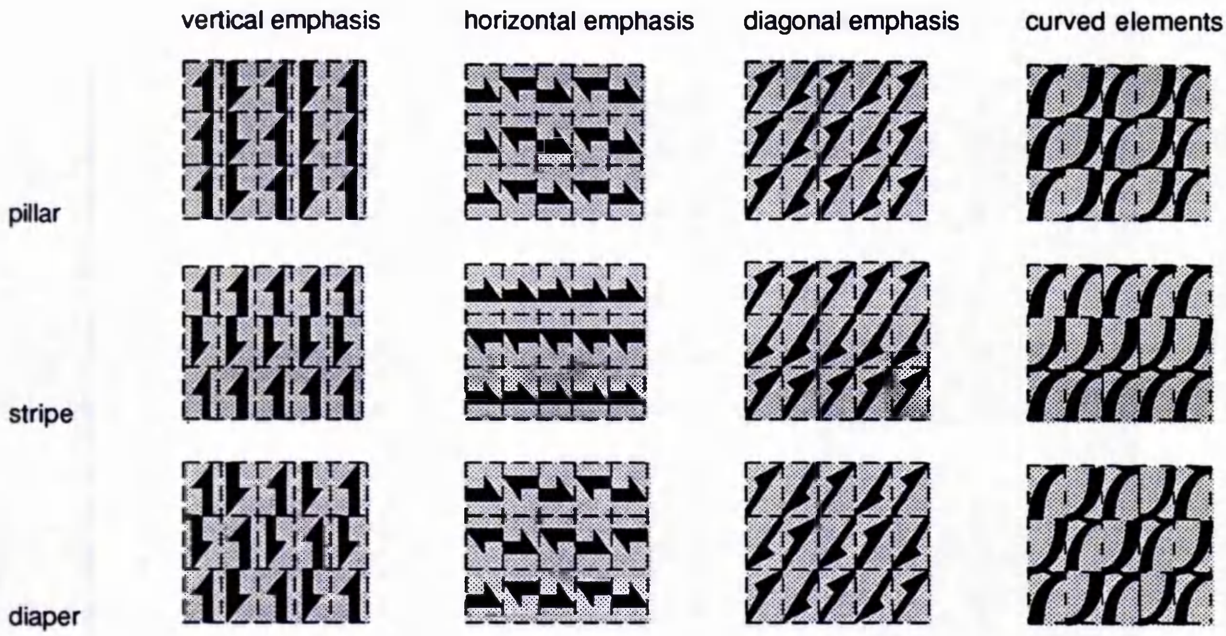
APPENDIX 4: BLOCK FORMATS WITH TRANSFORMATIONS



The block format with horizontal mirror transformation.

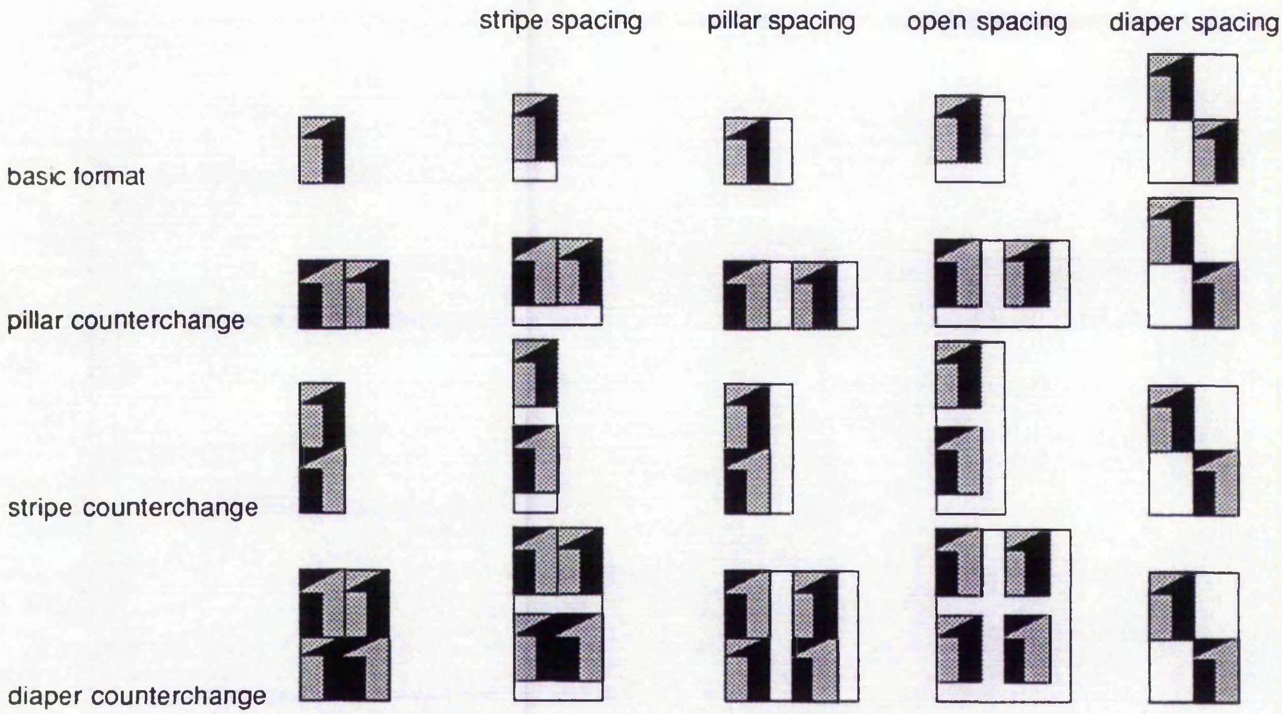


The block format with vertical mirror transformation.

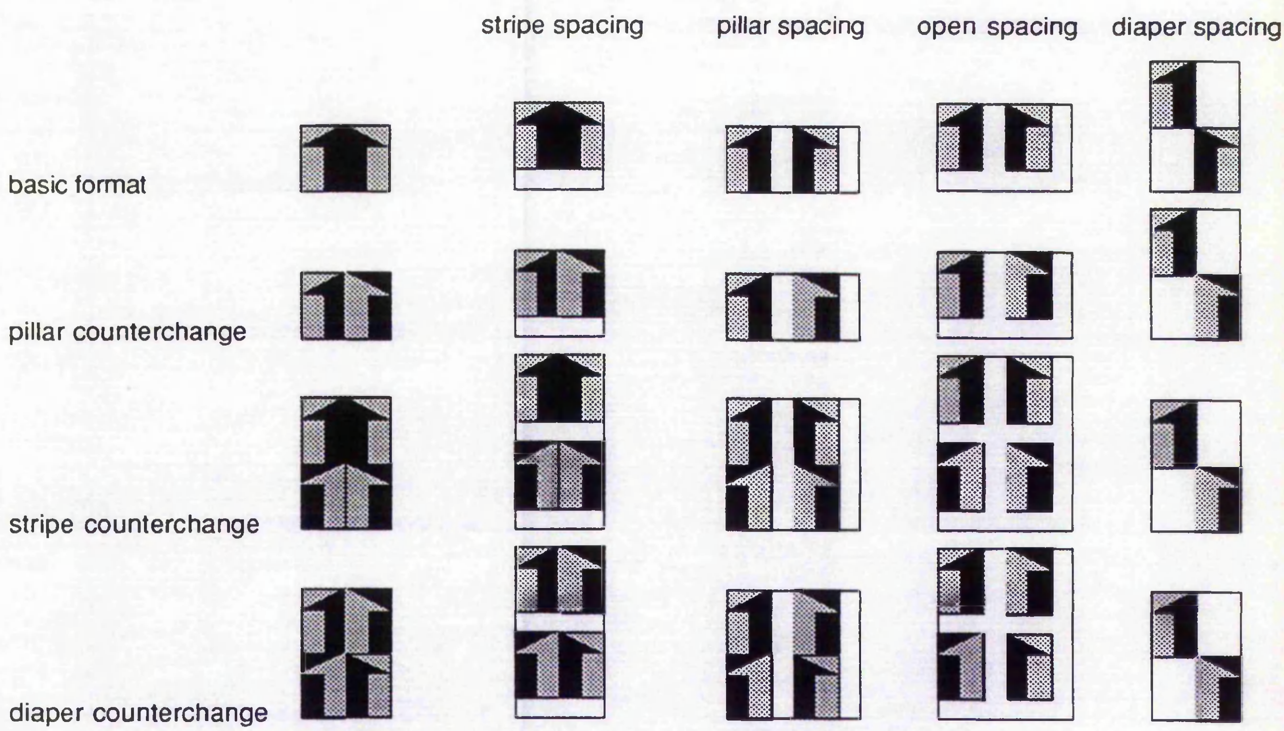


The block format with rotational transformation.

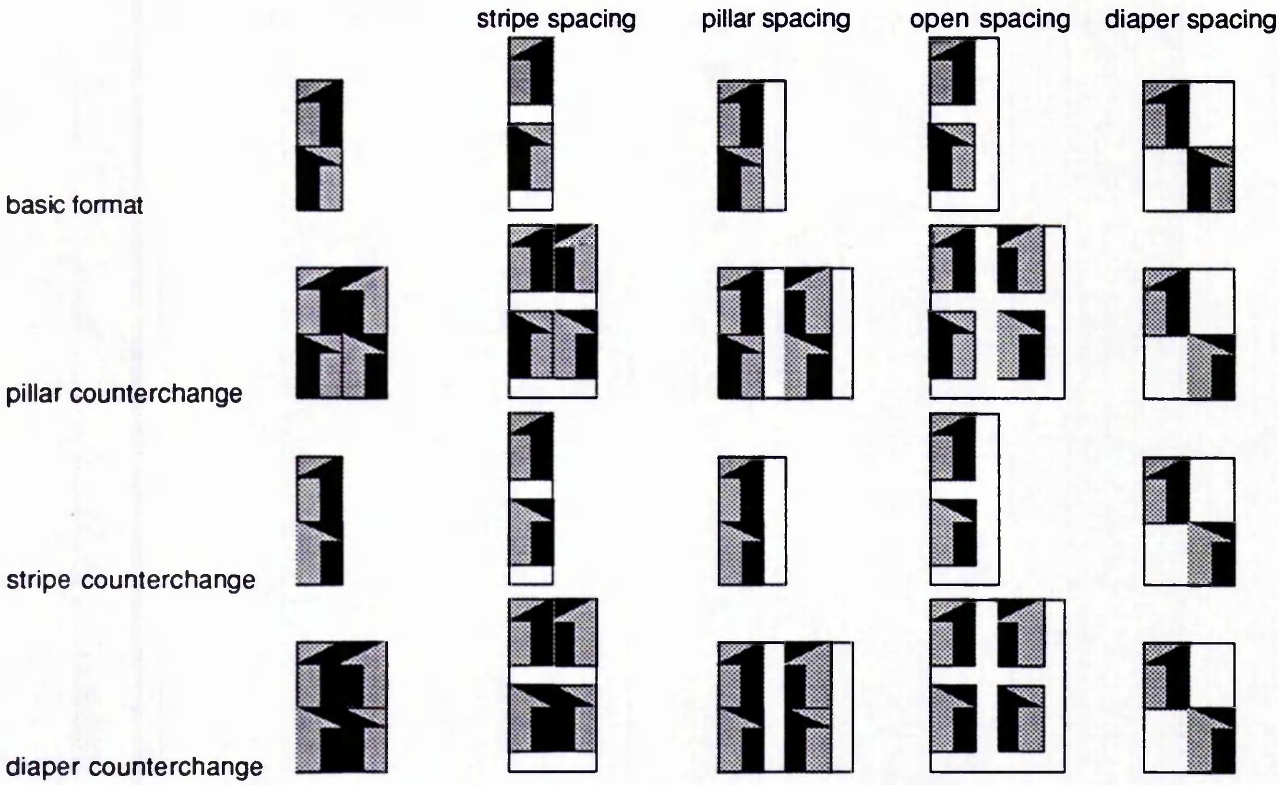
APPENDIX 5: BLOCK FORMATS WITH SECONDARY ORGANISATIONS



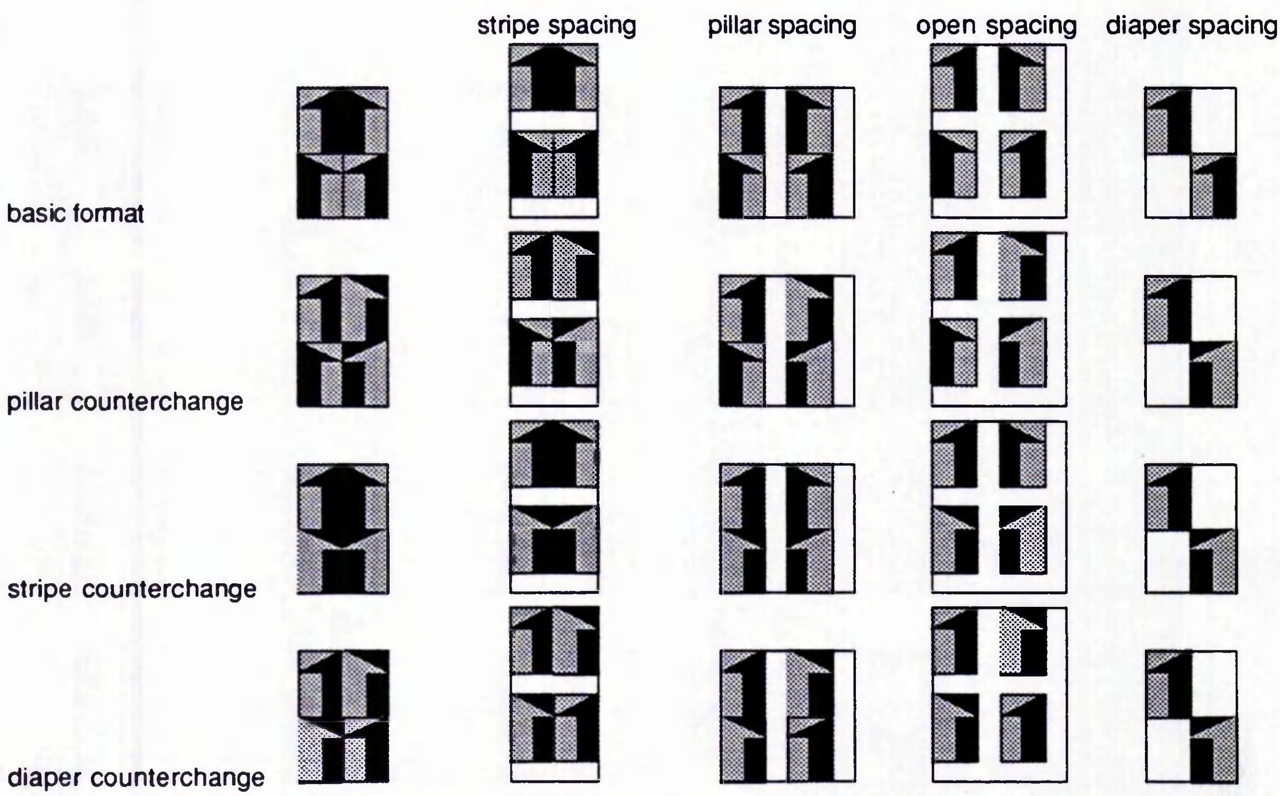
Block/simple format total repeat units



Block/pillar/horizontal-mirror format total repeat units

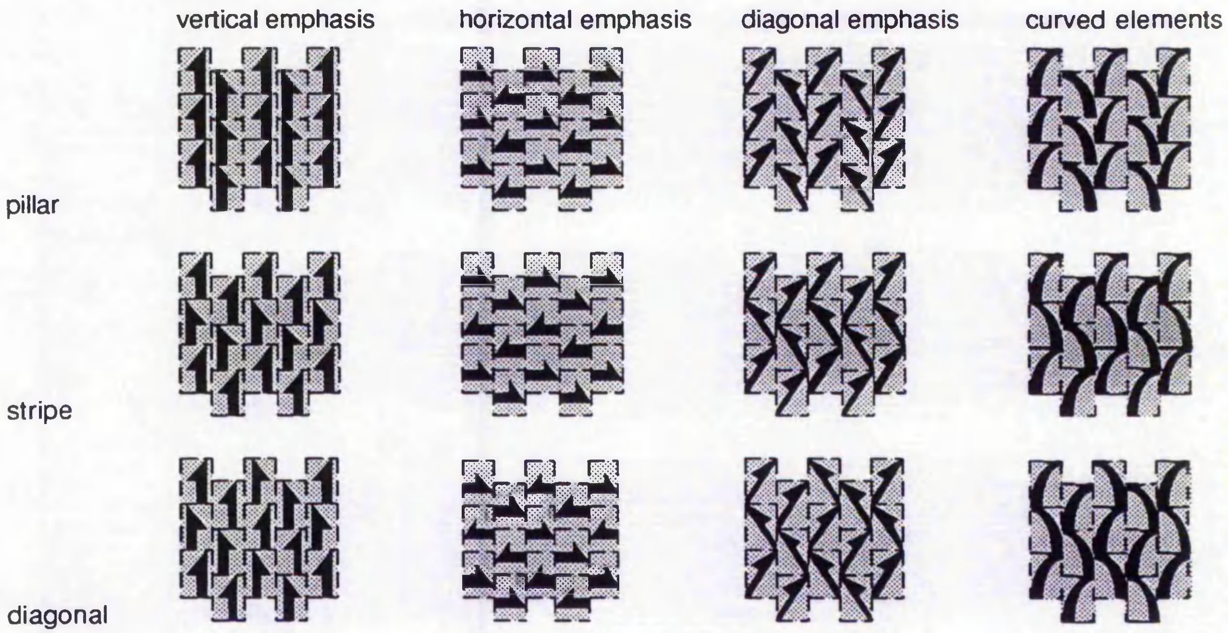


Block/stripe/horizontal-mirror format total repeat units

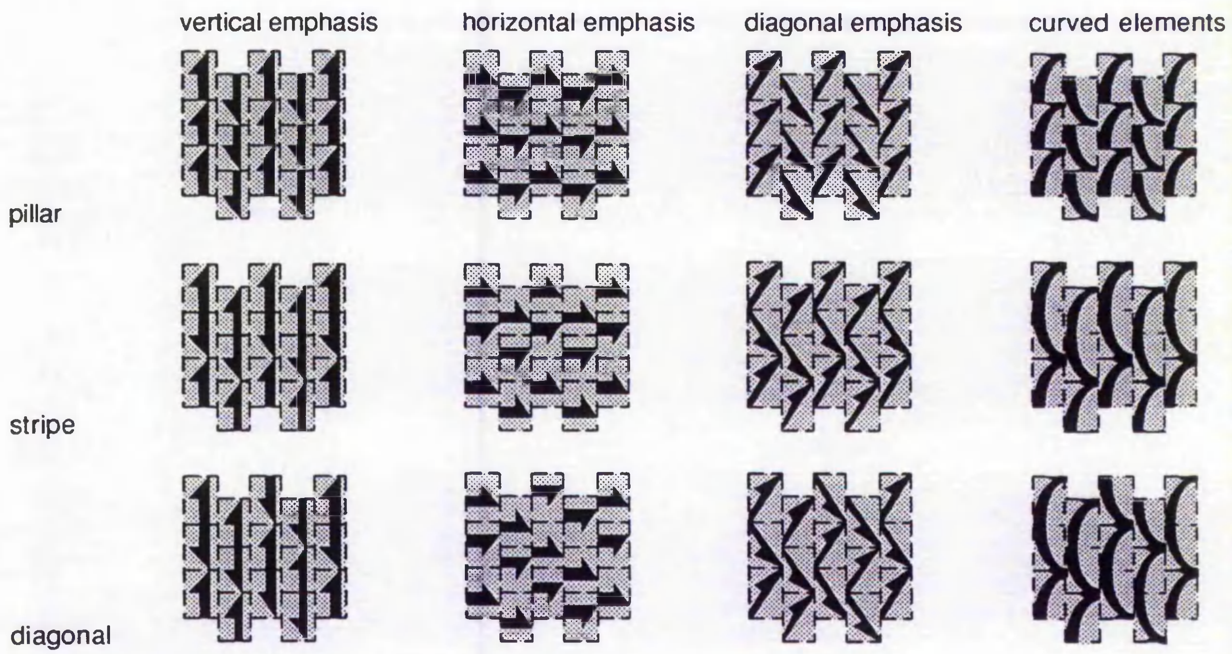


Block/diaper/horizontal-mirror format total repeat units

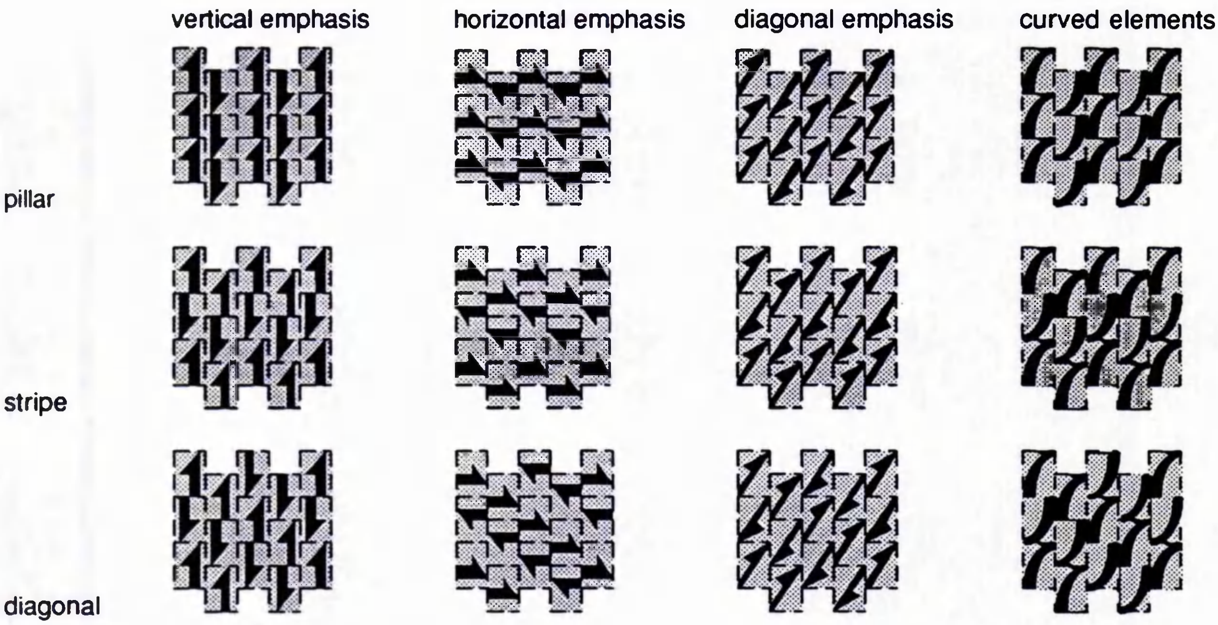
APPENDIX 6: DROP FORMATS WITH TRANSFORMATIONS



The drop format with horizontal mirror transformation.

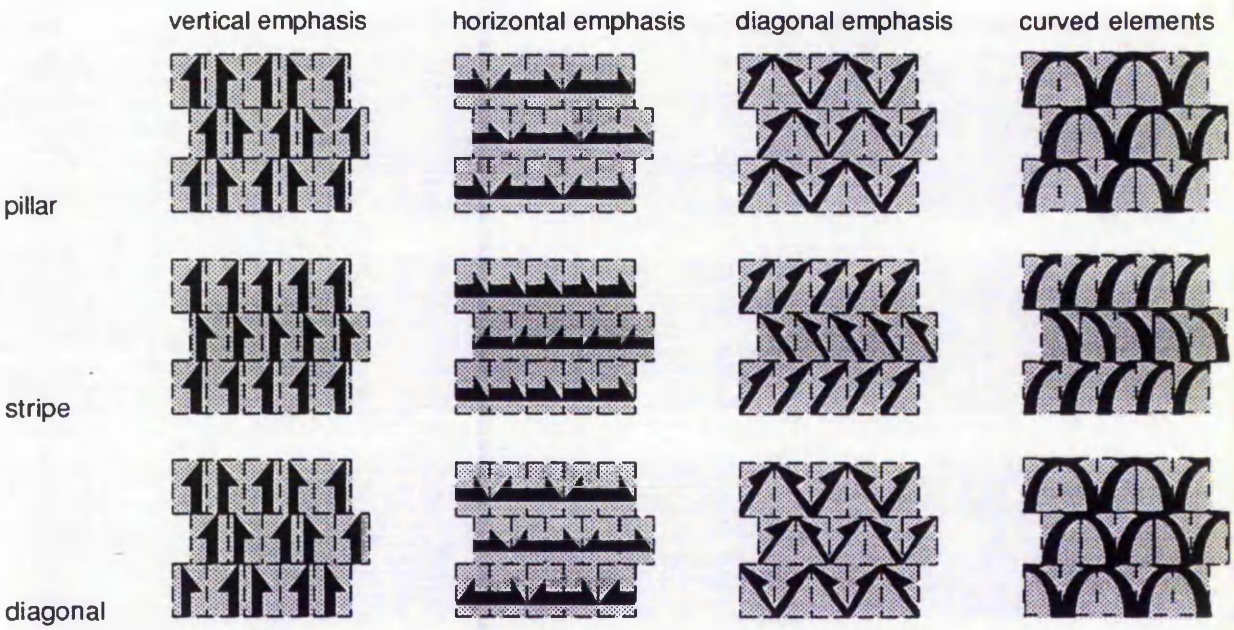


The drop format with vertical mirror transformation.

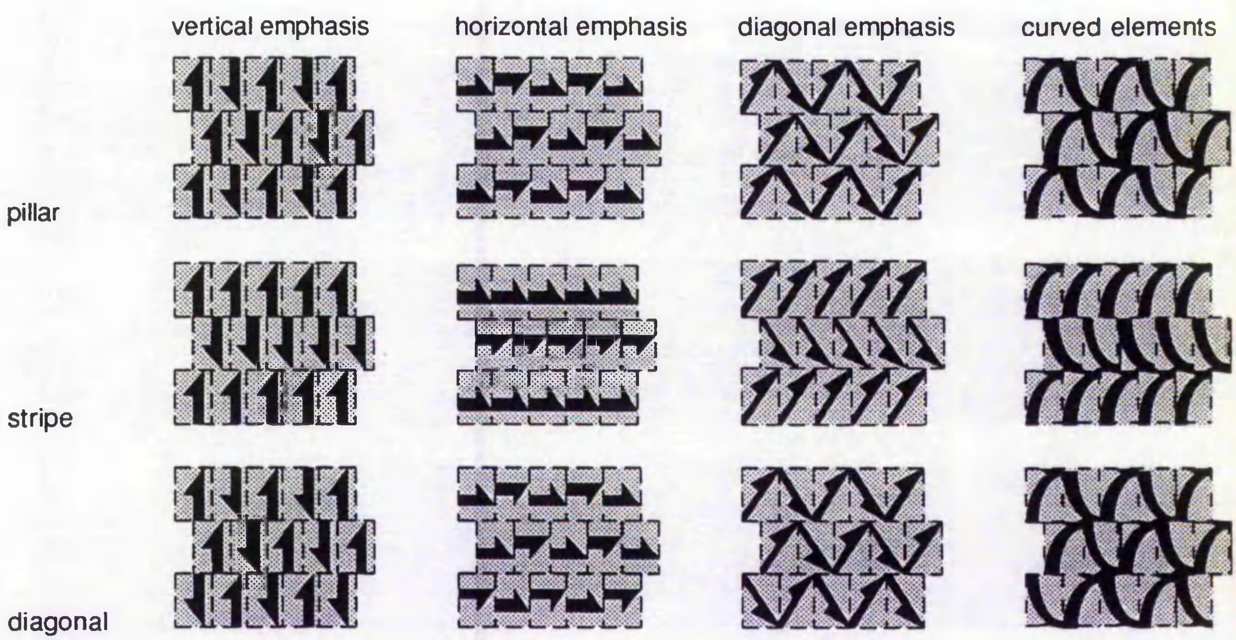


The drop format with rotational transformation.

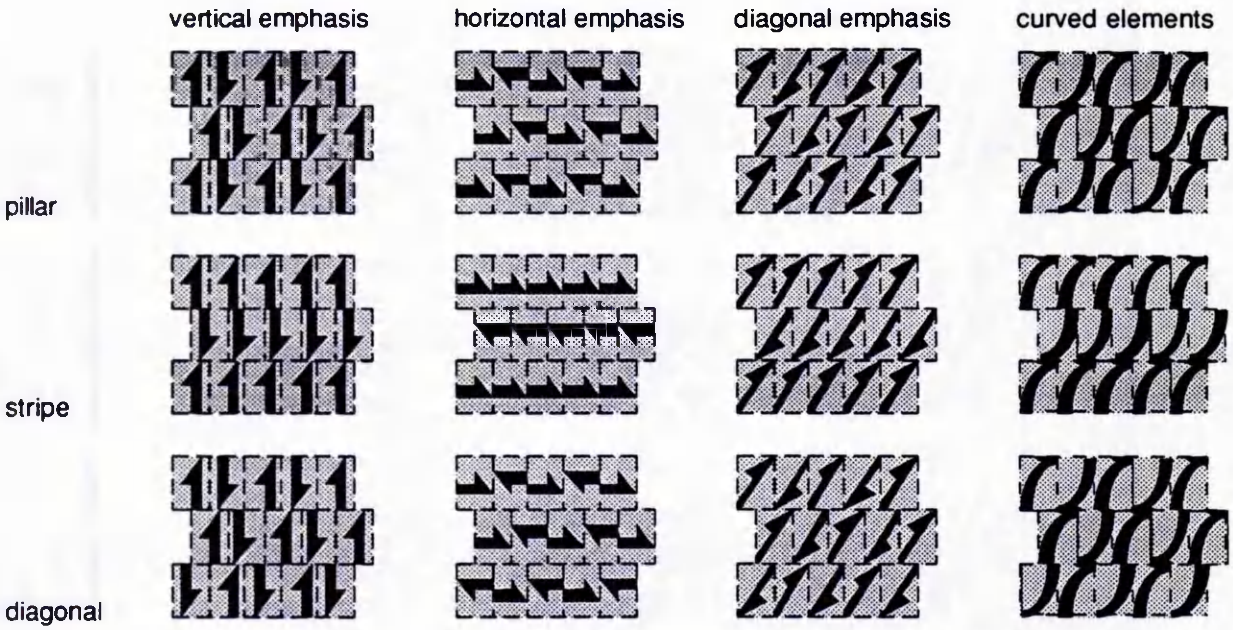
APPENDIX 7: BRICK FORMATS WITH TRANSFORMATIONS



The brick format with horizontal mirror transformation.



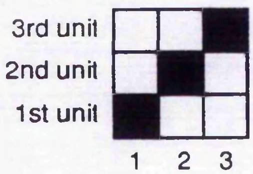
The brick format with vertical mirror transformation.



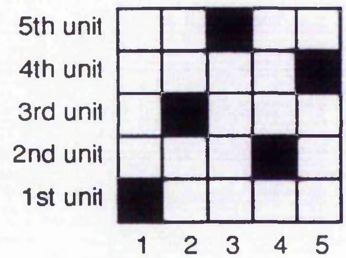
The brick format with rotational transformation.

APPENDIX 8: SPOT FORMATS

A spot format is an arrangement of units in a grid. The grid is the number of units squared. The units are arranged so that none appear in the same vertical or horizontal column of the grid. The group of units forms the total repeat unit.

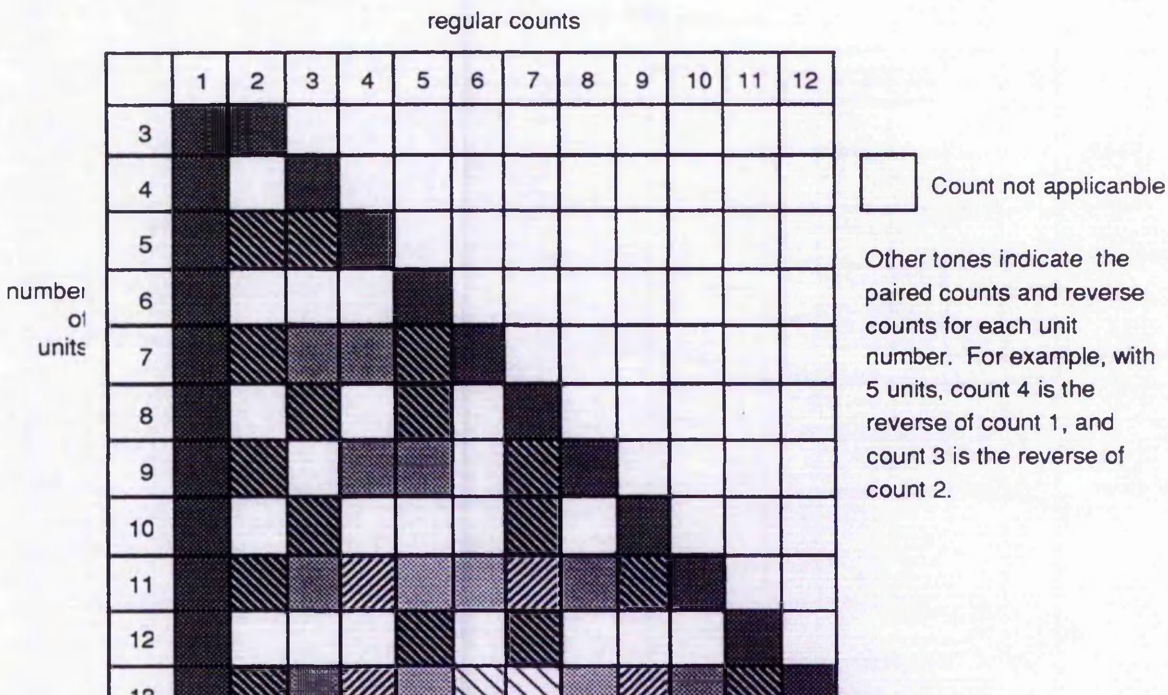


(a) Regular three-spot format. Count 1.



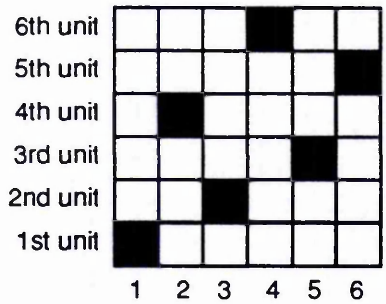
(b) Regular five-spot format. Count 3.

This three-spot format (a) has 3 units placed sequentially in columns 1, 2, and 3. This sequence (1,2,3) has an increment (count) of 1. Formats with a count of 1 produce continuous diagonal lines. Counts of one less than the number of units also produce diagonal lines, and can be seen as a reverse count from right to left. Formats using regular counts make patterns with linear arrangements of units, such as the five-spot format (b), which has a sequence of 1,4,2,5,3, with a count of 3.



Regular counts applicable to spot formats.

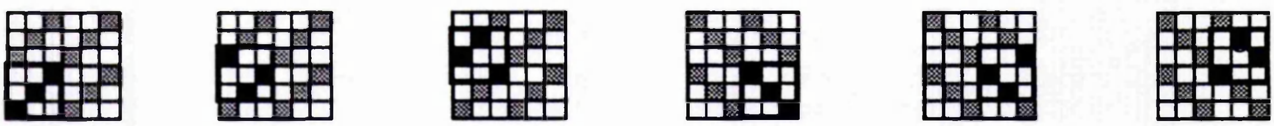
Irregular formats can be used to produce 'random' arrangements and units are placed in the grid using a variable count. The six-spot format below uses a sequence of 1,3,5,2,6,4 which has a count of 2,2,3,4,4,3.



Irregular six-spot format. Count 2,2,3,4,4,3.

Three-spot formats

There are six possible spot arrangements of three units within the grid. But, when repeated, they form one of two regular patterns. These have counts of 1 or 2 and form continuous diagonal lines of units.

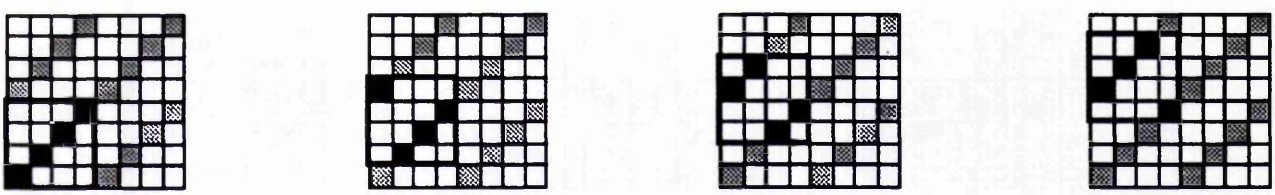


(a) 123 (b) 231 (c) 312 (d) 321 (e) 213 (f) 132

Regular three-spot formats. (a) to (c): count 1. (d) to (f): count 2.

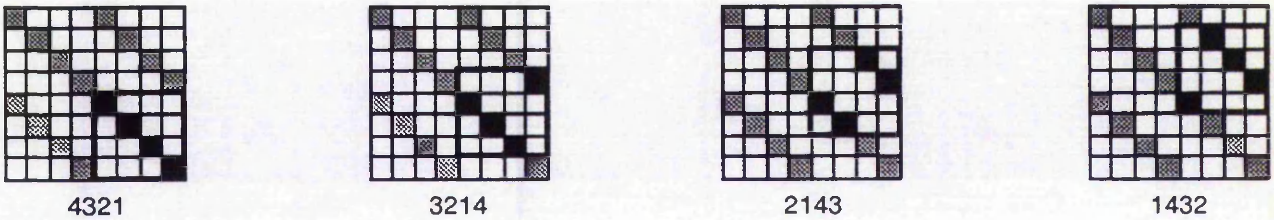
Four-spot formats

There are twenty four possible spot arrangements of four units which, in repeat, give three patterns, two of which are regular and one irregular.



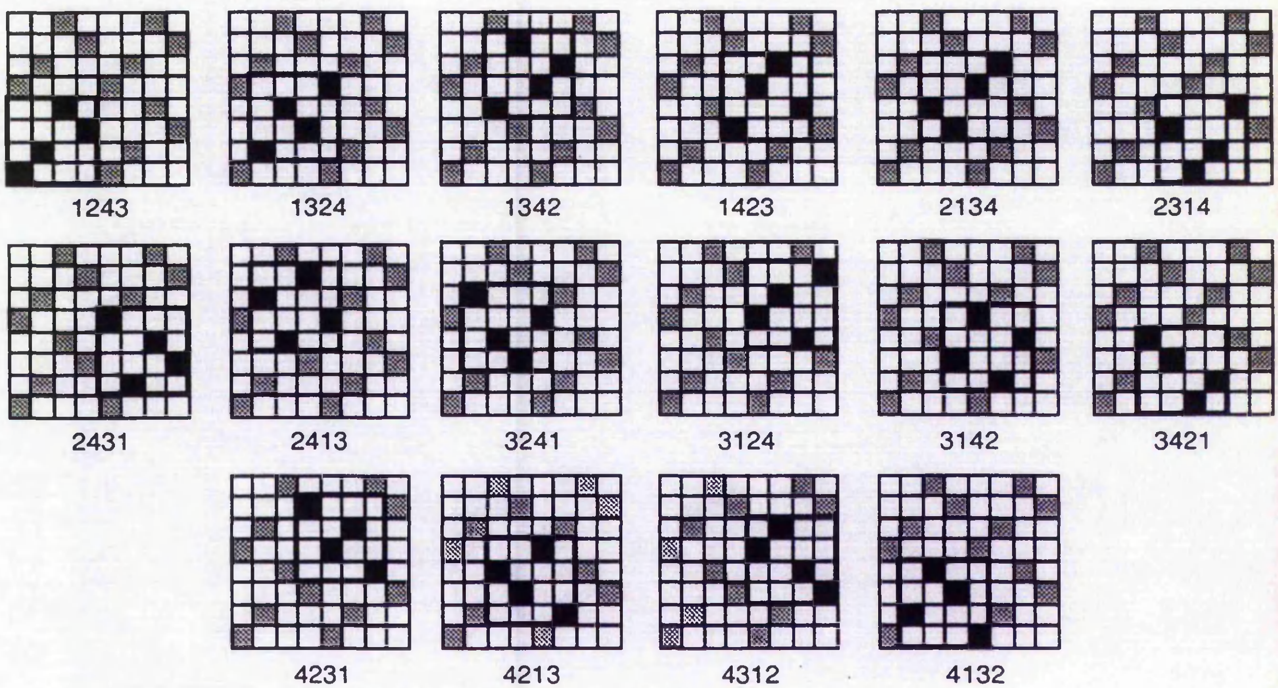
1234 2341 3412 4123

Regular four-spot arrangements. Count 3.



Regular four-spot arrangements. Count 1.

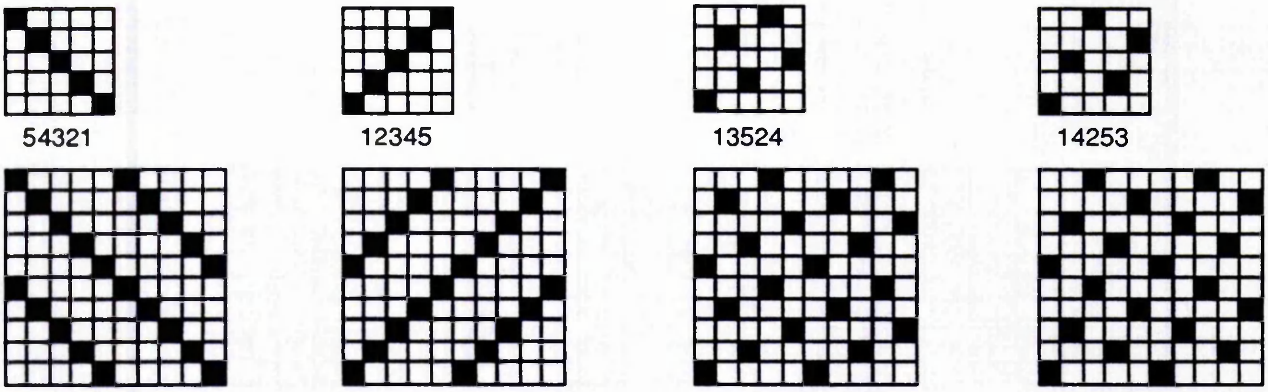
A count of 1 gives diagonal lines to the right, a count of 3 gives diagonal lines to the left (reverse of count 1). A count of 2 is not possible, because the 3rd and 4th unit would occur in the same columns as the 1st and 2nd units. There are sixteen variations of irregular arrangements in the grid and these form the same pattern in repeat. The count is 1,2,3,2.



Irregular four-spot arrangements. Count of 1,2,3,2.

Five-spot formats

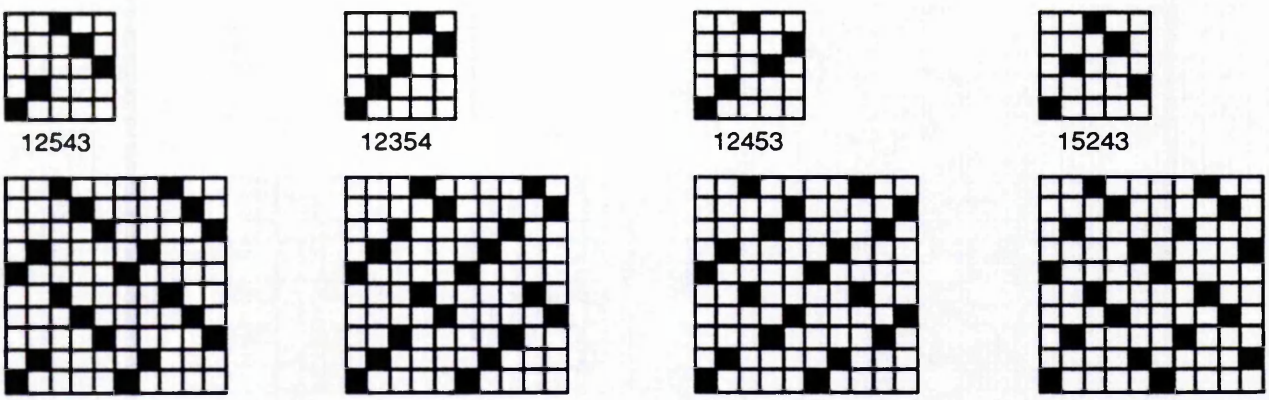
Four regular and four irregular patterns can be formed using five units although, as with three and four spot formats, there are many grid arrangements. Regular patterns have counts of 1, 2, 3, or 4. A count of 1 gives a diagonal line to the right and a count of 4 gives a reverse diagonal to the left. Counts of 2 and 3 produce less pronounced diagonal effects, 2 being the reverse of 3.



(a) count 1 (b) count 4 (c) count 2 (d) count 3

Regular five-spot patterns

There are two types of irregular patterns. Those with counts of 1,3,4,4,3 (a) and 1,1,2,4,2 (b), give broken diagonal lines of three units with groups of two units in the opposing direction. Those with counts of 1,2,1,3,3 (c) and 4,2,2,4,3 (d) give a more scattered effect with groupings of two units and single units.



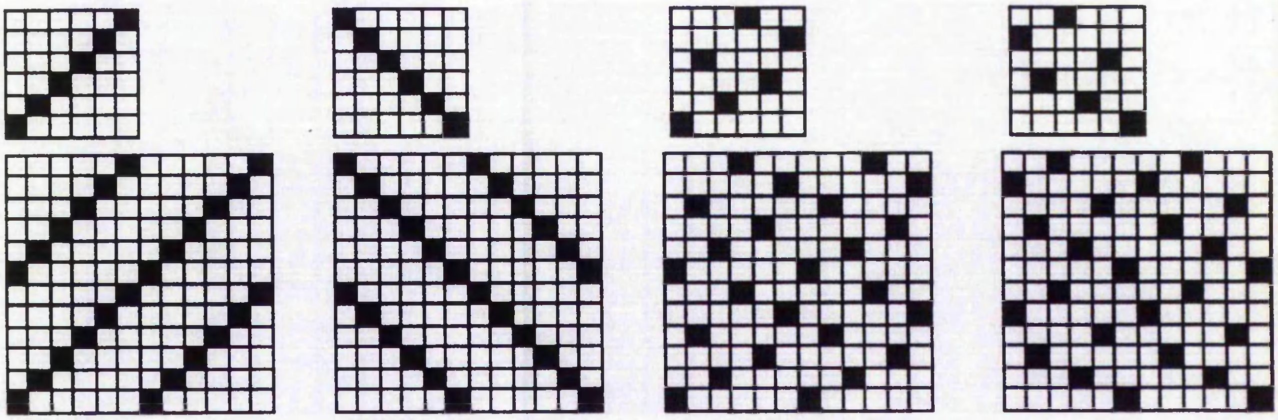
(a) count 1,3,4,4,3 (b) count 1,1,2,4,2 (c) count 1,2,1,3,3 (d) count 4,2,2,4,3

Irregular five-spot patterns.

The most random visual effects are produced by counts of 2 and 3, because the units are separated from each other.

Six-spot formats

Regular counts used are 1 and 5. With six or more units irregular counts can be used to form patterns that consist of separated units, whereas groupings of two or three units always occur with five or four spot formats.

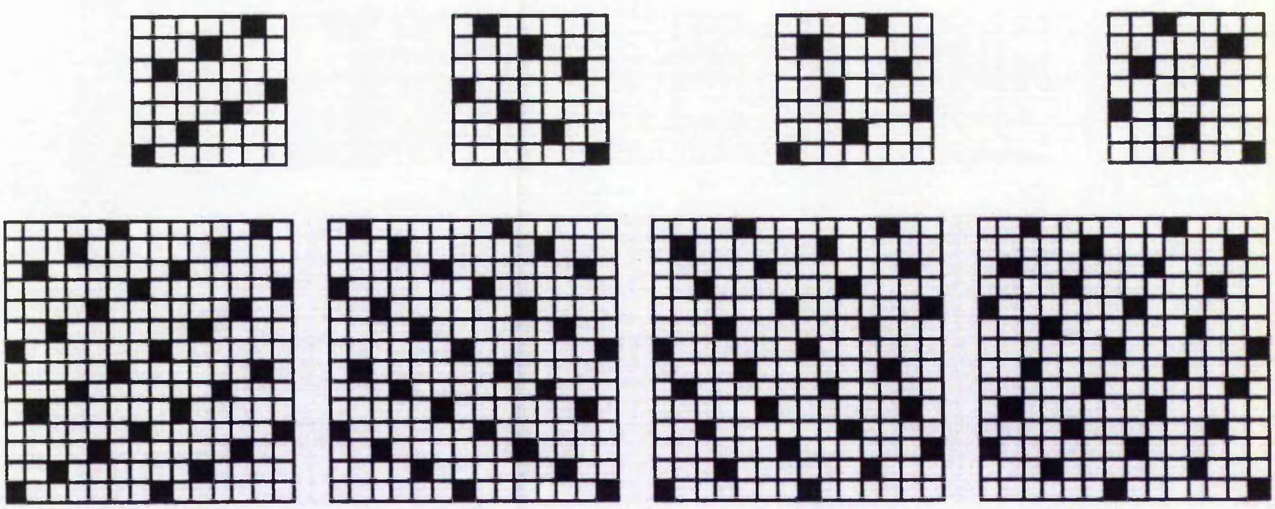


(a) count 1 (b) count 5 (c) count 2,2,3,4,4,3 (d) count 4,4,3,2,2,3

Six-spot formats. Regular (a) and (b). Irregular (c) and (d)

Seven-spot formats

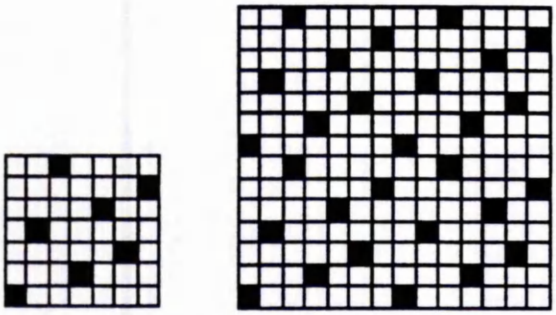
Regular counts are 1, 2, 3, and the reverse counts 6, 5, and 4.



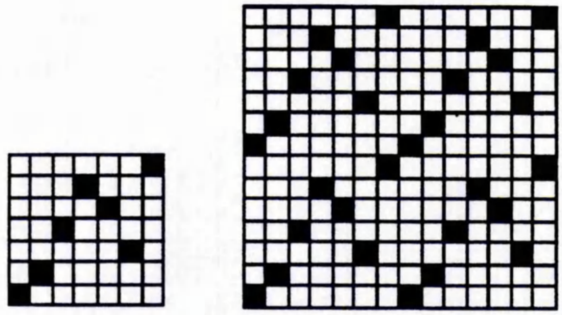
(a) count 2 (b) count 5 (c) count 3 (d) count 4

Regular seven-spot formats

The number of irregular arrangements increases with the number of units. The following two examples are only two of possible irregular seven-spot formats. They are a scattered pattern of separated units (a) and an arrangement of grouped units (b).



(a) count 3,2,3,3,2,3,5

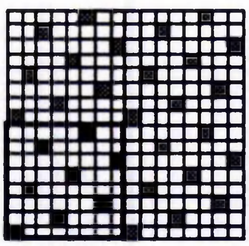


(b) count 1,4,4,2,6,3,1

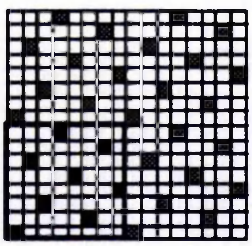
Irregular seven-spot formats.

Eight-spot formats

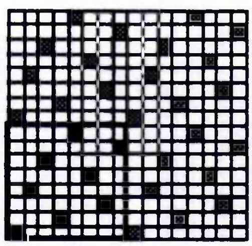
Regular counts are 1 and 3, and their reverse arrangements of 7 and 5. As with the seven-spot formats, only a few of the possible irregular arrangements are shown, these are scattered arrangements.



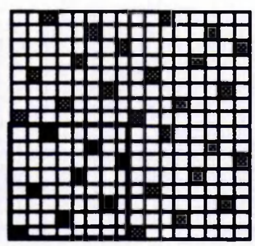
(a) count 3



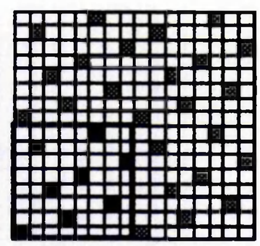
(b) count 5



(c) count 3,3,3,4,5,5,5,4



(d) count 3,3,3,3,3,6,5,6

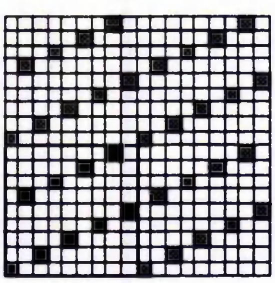


(e) count 3,3,4,2,3,2,4,3

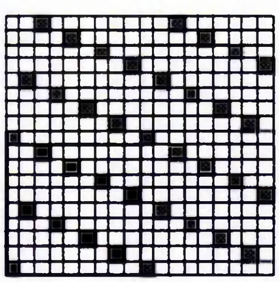
Eight-spot formats. Regular: (a) and (b). Irregular: (c), (d), and (e)

Nine-spot formats

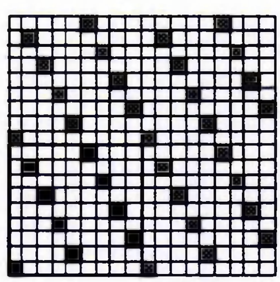
There are six regular counts; 1, 2, and 4 and the reverse counts 8, 7, and 5.



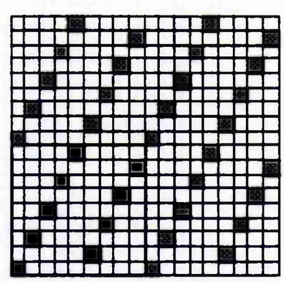
(a) count 2



(b) count 7



(c) count 4

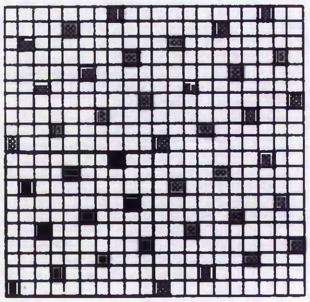


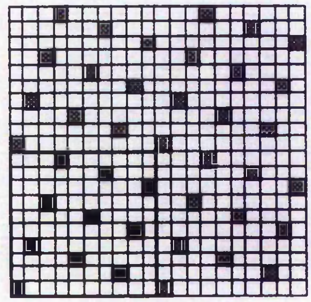
(d) count 5

Regular nine-spot formats.

Ten-spot formats

The regular counts are 1 and 3, and thee reverse counts of 9 and 7.

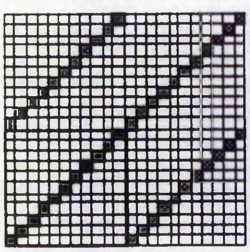

(a) count 3

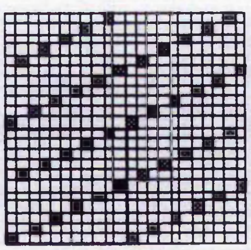

(b) count 7

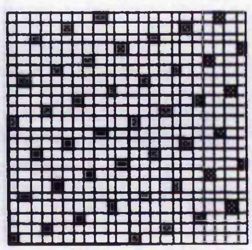
Regular ten-spot formats

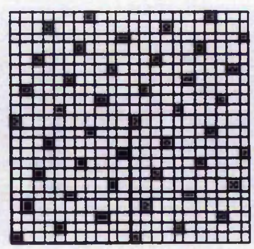
Eleven-spot formats

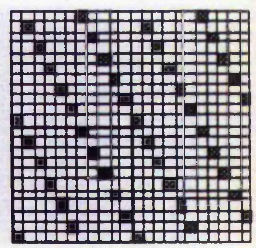
There are ten regular counts; 1, 2, 3, 4, 5, and the reverse counts of 10, 9, 8, 7, and 6.

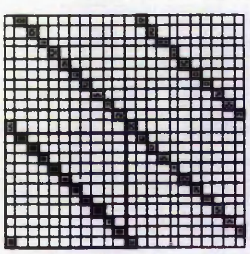

(a) count of 1

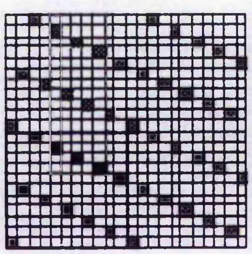

(b) count of 2

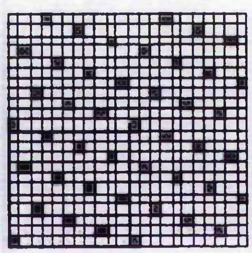

(c) count of 3

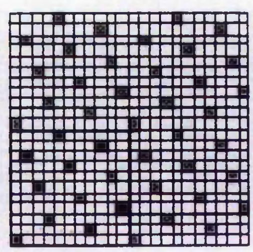

(d) count of 4

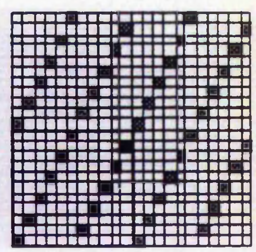

(e) count of 5


(f) count of 10


(g) count of 9


(h) count of 8

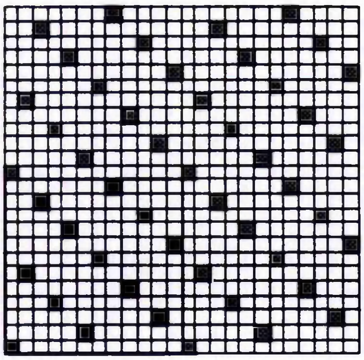

(i) count of 7


(j) count of 6

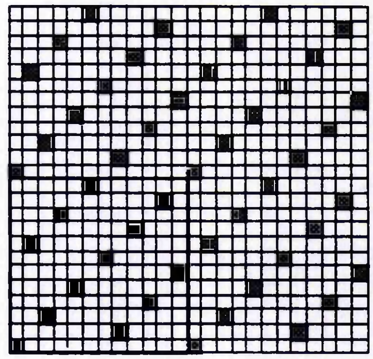
Regular eleven-spot formats.

Twelve-spot formats

The regular counts are 1, 5, and the reverse counts of 11 and 7.



(a) count 5



(b) count 7

APPENDIX 9: PAINT SOFTWARE EVALUATION: DESIGNER PAINT

This appendix covers specific methods of repeat construction using the software *Designer Paint®*. This was used on two computer graphics systems. One system had a resolution of 768 x 576 pixels and the other 1024 x 768 pixels. Both had two workspaces and this allowed the design to be backed up on one screen whilst working on the other or for work to be carried from one screen to another, whilst performing raster operations, such as copying and scaling. The software provided standard paint functions but no specialist textile facilities.

Grids - can be specified by the number of lines horizontally and vertically (3 lines are required for 4 columns). To ensure that the same number of pixels occur in each column or row, the number of lines must be a division of the screen resolution. A keyboard operated *grid lock* allows the cursor to be fixed on the centre points of the grid.

Auxcol - the transparent colour.

Scale - a raster can be scaled proportionately. Destination size can be determined by eye, with reference to a display showing the percentage scaling factor or by using the grid lock. Scaling down will result in a degradation of image as pixel information is lost. Often lines of one pixel width may disappear completely.

Prop - a pattern fill function, allowing a raster to be block repeated into a bounded area. The origin of the repeat is the top left hand corner of the screen.

Copy - a raster can be copied and moved. Setting *auxcol* to the background colour allows motifs to be copied without the background, and so enables butting up of motifs.

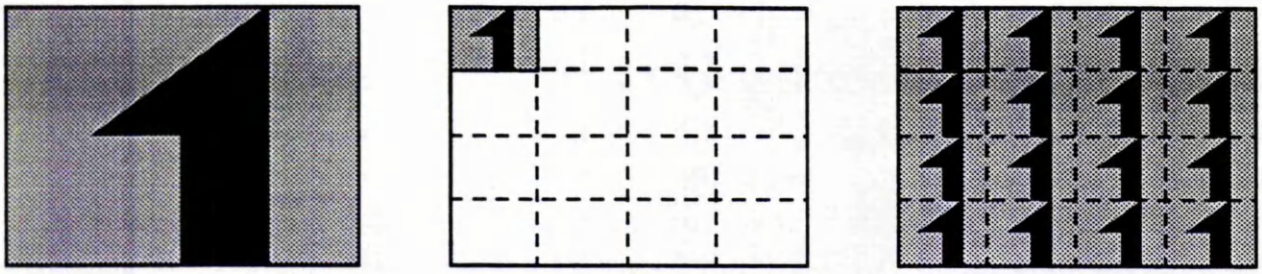
Mirror - copies, moves, and reflects a raster about its vertical axis.

Rotate - copies, moves, and rotates a raster. One version of the software gives 90º rotations, another allows rotations of 1º increments.

Repeat construction

Small designs (half of the screen size or less) can be put into repeat simply by selecting *prop,* defining a raster, 'flipping' to the other workspace, and indicating any point on the screen. This will fill the whole screen with the defined unit in block repeated form.

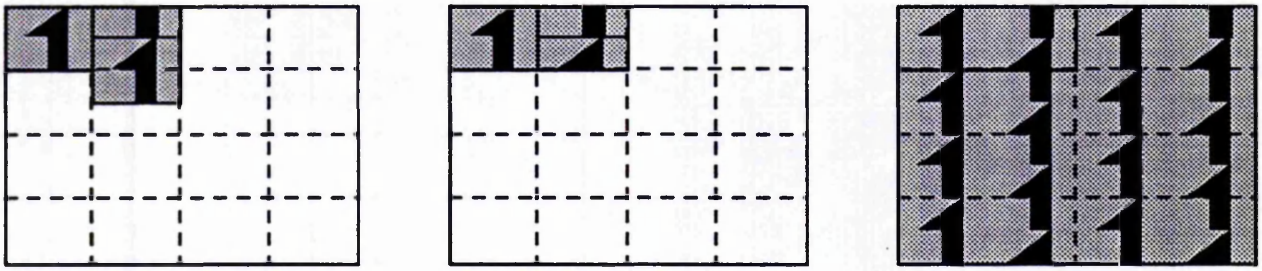
Whole screen image reproduced as a block repeat. A whole screen image can be put into repeat by scaling it down into the top left hand corner of the other workspace using the grid lock to control sizing. The reduced unit can be repeated into the remainder of the screen area using the *prop* function. The position of the scaled unit at the screen origin ensures the matching of repeated units.



(a) whole screen image (b) reduced to 25% on both axes (c) pattern fill of (b)
Pattern fill used for a simple block format.

If a simple block repeat is required, a 50% scaling may be sufficient. If a drop, brick, or complex repeat is required, then a further reduction will give more space for the image manipulation needed to build up a composite repeat. All formats can be contained within a rectangle that can then be repeated in a block form (Chapter 9). *Copy* can be used to place copies of the original design unit or scaled-down unit in appropriate positions in order to build up a particular repeat structure. The total repeat unit can then be propagated in order to view the extended repeat.

Whole screen image reproduced as a half drop repeat. The image is reduced and placed as above. This copy is moved from the original position by a distance equal to the width of the unit on the horizontal axis, and equal to half the height of the unit on the vertical axis. A grid lock can be used to place a copy of the reduced unit accurately in a half drop position using a grid set to 3 lines horizontally and 7 lines vertically. The lower half of this copy can be copied and placed above, horizontally adjacent to the original reduced copy. A raster containing the total repeat can be defined and repeated into the remainder of the screen area using the *prop* function.

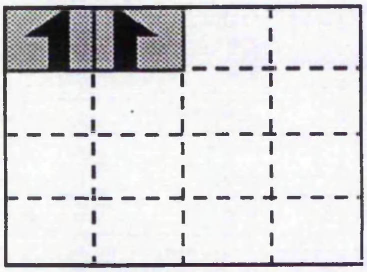


(a) copies in half drop format (b) half drop pattern unit (c) pattern fill of (b)
Pattern fill used for a simple half drop format.

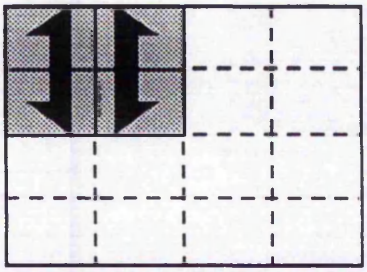
Construction of symmetrical and rotational repeats

Symmetrical and rotational repeats can be built up using *mirror* or *rotate,* and repeated using the same method. If a less rigidly structured appearance is desired, symmetrical composite units can be built up and modifications made to the elements on the axes of symmetry.

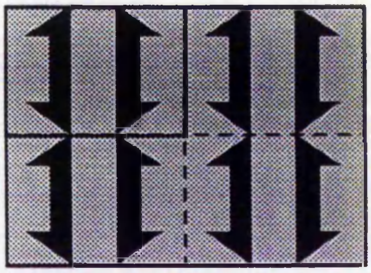
Whole screen image reproduced as a four-way mirror repeat. The image is reduced and placed as above. This reduced unit is mirrored horizontally and the mirrored copy placed horizontally adjacent to it. These two units are copied and rotated by 180 degrees, and placed directly below. This gives a total repeat unit consisting of four units. This area can be defined and repeated into the remainder of the screen area using the *prop* function.



(a) horizontally-mirrored copy



(b) vertically-mirrored copy of (a)



(c) pattern fill of (b)

Pattern fill used for a block/four-way mirror format.

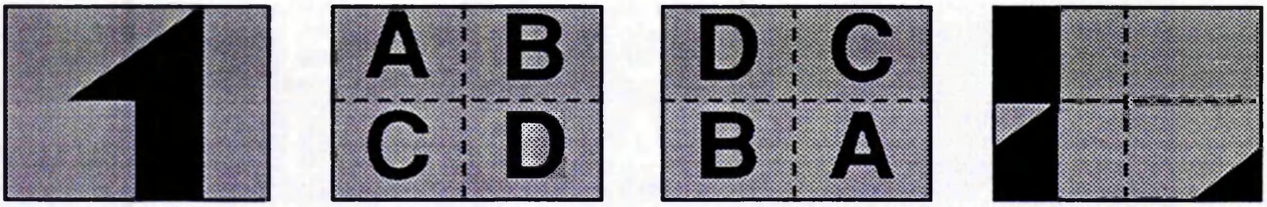
Other formats can be created using these methods. For example, a simple third drop would form a total repeat unit equivalent to three units, and a simple quarter drop a total repeat unit equivalent to four units (9.15). A variety of combinations of mirrored and rotated units can be combined with block, drop, and brick structures. Butting up of motifs can be achieved using *auxcol*, but in this case the definition of the rectangle for the total unit requires careful control. Spot formats can be constructed using *copy* in conjunction with the grid to help the placement of motifs within a predetermined plan. *Mirror* and *rotate* can be used to achieve a random appearance.

Designs can be combined. For example, a spot repeat can be copied without its background colour on to a textured or geometric design. Using a grid can ensure that the repeat of both designs matches. The same design can be offset in a different colour-way, or other combinations and variations can be tried out. These can then be combined for colour separations, or output separately if overprinting is desired.

The building up of complex repeats in this way means that variations of combinations of the basic unit can be tested in a small scale. Colour separations can be produced from the original whole screen image and multiples of these patched together in the selected format. This effectively increases the design size achievable from such relatively low resolution systems. One drawback is that the separations cannot be output accurately to a specific size. If this is required, say for accurate fitting to fabric widths, photographic enlargement or reduction is needed.

Quartering

Whole screen image quartered. Quartering can be achieved by copying the design from one workspace to the other in sections which are placed in appropriate rearranged positions. A grid of 1 line horizontally and vertically divides the screen area into four equal sections. The top left quarter (A) is copied onto the second screen and placed in the lower right-hand corner of the screen. The top right quarter (B) is copied onto the lower left-hand corner, the lower left quarter (C) is copied onto the top right-hand corner, and the lower right quarter (D) is copied onto the top left-hand corner.



(a) whole screen image (b) division for quartering (c) quartered arrangement (d) quartered version

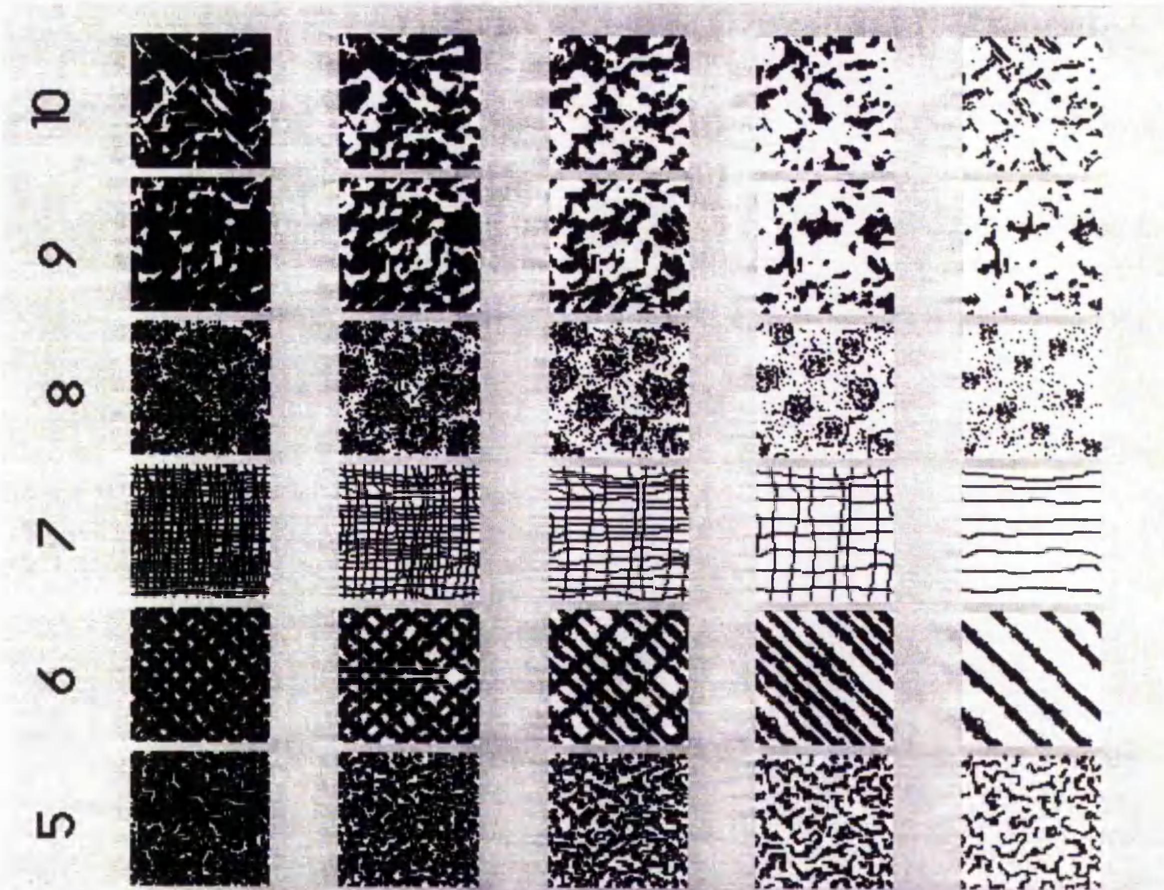
Quartering a design for a simple block format.

The design is modified so that elements are linked across the horizontal and vertical axes of the screen. The design can then be reduced and put into a block repeated form using the method described for a block repeat.

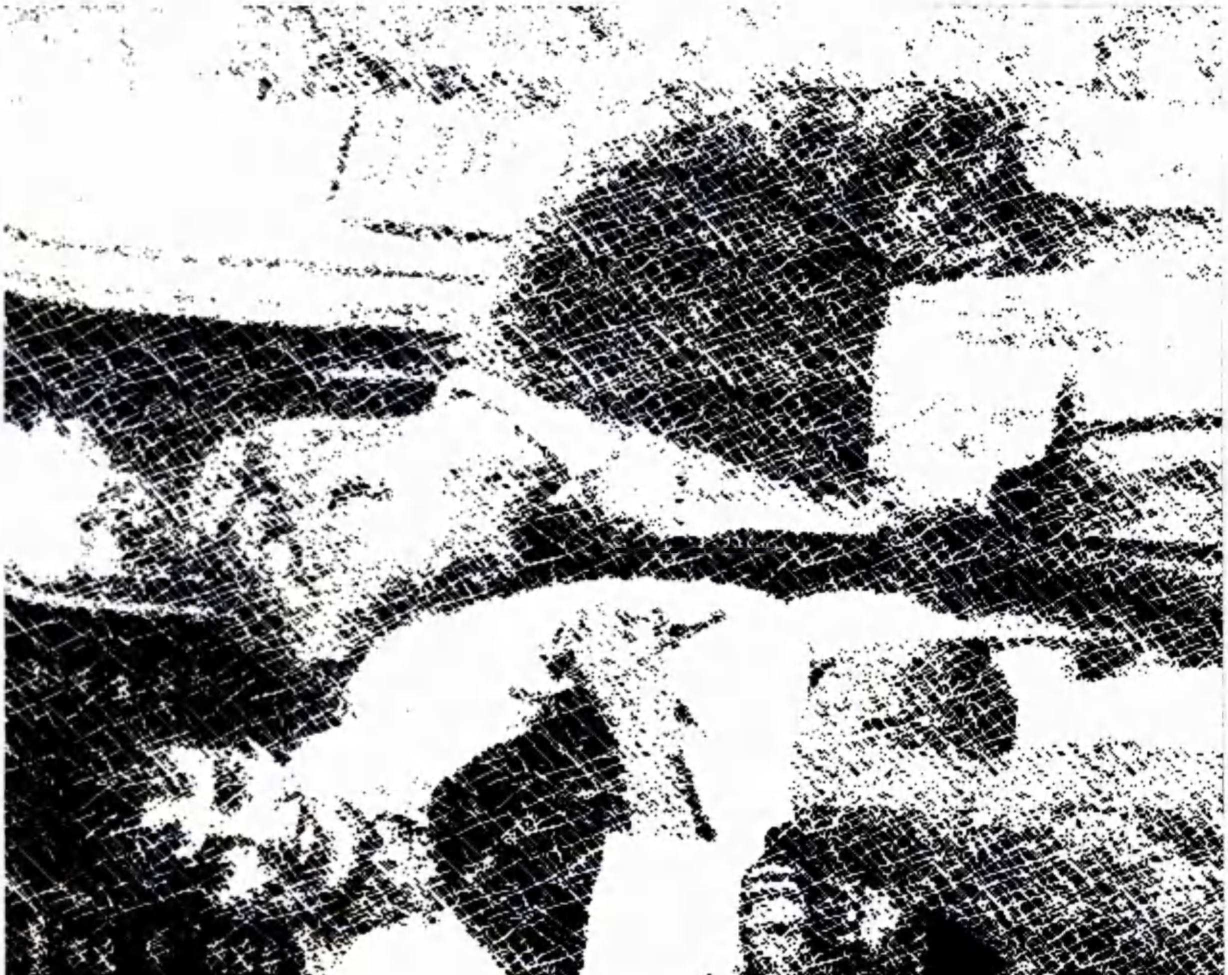
Pattern fill for texture effects

The *prop* function was used to introduce textured effects into designs and photographic images. The pattern units were of 64 x 64 and 128 x 128 pixels (these sizes allowed more organic type textures to be achieved than with smaller matrices). Each unit was designed to work in repeat to give a continuous effect. They were designed in black and white, but colour changes could be made. They were grouped in sets of five units with the units in each group designed to give five tonal variations of a basic theme by varying the proportions of black and white pixels in the units.

These units could be introduced into specific areas using *prop.* If the pattern is used in adjacent areas, the repeat will match up due to the common origin for the function. An equivalent of this is illustrated in Appendix 13, using texture units in Hi-Res. They can also be introduced into all the areas of a particular colour. *Prop* is used to repeat the selected texture over the whole of one screen, a colour in the image is selected as *auxcol*, and the image is copied or loaded onto the 'textured' screen. This was found to be useful in treating greyscale photographic images to produce an 'organic' halftone effect. The tones in the image were compressed to seven. Black and white were retained and the mid-tones replaced by the equivalent texture in the group tonal range.



Texture units (size 64 x 64 pixels), (a) to (e) indicate the tonal range for each group.



A photographic image with 'organic halftone' using texture group 2.

APPENDIX 10: PAINT SOFTWARE EVALUATION: DRAWMOUSE

This appendix covers specific methods of repeat construction using the software DrawMouse. This paint program, produced for the Research Machines Nimbus computer, has a low resolution workspace of 320 x 216 pixels. It is limited to 16 colours, but provides an extra 120 simulated colours by alternating pixels of two colours. It has standard paint functions and some specialist functions applicable to textile design, including colour separation and repeat facilities. The low resolution means that it is of limited application for printed textiles, apart from very small scale designs and novelty 'computerised' imagery. Owing to its ease of use and specialist facilities, it has proved a useful teaching aid in the introduction of computer graphics and teaching of repeat theory.

Grid - a snap grid can be specified by a number of pixels horizontally and vertically. It constrains the cursor movements to these spacings.

Undo - revokes the last screen change.

Repeat - repeats a defined raster over the whole screen area in the selected repeat format. These are zero drop (block), brick, drops (1/4, 1/3, 1/2, 2/3 and 3/4), unit drop (an alternation of unit and background), and repeat over (for butting up design motifs).

Mirror - reflects a raster over its horizontal or vertical axis. It is not combined with copy and move functions.

Turn - right or left rotates a raster by 90º clockwise or anti-clockwise, using the centre of the rectangle as the axis of rotation.

Reduce - reduces a raster by a specified percentage. For example, 25% will reduce it to 3/4 of the original size. The degradation in image quality experienced with all raster graphics is exacerbated by the two-colour mixes which may produce moire patterns on reduction.

Repeats

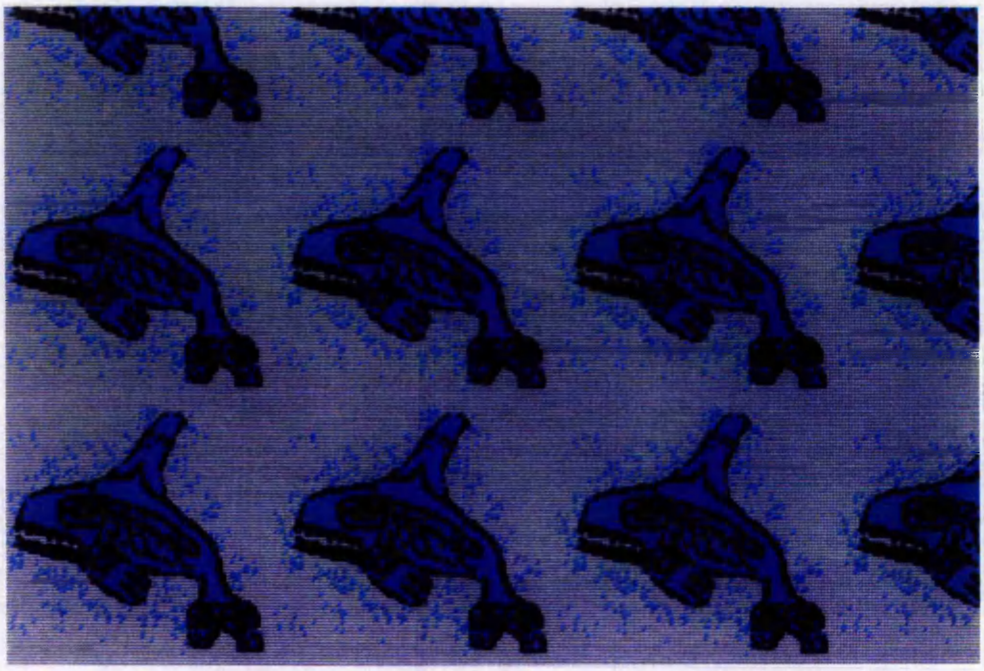
A full screen image can be reduced to a size capable of being repeated over the screen. Alternatively portions of an image can be selected for repetition. The provision of the *undo* option allows for consecutive selections, both of repeat type and area, to be tried out, and the full screen image to be regained. This allows for experimentation and chance effects. The terms used for the different repeats are mostly self-explanatory. *Mirror* and *turn* allow for the construction of symmetrical patterns. Variations on the block repeat can be constructed by placing and transforming copies of the repeat unit, followed by the selection of a total repeat unit for a zero drop. The user guide suggested the following method for the construction of a pattern with four-way mirror symmetry -

(a) Make a repeat pattern with zero drop.
(b) Mirror the whole of the first column of the pattern, horizontally.
(c) Mirror the whole of the bottom row of the pattern, vertically.
(d) Make a repeat pattern with zero drop from the symmetrical design in the lower-left corner of the screen.

Alternatively, *mirror* and *turn* can be applied to individual units in a constructed repeat, thus extending their use to repeats other than the zero drop.
The most innovative repeat provided by DrawMouse is *repeat over.* The following two methods apply this function to the construction of overlapping, or butted-up repeat patterns. Both methods apply to motifs drawn on the background colour (this is preset and cannot be selected).

Butted-up motifs using the *repeat over* facility. A zero drop repeat is selected and a raster defined of the required size for the final repeat unit which is smaller than the motif. After the repeat is drawn, *undo* is selected, and this returns the previous screen image containing the single motif.
Repeat over is selected and a raster defined that contains the whole motif. This is repeated using the previously selected repeat type and unit size. Any parts of the motif that exceeded the original unit but which are included in the second unit will overlap adjacent repeated units in the final pattern (figure 10.09).

Repeated motifs with filling elements using the *repeat over* facility. This uses the same motif repeated using a zero drop and a unit size that accommodates the whole motif. *Undo* is selected to regain the motif. Additional detail, which exceeds the boundaries of the first unit, is added to the motif. *Repeat over* is selected and a raster is defined containing all of the modified motif. This is repeated using the previously selected repeat type and unit size. Any additions that are included in the second unit are overlapped on to adjacent repeated units in the final pattern. This pattern is the same as the first pattern but contains additional filling details.
As with Designer Paint, a screen image created on the background colour can be loaded over another image allowing the combination of two repeat types.



Zero drop using the whole motif (shown in figure 10.09.a).

Motif with additional detail.

Repeat over using the same format as above. Additional detail has been included without the background colour.

APPENDIX 11: DRAWING SOFTWARE EVALUATION: ORMUS FASHION

This appendix covers specific methods of repeat construction using the software Ormus Fashion. The layers within an Ormus file are termed *pieces* and are worked on individually. A piece must be closed before another is opened, but can be made visible whilst another is being edited. All the elements of a piece can be copied to another piece in two different forms. One is *duplicate piece*, in which the copied elements can be modified. The other form is *copy piece*, in which the copy cannot be modified directly, but any modifications or additions to the original piece will be carried through to the copy. Scaling, mirroring, and rotation can be specified when using copy piece.

Linear copy allows multiple copies of a piece to be placed using regular spacing in one direction. A dialogue display requests the piece name and the number of copies required. The first piece can be placed by eye, using a snap grid, or by numerical input of co-ordinate positions. Each piece is given a reference point by the user, and this point is used to position the copy on the specified co-ordinates. The second copy can be positioned, again by eye, by use of the snap grid, or by a numerical input of the displacement distance (on the x and y axes) from the first copy. This displacement is used in positioning any subsequent copies.

Angle copy allows for multiple copies of a piece to be placed at specified angles around a rotation point. Inputs are required for the angle of rotation and the rotation point, in addition to the piece name, number of copies, and the positions of first and second copies. The piece reference point is especially important in determining the particular orientation of each copy. Different arrangements can be achieved by the specification of different points.

Because pieces copied to another piece are drawn from the data of the original piece, any modifications to the original piece appear in the copies. This feature of the software was investigated to establish files that would allow a design to be drawn in repeat. The basic method is documented in Chapter 10.13, the following are specific examples of its application to various formats. The designs were output to a pen plotter, and some of the figures were plotted at a reduced scale.

Repeat construction: basic method.

(a) Decide on the size of the repeat unit and construct a rectangle of those dimensions in piece 1. End piece with a reference point.

(b) Start piece 2, make visible piece 1, and place direct or transformed copies of piece

1 in the required format. End piece 2.

(c) Open piece 1, make visible piece 2, draw the design. Select *draw all* periodically. This will update the copies in piece 2 and show the additions so that the design can be viewed in its repeated form.

Block repeat. This method was used in the construction of figure 10.10.

(a) A rectangle 89 x 123 mm was constructed in piece 1. The piece was ended with a reference point at the top left-hand corner of the rectangle.

(b) Piece 2 was opened and piece 1 made visible. Three copies of piece 1 were positioned so that the rectangles were adjacent to the original. Piece 2 was ended.

(c) Piece 1 was opened and piece 2 made visible. The design was drawn.

Parts of the design in piece 1 exceeded the boundaries of the repeat unit. Those that were drawn over the top edge of the unit appeared in the lower half of the unit as parts of the copy which was placed below. Those that were drawn over the left-hand edge appeared in the copies on the right-hand side. This method was useful in ensuring that elements, such as the serpentine stem, linked effectively over the joins of the repeat. Lines could be modified, and the changes viewed quickly. To be applicable to all types of design, the original unit would need to be completely surrounded by copies, thus ensuring continuity on all sides.

Block/diaper/horizontal-mirror. This method was used in the construction of figure 10.11.

(a) A rectangle 36 x 62 mm was constructed in piece 1, and the piece ended with a reference point at the top left-hand corner of the rectangle.

(b) Piece 2 was opened and piece 1 made visible. Eight copies of piece 1 were positioned so that the rectangles surrounded the original, giving a block of 3 x 3 units. Some copies were mirrored horizontally to construct the format (figure 10.11.a). Piece 2 was ended.

(c) Piece 1 was opened and piece 2 made visible. The design was drawn.

All elements drawn in piece 1 were automatically transformed in the mirrored copies. As in the previous example, this method was effective in helping to achieve continuity in the design, especially on the top and bottom edges.

Block repeat with units rotated 90 degrees. This method was used in the construction of figure 10.12.

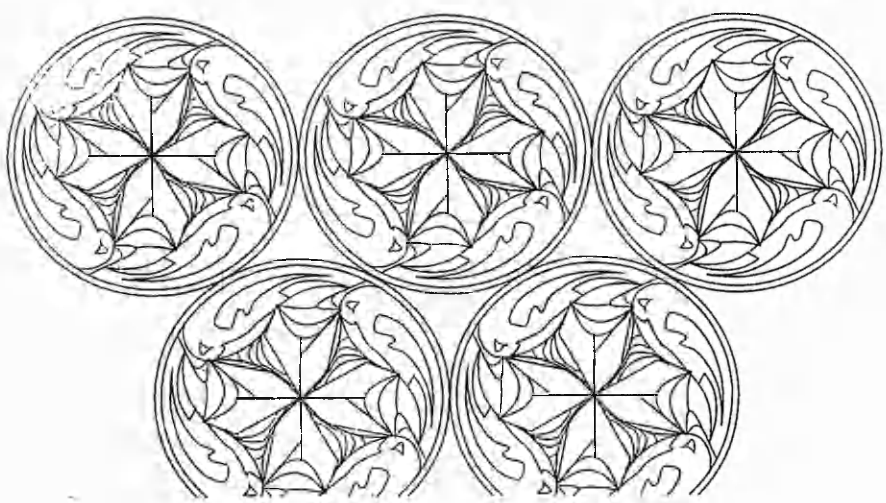
(a) A unit 34.5 mm square was constructed in piece 1, and the piece ended with a reference point at the top left-hand corner of the unit.

(b) Piece 2 was opened and piece 1 made visible. Fifteen copies of piece 1 were made, copies 1, 2 and 3 were rotated 90º, 180º and 270º respectively, using the top left-hand corner of the original unit as the rotation point. The other twelve copies were placed in three groups consisting of four rotated units, giving a block of 4 x 4 units (figure 10.12.a). Piece 2 was ended.

(c) Piece 1 was opened and piece 2 made visible. The design was drawn.

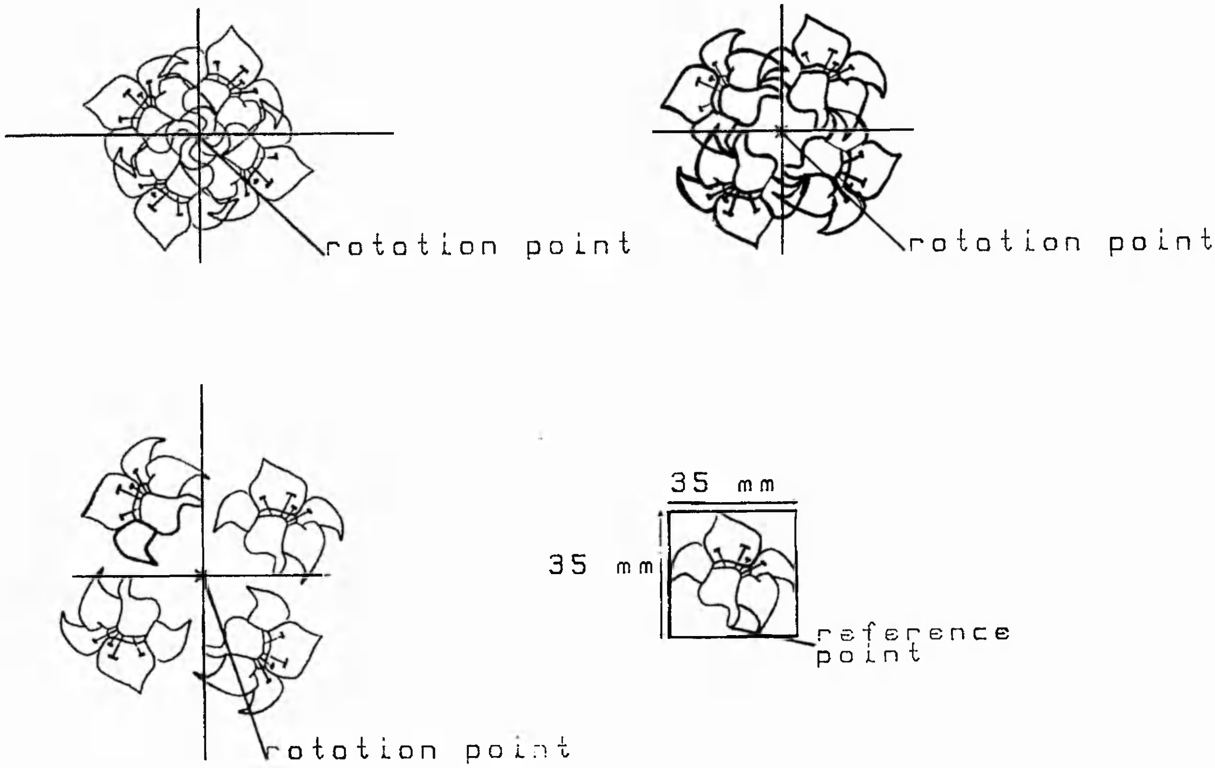
All elements drawn in piece 1 were automatically rotated in copies 1, 2 and 3, and the rotational organisation of these four units was exhibited in the other three groups. This method was useful in constructing rotational patterns, such as figure 10.14. A similar procedure was used to construct the 60º rotational pattern below.

Individual unit. 6 units rotated by 60 degrees to form a composite unit.

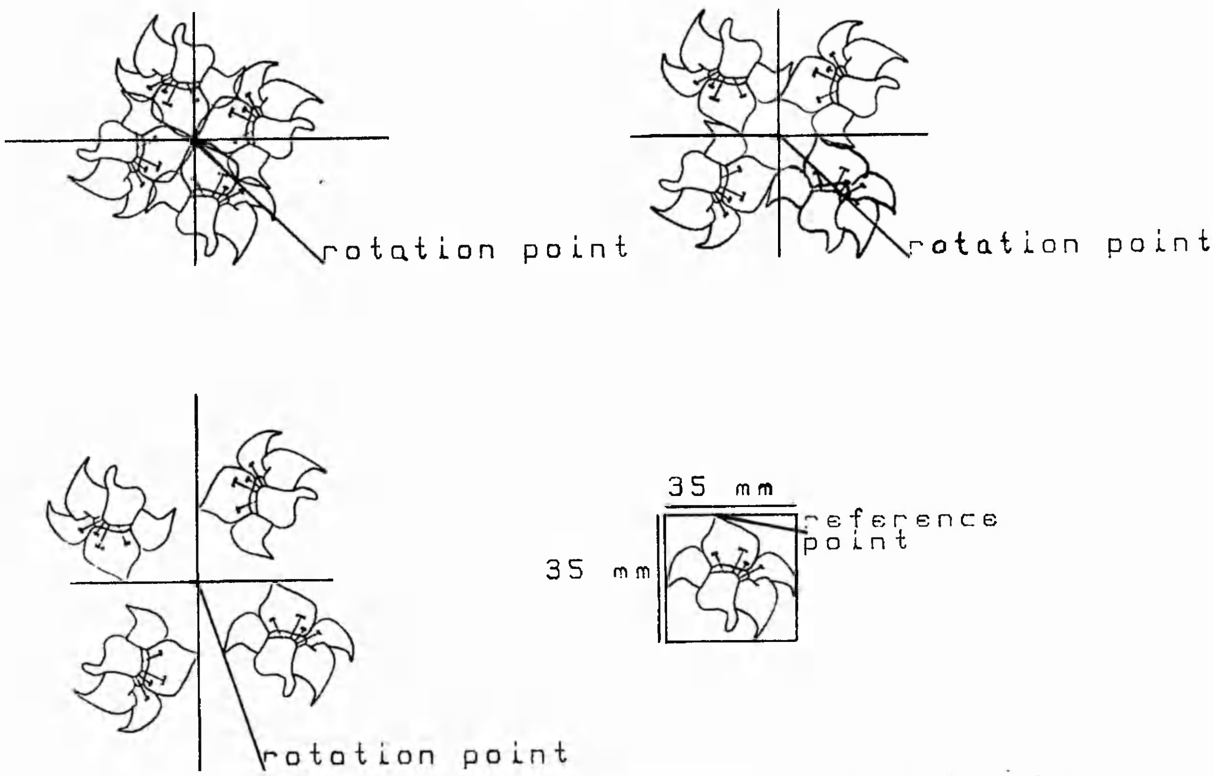


Brick repeat using the 60 degree composite unit.

These methods were applied to all the formats documented in Chapter 9. The position of the reference point was found to be crucial in placing the units and performing transformations.



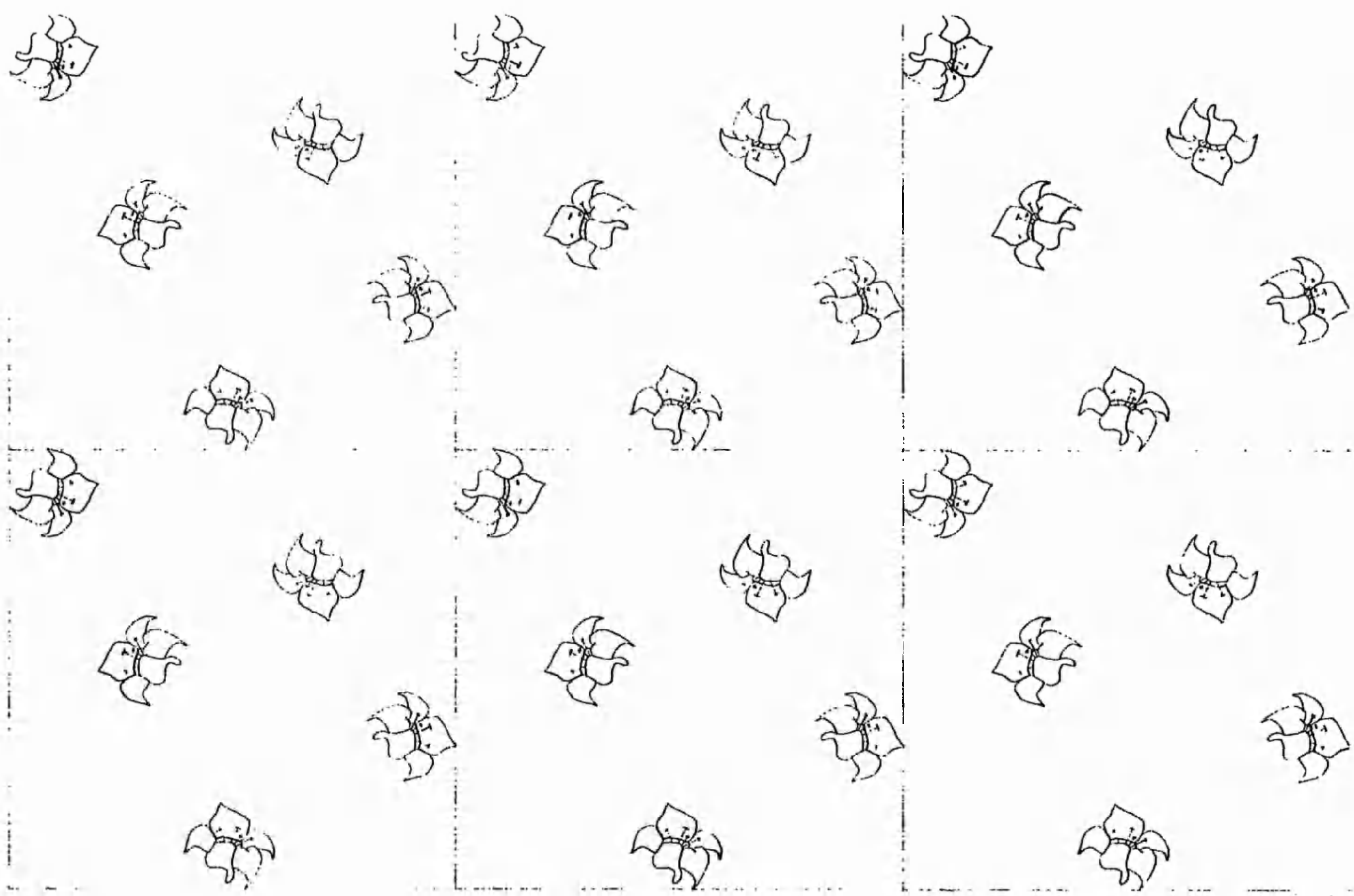
Motifs rotated 90 degrees, using distances from the rotation point of 0, 10 and 20 mm.



Motifs rotated 90 degrees, the reference point differs from that in the figure above.

The prevous figures illustrate the difference in orientation of motifs achieved by changing the position of reference point for 90 degree rotations. Both figures also show three different arrangements achieved by altering the distance of the reference point from the rotation point.

Various procedures were developed for creating spot repeat patterns. These used grid methods based on sateen organisations (9.35). The following figure shows a five spot format with a count of three. Individual motifs have been transformed by rotation or mirroring. The original unit was drawn in piece 1, the basic repeat unit (indicated by the grid lines) was created using copies in piece 2. The repeat was constructed using copies of this composite unit in a block repeat format in piece 3. It was found that by changing the piece copied into piece 2 (introducing a different motif), a variety of spot patterns could be easily created using the basic format. With detailed designs piece 3 could be made invisible to reduce the redraw time, and made visible occasionally to see the full repeat.



Five spot format with a count of three block repeated.

APPENDIX 12: COMBINED RASTER AND VECTOR SOFTWARE: ALDUS FREEHAND

This appendix covers specific methods of repeat construction using the software Aldus FreeHand®. Due to the mathematical basis of this type of software, repeat units can be created, copied, repositioned, and transformed easily and accurately. Design elements can be grouped and then transformed as one object.

Clone - makes a copy of an element or group in exactly the same position as the original.

Move - an element or group can be moved by a specified distance on the horizontal and vertical axes. A sequence of clone and move can be *duplicated* to give a regular repetition of units.

Mirror and *rotation* - can be controlled by specifying a point about which the transformation is performed. Horizontal and vertical mirror operations are selected by specifying the axis of reflection.

Tile - allows elements to be repeated in another element. Spacing is determined by the overall size of the elements. To apply this satisfactorily to repeats, the total repeat unit was pasted into a rectangle, which was then tiled. Bit-mapped images cannot be tiled.

Repeat construction

The sizes of repeat unit were decided at the start of the process and guided the move and transformation operations. Relating the movement to the repeat unit dimensions, rather than the overall size of design unit, allows designs exceeding the unit boundaries to be butted up.

Half-drop/pillar/horizontal-mirror format. This method uses a combination of clone, move, mirror, and tile operations.

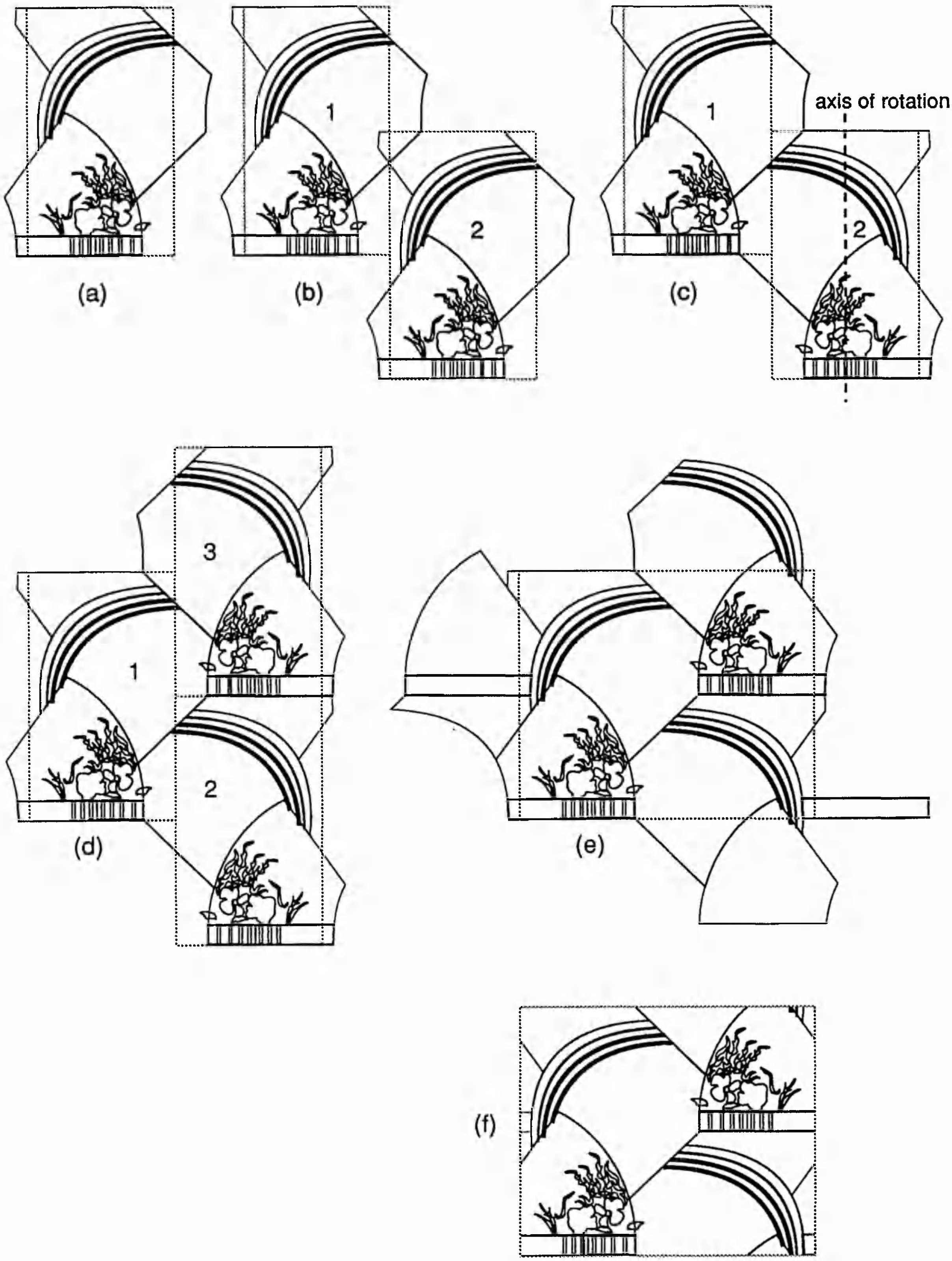
(a) The repeat unit rectangle is constructed and the design outlines drawn in. These are not wholly contained in, nor fully fill, the unit rectangle.

(b) The unit is cloned and moved into a half drop position by a displacement of the unit width on the horizontal axis, and half of the unit height on the vertical axis.

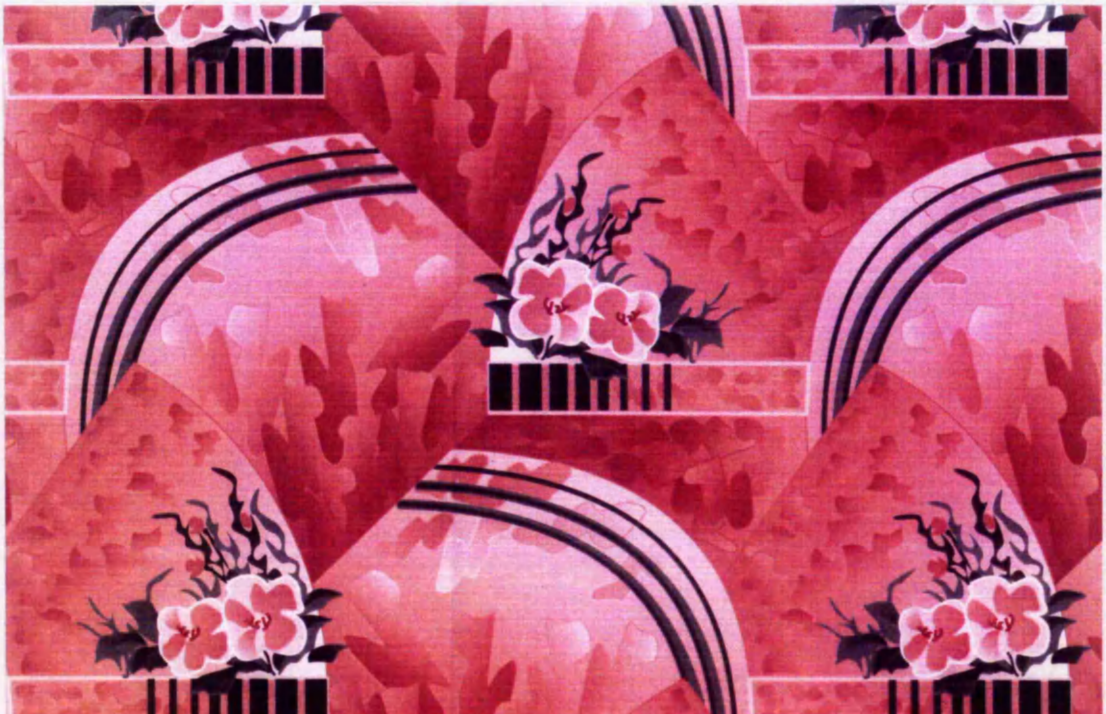
(c) Unit 2 (the clone) is mirrored about the vertical axis of the unit rectangle.

(d) The transformed unit 2 is cloned and displaced by the height of the rectangle.

After the design outlines are drawn in, stages (b) to (d) are performed to see how the units interact and modifications are made to unit 1 in order to improve the 'fit'. Units 2 and 3 are deleted and stages (b) to (d) performed again. When the basic structure is satisfactory, the original repeat in unit 1 is completed. Units 2 and 3 are deleted and stages (b) to (d) performed again.



(a) to (f) The construction of the tile unit.



(g) Half-drop/pillar/horizontal-mirror format.

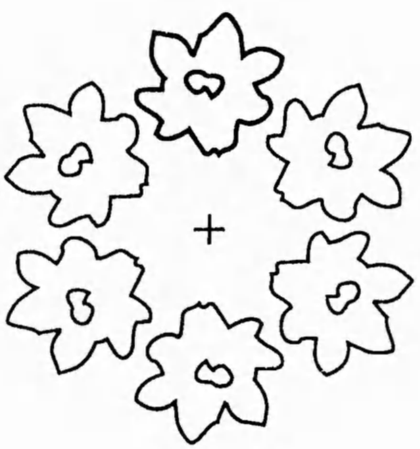
(e) Shows the composite repeat unit rectangle. It is twice the width of the original rectangle in order to encompass the dropped units. Design elements that exceed its boundaries on the left-hand side are cloned and moved by twice the unit width, thus entering the composite unit on the right-hand side. A similar operation is performed on those exceeding the right-hand edge so that they enter on the left-side of the composite unit. Elements of clones 2 and 3 which are outside the composite unit are deleted.

(f) All the design elements are cut and pasted into the total repeat unit rectangle.

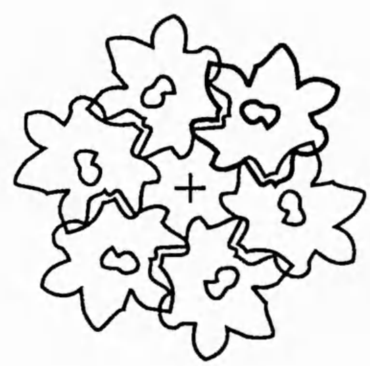
(g) The outline is made invisible and the pattern unit tiled into a larger rectangle to form the repeated pattern.

The illustrations in *Repeat Patterns* were constructed using variations of this technique. It was especially useful for Escher type designs that rely on the interlocking of identical units subjected to reflection or rotation.

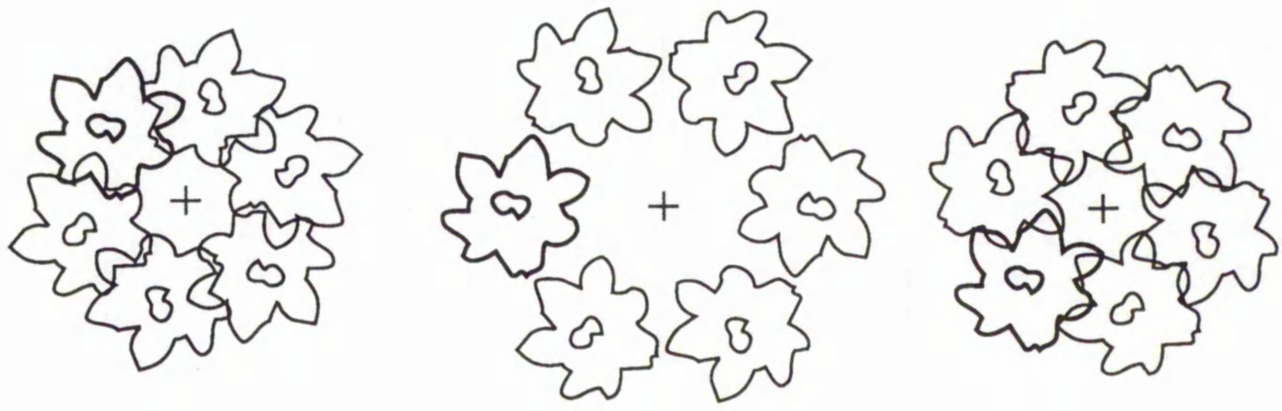
Rotation. A variety of arrangements can be achieved by altering the rotation point for a motif in a sequence of clone, rotate, and duplicate operations. The sequence for (a) in the following examples was: clone element, rotate by 60 degrees about a point 20mm below the centre of the motif, and duplicate four times. This gave six motifs rotated about the specified point.
The other arrangements varied in the distance and orientation of the centres of the elements from the specified rotation points. Although the arrangements differed, it was found that the orientation of specific motifs in each group was the same. This contrasts with the similar exercise carried out using Ormus Fashion (Appendix 11) in which the orientation of motifs can be altered by the additional variable of a reference point.



(a) Rotation point 0, -20 from unit centre.



(b) Rotation point -10, -10 from unit centre.



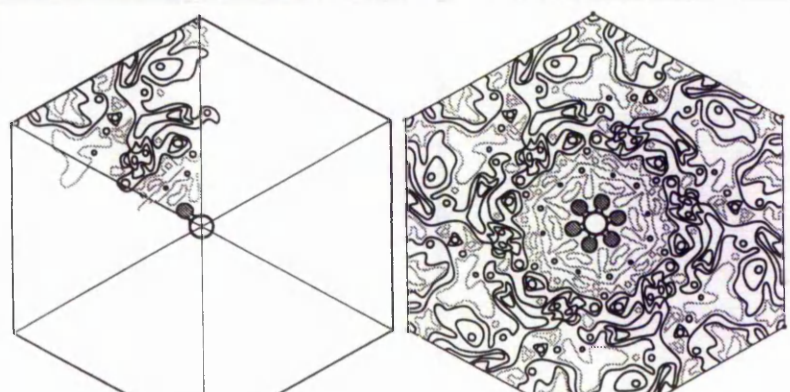
(c) Rotation point
10, -10 from unit centre.

(d) Rotation point
20, 0 from unit centre.

(e) Rotation point
10, 10 from unit centre.

Various arrangements of motifs achieved by changes in the rotation points for 60 degree rotations.

Hexagonal pattern using 60 degree rotation. This method was used for the construction of figure 10.13. The unit (a) was reproduced by five sequences of clone and rotated by 60 degrees to form the hexagonal unit in (b). The centre of the hexagon was specified as the rotation point. The repeat was built up using a sequence of clone and move, rather than the tiling method.



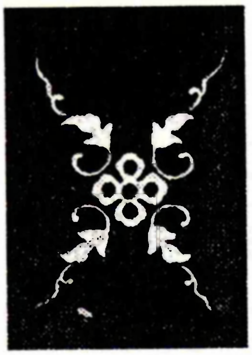
(a) unit

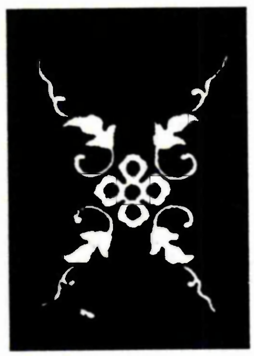
(b) composite hexagonal unit

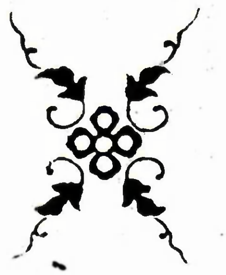
Construction of the rotational composite unit used for figure 10.13.

90 degree rotational pattern. This method was used in the construction of figure 10.14. One unit (a fish) was cloned and rotated by 90 degrees three times, using the centre of the square as the rotation point (figure 10.14.a). The unit was modified so that the units all fitted together without any gaps. This group of four was cloned and moved four times to build up the composite repeat (b). The elements within the square were tiled to form the repeated design shown (c).

The following illustrate some of the modifications and applications of bit-mapped images in Aldus FreeHand®.


(a)


(b)

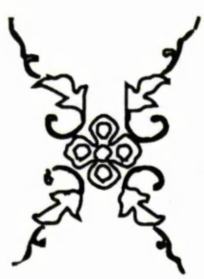

(c)

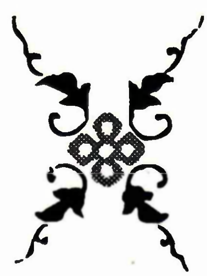

(d)

(a) A scanned greyscale image, imported as a TIFF file.
(b) The image (a) converted to black and white.
(c) The black and white image (b) converted to a negative.
(d) The image (a) polarised (reduced from 16 grey levels to 4).


(e)


(f)


(g)


(h)

(e) (a) cropped by using cut and pasted into a rectangle.
(f) (a) cut and paste into an irregular element.
(g) The negative black and white image (c) traced to produce an out-lined form.
(h) The traced image (g) filled with two colours.

APPENDIX 13: COMBINED RASTER AND VECTOR SOFTWARE: ORMUS HI-RES®

This appendix covers specific methods of repeat construction using the software Ormus Hi-Res®. This allows Ormus vector files (Appendix 11) to be converted to bit-mapped images at high resolution. Therefore, when the image is output to a printer, the lines are smoother than with most raster graphics, although less smooth than a line output to a pen plotter. Scanned and painted imagery can be imported in various raster file formats. PIC files were used in the following examples.

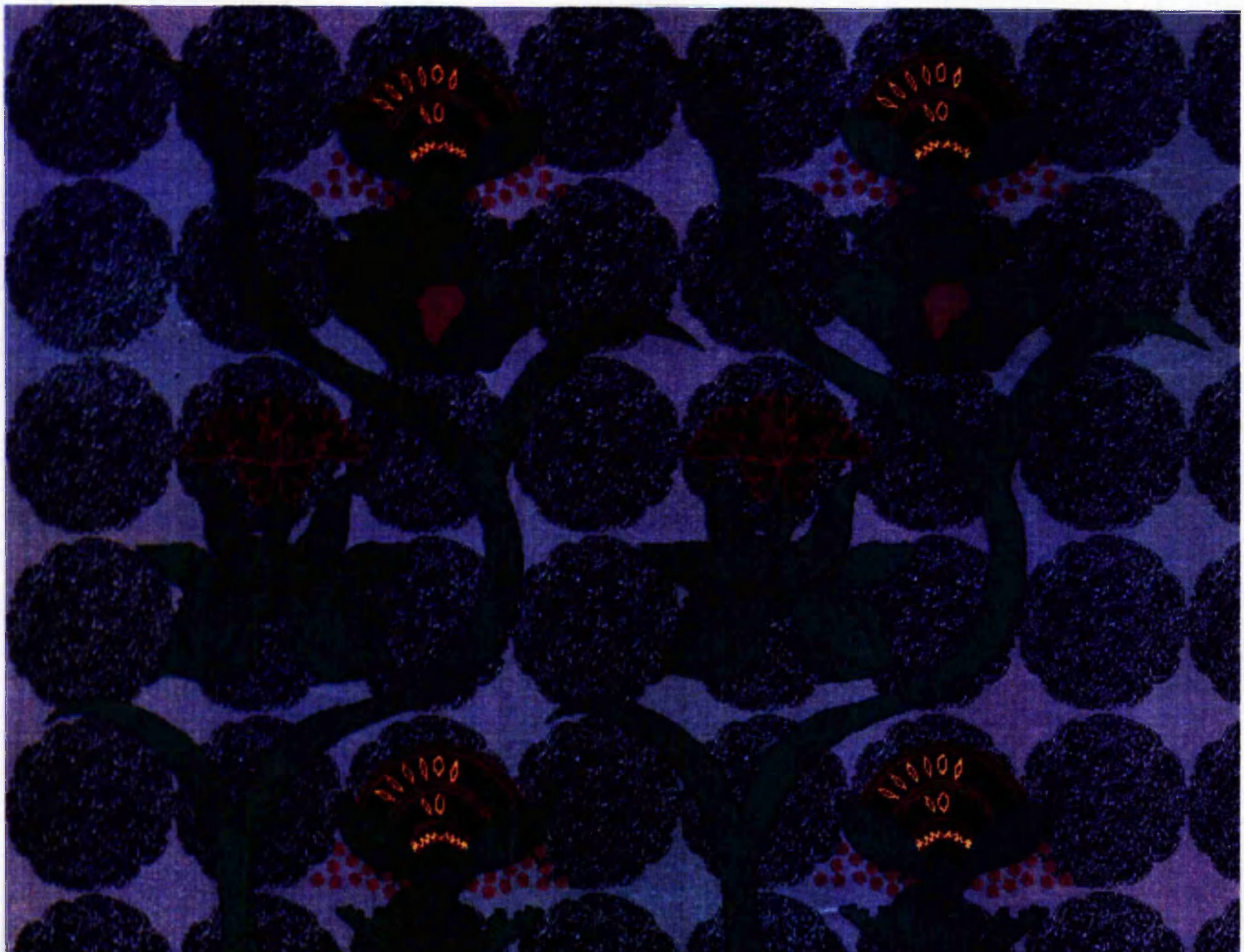
Conversion to bit-mapped images. Specifications of resolution and line width can be made prior to this conversion. Figure 10.15 shows three examples of an Ormus line drawing converted using different specifications.

	line width	resolution
(a)	1	75 dpi
(b)	1	150 dpi
(c)	2	300 dpi

Output. The examples in figure 10.15 were printed at these same resolutions on an A3 thermal printer, and were all the same scale as the original line drawing (figure 10.12). (The other examples from Hi-Res, in this thesis, have been reduced in size by photocopying). The selection of different output resolutions enables large designs to be produced and allows accurately scaled 'rasterised' images to be printed. Student research using this software has resulted in the production of furnishing prints but, due to the limited size of printer output, the colour separations had to be printed in sections and patched together.

Paint facilities. The software provides pixel editing, a variety of brush types, flood filling (flat colour), and pattern filling. An image that has been converted using a small line width may have breaks in the lines, but pixel editing allows these to be corrected before using the fill functions.

Pattern fill. This uses a raster copied into the clipboard to fill a bounded area. Small patterns can be created by pixel editing and copying. The software allows more than one file to be open at once. This facility was used in conjunction with the pattern fill to introduce textures to a line image. A PIC file containing black and white texture patterns



A converted Ormus line drawing (figure 10.10) with flood filling in bounded areas and a pattern fill in the background area.

from Designer Paint (Appendix 9) was opened, a raster encompassing one texture block was copied, and used as a pattern fill in another file. A converted Ormus line file (figure 10.15. a) was pixel edited, and bounded areas were flood and pattern filled as above (figure 10.16). The colours were specified by colour matching at the printing stage. The example opposite is a converted Ormus line file (figure 10.10) which has been flood filled. The background pattern was introduced by using a pattern fill on the background colour with a pattern unit taken from a scanned image.

Repeats. Designs can also be transferred from lower resolution paint systems to be repeated and modified prior to output. The repeat function provides simple formats (block and drop or brick with specified offset). The repeated design can then be painted into, and additions made to individual units.

GLOSSARY

Acanthus pattern -	Stylised pattern of curling leaves often seen on Italian velvets and damasks.
Adinkira cloth -	African patterned fabric with small repeated stamped designs within linear divisions drawn with combs.
Adire cloth -	West African tie-dye and resist dyed cloth of white patterns on a blue ground, produced by tying, folding, stitching, or painting with cassava paste followed by dying with indigo.
Alizarin -	Synthetic red dye which replaced madder. Introduced in 1865.
Anilines -	Group of dyestuffs based on coal tar developed in the 19th century, often referred to as the first synthetic fabric dyes.
Appliqué -	Applied work: a technique in which one fabric is applied to another to form a surface decoration.
Arabesque -	Scrolling decorative motif with entwining leaves and branches, often found in Rococo designs.
Batik -	The drawing of a design in melted wax followed by the immersion of the fabric in a dye bath. The wax resists the dye, and when removed leaves the pattern reserved on a dyed ground.
Bed hangings -	Curtains which trimmed fourposter beds, and provided privacy and warmth.
Berlin work -	A type of embroidery copied onto canvas from patterns printed on squared paper, especially popular around 1840.
Bitmap -	An array of memory elements which when mapped directly onto a display screen generates an image.
Bizarre silks -	Woven exotic designs which were fashionable between the late 17th century and about 1720. They reflected the influences of Oriental, Indian and Persian designs.
Blotch -	Any relatively large area of uniform colour in a printed design.
Blue-resist -	These differ from normal resist prints in that the design is blue on a white background.
Boteh -	A dominant motif in Indian decorative arts which was introduced from Persia during the Mughal period. From the Hindu word 'buta' for flower. It was the basis of the Paisley pattern via Kashmiri shawls.
Brocade -	A multi-coloured woven figured fabric in which the pattern is produced by floating the warp threads, or the weft threads, or both.
Burin -	Steel hand tool used for copper plate and roller engraving.
CAD -	Computer-Aided Design.
CAD/CAM -	Computer-Aided Design and Manufacture.
Calico -	Plain weave cotton originally from India, usually lightweight and bleached. Also known as calicut. Used extensively in Europe from the 17th century for block and resist printing.
Caraco -	A short fitted jacket worn with high-waisted dresses from the 1780's, from the French peasant jackets or caracots. (See also Spencer).
Cartouche -	A panel device, based on a stylised scroll, often used as a frame for pictorial imagery.
Cashmere pattern -	A filling pattern derived from Persian or Indian floral designs, often using the boteh motif.
CD-Rom -	Compact Disk-Read Only Memory.
Cheese cloth -	An open light-weight fabric of plain weave, usually made from carded cotton.

Chevron pattern -	Pattern of diagonal lines lying in alternate directions.
China-blue -	An 18th century printing technique involving the printing of a paste containing indigo, iron sulphate and a thickener directly on to the cloth by copperplate or block. The pigment was dissolved and transferred onto the textile by successive applications of lime and copperas. Varying shades of blue were produced by different proportions of indigo.
Chiné -	See warp prints.
Chinoiserie -	European designs derived from Chinese imagery and decoration.
Chintz -	Glazed cotton cloth with a printed design. Originally Eastern hand-painted cloths imported during the 17th and 18th centuries.
Clouded silk -	See warp prints.
Computer graphics -	Computer applications concerned with the creation and manipulation of images. A display of pictorial information generated by a computer and the person-computer interaction which may modify that display. Pictorial information may be represented in various formats, depending upon the particular application.
Coppered block -	Woodblock with added metal elements.
CRT -	Cathode-ray tube. A device for converting the computer's electrical signals into visible images.
Damask -	One colour figured fabric using different weave structures to form the pattern.
Design unit -	The basic building block of a design. Copies of the unit can be arranged in simple formats to build up a repeated pattern. Secondary organisations and transformations can be applied to individual units within a format.
Design element -	An individual line, geometric shape, motif, or image used in a design.
Digitiser -	An active surface for generating Cartesian coordinates from line drawings for storage and display on a computer system.
Direct dyes -	Organic materials which readily dissolve in water, thereby allowing the fabric to take on colour, often fugitive but can become fast in combination with mordants. Also called substantive dyes.
Direct printing -	Printing with a paste containing colour and fixing agent, the colour coats the outside of the fabric.
Discharge printing -	Colour is removed from a previously dyed cloth to create a white pattern on a coloured background which can be reprinted with in another colour. Modern methods combine discharge and colour replacement in one process.
Document fabrics -	Faithful reproductions of textiles from the past.
Dpi -	Dots per inch.
Drab style -	The colour range of yellows, buffs, and browns associated with a fast yellow dye, quercitron, introduced in 1800.
Engineered print -	Printed design arranged to fit in a specific garment shape.
English blue -	See pencilled blue.
Engraving -	The general term applied to methods of transferring a design to a textile printing element. In the production of woodblocks, engraving is applied specifically to the cutting

	of blocks for paper printing and carving to the cutting of blocks for textiles.
Felting -	A block-cutting technique in which the block was hollowed out and filled with a felt pad to ensure an even spread of colour when printing large blotches.
Filling pattern -	Pattern formed of small-scale regularly spaced motifs, often combined with borders for shawls or curtains.
Fondu -	See rainbow stripes.
Foulard -	Small-scale regular geometric patterns originating from block-prints.
Fractal -	A pattern generated by computerised simulation of the behaviour of non-linear mathematical equations. The patterns generated, on closer inspection, are due to a self-repeating motif which recurs at smaller scales *ad infinitum.*
Fret -	Pattern composed of straight lines usually joined at right angles.
Fustian -	Linen warp and cotton weft.
Glass pattern -	Glass patterns are often used in psychophysical research, these are formed by duplicating a random scatter of dots and moving the copies by a fixed distance and direction from the original, giving groupings of paired dots. Detection of these patterns is affected by the distance and direction of the displacement.
Graphics card -	A printed circuit board which can be added to a computer to provide an enhanced graphics facility.
Honeycomb ground	Small-scale regular hexagonal pattern used as a machine printed fancy ground.
Ikat -	A fabric patterned by weaving resist-dyed yarns. See also warp printed.
Imbrication -	See scale pattern.
Indienne -	European designs derived from Indian painted and printed cottons.
Indigo -	Deep, fast blue dye-stuff, insoluble in water. See China-blue, blue-resist, resist printing, and pencilled-blue.
Intaglio -	A design or line cut into a surface so as to form a hollow or indent.
Irisé -	See rainbow stripes.
Island pattern -	Pattern in which the motif is isolated in repeat on a plain ground.
Jaspé -	Jaspered, or marbled, speckled appearance.
Lapis style -	Related to the use of resist mordants (1800). Resist-red, a thick paste to block indigo dye was combined with a mordant that would produce red in conjunction with the madder bath. This allowed red and blue to be printed adjacently with no risk of white outlines.
Leuco dye -	A reduced form of a dye from which the original dye may be regenerated by oxidation. See vat dye.
Long film -	Colour separations produced on transparent film used for the engraving of copper rollers or rotary screens.
Lotus motif -	Stylised depiction of the flower, buds, or leaves of the lotus plant, originating from Egyptian art.
Machine ground -	Small-scale, regular, all-over roller printed design, such as honeycomb or trellis patterns. They were often used as grounds for larger scale block or roller printed designs.

Madder -	Vegetable dye producing red or black with the prior application of mordants. The Indian red dye is derived from chay, which is a plant from the same family.
Madder style -	Style of printing associated with madder and other soluble organic colours. A thickened mordant was printed, this took up the colour when the cloth was immersed in a dye bath leaving an unprinted ground.
Matrix -	A rectangular array of rasters.
Medallion -	Rounded ornament often containing other motifs.
Moiré -	Watered effect produced by subjecting a ribbed or corded fabric to heat and heavy pressure by rollers after weaving. Often imitated by printing.
Mordant -	Designs painted or printed with mordants retain colour when the cloth is dyed, the colour is washed out of areas not treated, leaving a coloured design on a plain background.
Ogee -	Combination of a concave and convex line, producing a serpentine shape.
Ombré -	See rainbow stripes.
Padding style -	Printing style associated with mineral colours.
Paint system -	Computer raster graphics system on which the user can create images using tools simulating brushes, pens, airbrushes, etc.
Paisley pattern -	Design based on the oriental boteh motif, especially popular for shawls and dress fabrics in the 19th century.
Palampore -	Painted Indian calico bedspread, single panel, sometimes with block printed border patterns.
Palmette -	Classical motif based loosely on a stylised palm leaf.
Pantograph -	Adjustable device for the copying and rescaling of designs. It allows multiple repeats to be engraved on rollers.
Pattern -	A design composed of one or more devices, multiplied and arranged in an orderly sequence.
PC -	Personal computer.
Pencilled-blue -	18th century method of applying indigo mixed with chemicals and thickeners by directly by hand painting. Also called English blue and *Englischblau*.
Pencilling -	Hand-painting technique for applying colour to printed designs, for the filling of outlined forms or overlaying areas to provide tonal effects.
Petal diaper -	See scale pattern.
Picotage -	See pinning.
Pillar print -	Vertical stripe patterns with representations of architectural columns interrupted by ornamental capitals and flowers.
Pinning -	The fixing of metal elements into the surface of a woodblock to produce printed effects, various simple shapes, lines, crescents, and stars were used. Also called picotage.
Pin-spot pattern -	Printed effect produced by pinning, or picotage. Also called stormont grounds.
Pitch pins -	Pins fixed on the corners of woodblocks used to guide the placement of impressions.
Pixel -	The smallest addressable element of a computer graphics image.
Polonaise -	An overdress with a decorative looped skirt shorter than the petticoat or underskirt. The

term was of French origin used from the 1770's, and used again from the late 1860's for almost any form of draped overskirt.

Pomegranate - Stylised motif depicting an open fruit , its seeds exposed and surrounded by leaves and blossoms.

Pompeian - Early 19th century style of colouring derived from red-ground classical frescoes and pottery. Colour combinations red, black, and yellow, the latter from quercitron.

Pouncing - The dusting of powdered charcoal through perforated holes of paper or glazed calico to transfer the outlines of a pattern onto cloth prior to painting.

Quercitron - A fast yellow dye introduced in 1799, it could be combined with mordants to produce a range of colours. See also Drab and Pompeian.

Quick Response - A term coined during the 1980's, covering the industrial practices involved with faster reactions to market demands, such as cutting lead times and producing short runs.

Rainbow stripes - Printed vertical, horizontal, or diagonal multicoloured or vari-toned stripes. Block printed in the early 1820's and adapted to roller and surface printing. Colours could be merged or defined. Also called fondu, irisé, or ombré effects.

Raster - One line of pixels displayed on a computer display screen.

Raster graphics - Computer graphics systems which process images formed from rasters of pixels.

Resist - A substance applied to a substrate to prevent the uptake or fixation of a dye on a subsequent operation.

Resist printing - The painting or printing of a design with a resist paste, followed by immersion of the cloth in a dye vat. Often used with indigo to produce white patterns on blue grounds. Resists were also used to prevent the application of mordants.

RIP - Rater image processor. A computer peripheral which converts vector data into a raster format for output to an imagesetter or printer.

Rococo - Style of the early to mid-18th century, dominant design elements were C scrolls, countercurves and shell motifs.

Sablé ground - See vermicular.

Scale pattern - Pattern of overlapping scale-like shapes. Also called petal diaper and imbrication.

Scanner - A device for converting an image on paper, or other material into a matrix of pixels for storage and display on a computer system.

Separation - The opaque painted or photographically produced positive of all areas of one design colour on transparent film.

Serpentine pattern - Stripe pattern composed of concave and convex lines to form a waved effect.

Shawl pattern - See cashmere pattern.

Shell pattern - A small repeating pattern with tiny sprigs.

Shell roller - Hollow copper roller, enabling larger widths and vertical repeats.

Spencer - English fitted short jacket (mid-1790's to 1820's) worn with high-waisted dresses.

Sprigged design - Small-scale pattern of regularly spaced flower and leaf motifs to which changes of orientation are applied to create a scattered effect.

Starch-resist adire cloth -	Adire cloth produced using cassava paste as a resist, applied by metal stencils, feathers, sticks, combs and found objects to achieve a variety of effects.
Stippling -	Hand engraved tonal effects produced by punching small dots on a copper roller with a series of punches and hammers.
Stormont ground -	See Pin-spot pattern.
Style -	The collective individuality exhibited in the designs of particular cultures and eras, or movements within them, which is produced by distinctive combinations and uses of visual characteristics, such as line, colour, imagery, visual format, and spatial organisation.
Sublimation -	See vapour transfer and transfer printing.
Substantive dye -	See direct dye.
Tie-dye -	Hand-dyeing technique in which the fabric is tied or stitched into bunches, sometimes around objects, dipped in dye and then untied. Patterns are left where the dye has not penetrated.
Toiles de Jouy -	Scenic or floral printed cottons produced at Jouy near Versailles, between 1760 and the 1840's. Popular throughout the late 18th century for furnishings. Characterised by detailed figurative engraved vignettes. Toile indicates any fabric of this type.
Topical style -	The printing of a colouring matter with or without a mordant which was then fixed by steaming or drying.
Transfer printing -	Any process by which a design is transferred from paper to another substrate. Several techniques have been used: melt-transfer, film-release, and wet-transfer, but vapour transfer (sublimation transfer) is the most important.
Trompe l'oeil -	Images which deceive the eye by creating the illusion of three dimensions.
Turkey red -	Synthetic dye based on madder used from the 18th century until replaced by alizarin.
Vapour transfer -	Transfer printing process in which selected disperse dyes transfer in vapour form to thermoplastic fibres when the printed paper and fabric are brought into close contact in a transfer press at 170 - 220 degrees C. Also called sublimation transfer.
Vat dye -	A water-insoluble dye which is normally applied from an alkaline aqueous solution of the reduced (leuco) form, which is subsequently oxidised in the fibre to the insoluble form.
Vector graphics -	Computer graphics systems in which images are composed of discrete lines (vectors).
Vermicular ground -	fine-spot pattern produced in block printing by pin work. French sablé (sanded ground). Also called 'worm' ground.
VDU -	Visual display unit.
Warp prints -	Fabrics in which the warp is printed before weaving to produce a blurred effect. Also called chinés and shadow or clouded silks.
Watered silks -	See moiré.
Weld -	European yellow vegetable dye, used until the development of Quercitron.
Wood-block -	The word 'printing' is derived from the Latin verb 'premere', to press. This relates to the process of block printing in which a block is pressed onto the substrate, thus transferring the design which has been cut in relief and the raised parts charged with colour.

BIBLIOGRAPHY

Books

Adburgham, A., *Shops and Shopping,* London: Barrie & Jenkins, 1989.

Albarn, K., *The Language of Pattern,* London: Thames & Hudson, 1974.

Aldrich, W., (editor), *CAD in Clothing and Textiles: A Collection of Expert Views,* Oxford: Blackwell Scientific Publications, 1992.

Allen, J., *The Designer's Guide to Samurai Patterns*, London: Thames & Hudson, 1990.

Arnheim, R., *Entropy and Art: An Essay on Disorder and Order*, London: , 1971.

Arnheim, R., *Towards a Psychology of Art*, California: , 1966.

Audsley, G., *The Ornamental Arts of Japan*, London: Sampson, Low, Marston, Searle & Rivington, 1882-84.

Audsley, G. and W., *Polychromatic Decoration as Applied to Buildings in the Medieval Styles*, London: , 1882.

Audsley, W. and G., *Outlines of Ornament in the Leading Styles*, 1882, reprinted as *Designs and Patterns from Historic Ornament*, New York: Dover Publications, 1968.

Bain, I., *Celtic Knotwork,* London: Constable, 1986.

Beauclair, R., *Dessins d'Ornementation plane en couleurs*, Paris 1900, reprinted as *Art Nouveau Patterns and Designs*, London: Bracken Books, 1988.

Benedictus, E., *Variations quatre-vingt-six motifs decoratifs en vingt planches*, Paris, 1926, and *Relais quinze planches donnant quarante-deux motifs decoratifs*, Paris, 1930, reprinted as *Art Deco Designs*, London: Bracken Books, 1988.

Biriukova, N., *West European Printed Textiles: 16th -18th century,* Moscow: Iskusstvo Publishers, 1973.

Birkhoff, G.D., *Aesthetic Measure,* Cambridge, Mass., 1933.

Blanc, C., *Art in Ornament and Dress*, English edition, London, 1877.

Boas, F., *Primitive Art*, Oslo 1927, reprinted New York: Dover Books, 1955.

Boring, E.G., *Sensations and Perceptions in the History of Experimental Psychology,* New York 1942.

Bourgoin, J., *Théorie de l'Ornement,* Paris, 1873, reprinted partly in *The Decorative Arts of Arabia,* London: Studio Editions,1989.

Brédif, J., *Toiles de Jouy,* London: Thames & Hudson, 1989.

Buswell, G.T., *How People Look at Pictures*, Chicago 1935.

Chapman, S.D. and Chassagne, S., *European Textile Printers in the Eighteenth Century,* London: Heinemann, 1981.

Cheatham, F.R., Cheatham, J.H., and Haler, S.H., *Design Concepts and Applications*, London: Prentice-Hall, 1983.

Christie, A.H., *Traditional Methods of Pattern Designing*, Oxford: Clarendon Press, 1910. Reprinted as *Pattern Design*, London: Dover Publications, 1969.

Cirlot, J.E., *A Dictionary of Symbols*, English translation, London: Routledge & Kegan Paul, 1962.

Clabburn, P., *The National Trust Book of Furnishing Textiles,* London: Penguin, 1988.

Clabburn, P., *Shawls, in imitation of the Indian,* Princes Risborough: Shire Publications, 1981.

Clark, H., *Textile Printing*, Princes Risborough: Shire Publications, 1985.

Collingwood, W. G., *The Philosophy of Ornament*, London, 1883.

Collon D., *Near Eastern Seals,* London: British Museum Publications, 1990.

Conran, T., *Printed Textile Design,* London: Studio Publications, 1957.

Conran, T., *The House Book,* London: Mitchell Beazley Publishers, 1974.

Critchlow, K., *Islamic Patterns: An Analytical and Cosmological Approach*, London: Thames & Hudson, 1976.

Critchlow, K., *Order in Space*, London: Thames & Hudson,1969, reprinted 1987.

Darly, M., *A New Book of Chinese, Gothic and Modern Chairs,*1751.

Darly, M., *A New Book of Chinese Designs,* 1754.

Darly, M., *The Ornamental Architect or Young Artist's Instructor,* 1770.

Darly, M., *A New Book of Ornaments in the Present (antique) Taste as now used by all Professions,* 1772.

Davis, P.J. and Hersh, R., *Descartes' Dream,* London: Penguin Books, 1990.

Day, L.F., *Pattern Design,* London: Batsford, 1903, reprinted 1915.

Day, L.F, *The Analysis of Pattern,* London, 1887.

Denon, D.V., *Voyages dans la basse et la haute Egypte,* Paris, 1802 and London, 1803.

Deregowski, J.B., *Distortion in Art: The Eye and the Mind*, London: Routledge & Kegan Paul, 1984.

Dresser, C., *Studies in Design,* London: Studio Editions, 1988. First published, London: Cassell, Petter & Galpin, 1876.

Dresser, C., *Rudiments of Botany* and *Unity in Variety* , London,1859.

Dupont-Auberville, M., *L'Ornement des Tissus*, Paris: Ducher & Cie, 1877, printed in English as *Ornamental Textile Fabrics*, London: Asher & Co., 1877, reprinted as *Classic Textile Designs*, London: Bracken Books, 1989.

Durant, S., *Ornament: A Survey since 1830,* London: Macdonald, 1986.

Dyce,W., *The Drawing Book of the Government School of Design*, 1842.

Edwards, E.B., *Dynamarhythmic Design*, New York: The Century Company, 1932, reprinted as *Pattern and Design with Dynamic Symmetry*, New York: Dover Publications, 1967.

Eidelberg, M., *Design 1935-65: What Modern Was,* New York: Harry N. Abrams, 1991.

El-Said, I. and Parman, A., *Geometric Concepts in Islamic Art,* London: World of Islam Festival Publishing, 1976.

Escher, M.C., *Escher on Escher: Exploring the Infinite*, edited by Wilson, J., New York: Harry N. Abrams, 1989.

Ferrière, M.T., *Swiss Textiles,* Leigh-on-Sea: F. Lewis Ltd., 1953.

Flower, L., *Ideas and Techniques for Fabric Design*, London: Longman Group, 1986.

Gell, W. and Gandy, J.P., *Pompeiana; the Topography, Edifices and Ornaments of Pompeii,*1817-19.

Ghyka, M., *Geometrical Composition and Design*, London: Alec Tiranti Ltd., 1956.

Ghyka, M., *The Geometry of Art and Life,* New York: Sheed & Ward, 1946.

Gibson, J.J., *The Perception of the Visual World*, Cambridge: Riverside Press, Mass. 1950.

Gillow, N.C., *William Morris: Designs and Patterns,* London: Bracken Books, 1988.

Gilmour, J. and Walters, M., *The New Naturalist: Wild Flowers,* London: Collins, 1962.

Ginsburg, M. (editor), *The Illustrated History of Textiles,* London: Studio Editions, 1991.

Glass, F. J., *Drawing Design and Craftwork*, London: Batsford, 1920.

Gleick, J., *Nature's Chaos,* London: Sphere Books, 1991.

Gombrich, E.H., *The Sense of Order*, Oxford: Phaidon, 1979. 2nd edition, London: Phaidon, 1984.

Goodyear, W., H., *The Grammar of the Lotus,* New York, 1891.

Bibliography

Gregory, R.L. and Gombrich, E.H. (editors), *Illusion in Art and Nature*, London: Duckworth, 1973, p.50.

Gregory, R.L. (editor), *The Oxford Companion to the Mind,* Oxford: Oxford University Press, 1987.

Haftmann, W., *Painting in the Twentieth Century,* London: Lund Humphries, 1960.

Hambidge, J., *Dynamic Symmetry*, New Haven: Yale University Press, 1920.

Hambidge, J., *The Parthenon and Other Greek Temples: Their Dynamic Symmetry*, New Haven: Yale University Press, 1924.

Harris, J., *Lucienne Day: a career in design,* Manchester: The Whitworth Art Gallery, 1993.

Harrison, T.Erat, and Townsend, W.G.Paulson, *Some Terms Commonly used in Ornamental Design*, London: Batsford, 1906.

Hefford, W., *The Victoria & Albert Museum's Textile Collection: Designs for Printed Textiles in England from 1750 to 1850,* London: Victoria & Albert Museum, 1992.

Helmholtz, H. von, *Treatise of Physiological Optics*, 1867. English translation, New York, 1962.

Hogarth, W., *The Analysis of Beauty*, London 1753.

Hughes, R., *The Shock of the New,* London: BBC Publications, 1980.

Huygen, F., *British Design: Image and Identity,* London: Thames & Hudson, 1989.

Irwin, J. and Brett, K.B., *Origins of Chintz*, London: HMSO, 1970.

Jankel, A. and Morton, R., *Creative Computer Graphics,* London: Book Club Associates, 1984.

Johnston, M.P. and Kaufman, G., *Design on Fabrics,* New York: Reinhold, 1967.

Jones, O., *The Grammar of Ornament*, London : Day & Son, 1856, reprinted London: Omega Books, 1987.

Jones, O., *The Grammar of Chinese Ornament,* London: S. & T. Gilbert, 1867, reprinted London: Studio Editions, 1987.

Justema, W., *The Pleasures of Pattern*, New York: Reinhold, 1968.

Kanisza, G., *Organisation in Vision*, New York, 1979.

Kant, I., *Critique of Pure Reason,* 1781.

Katzenberg, D.S., *Blue Traditions,* Baltimore: Baltimore Museum of Art, 1973.

Knecht, E. and Fothergill,l J.B., *The Principles and Practice of Textile Printing,* 3rd edition, London: Charles Griffin & Co., 1936.

Lansdell, A., *Seaside Fashions: 1860 - 1939,* Princes Risborough: Shire Publications, 1990.

Lecomber, T., *Antichaos & the Science of Complexity,* London: Channel 4 Television, 1992.

Lewis, L., and Darley, G., *Dictionary of Ornament*, Moffat: Cameron & Hollis, 1990.

Lindley, J., *The Symmetry of Vegetation,* London, 1854.

Lings, M. and Safadi, Y. H., *The Qur'an*, London: World of Islam Festival Publishing, 1976.

Locher, J.L., ed. *The World of M. C. Escher,* New York: Harry N. Abrams, 1971.

Locke, J., *Essay concerning Human Understanding,* London, 1690. Abridged version edited by Cranston, M., New York: Collier-Macmillan, 1965.

Lucie-Smith, E., *Cultural Calendar of the 20th Century,* Oxford: Phaidon, 1979.

Macgilavry, C.H., *Fantasy and Symmetry,* New York, 1976.

Marshall, Sir J., *Mohenjo-Daro and the Indus Civilisation,* London, 1931.

McDermott, C., *English Eccentrics: The Textile Designs of Helen Littman,* London: Phaidon, 1992.

McDowell, C., *McDowell's Directory of Twentieth Century Fashion,* London: Muller, Blond & White, 1984.
Meller, S. and Elffers, J., *Textile Designs,* London: Thames & Hudson, 1991.
Mendes, V., *The Victoria & Albert Museum's Textile Collection: British Textiles from 1900 to 1937,* London: Victoria & Albert Museum, 1992.
Meyer, F. S., A *Handbook of Ornament*, London: Batsford, 1894, reprinted London: Omega Books, 1987.
Miles, L.W. C., *Textile Printing,* Bradford: Dyers Company Publications Trust, 1981.
Montgomery, F.M., *Printed Textiles: English and American Cottons and Linens 1700 - 1850,* London: Thames & Hudson, 1970.
Morris, B., *Liberty Design,* London: Octopus Books, 1989.
Newman, W.M. and Sproull, R., *Principles of Interactive Computer Graphics: International Student Edition,* Tokyo: McGraw-Hill, 1981.
O'Brien, *The British Manufacturers Companion and Calico Printers Assistant,* 1791.
Oeri, G., *Man and his Images,* London: Studio Vista, 1968.
Padwick, R. and Walker, T., *Pattern: its structure and geometry,* Sunderland Arts Centre, 1977.
Parnell, E.A., *Dyeing and Calico Printing,* London: Taylor, Walton & Maberly, 1849.
Parry, L., *William Morris and the Arts and Crafts Movement,* London: Studio Editions, 1989.
Petrie, F., *Decorative Patterns of the Ancient World*, London, 1930, reprinted London: Studio Editions, 1990.
Phillips, B., *Fabrics and Wallpapers,* London: Ebury Press, 1991.
Phillips, P., and Bunce, G., *Repeat Patterns: a manual for designers, artists and architects,* London: Thames & Hudson, 1993, ISBN 0 500 27687 0.
Pillement, J., *A New Book of Chinese Ornaments,* 1755.
Popper, K.R., *Objective Knowledge: An Evolutionary Approach*, Oxford: The Clarendon Press, 1972.
Prisse d'Avennes, A., *L'Art Arabe d'apres`les monuments du Kaire depuis le VIIe siecle jusqu'a la fin du XVIIIe siecle*, Paris: Morel et Cie., 1869-77, reprinted in part in *The Decorative Arts of Arabia*, London: Studio Editions, 1989.
Racinet, A., *Deuxième Série de L'Ornement Polychrome,* Paris: Firmin-Didot et Cie., 1885, reprinted as *The Dictionary of Ornament,* London: Studio Editions, 1990.
Radice, B., *Memphis: Research, Experiences, Results, Failures and Successes of New Design,* London: Thames & Hudson, 1985.
Riegl, A., *Stilfragen*, Vienna, 1893.
Reilly, V., *Paisley Patterns,* London: Studio Editions, 1989.
Robinson, S., *A History of Printed Textiles,* London: Studio Vista, 1969.
Rosenburg, N., *Inside the Black Box: Technology and Economics,* Cambridge: Cambridge University Press, 1982.
Ruskin, J., *Seven Lamps of Architecture*, London, 1849.
Schoeser, M. and Rufey, C., *English and American Textiles,* London: Thames & Hudson, 1989.
Schönsperger, J., *Furm oder Modelbüchlein,* Augsburg,1523.
Schwartz,P.R., *Histoire générale des techniques,* Paris, 1968.
Searle,V., and Clayson, R., *Screen Printing on Fabric,* London: Studio Vista, 1968.

Bibliography

Segall, M. H., Campbell, D., and Herskovits, M. J., *The Influence of Culture on Visual Perception*, Indiana 1966.

Seguy, E. A., *Suggestions pour Etoffes et Tapis* and *Floreal, Dessins et Coloris Nouveau,* Paris, 1925, reprinted as *Abstract and Floral Designs,* London: Bracken Books, 1988.

Shubnikov, A.V. and Koptsik, V.A., *Symmetry in Science and Art*, New York: Plenum Books, 1974.

Silver, A., *The Silvern Series,* London, 1889.

Smeets, R., *Signs, Symbols & Ornaments*, London: Van Nostrand Reinhold, 1975.

Smith, A., *Fabric Printing,* London, 1953.

Speiser, A., *Theorie der Gruppen von endlicher Ordnung*, 3rd edition, Berlin, 1937.

Speltz, A., *Das Farbige Ornament aller Historischen Stile*, Leipzig: A. Schumann's Verlag, 1915, reprinted as *The History of Ornament*, New York: Dover Books, 1989.

Stevens, P.S., *Handbook of Regular Patterns*, London: MIT, 1980.

Storey, J., *Textile Printing,* London: Thames & Hudson, 1974. Revised Edition, 1992.

Tagliente, G. A., *Essempio di recammi*, Venice, 1524.

Tilby, A., *Soul: An Introduction to the New Cosmology - Time, Consciousness and God,* London: BBC Publications, 1992.

Turnbull, G., *A History of the Calico Printing Industry of Great Britain,* Altrincham: John Sherratt & Son, 1951.

Turner, M. and Hoskins, L., *Silver Studio of Design,* London: Webb & Bower, 1988.

Vallance, A., *The Life and Work of William Morris*, London: George Bell & Sons, 1897, reprinted London: Studio Editions, 1986.

Victoria and Albert Museum, *Ascher,* London: Victoria and Albert Museum, 1987.

Victoria and Albert Museum, *Designs for British Dress and Furnishing Fabrics,* London: Victoria and Albert Museum, 1986.

Victoria and Albert Museum, *Fifties Furnishing Fabrics,* Webb & Bower, London, 1988.

Victoria and Albert Museum, *Four Hundred Years of Fashion,* London: Webb & Bower, 1984.

Victoria and Albert Museum, *Novelty Fabrics,* London: Webb & Bower, 1988.

Victoria and Albert Museum, *Patterns for Textiles*, London: Webb & Bower, 1987.

Victoria and Albert Museum, *Persian Printed Cottons,* London: Webb & Bower, 1989.

Victoria and Albert Museum, *Rococo Silks,* London: Webb & Bower, 1985.

Victoria and Albert Museum, *Thirties Floral Fabrics,* London: Webb & Bower, 1988.

Vince, J., *Computer Graphics for Graphic Designers,* London: Frances Pinter, 1985.

Vince, J., *Computer Graphics,* London: The Design Council, 1992.

Watt, R., *Understanding Vision*, London: Academic Press, 1991.

Wersin, W. von, *Das elementare Ornament und seine Gesetzlichkeit*, Ravensburg, 1953.

Wilson, E., *Islamic Designs*, London: British Museum Publications, 1988.

Woodham, J.M., *Twentieth-Century Ornament*, London: Studio Vista, 1990.

Wornum, R. N., *The Analysis of Ornament*, London: Batsford, 1884.

Wright, R.H., *Modern Textile Design and Production,* London: National Trade Press, 1949.

Yasinskaya, I., *Soviet Textile Design of the Revolutionary Period*, London: Thames & Hudson, 1983.

Conference proceedings and theses

Aldrich, W., PhD Thesis, *New Technology and Clothing Design,* Nottingham Polytechnic, 1991.

Barton, D.J., *Gravure Cylinder Making by Laser,* TAGA Proceedings, 1980, pp.375-380.

Bergen, J.R. and Julesz, B., *Rapid discrimination of visual patterns,* IEEE trans. Systems, Man Cybernet 1983 SMC-13, pp.857-863.

Hearle, J.W.S., Newton, A., and Grigg, P.J., *Computer-aided Design: A Liberating Prospect,* Proceedings of the Textile Institute Conference - Computers in the World of Textiles, 1984, pp.1-18.

Lourie, J.R., and Lorenzo, J.J., *Textile Graphics Applied to Textile Printing,* IEE Fall Joint Computer Conference, 1967, pp.33-40.

Ogden, O., and Staudhammer, J., *A Simple Textile Patterning System,* IEEE Proceedings of the 1975 IEE South East Regions Conference on Electricity and Expanding Technology, 1975, part 1, pp.2E/1/1-5.

Schaub, H.H.W., *Combined rotary screen and roller printing, what possibilities can be expected?,* proceedings of the AATCC Textile Printing Symposium, January 1978, pp.21-3.

Schmid, F., *Intermittent printing on Buser rotary screen printing machine,* proceedings of the AATCC Textile Printing Symposium, January 1978, pp.27-9.

Newspapers and journals

Adair, G., *The postmodernist always rings twice,* The Guardian, August 20, 1992, p.30.

Attneave, F., *Multistability in perception,* Scientific American, 1971, 225, pp.63-71.

Barlow, H.B. and Reeves, B.C., *The versatility and absolute efficiency of detecting mirror symmetry in random dot displays,* Vision Res., 19, pp.783-793.

Barrow, J., *Counter Culture,* The Guardian, October 21, 1993, pp.12-13.

Beard, J., *Computers weave a new fashion,* New Scientist, 10 February, 1990, pp.48-50.

Berfelo, K., *Laser engraver enables finer detailing of designs,* Textile Horizons, September 1990, p.32.

Boothroyd, D., *Cut your cloth according to your computer?,* Electronic Times, 1984, vol.288, pp.24-5.

Brassington, L., *New Printed Textiles from India,* The Textile Society Magazine, Vol.17, Spring 1992, pp.17-8.

Buser Gazette, *A reliable address: Printed SpA, Como,* September 1990.

Bygrave, M., *Time's Enemy,* The Guardian Weekend, 3rd July 1993, p.33.

CADCAM International, *User Case Study: Sr Gent Introduces New Line,* October 1989, pp.32-33.

CADCAM International, *Dedicated Followers of Fashion,* October 1989, p.36.

Canter, D., *From knobs and dials to knowledge,* Design, no.428, August 1984, pp.31-33.

Charnock, R.E., *The Significance of Millitron,* International Dyer & Textile Printer, March 18, 1977, pp. 274-7.

Cheung, M.L., *Dyeing Automation for Hong Kong,* Textile Asia, March 1991, pp.73-8.

Chong, T.F., *Computers in textile production,* Textile Asia, May 1990, pp.51-6.

Cook, F.C., *QR, Environmental pressure will drive dyeing, printing,* Textile World, December 1990, pp.83-85.

Cooley, M.J.E., *Impact of CAD on the designer and the design function,* Computer-Aided Design, vol. 9, no. 4, October 1977, pp.238-242.

Cross, N., *Styles of learning, designing and computing,* Design Studies, vol.6, no.3, July 1985, pp.157-162.

Darlington, F., *Modern 'engraving' done on computer tapes,* America's Textiles R/B Edition, 1979, vol.8, part 7, pp.34-7.

Bibliography

Dodge, R., *Five types of eye movement*, American Journal of Physiology 1902, no.8, pp.307-329.

Ellis, H., *Printing Techniques: The Choice,* Textile Horizons, April 1985, pp.37- 40.

Elsässer, H.B., *Optimised flatbed screen printing,* Textil Praxis International, 1985, Issue 7, pp.4-7.

Elsässer, H.B., *Rotary or flatbed screen printing? An old question regains topicality,* Textil Praxis International, 1985, Issue 3, pp. 21-2.

Emmett, A., *The Vanishing Vector,* Computer Graphics World, April 1988, pp.55-60.

Fantz, L.F., *Pattern Vision in Young Infants*, The Psychological Record, 1958 vol.8 pp.43-7.

Floud, P.C., *The English Contribution to the Early History of Indigo Printing,* The Journal of the Society of Dyers and Colourists, LXXVI, no. 6, June 1960, p.345.

Floud, P., *Richard Ovey and the Rise of the London 'Furniture-Printers',* Connoisseur, CXL, November 1957, p.96.

Floud, P., *English printed textiles: Copperplate pictorials,* Antiques, 1957, vol. LXXI, pp.238-41.

Fox, E., *Fashion Engravers, Inc.: Innovation in Screen Printing Technology,* American Dyestuff Reporter, February 1989, pp.15-7.

Fox, E., *Fieldcrest-Cannon, Inc.: Improving 'Quick Response' in Screen Printing Applications,* American Dyestuff Reporter, February 1989, pp.18-20.

Fulmer, T.D., *In Prints With Style,* American Textiles International, 1989, Vol.18, No.2, pp.28-30.

Graham, R.L. and Spencer, J.H., *Ramsey Theory,* Scientific American 1990 July, pp.80-85.

Greenwood, J., *"Spotting the True Image": The Industrial Textile Printer,* The Textile Society Magazine, Vol.17, Spring 1992, pp.6 -12.

Grigg, P.J., *A CAD interface for textile design,* Computer Aided Design, vol.15, no.1, January 1983, pp.37-40.

Haimes, R., *Graphic Design Technology Matures,* Computer Graphics World, February 1988, pp. 50-56.

Haimes, R., *Colour on the Desktop: Pioneering users are changing the way we print,* Computer Graphics World, May 1988, pp.38-41.

Harpers & Queen, *Fashion Moves: Printed Anarchy,* March 1990, p.141.

Hearle, J.W.S., *Function and Form: Computing as a tool in Textile Design,* Advance, 1971, vol.11, pp.32-7.

Hearle, J.W.S., *Computer-aided textile design: The problem of three cultures,* Textile Horizons, vol. 13, no.5, October 1993, pp.15-19.

Hebert, T., *Ink-Jet Tech Has A Colorful Future,* Computer Graphics World, May 1986, pp.34-42.

Holme, I., *Print Design: The Future,* Textile Horizons, May 1982, pp.30-1.

Holme, I., *Tools for quick response,* Textile Horizons, February 1990, pp.33-6.

Holme, I., *Printing and dyeing in the 1990's,* International Dyer & Textile Printer, August 1990, pp.38-9.

Holmes, J., *CAD in Production Proofing,* Manufacturing Clothier, June 1993, pp.15-17.

Hubbold, R.J., *Computer Graphics and Displays,* Computer-aided Design, vol.16, no.3, May 1984, pp.127-133.

Hunt, A., *British Textiles,* Architectural Review, December 1932.

Hutzel, I., *Trends in PC Paint System Development,* Computer Graphics World, March 1985, p.47-58.

International Dyer & Textile Printer, *Shaw Carpets reveal Millitron patterning potential,* March 18, 1977, pp. 273-278.
International Dyer & Textile Printer, Versatility is the key to flatbed printing, July 1983, pp.21-22.
International Dyer & Textile Printer, *Investment in energy saving pays off at Strines,* June 1985, p.23.
International Dyer & Textile Printer, *Investing in high quality design,* April 1985, pp.14-5.
International Dyer & Textile Printer, *Top Ulster printer installs first Japanese unit in Europe,* April 1985, p.6.
International Dyer & Textile Printer, *Foamprint: commercial success for a 'revolutionary' system,* January 1986, pp.5-8.
International Dyer & Textile Printer, *Screens supreme into the nineties?,* June 1984, p.13-5.
International Dyer & Textile Printer, *Cotton warp yarn transfer printing,* August 1990, p.36.
Inter-Vision, *Stork Excelerator ideal for judgment of created design,* No.11, October 1990,pp.24-5.
Inter-Vision, *The Stork IPS 2000 in the USA,* No.11, October 1990, p.4.
Jerrard, R.N., *Computer-aided design of textiles,* Computer Aided Design, October 1976, vol. 8, no. 4, pp.239-46.
Joehnk, D., *Use of Electronics in Patterning in the Textile Industry,* Melliand Textilberichte (English Edition), vol.61, part 2, February 1980, pp.143-6.
Johnson, E., *Laura Ashley bursts its seams - with growth,* Textile World, June 1988, pp.83-4.
Keighley, M., *Lancashire cotton printers make a fine impression,* International Dyer & Textile Printer, April 1987, Vol.172, No.4, pp.10-17.
King, B., *Chintz,* Textiles, 1991, no.1, pp.24-5.
King, B., *Cresta Silks Ltd (The Textiles of the 1930's),* The Textile Society, vol.15, 1991, pp.4-8.
Knebusch, M., *Color Graphics Terminals Sharpen their Image,* Machine Design, November 1984, pp.109-114.
Lee, W.K., *Rotary screen printing developments,* Textile Asia, September 1987, pp. 165-6.
LePelley, N., *Cotton Picking Lot,* The World of Interiors, May 1991, pp.106-11.
Maloney, R.K., Mitchison, G.J., and Barlow, H.B., *Limit to the detection of Glass patterns in the presence of noise*, Journal Opt. Soc. Am. A4 2336-2341.
Masters, N., *CAD in Fashion,* Computer Images International, April 1989, pp.16-17.
McCrone, J., *My family and other strangers,* The Independent on Sunday, 1st March 1992, p.40.
Meacock, C., *Electronic Engraving,* Printing World, January 27, 1982, pp.23-26.
Melliand Textilberichte (English Edition), *Electronic Design Processing for Textile Printing,* 1980, Vol.61, Part 3, p.281.
Miller, L., *A day in the life of the designer of the future,* Textile Horizons, August 1986, p.18.
Miller, L., *CAD: The Tools are With Us,* Textile Horizons, December 1984, pp.24--5.
Moore, D., *Innovate & Automate,* Aldus News, vol.1 issue 3, Autumn 1990, p.7.
Niesewand, N., *Live wires . . . computers byte back,* Vogue, November 1993, pp.101-104.
Norman, G., *Junk Porcelain*, The Independent on Sunday, February 16th 1992, pp.52-3.
Nothdurft, H. C., *Sensitivity for structure gradient in texture discrimination tasks*, 1985 Vision Re. 25 1957-1968.
Patterson, C., *Cladistics,* Biologist, 27, 1980, pp.234-40.
Patwardhan, S., *Computer aided Textile designs,* Man-Made Textiles in India, April 1987, pp.177-208.

Bibliography

Pipes, A., *The cad cover-up,* Design, no 432, December 1984, pp.54-55.

Radford, T., *God = 10^{-43}*, Impact, Autumn 1992, p.49.

Robertson, B., *Paint Systems,* Computer Graphics World, April 1988, pp.62-8.

Rubens, P., *Digital presses cut cost of printing,* Sunday Times, 31 October 1993, section 3, p.11.

Ruckl, S., *The Technical Story,* Textile Month, March 1989, pp.43-4.

Russel, A., *Industry, printed textile design and the mass market in the nineteen fifties,* The Textile Society Magazine, Vol.17, Spring 1992, p.21-2.

Schaub, J.H.W., *Future Prospects for the Textile Printing Industry,* Melliand Textilberichte / English Edition, 1982, Vol.63, Part 1, pp.59-60.

Schoeser, M., *Pattern in Textiles,* Textile World, April 1985, p39.

Schofield, S., *Textile printing: continuing dominance of the rotary method,* International Dyer & Textile Printer, February 1985, p.8.

Schulzen, H., *Additional coloristic possibilities with the subicolor process,* Melliand Textilberichte (English Ed.), 1974, Vol.55, Part 5, pp.467-78.

Screen Process, *Printing on Silk,* May 1990, Vol.40, Part 5, pp.60-61.

Shore, J., *Machines for textile coloration,* Textiles, 1990, vol.19, no.1, pp.19-25.

Siebers, G.R., *An Introduction to Computer Graphics,* Computer-aided Design, vol.18, no.3, April 1986, pp.161-178.

Suchecki, S.M., *Innovations in Printing Machinery Technology,* Textile Chemist and Colourist, 1980, Vol.12, Part 5, pp.23-6.

Suchecki, S.M., *Fast Film Service,* Textile Industries, December 1976, Vol. 140, part 12, pp.104-7.

Sugiyama, M., *Designing Programs: Think DOCS- Film Making of Original Design by Computer and NC,* Japan Textile News, 1977, vol.270, pp.91-5.

Taylor, G., *Printing effects,* Textile Asia, May 1982, pp.34-43.

Ten Kate, H.J.G., *Textile printing tomorrow,* Textile Industries Dyegest S.A., December 1988, pp.2-4.

Textile Horizons, *Full-colour fidelity for fabrics,* December 1982, pp.42-3.

Textile Horizons, *User-friendly Design Conversion,* April 1985, p.40.

Textile Month, *The Increasing Influence of the Computer,* May 1986, pp.39-40.

Textile Month, *Development of CAD Systems for Textiles,* May 1991, pp.31-3.

Textile Month, *Keeping up with trends - from design to production stage,* May 1991, p.36.

Textile Month, *ITMA Preview: Finishing,* September 1987, p.86.

Textile Month, *Automation a key feature in printing,* August 1987, p.42.

Textile World, *TW special report / Itma at Hanover,* December 1979, Vol.129, part 12, p.82.

Textile World, *Stork launching diverse projects,* June 1988, p.84.

The Gazette, *State-of-the-art at Steads,* 1 December 1990, p.113.

The Seybold Report on Publishing Systems, *Dr.-Ing. Rudolf Hell GmbH: A Pioneer Faces the Changing World,* 1988, vol.18, no.5, pp.3-18.

The Seybold Report on Publishing Systems, *Scitex Open Strategy Shows in New Systems,* vol.23, no.1, September 1993, p.1.

Turner, G.R., *Textile Printing in the 1990's,* Textile Chemist and Colourist, vol.20, no.8, August 1988, pp.19-22.

Vincent, J., *Designer Software,* CADCAM International, October 1989, pp.32-36.

Warkentin, J., *Anatomy of a trend,* The Guardian, September 28th, 1992, p.18.

Watkins, P., *Première Vision - Sping/Summer 1992,* Textile Horizons, May 1991, p.17.

Wilson, E., *Fashion and the meaning of life,* The Guardian, May 18 1992, p.34.

Wingrave, J., *Textile Printing - a Review of Technical Development in Australia,* Australasian Textiles, 1990, Vol.10, Part 5, pp.42-4.

Exhibition catalogues

Andy Warhol, London: Tate Gallery, 1971.

A Popular Art: British Wallpapers 1930 - 1960, London: Middlesex Polytechnic, 1989.

Art in Revolution, London: Hayward Gallery, 1971.

Barnett Newman, London: Tate Gallery, 1972.

Coronations and Cricket Bats, Manchester: Whitworth Gallery, October 1991 - January 1992.

'From today painting is dead': The Beginnings of Photography, London: Hayward Gallery, 1972.

Modern Art in Textile Design, Manchester: The Whitworth Gallery, 1991.

Parasols and Pagodas, Oriental influence in Western Wallpapers, Manchester: Whitworth Gallery, October 1991 - April 1992.

Ratti and Paisley, New York: Fashion Institute of Technology, 1987.

The New Look: Design in the Fifties, Manchester: Manchester City Art Galleries, 1991.

Manuals and publicity material

Colour Solutions From IRIS Graphics, IRIS Graphics Inc., Bedford, MA, 1993.

Eikonix ® Designmaster® 9000: Delivers quick response and reduces costs, Eikonix Corporation, Bedford, MA, 1987.

IGOS: Interactive Graphic Computer Systems, HCS Computer Graphics, Utrecht, 1990.

MacPaint® Reference Manual, CLARIS Corporation, California, 1987.

Painter, Fractal Design Corporation, California, 1992.

Top Design CAD/CAM System for Textile Printing, Institute for Applied Mikroelectronics Ltd. (IAM), Braunschweig, August 1992.

U4ia®, Computer Design, Inc., Grand Rapids, September 1993.