NEW TECHNOLOGY AND CLOTHING DESIGN:

Effects of New Technology on Design in Clothing Manufacture and the Potential Problems of Colleges Training Designers for an Industry Undergoing Fundamental Changes

WINIFRED MARY ALDRICH M.ED F.C.F.I.

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'For I have changed my mind - the only way to prove
you have a mind is to change it,'

Reyner Banham 1981

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ABSTRACT

The research explores the rationale and the implications of an imposed curriculum innovation, the introduction of computer aided design, (CAD), into fashion design courses. The work is a singular, personal exploration of the phenomenon CAD; it is seeking explanations and does not attempt to offer generalisations or theories.

The study examines theories and ideas of creativity, and the process of design in the production of fashion garments. Philosophical, psychological and physiological ideas and attitudes that cluster around the concept 'design' are examined. The transient nature of knowledge assumes increasing importance as the study progresses.

The field work covered three major areas. First, a survey of CAD systems and their use in the British clothing industry was undertaken in 1985. This provided a 'snapshot' of aims and attitudes towards CAD at that time. Contacts with the same companies in 1989 showed that some perceptions of CAD had changed. Second, studies were made of the use of CAD in the design process. The research was directed towards the activities of individual students when using CAD, with reference to their process of design, their thinking style, and their personality. Third, the possibilities of CAD were explored in a commercial design context. Theoretical and personal explorations and experiences of the use of CAD were undertaken and recorded. Design projects and artefacts were realised.

In order to extend knowledge of computer aided design, a CAD system with a differing set of priorities from established commercial systems was developed. This was done in co-operation with a commercial software house, Concept II Research; the software programme ORMUS-FASHION was created. The system was used in the field studies with students, and for personal design work.

The research offers new insights into the accessibility of CAD to the fashion/textile designer, regardless of his or her technological knowledge. It demonstrates that CAD is not neccessarily a preserve of the logical mind. The effective use of CAD in the Fashion Industry is related to a wider set of human characteristics, motives and changing processes of creative thought; and these are, of course, very often illogical.

It is a case study which shows knowledge being selectively changed, intentionally changed, individually changed, collectively changed, experientially changed, unconsciously changed, inexplicably changed, continually changed. There is no access to things as they <u>are</u>.

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INTRODUCTION

This research is an exploration of the rationale and the implications of an imposed curriculum innovation, Computer Aided Design (CAD), in the teaching of Fashion Design. This statement requires some initial explanation. First, some evidence should be offered to support the claim that the curriculum is 'imposed'; second, one has to be clear about the rationale offered for its introduction and finally what is meant by the term Computer Aided Design must be considered.

THE CURRICULUM INNOVATION

During the last century technological innovation has played a significant part in the evolutionary changes which have taken place in fashion and textile departments. Industrial changes towards mass production methods have resulted in a shift from the training of the artisan-craftsman and needlewoman to the education of the industrial designer. However, the pace of change and the emphasis of the industrial connection cannot be seen as a consistent or regulated process. Historically, fashion departments have proceeded along autonomous paths working within an ethos in which individualism was generally encouraged. The re-organisation of fashion/textile education in the 1970's; the introduction of the BA degrees and BTEC qualifications, which could be regarded as interventionist in terms of the introduction of course hierarchies and the identification of general aims; still left considerable curricula freedom, particularly in BA courses in the field of design[1]. It is therefore interesting to note that the tone of a report issued by a CNAA working party on Information Technology[2] in May 1983 and circulated for 'consultation', could be seen instead as prescriptive. Two recommendations, which relate to design, are of particular importance; they are underlined in the report to indicate emphasis.

> 'Courses in Art and Design should therefore include at an early stage effective means of demonstrating to students the importance of IT in the area of their likely professional activity, and its relationship to the traditional component of Art and Design courses.
>
> For this, both theoretical study and hands-on experience are required within the taught component of the course, as a preparation for experience outside the institution.'[3]

The CNAA policy guidelines on Information Technology issued in 1985 which resulted from considerations of the Working Party's report made recommendations that were clearly directive:

> 'it should be the policy of institutions to make specific resource provision for IT related developments... it should be demonstrated to students the importance of IT... students should be made aware of the effects of IT on product design and manufacture.... practical experience and related theoretical experience should be included in the taught component of Art and Design courses.'[4]

Whilst recommendations from working parties or policy statements are not conditions of validation, it could be argued that the introduction of Computer Aided Design into CNAA Fashion/Textile degree courses could be seen as an imposed curriculum innovation by implication. Colleges offering BTEC courses have been offered similar general guidelines[5]. The Board for Design have also been decisive about how it should be done.

> 'Incorporation of information technology into the content of a design course requires curriculum re-design. IT cannot adequately be achieved just by adding on another module.'[6]

THE RATIONALE FOR THE INTRODUCTION OF CAD

The rationale for the introduction of CAD, given by the 1983 working party[7], appears to be this: it now exists, it has given designers new tools, it speeds up repetitive tasks and it is being used in the manufacture of artefacts.

> 'The principal consequence for Art and Design education of these developments is that staff and students on Art and Design courses can no longer - if they ever could - see their concerns as being unaffected by changes in technology in the outside world. As well as changing the nature of the design activity itself IT-related developments have resulted in the disappearance of whole areas of traditional employment and the emergence of new ones. It is imperative that these effects are assimilated by Art and Design education in a time scale which is no less rapid than the one in which the development of IT has taken place.'[8]

Whilst not offering a revision of these ideas, the later revised recommendations (1985)[9], gave implicit notes of caution; they suggested that the teaching should include more than description and use, by covering theoretical studies into the nature of new technology and its social and design implications. The positive attitudes of the validating bodies and a grant of £4,500,000 in 1986 from the Department of Trade and Industry, (to be made up from County Councils and Industry to £9,000,000), to assist colleges to install CAD systems in fashion and textile departments has provided an impetus for technological change in fashion and textile design education. The purpose of the DTI in 1986 was made quite clear:

> 'The intention is to improve the training of students by giving them 'hands on' experience of the latest advanced equipment to meet the needs of modern production and design methods in the textile and clothing industries.'[10]

One could argue that any educational rationale for the use of a process must be contingent on the nature of the process and therefore justification for its introduction should rest on more than the fact that it exists and that it is in use in industry. However, this hypothesis poses a problem in that CAD is an active process, therefore the acquisition, practice and knowledge of it is required before deliberations on its nature can be usefully offered.

The research reported in this thesis is an attempt to address the problem of the nature of CAD; it examines the use of CAD in industry, the use of CAD in education, my personal experience of CAD and the experiences of an opportunity sample of 15 BA Fashion Design students using CAD during their final year. No man-made object or process is value free, nor is the original generated form necessarily fixed, therefore knowledge of the nature of this technology may change if approached from an alternative perspective. The idea of interest is that it may be possible to identify other facets of CAD by designing a software programme to assist personal understanding and by observing and working with design students, who have had no previous practical experience of CAD, using the technology in the production of part of their fashion collection.

At this stage two elements have to be clarified, what do I mean when I talk about 'knowledge of CAD', and what kind of research methods were seen as appropriate in seeking some definition?

KNOWLEDGE OF COMPUTER AIDED DESIGN

The position from which I must start is to make clear the concept of 'knowledge' that is being pursued in this study.

Magee believes that the revolt against the Cartesian view of knowledge, that of subject viewing object, is one of the salient characteristics of twentieth century philosophy; he asserts that the common idea that knowledge is by its nature bound up with activity and that truth and meaning must have some relation to activity was, for example, shared by Frege, Heiddegger, Wittgenstein and Popper, but it is often hidden by their different traditions and perspectives.[11]

Polanyi sees the body as the ultimate instrument of all our external knowledge, 'we are <u>relying</u> on our awareness of contacts of our own body with things outside for <u>attending</u> to these things'.[12] He argues that it is not by looking at things, but by dwelling in them, that we understand their meanings.[13]

Searle believes that probably the most important work that Wittgenstein did was to see language as a part of human activity, not a product of some inner theory.[14] Searle's work concentrates on the idea that all of our mental life, conscious and unconscious, really goes on against a background of non-representational, non-theoretical mental capacities.[15]

Polanyi's theory, that tacit knowledge is a means by which we use these capacities,[16] appears to me to solve some of the problems and paradoxes which have separated and confounded differing schools of philosophical, psychological and sociological thought. He starts to consider human knowledge from the fact that 'we can know more than we can tell',[17] that what we know cannot be fully described in words, not even, by pictures. Instead of perception taking place through the spontaneous equilibrium of particulars impressed on the retina or on the brain, a form of Gestalt understanding is the outcome of an active shaping of experience performed in the the pursuit of knowledge.

> 'This shaping or integrating I hold to be the great and indispensable tacit power by which all knowledge is discovered and, once discovered, is held to be true.'[18]

Perception from this view is then seen only as a bridge between the higher creative processes and an action of attending from to attending to. Polanyi believes that this ability to integrate complex information into personal knowledge can be destroyed by 'unbridled lucidity'.

> 'Scrutinize closely the particulars of a comprehensive entity and their meaning is effaced, our conception of the entity is destroyed.'[19]

These ideas are set within a theoretical position of a human innate capacity to form coherent structures but holds to the idea that tacit knowledge offers an intimation of something hidden, a pointing to indeterminate alternatives. 'I speak not of an established universality but of a universal intent.'[20]

Polanyi is not prepared to accept a separation of practical and theoretical forms of knowledge, he rejects Ryle's ideas of knowing 'how' and knowing 'that'.[21] I see this notion of integration as important;

however, Polanyi appears to have little to say regarding the arts and nothing to say about visual knowledge and its role in perception. This factor is central to my examination of Computer Aided Design. Any research into areas of design should also examine the value, and the problems of the instability of personal knowledge; the fact that we look at what appears to be the same ideas yet we never re-interiorize the same particulars or recover the identical meanings.

Psychological theories, which see the brain as holding innate complex hierarchical structures and capacities,[22] may explain why we can exist unconsciously, yet consciously, and select perceptions which interest us or allow us to deal with events which impose upon our unconscious. If one can accept the notion that human activity can be seen as a state of change, yet accept that coherent ideas are the way that we make sense of the world, then from this view theories can be applied in situations as 'staging posts', en route to understanding. This coherent capacity may offer an explanation for our ability to communicate within forms of knowledge which can be universally recognised and yet allow our personal knowledge to remain individually unique.

This position could also accept that whilst any findings may only be valid for the particular instance or situation, it need not be regarded as a factor of concern. It was from this view that psychological theories of personality and thinking styles were modified and used during the study; they were used as impermanent descriptive features which complemented other recorded characteristics in the profiles of students using the CAD system. Throughout the study the focus was directed on activities taking place within a context. Any requirement for assessment in any part of the study was by self-assessment or by consensus by other direct or indirect 'members' of the situation.

If one sees knowledge not as a commodity, that one chooses or does not choose to accept, but from a view that sees man's ideas of truth and meaning, irrespective of notions about their source, as having some relation to his own activity in particular situations, then 'knowledge of CAD' must be as indeterminate as the time, the context and the participants. Intention to pursue it however, remains as valid as the pursuit of any knowledge of new phenomena.

STUDY METHODS

All research has to be, to some extent, a prisoner of history. Ten years ago the eclecticism of the methods of this research might have resulted in it being seen as unrespectable. Burgess states that no longer are researchers who work within education pre-occupied with quantitative methods based upon statistical sampling, measurement and experiment, for much research now uses qualitative as well as quantitative methods.[23] Delamont and Hamilton in 1976 were seeking new attitudes towards research, 'in which eclectic combinations of research methods can be used and in which different problems can be tackled by different, and mutually appropriate, methods.[24]'

It was seen as important that the practical and theoretical technological implications were understood, and so the early part of the study concentrated on working on an industrial CAD system and on the personal design of a CAD software programme, ORMUS-FASHION. The main body of the research was conducted through personal contact with groups or individuals. The methods used were the structured interview, and participant observation; part of the participation involved periods of working with groups and individuals in education and industry in the use of CAD systems. Whilst a body of the research was concentrated on a singular study of a student group, this only stands as a piece of work in its recognition of the educational, industrial and social context of which it is a part. I was not interested in the minutia of a person's behaviour or interaction but in an individual's or group's comprehension of his experience. It must also be made clear that it is not assumed that any example is typical of any wider sample; the study is, in fact, looking for 'unexpected outcomes'. Bassey notes that:

> 'Study of singularities' is the mode of research which is appropriate when the data being investigated are such that worthwhile generalities cannot be established and yet where the uniqueness and significance of the data is perceived as meriting study.'[25]

Cohen and Manion state that possibly the most important tool of the scientist for discovering truths is the hypothesis.[26] Their certainty of the ability of the hypothesis to discover 'truth' is only one of their statements which appear to make sweeping value judgements. Little recognition is given to the limitations of the use of the hypothesis in the field of social studies or of the care required in its construction. Stake suggests that every aspect of an educational programme holds at least as many truths as there are viewers.

> 'Each sees value in a different light. The evaluator has no cause to force a consensus, but certainly to show the distribution of perceptions.'[27]

Nisbet and Entwistle point to the dangers of the instant formulation of a hypothesis even after preliminary field work or case studies have been undertaken.[28] I would argue that a lack of field work and observation prior to hypothesis formulation leads to research that offers 'closed generalisations'[29] which are at best of slight value and at worst misleading by their cloak of scientific respectability. It would seem sensible therefore, that before human or financial resources are spent on any kind of large scale systematic enquiries into the use of CAD in the learning process, it is important that more in-depth studies are encouraged in attempts to understand the 'nature of the phenomenon' CAD and what constitutes knowledge of it.

A DESCRIPTION OF THE RESEARCH PROGRAMME

The first part of the study examines the current ideas of design and creativity in fashion design. Some comprehension of the transient nature of these concepts was seen as a necessary preamble to the research.

Part Two is a description of the CADCAM systems available in 1985, and their operation, within companies. This section, unrevised extracts from my papers[30] [31] written in 1985-86, offers some insight into my perceptions of the situation at that time.

Part Three is a description of my personal perspective, influenced by the current literature, at the commencement of the setting up of the study and its influence on the selection and modification of software 'tools' that were to be used. That this selection would be influenced by my depth of tacit knowledge in traditional methods of garment design, was accepted as an interesting feature of the research. It was also accepted that these ideas, and the ideas of the students, would be subject to change during the progress of the study. Attempts would be made to assess the character of these changes.

Part Four is an attempt at an evaluation of the software programme; it is also an exploration of the potential of CAD, in this form or in other programme forms, in the work of an individual designer. Fifteen BA Hons. fashion students were given access to the programmes. The field research with the students did not resolve many of the questions that focussed on a designer using CAD in a personal way. The students were subjected to external controls and were protected from commercial considerations. The decision was made, therefore, to change the research method from participant observation, to full participation in CAD design activity.

Part Five is a personal exploration of the technology in use in a commercial design environment. Working from a design studio with a personally purchased set of CAD equipment, I recorded the experiences of working with CAD as a practising independent designer. This situation allowed me to have some control on the selection of the work and to choose when and where I used the technology during the design process.

The instability of knowledge and change of perception, particularly in an area of innovation, are the main issues of this study. Part Six summarises the research. It examines changes in direction, attitudes and the intentions of companies who were using CAD during the field study. This data is explored within the context of the present state of the technology and its imminent developments. This section also reflects on the implications of the findings from the field studies, for the use of CAD in industry and education. However, this is done only in relation to this particular piece of research, any form of generalisation is not attempted.

NEW KNOWLEDGE

The claim to new knowledge is that the study may provide a clearer understanding of some of the current dominating ideas about the use of CAD by a designer. A comparison of these ideas with and the actual use of a system by design students and personal commercial design experiences, may provide alternative views. The use of CAD in the process of learning and the development of creative potential may have unexpected implications that its current use in industry has not yet revealed. It must be noted that 'current' refers to the time and the situation of any research encounter. My present personal knowledge of CAD, and the participants' knowledge of CAD will, of course, have changed.

REFERENCES

1 The CNAA requires colleges to submit their course proposals for validation, giving only general guidelines which ask colleges to state their rationale, course structure and content. See paragraphs 8.5 - 8.7.1 in the CNAA, Handbook 1988, pp. 42-43.

2 The Working Party stated that it was not their intention to make specific recommendations about Information Technology; they described the kinds of approach that 'in our view, ought to be adopted in the cause of furthering a wider dissemination of knowledge about IT in Art and Design courses'. They also thought it necessary to state that recommendations made in the report were intended to point the way towards additions to the traditional components of Art and Design courses, rather than replacements for them. Report of the Information Technology Working Party to the Committee of Art and Design CNAA Publication 2e/24, May 1983, pp. 2,3,4.

3 Report of the Information Technology Working Party to the Committee of Art and Design CNAA Publication 2e/24, May 1983, p. 4.

4 The paper, Information Technology: Art and Design Policy Guidelines (1985) Concerning Course Design and Operation CNAA GENERAL/IT HAJ/LM/HR, July 1985, issued revised recommendations from the 1983 Working Party, p. 0.

5 Guidelines, similar to those offered by the CNAA, can be found in Design and Associated Studies Guidelines BTEC National and Higher National Awards, Business & Technician Education Council, June 1984, p. 5.

6 Board for Design: Recommendations on the Incorporation of Information Technology into the Content and Teaching Methods of Design Courses CNAA November 1984, p. 1.

7 Report of the Information Technology Working Party to the Committee of Art and Design CNAA Publication 2e/24, May 1983.

8 Report of the Information Technology Working Party to the Committee of Art and Design CNAA Publication 2e/24, May 1983, p. 2.

9 Information Technology: Art and Design Policy Guidelines (1985) Concerning Course Design and Operation Revised guidelines from the Working Party on Information Technology of the Committee for Art and Design, CNAA 1985.

10. Textile and Clothing Education Equipment Scheme Department of Trade and Industry, TS1, 1986, p. 1.

11 Brian Magee, The Great Philosophers BBC Books, London, 1987, p. 294.

12 Michael Polanyi, The Tacit Dimension Routledge & Kegan Paul Ltd, 1967, pp. 15-16.

13 Michael Polanyi, The Tacit Dimension Routledge & Kegan Paul Ltd, 1967, p. 18.

14 John Searle in discussions with Magee, Brian Magee, The Great Philosophers BBC Books, London, 1987, p. 345, states that he agrees with Wittgenstein's devastating refutation of the view that words get their meaning either by standing for objects in the world or by being associated with some introspective process in the mind.

15 John Searle, Intentionality Cambridge University Press, 1983.

16 Michael Polanyi, Personal Knowledge Routledge Kegan & Paul, London, 1978. First published in 1958, Polanyi started by enquiring into the nature and justification of scientific knowledge; however, this work led to questions outside science and to his theory of tacit knowledge which he saw as an 'alternative ideal of knowledge, quite generally'. The contradiction of the terms 'personal' and 'knowledge', which is deemed to be impersonal objective and universal, can, he says, be resolved by modifying the conception of knowing.

17 Michael Polanyi, The Tacit Dimension Routledge & Kegan Paul Ltd, 1967, p. 4.

18 Michael Polanyi, The Tacit Dimension Routledge & Kegan Paul Ltd, 1967, p. 6.

19 Michael Polanyi, The Tacit Dimension Routledge & Kegan Paul Ltd, 1967, p. 18.

20 Michael Polanyi, The Tacit Dimension Routledge & Kegan Paul Ltd, 1967, p. 78.

21 Gilbert Ryle discusses his ideas of the structures of knowledge in

the chapter 'Knowing How and Knowing What' in The Concept of The Mind Penguin Books, London, 1949, pp. 26-60. He rejects the idea of the 'ghost in the machine' but then separates activities performed instinctively from those performed with conscious thought and rational analysis, that which 'constitutes theorising'. 'Even where efficient practice is the deliberate application of considered prescriptions, the intelligence involved in putting the prescriptions into practice is not identical with that involved in intellectually grasping the prescriptions'.

22 Interesting theories of the mind are being stimulated by research into artificial intelligence, controversy rages between those who have adopted a 'functional machine' approach to the mind to those who see the work as irrelevant in providing helpful models. Whilst the role of intentionality is a central feature of the debate, it is generally accepted by most participants that the brain has innate capacities to form structural patterns and that stored knowledge and assumptions actively affect even the simplest perceptions. Richard Gregory's work on perception will be further discussed, however, references to much of the latest literature in this field can be found in The Oxford Companion to The Mind ed. Richard Gregory, Oxford University Press, Oxford, 1987.

23 Robert G.Burgess, 'Preface' 1984, p.vii. in The Research Process in Educational Settings: Ten Case Studies ed. R.Burgess, Falmer Press, London, 1984.

24 Sara Delamont and David Hamilton, 'Classroom Research: A Critique and a New Approach' in Explorations in Classroom Observation ed. M. Stubbs and S. Delamont, John Wiley, London, 1976, pp. 16-17 stated that they were not looking for methodological convergence but instead upon a re-conceptualization and transformation of the dimensions which divide the two traditions. Sara Delamont wrote in 1984 in 'The Old Girl Network: Recollections on the Field work at St Lukes' in The Research Process in Educational Settings ed. Robert Burgess, The Faber Press, London, 1984, pp.18-20, that although she found that interaction analysis and participant observation were, in fact, compatible during the field work for her Ph.D thesis in 1973, she found difficulty in producing a coherent report because of the lack of any established conventions for presenting such data. Her unease resulted in her decision to delay the submission of her thesis until a particular influential member of staff (Liam Hudson) was on sabbatical.

25 Michael Bassey, 'Pedagogic Research into Singularities: case studies, probes and curriculum innovations', Oxford Review of Education Vol. 9, No. 2, 1983, p. 109.

26 Cohen and Manion also appear to be attracted by Kerlinger's ideas of the value of the hypothesis as a research tool in that: 'hypotheses can be tested either empirically or experimentally, thus resulting in confirmation or rejection', and 'hypotheses are powerful tools for the advancement of knowledge because they enable man to get outside himself'. Little account is given of the hazards of its use, that hypothesis testing can only be useful within narrow proscribed limits or variables can play havoc with results. The notions of the 'discovery of truths' and 'enabling man to get outside himself' appear to be closer to ideas of

faith rather than to those of reason. Louis Cohen and Lawrence Manion, Research Methods in Education Croom Helm, London, 1982, p. 21.

27 Robert Stake, 'The Seven Principal Cardinals of Educational Evaluation', Beyond the Numbers Game ed. David Hamilton, Macmillan, London, 1977, p. 160.

28 F.J.D.Nisbet and N.J.Entwistle, Educational Research Methods University of London Press, 1970, pp. 141-142.

29 See Michael Bassey's argument that closed generalisations are of little use to the practising teacher in 'Pedagogic Research: on the relative merits of search for generalisation and study of single events', Oxford Review of Education Vol. 7, No. 1, 1981, pp. 73-94.

30 W.M.Aldrich, 'IMB An Alternative View' in Textile Horizons The Textile institute, Manchester, August 1985.

31 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986.

PART ONE: IDEAS CONCERNING DESIGN

CHAPTER ONE: IDEAS CONCERNING DESIGN

Words can be seen as vehicles of communication, in many basic transactions they are unquestioned. One could argue that social interaction would almost cease if an immense area of our lives did not take place at a tacit, unconscious or biological level. The degree to which this takes place, the effects of culture, or constructed socialisation on the complex process of abstracting personal meaning from words and other forms of communication has provided generations of academics with interesting but historical activity. Ideas are reflexive; they are unique yet bounded by context. They are immediate yet historical. They are a statement of time; any reflection, re-consideration or any transmission or discussion of it changes the idea, which was itself part of a comprehension of total human activity. Heiddegger's[1] conception of an ideational whole which is in a constant state of change and activation is a philosophical theory of great attraction.

Discussions or analyses of complex concepts, particularly those attempting to describe activities in the visual arts or music, face communication problems that can only be solved by metaphorical expression. This excites the few and leaves the majority ignorant of the 'idea'. Thus many ideas have a circulatory limit.

Theoretical positions, even historical ones, can be helpful in the examination of beliefs and notions that are central to any activity of interest, which in this case is, the design process in fashion and the decorative arts. The theory,[2] seen as useful to this study, states that if you wish to understand the meaning of a word or expression, look at the 'game' in which it is being used. To the game's active participants, their use and communication of a word or expression <u>is</u> its 'true' or 'required' meaning at that time. It should not, however, be seen as any fixed attribute to them or their activity, but it should be understood that it only has 'true' meaning within the context in which it was being used and their part within it.

The variations of the use of the word 'design' raises problems when it is offered as a generally understood concept. It is used commonly as a noun, a verb, an adjective. At this point one could attempt forms of linguistic exercise by an examination of an 'expert's'[3] use of it; or accept the anarchic utterances of Carroll's Humpty Dumpty[4]; or accept the limits of theoretical production and withdraw from the argument; or simply examine the context in which it is being used and understand that our mastery of our cultural context is at all times limited by our view. I would argue that the latter is not a venture into the extremes of deconstructionist[5] theory. It is an idea, that instead of concern about definition, gaining an understanding of the ideas and activities in which design is immeshed is a more fruitful enterprise.

In my work as a practising designer I recognise that one rarely analyses the process one is engaged upon, one just does it. As Searle[6] states, 'Roughly speaking an inner process doesn't stand in need of anything it just is'. The decision was made, therefore, to record statements made 'in or around the game' and to offer only descriptive comments on the context of the statements. This approach may be seen as a flippant retreat from theoretical language analysis, but I would argue that it is an appropriate means of access to new aspects of knowledge which have intimate connections with group or personal perceptions. The selection and organisation of the material will demonstrate my interests and bias at the time of its collation, but it is expected that the reader's own experience will be engaged to modify the present and pursue the future.

IDEAS OF DESIGN: THE CONTEXT... TIME

The following quotes should be read resting on the conviction, once formulated by Wolfflin and quoted by Gombrich, 'not everything is possible in every period.'[7]

'If it has an origin no higher, no taste can ever be formed in manufactures, but if the higher Arts of Design flourish these inferior ends will be answered of course.'[8]

Joshua Reynolds 1769

'the power of drawing the figure does not in the smallest degree imply the capability of producing a useful pattern for fabrics... he will regret rather than feel gratified with the possession of a mere accomplishment which he is unable to turn to useful purpose.'[9]

William Dyce 1840

'All that is necessary is to improve the practical part, not to shirk the work but to go humbly and zealously to work with faith in the subject.'[10]

Henry Cole 1849

'The tap root of all this mischief is the endeavour to produce some ability in the student to make money by designing for manufacture. No student who makes this his primary object will ever be able to design at all; and the very words "Schools of Design" involve the profoundest of art fallacies.'[11]

John Ruskin 1879

'The lower the culture, the more apparent the ornament. Ornament is something that must be overcome. The Papuan and the criminal ornament their skin. The Indian covers his paddle and his boat with layers and layers of ornament. But the bicycle and the steam engine are free from ornament. The march of civilization systematically liberates object after object from ornamentation...'

'....by economic independence earned through work will the woman bring about her equal status with the man. The woman's value or lack of value will no longer fall or rise according to the fluctuation of sensuality. Then velvet and silk, flowers and ribbons, feathers and paints will fail to have their effect. They will disappear.'[12]

Adolf Loos 1898

'The ultimate aim of all design activity is the building... Architects, sculptors, painters we all must go back to handicraft... There is no essential difference between artist and craftsman, the artist is a heightened craftsman... The foundation of craftsmanship is, however, indispensible for every artist. There is the fountainhead of creative design.'

from the manifesto of the Bauhaus 1919[13]

'The immediate future of modernism is undoubtedly towards the continued development of function. We shall tend more and more consciously to examine function, to find it and strip it of extraneous decorative details which have gradually grown around it through the centuries. Our furnishing will thus become simpler and clearer of expression and the final elimination of fussy details should leave us, not with a skeleton but with as pure a style as was finally achieved by the Greeks in the age of Pericles'[14]

Serge Chermayeff 1930

'Modern England is rapidly Blackpooling itself. Notice how the modern things, like films and wireless and sixpenny stores, are absolutely democratic, making no distinction whatever between their patrons... Unfortunately, it is a bit too cheap. That is, it is also cheap in the other sense of the term. Too much of it is simply trumpery imitation of something not very good in the original... Too much of this life is being stamped on from outside, probably by astute financial gentlemen...'[15]

J.B.Priestley 1934

'...there can be no general recovery of style without the recovery of an organic tradition... it has proved easier to seek out the laws of mathematical harmony than to preserve an organic tradition, but the result has been less than perfect art... We have perfected this all powerful tool, the machine, and could we but use it with instinctive wisdom, the results might exceed in beauty and splendour any monuments of the past.'

Herbert Read[16] 1956

'The illusion of a common objectivity residing in the concept of function, and in the laws of Platonic aesthetics has been a stumbling block to product criticism ever since... It is clearly absurd to demand that objects designed for a short useful life should exhibit qualities signifying eternal validity - such qualities as 'divine' proportion, 'pure' form or "harmony" of colours.'[17]

Reyner Banham 1960

'Unlike our grandparents, we live in a world that we ourselves made... We are crammed like battery hens with stimuli, and what seems significant is not the quality or meaning of the messages, but their excess Overload has changed our art. Especially in the last thirty years capitalism plus electronics have given us a new habitat, our forest of media.'[18]

Robert Hughes 1981

'... the values attributed to objects, situations and actions far from being an unassailable free-for-all, can be understood within the limits of human knowledge as deriving lawfully from the conditions prevailing in the target and the recipient. This position differs from that of the destructive relativism by asserting that the objective property of the target to be perceived and evaluated is an indispensable component of any encounter... the answer, it seems to me, must be that we harbor ineluctably an image of what is in the best interests of mankind.'[19]

Rudolf Arnheim 1986

'Functionalism...... which is falsely thought to have been another Bauhaus invention, has also come into question: "functional" form is now seen as much of a separate aesthetic as any other consciously imposed style. An emphasis on simplicity and on lack of decoration at all costs has become increasingly suspect: individualism and even whimsy is increasingly prized.'[20]

Frank Whitford 1984

'... within the framework of industrial capitalism which created it and continues to dominate it in contemporary Western society, design is characterised by a dual alliance with both mass production and mass consumption and that these two phenomena have determined nearly all its manifestations.'[21]

Penny Sparke 1986

'The decorative art can only be understood in context. Fine art is timeless.'

Yves St Laurent 1988

'Abstract ideal beauty, there is no such thing in fashion, it is always of the time.'

Karl Lagerfeld 1988

'Donna Carron could only happen now.'[22]
Meredith Etherington Smith 1988

Many ideas about design have appeared to be viewed as man's reaction to his environment, a transposing of his perceptions. The crude descriptions of classical man, organic man, mechanistic man, manipulated man, are often seen as metaphorically sufficient. The idea that man is very definitely situated within the context in which he is perceiving and acting, and is perhaps the most active agent within it, is an uncomfortable position and therefore rarely pursued.

IDEAS OF DESIGN: CONTEXT... MARKETING - MANUFACTURE - PRACTICE 1984+

MARKETING

'Their interest in the field of design as popular symbolism is in the pattern of the market as the crystallisation of dreams and desires - the pattern as it is about to occur.'[23]
Reyner Banham 1960

'At Fitch we work with clients to ensure that, alongside marketing and finance, design becomes a strategic business resource... we want to explain why the function of design is not purely decorative but, in management terms, highly practical and commercial... Design is about capturing the customer's imagination. Through this, the customer's time and his disposable income is captured. Design thus deals in the issues which comes closest to a human being's personal reality. Designing is about needs and desires, about social circumstances: it is about touching people in their hearts as well as in their pockets... Consistently pursued, good design can carry a brand through any number of changes. It can be not only the physical, but also the spiritual and intellectual framework for presenting a retailers's corporate culture.'[24]
Rodney Fitch and James Woudhuysen 1987

'"Designer" as a prefix has become the cliche of the decade. Designer Buddhism. Designer socialism. Designer stubble. Designer violence. Britain is now the acknowledged "style" arbiter for the rest of the world...'[25]
Gordon Burn 1988

'Its the marketing objective now which is crucial. Design is becoming PR- and acccount-manager led. Its money culture. Its cynical and its formularised and its awful.'[26]

Ian Brody 1988

'It was observed at the Paris men's collections that the suit had disappeared. The sharp dark suit that had determined status in the materialist eighties had entirely gone from the catwalks... In Britain, however, the suit has not disappeared... The "designer decade" was vilified here for its transitory nature, its superficiality, and above all for its arriviste pretensions. When the British suit of signals was challenged by the European suit of labels, the presence of the latter was surveyed with a shiver of disgust.'[27]

Charlotte Du Cann 1989

'"Targeting" and "lifestyle" were the new buzz words-the careful selection of a narrow group of consumers and the construction of pre-packaged images to attract them. Shop fronts were deliberately contrived to repel the mass of older poorer customers - a form of cultural apartheid.'

Carl Gardner 1989 [28]

'The 80's seem above all a time when consumerism got out of hand... but by the time the 80's drew to a close the moral bankruptcy of these ideas were being exposed. The 80's too were the decade of style, when who you were was best expressed by what you bought. The Face, Blitz and i-D told us what to buy, and how to wear it, and where to go and what to do with it... It was not enough to sell a sweater. You had to conjure up images of the world the sweater wearer wanted to inhabit - and that seemed to be the world of lots of old discreet money......Nostalgia ran wild.'[29]

Lucia van der Post 1989

'Unscrew the silver blinds, hang up the William Morris print curtains; paint the matt black table greenery-yallery, with a floral border for good measure. Replace those stark steel candlesticks with Archibald Knox originals and substitute heirlooms for Eighties monochrome gadgetry.

It's now safe for all things arty and crafty to come out of the closet. This, year according to many British designers, is the beginning of the artisan decade.'[30]

Nicola Jeal 1990

Note that many of the quotations in this piece have been taken from magazines and newspapers. This has been a conscious act, it is a recognition of the importance of mass communication for dissemination of mass culture. Hughes[31] states that mass production strips every image of its singularity, rendering it schematic and quickly identifiable, so that it resembles a sign. He sees a sign as a command, 'nuance and ambiguity are not important properties of signs.... a sign dictates meaning... mass language always tends to speak with an imperitive voice'.

Sparke[32] comments that it may emerge that the word 'designer' is in fact too general a term to be very useful in the future. The media and advertising campaigns have stretched its semantic limits further to imply anything of high style or high quality, thus infering that anything of lower price is not designed but has come into being by chance. The gap between this meaning and a job description is enormous. Design has become strategy for marketing, a symbol, a means of persuasion to consume. It has little relationship with the design activity of resolving the problems of producing an artifact in terms of its appearance, use and cost.

MANUFACTURE

> 'Aesthetic values also are important to those who see, but as novelty and originality are aesthetic virtues, there are no absolute standards by which such values can be judged. Preferences are influenced by whim or fashion and are best assessed by those sensitive to such changes in the market sought.Generally some additional cost is involved in adapting a conception to suit contemporary aesthetic tastes, and the extent of this cost can be determined only by difference between the actual cost and the least cost essential for the technical satisfaction of the design requirements. Fortunately, with innovative projects such considerations are of minor significance.'[33]
>
> David Andrews 1984

> 'The industrial designer's responsibility should be to produce commercially viable products, within the framework of budgets and affordable production facilities to maximise profit.'[34]
>
> David Mars 1982

'The pragmatist or realist, the expert on management and efficiency, who flatters himself on being immune from anything airy and artsy - he is not free from the sway of ideas. He is merely in the grip of a particularly coarse and unexamined set of them.'[35]

Simon Blackburn 1989

'I would argue that the design of a competitive modern product is not the consequence of any individual cry of "Eureka", but is derived from the concentrated combination of the highest quality creative skills brought together in a mutually supportive, non hierarchichal way.'[36]

Gordon Edge 1985

'I would not care if the whole design room left to-morrow but I could not survive without my technical staff.'[37]

Production Manager Field Study 1986

'Many people have original ideas, only a few can get it together. Those are the people I am looking for.'[38]

Michael Rudman Field Study 1986

'Design is values made visible... it is not only about a design solution but deliverables.'[39]

Phil Gray 1989

'... good design is the best you can do between now and next Tuesday.'[40]

Charles Eames 1982

'Design is a business not just a creative pursuit... it is creativity harnessed to commerce... design is aspirational lifestyle targeting...'[41]

J Kern 1989

'I make clothes... I don't package Ideas... Our designers supply what women want to wear... it is insight, knowing instinctively what the customer wants to buy.'[42]

Jennifer Rosenberg 1989

'should they deploy their talents on the design,

> styling or promotion of products that are superfluous pampering of the already over-provided; that waste non-renewable resources; that destroy amenities;... a return to the earlier ideals of the profession of industrial design which aimed to meet the needs of the modern world by designing in human terms where social purpose combined with aesthetic expression and symbolic value.'[43]
>
> Christopher Cornford 1976

The Designer 2000 study found that designers' qualifications vary from academically orientated Master's Degrees.......to those with no qualifications at all. 'This only highlights the complexities of the design function and the impossibilty of providing one standard definition which encompasses the diversity of work involved.[44]' The study also found that very few clothing manufacturers employ purely creative designers, (this is supported by findings made during the field study of this research), 76% of their respondents had not employed a designer in any capacity.[45]

The future of design is not only in the creation of artefacts and an enviroment but is a cultural phenomena. The silent shaping of our subconscious is, to an unknown extent, in the hands of manufacturers and retailers, the new patrons of design. Yet, 'industry[46] has no single clear idea of the role a designer should fulfil'.

PRACTICE

> 'British Industrial design of the present and recent past gives the impression that it lacks direction. I feel that the root cause of this is that designers have formed no satisfying philosophy to guide them.'[47]
>
> Giles Smith 1982

> 'Like politics, design is literally the art of the possible, as much the art of applied psychology as the art of applied materials technology. It is a social art in the widest possible sense and is at the core of commercial viability.'[48]
>
> Ryan Lewis 1982

> 'My innate distrust of theory has long since been tempered by a respect for systematic method, but

method applied in a way that does not prejudice the intuitive elements of the design process.'[49]
David Newton 1982

'It was a subconscious or intuitive feeling that you get only occasionally - a feeling that you have created something that cannot be made better - by anyone'[50]
Herb Lubalin 1967

'Design is the articulation of thoughts in my head... the creation of something that I want, which is inspired, it is a means of communicating them.'[51]
Judy Foulsham 1989

'It seems that when you sit down and draw, you are forced to analyse what is important.'[52]
Zandra Rhodes 1988

'I keep my eyes open, looking around all the time... then design without thinking about it. The more work I do the more I can do.[53]
Georgio Armani 1988

'Companies do not understand what a designer does. They expect you to go in at 9 o'clock in the morning and sit down and design till 5.30.'[54]
Paul Smith 1988

'Its very hard to talk about because it comes from an area of the mind which we are not educated to use in a way which we can see or touch, and yet we use it the whole time.'[55]
Katherine Hamnett 1985

'People are afraid of the words "trade" and "commerce", but that is , after all, what we're in.....I've been told that technical training interferes with creativity but that's a lot of tommy rot.'[56]
Jean Muir 1988

'Marks & Spencers selectors say that they want us to produce our own range of designs instead of doing variations on their ideas... but it rarely happens... I suppose its got a bit better recently'. (1986)

'I have not done a fashion drawing, the type we did at college since I came here five years ago. It all happens on the bench.' (1986)

'Its changed a lot in the last few years, the selectors expect story boards and much better presentation... the image is important... our competitors are investing large amounts in technology that speeds forecasting and presentation work.' (1989)

Designers in large manufacturing companies [57]

'The Swedish definition of design is "form giving".' [58]

Kjeisti Nicolaysen 1989

Any summary of the diverse collection of views and ideas quoted in this section of the study, would have difficulty in offering a clearer statement than that given by Rzevski:[59]

'Design may be considered from many different points of view. For some it is the expression of a mysterious urge, for others, the act of creating a marketable product, an attempt to embellish the living environment, the generation of pure functionality, the synthesis of form, or strangely enough, an information processing activity.' A designer's view on this matter, like on any other matter, is primarily a product of his or her attitudes and values and, to a lesser degree, of knowledge.'

IDEAS OF DESIGN: THE CONTEXT - THE DESIGN PROCESS

Perhaps because of its complexity, Jones[60] defines the practice of design in broad terms, he sees it as being to 'initiate change in man-made things'. Within the context in which designers of artefacts promote their activity, Hurlburt[61] states that creativity is usually regarded as 'having the imagination and ability to discover fresh and original concepts'. Ideas about stages in the creative process vary, for example Hurlburt[62] offers: analysis, incubation, inspiration and verification; but other stages can be suggested, origination, elaboration, evaluation and the decision that it is finished also appear to be crucial elements. Whilst it is fairly clear that all these elements exist at times within different design projects, to pursue the idea that there are 'fixed' sequential stages appears arbitrary. Hurlburt[63] admits that to most designers the precise recollection of how an idea was generated or developed appears to be unobtainable, how inspiration is arrived at remains somewhat mysterious.

> 'The design process is both complex and highly personal. Even though the results may sometimes seem to be accidental, the quality of the solution will usually depend on the careful blending of the pragmatic and intuitive elements of the designer's personality and a balance between intellectual and emotional responses. Some designers find their way to dynamic presentation through a careful step-by-step process. Some often seem able to form a fully realized concept in the inner recesses of the mind before committing a mark to paper. Still others will work their way through a growing tangle of idea sketches only to unravel them into a final solution.'

Other studies[64] have shown that not only the means by which individual designers generate ideas differ but that they have difficulty in explaining their activities. Mayall[65] believes that what is good design is in fact unsayable only demonstratable, he states that there is a problem in that when we describe thought processes, they have to be produced in terms we can understand and this requires putting words together in a sequential and structured manner. This makes describing even the most simple design process seem complicated, and, as the experienced designer might argue, unnecessarily complicated simply because of the way we write about designing them. However, most designers appear to agree that design is usually the result of connections - the link between knowledge, experience, invention and action. Mayall[66] considers that synthesis is the most significant element of the activity, 'it is not the invention but getting it together that provides the exhilaration of the activity'.

The most common experience of designers appears to be that their ideas contain some form of intuitive response. Hudson[67] and Gregory,[68] both state that the common feature of studies of creativity is the stress placed on the process of incubation. If a problem is placed to one side, a later flash of inspiration solves the problem. 'You are not even thinking about the work and then you know that the sky has just got to be red[69].... it couldn't be any other colour.' Hudson[70] believes that there is a clear indication that our brains are at their most efficient when allowed to switch from phases of intense concentration to ones in which we exert no conscious control at all. Both are interested in the preconscious level that Freud located between the conscious and unconscious level. Freud considered this to be more accessible than the unconscious. He saw it as the 'site' of intuition, the insight which produces ideas without any apparent involvement in conscious thought.

Hudson[71] considers that it may well be that creative people have access to aspects of the mind's functioning from which others are excluded; he thinks that in order to innovate we have to break the grip on the imagination of logical thought and subvert the conventional wisdom on which everyday competence depends. Arnheim[72] argues that truly productive thinking, in whatever area of cognition, takes place in the realms of imagery. He takes an eloquent but extreme stance that suggests that unless we are able to conjure up an image of some process or concept, we will be unable to think clearly about it. Studies in the psychology of art and design appear to concentrate on the relationships between rationality and intuition. Arnheim[73] states clearly, 'Intuition and intellect are the two cognitive procedures'. Vickers[74] discusses design within this context; he concludes that the successful designer has a sensitivity to form and a cerebral organising capacity, 'a specially happy combination of two cognitive styles'. However, Gardner[75] believes that too many studies concentrate on the dichotomization of the intellect. His theory of multiple intelligences offers a more complex set of relationships and interactions of sensory, imagistic, cognitive, spatial and linguistic intelligences. Any form of intelligence requires an ingredient of knowledge, but it is important to distinguish between knowledge that is given, and knowledge which is built internally by the interaction of information and thought. It is the latter which is of interest to this study.

Gregory[76] sees memory as being crucial to all new areas of thought. He believes that the mind appears to have two levels of memory, that the brain filters and sorts the perceptions and ideas into those which may be of use and discards those that are not going anywhere. It seems to be the quality of this sorting process that effects the quality of innovation. Miller[77] believes that creativity emerges from:

> 'paying attention to the rubbish of life... the inadvertant... the unattended.'

Dennett's[78] view, whilst more mechanistic in approach, supports this idea. He believes that we develop virtual machines... operating systems that allow us to get through life and that these virtual machines tend, 'in their heuristic leap into the void of combinatorially explosive possibilities to notice the right things at the right times... they also tend to ignore what can be ignored.' It is, he believes, that literal eccentricity - a certain imbalance is the key to making progress, and that figurative eccentricities of behaviour are often not mere byproducts but sources of creative intelligence.

Perception is not the special property of artists and designers, what they are usually doing is often using this human facility in a more intense way, consciously or unconsciously. Martinez and Block[79] believe that designers have an intuitive sense of Gestalt, an ability to disturb order and re-arrange it to make 'visual sense'. This may be why a characteristic of many successful designers is an ability to cope with elements of incoherence when proceeding with a project.

Gregory[80] states that problem solving always produces knowledge, and that this knowledge can be 'frozen' and then 'thawed' for future use. He calls this bank of knowledge potential intelligence and the action of using knowledge to solve further problems or generate new paths kinetic intelligence. Potential intelligence can be viewed as available solutions and answers that were created by an inventive leap (kinetic intelligence). I would agree that creativity is this gathering, sorting, analysing, problem solving and idea creation that he describes and that:

> 'It is absurd to consider intelligence separately from creativity... We might define intelligence as the generation of successful novelty.'

Gregory[81] argues that there is a major difficulty in that the contribution of stored potential intelligence is overwhelmingly greater than that of the small inventive steps of kinetic intelligence. Tests on intelligence by psychologists are usually swamped by the power of potential knowledge. It is not clear that the kinetic intelligence of problem solving can be isolated for measurement. Gregory[82] also states that we must not ignore another way to be creative which may be seen as much duller, that you do not have to have original leaps but that you can carry out step by step procedures, for example on a computer, and still generate extraordinary results. However, I would argue that a degree of kinetic intelligence would determine the steps which had to be taken. This position leads us to look at the nature of knowledge above the level of stark information. My position is that all discoverable knowledge, once internalised, is individual knowledge and is changed. Potential knowledge is personal knowledge. When a past idea is recovered, (potential knowledge cannot return in isolation), the manner of its return must have a relationship with the way it is stored. It would seem that Miller's[83] apparently simple remark may indeed be the key to the generation of inventive design. Hurlburt[84] states that it seems that when creative ideas do come, they come and go with remarkable rapidity and unless these concepts are recorded promptly, they may be lost forever.

It is clear that simply to be prolific with new ideas is not enough, that there is more to being creative than mere fecundity. The generation of novelty amounts to little unless you have the intelligence to tell a good idea from a bad one. Intelligence, in whatever form you wish to describe its structure or structures, appears to be a significant ingredient in the creation of new ideas. Steinberg[85] states that it is also recognition of when you have to go further than the present state, and, probably just as important, when to stop searching. Bailey[86] enforces this point when he explains that in commercial design you have to lead the public, but not too much... 'go all the way you can, then pull back'. This appears to recognise the quality of tenacity[87] that allows people to make sense of the world if the speed and style of change is tangible but makes them uncomfortable if images become obscure.

Jones[88] has something useful to say about the instability of the design process, he notes that the designer is obliged to use current information to predict a future state that will not come about unless their predictions are correct and in which they may be part of the instrument of that change.

Gardner[89] is prepared to talk about bodily intelligence from within a theory of multiple intelligences, few studies pay much attention to the fusion of mind and action. The idea of separating the body from the mind, 'the ghost[90] in the machine' may have been discarded, but some confusion has filled the void. Art and design has always straddled across the psychological and philosophical arguments of 'knowing how and knowing that'.[91] The work of Frayling and Snowden[92] is more pertinent to this study, they looked at the work of designer craftsmen and their views of the relationship between expression and bodily skills. To some it was 'the therapeutic bit between the struggle of designing'; to others it was the retention of control, 'teaching the machine manners'; to most, however, it was unacceptable to make any separation between thinking and making.

Searle[93] insists that we have got to get out of the idea that mental implies non-physical, physical implies non-mental, he argues that the operation of the brain itself is physical. Searle is also prepared to talk about emotion, he accuses cognitive scientists of neglect. He sees the separating of human functions as a mistaken course, 'human beings are biological beings situated in a social and natural world. Absolutely fundamental to that human subject as it interprets itself are what we've been calling the emotions.' Searle sees this whole sequence of emotions as being amongst, and indeed perhaps are, the most fundamental motivators in our life.

Daley[94] poses the question that if we can never, in any describable sense, know what happens when artists and designers practice, what exactly can we say on the subject? She believes that we must portray the designer not as an intellect executing rational decisions but as a human being whose entire mental life is immersed in the parameters and priorities of his existence as a social being. Daley argues that if design and artistic creativity are experimentation with our perceptual limits, then they are irrevocably outside the realm of verbal description. We cannot describe the bounds of our experience because we cannot step outside them.

REFLECTIVE COMMENT

At this stage it is reasonable to ask what can be gained from this ramble through the literature. What points are relevant or important to this study?

First, design is understood here as a phenomena that embraces and integrates most forms of human activity. The arbitrary boundaries often imposed on it by specialists and experts are incompatible with its practice. Second, that it is a human activity that requires the operation of multiple intelligences which are driven by an 'engine' of expression or motivation. Third, the level of creative innovation appears in some sense to be linked, very personally, with the designer's personality, perception, mode of brain function and the context in which he is operating.

The context in which the study is interested is a commercial environment. The spectrum of design activity will stretch between that occurring between the designers whose personal commitment outweighs the profit motive to the designers who enjoy or who are content to work within the restrictions of commercial parameters. Within this context the design activity of interest is the generation of 'novel but appropriate' ideas. 'Novel' is used in the sense of not only new but attention seeking; 'appropriate' is used in the sense that the artefact does not disturb the perceiver to the extent that the idea is totally rejected.

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1 Martin Heiddeger, Being and Time trans. John Macquarrie and Edward Robinson, Harper and Row, New York, 1962, and Basic Writings from 1927-1964 ed. David Heiddegger, Farrell Krell, Routledge & Kegan Paul, London, 1978.

2 The difficulties of developing theories of language are discussed in Justus Hartnack's Wittgenstein and Modern Philosophy trans. M. Cranston, Methuen & Co Ltd, London, 1962. and in a conversation between John Searle and Brian Magee The Great Philosophers BBC Books, 1987, pp. 320-347. Read the original ideas in Ludwig Wittgenstein, Philosophical Investigations trans. G.E.M. Anscombe, Basil Blackwell, Oxford, 1967.

3 Attempts are made to define the words 'fashion' 'design' and 'style' by reference to 'experts' views, in 'Fashion: An Interdisciplinary

Review' by M.A. Hann and K.C.Jackson, Ed. P.W. Harrison, Textile Progress Vol. 16 no. 4, The Textile Institute, Manchester, p. 1. It is a common sense approach that appears to preclude argument, 'in the context of clothing, a design is a unique combination of characteristics that within a given class of products, distinguishes one item from another.'

4 Lewis Carroll, Through the Looking Glass in The Complete Works of Lewis Carroll pp. 196-197, The Nonesuch Press, London, 1977 edition. Humpty Dumpty tells Alice, 'When I use a word, It means just what I choose it to mean - neither more nor less... The question is, which is to be master - that's all... I can manage the whole lot of them! Impenetrability! That's what I say!' Patricia Meyer Spacks does not see this passage as nonsense, she sees it as central to the notion of 'meaning'. She quotes the conclusion of C.K. Ogden, I.A. Richards, and Ivor Armstrong in The Meaning of Meaning 'In spite of a tacit assumption that the term is sufficiently understood, no principle governs its usage, nor does any technique exist whereby confusion can be avoided. Yet the most elementary principle of semantics is, that agreement about the use of signs rather than the signs themselves enables us to communicate'. See Spacks discussion of Carroll's devastating use of the fact that many people are unwilling to recognise high handed dealings with language in, 'Logic and Language in Through the Looking Glass', in Aspects of Alice ed. Robert Phillips, Victor Gollancz Ltd, London, 1972.

5 The work of Jaques Derrida is often criticised as a melancholy and destructive examination of the social and cultural theories and structures which, it is argued, are intrinsic to the notion of societal communication. It is a scepticism about traditional common sense assumptions about the way we think and read. It is criticised as undermining our mastery over our words and thoughts and a doctrine of irrationalism. Christopher Norris writes clearly on the subject, see Derrida Fontana, London, 1987 and The Deconstructive Turn Methuen, London 1984. Hilary Lawson writes lucidly on deconstruction in Reflexivity: The post-modern predicament Hutchinson, London, 1985.

6 John Searle in conversation with Brian Magee, The Great Philosophers BBC Books, 1987, p. 336.

7 E.H.Gombrich, Art and Illusion Phaidon Press, London, 1962, p. 4.

8 Joshua Reynolds, Discourses 1,3, ed. Roger Fry, Seeley and Co. Ltd. London, 1905, p. 5. Reynolds disapproved of decorative or imaginative art, he criticised brilliant colour or ornamental style. His teaching at the Royal academy was in the classical tradition which rejected the Romantic's idealism which searched for beauty in natural forms.

9 An extract from William Dyce's report to the Board of Trade on the Foreign Schools of Design, Sessional Papers (98) XXIX, Irish University Press, 1840, p. 39.

10 Henry Cole's statement to the Select Committee on the Schools of Design 1849, Sessional Papers (576) XVII, Irish University Press, p. 191. Dyce and Cole's utilitarian theories produced tedious and repetitious drawing exercises, they translated academic copyist

traditions into derivative techniques for decoration. The study of the figure was seen as a temptation not to be offered to the 'lower departments'.

11 John Ruskin in 'The Laws of Fesole: A Familiar Treatise on the Elementary Principles and Practice of Drawing and Painting', 1879, in the The Works of John Ruskin Vol XV, ed. Wedderburn & Cook, George Allen, London, 1905, p. 344. The pragmatists, seeing the practical utility of the 'development of hand and eye', accused the Romantic movement of replacing the snobbery of classicism with the snobbery of medievalism.

12 'Ladies Fashion', Neue Freie Presse, August 21 1898, in Adolf Loos Spoken into the Void Collected Essays by Adolf Loos 1897-1900, The MIT Press, London, 1982, pp. 102-103.

13 See Design and Form by Johannes Itten, Thames and Hudson, London, 1967. Itten taught at the Bauhaus, he introduced ideas of teaching in the Basic Design course that were to influence art and design courses for many decades.

14 Serge Chermayeff, from an article 'Modernism' in The Cabinet Maker, June 28 1930, in Design and the Public Good ed. Richard Plunz, The MIT Press Cambridge Massachusetts, 1982, p.11. Chermayeff, an architect of influence particulary during the modernist movement in the thirties, centred most of his work in functionalism. His associations with the Fabian society, the logical positivism of Bertrand Russell and the pragmatic technological influence of Eric Gill are reflected in his writings.

15 J.B. Priestley, English Journey William Heinemann Ltd, London, 1934, p. 402.

16 Art and Industry the principles of industrial design by Herbert Read, Faber & Faber Ltd, London, 1956, p. 12. Read explains that Morris believed in tradition, an organic continuity in methods of work. Work in this sense is not an activity in which the worker is conscious of such qualities as beauty or style; it is the spontaneous activity accompanied by joy and satisfaction, and beauty is its natural by-product. Morris felt that in the machine age only makeshift art was possible: not beauty mere utilitarianism. Read's ideal, whilst communicating many of Morris's ideas, conflicts with Morris's joy in ornament and decoration; Read's writings make his distaste for ornament quite clear.

17 Reyner Banham, 'A Throw Away Aesthetic', in Design by Choice ed. Penny Sparke, Academy Editions, London, 1981. Reyner Banham argues against rigid design theories that relates all value to some supposed universal concepts of truth and form. He sees a validity not only in the aesthetic that lingers on as a permanent monument to an expression of a time but also in products that have been designed for transitory beauty according to an expendable aesthetic, 'then they will fall not into ridicule but into calculated oblivion where they can no longer embarrass their designers', p. 90.

18 Robert Hughes' personal view of art movements illustrates the dichotomy of ideas and emotions that have threaded through human experience and been expressed in the visual arts. A non-historical view of ideas in art. The Shock of the New BBC, London, 1981, p. 324.

19 Rudolf Arnheim in New Essays on the Psychology of Art University of California Press, Los Angeles, 1986, p. 325. Arnheim's writings on universal values have had considerable influence on art and design education, '...it is by general criterion that we do not hesitate to attribute more value to truth than to falsehood, to peace than to war, to life than to death, to profundity than to triteness, even though this or that individual may judge otherwise'.

20 Frank Whitford, The Bauhaus Thames and Hudson, London, 1984, p. 200.

21 Penny Sparke in An Introduction to Design in the Twentieth Century Allen & Unwin, London, 1986, p. XIX. A sociological perspective of art and design which has been controversial and stimulating. It centres man as active agent within his environment and rejects the idea of man as a passive recipient or a reactor to external phenomena.

22 Opinions expressed by and about current leading fashion designers, The Story of Fashion April 17th 1988, Channel 4.

23 Reyner Banham, 'A Throw Away Aesthetic', in Design by Choice ed. Penny Sparke, Academy Editions, London, 1981, p. 93.

24 Rodney Fitch and James Woudhuysen, 'The strategic significance of design', The Changing Face of British Retailing ed. Edward McFadyen, Newman Books, London, 1987, pp. 14-21. It must be recognised that this apparent extravagant piece of copy was written when fashion marketers seemed to believe that they had found the fashion marketing equivalent of the Holy Grail, 'lifestyle targeting'. At 'Design Management: creativity in a corporate environment', a conference, University of Leeds, October 1989; and at 'Textiles: Fashioning the Future' the Textile Institute World Conference, November 1989, disciples of the movement were still spreading the message. The recognition of this strategy came with the apparent success of the fashion chain, Next. However, as Penelope Oddy points out, 'The basic Next concept was, admittedly not new. Leading fashion retailers and suppliers had been talking about 'lifestyle' merchandising for years, well co-ordinated collections targeted at specific market segments.' p. 2.

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'designer decade' with what could be considered an equally signal-ridden appeal of the British class system. Charlotte Du Cann, 'The strange rituals of the serious suit', The Independent 18th May 1989.

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42 A paper given by Jennifer Rosenberg, Joint Managing Director, J & J Fashions Ltd., at the Textile Institute World Conference, Nottingham, October 1989, Textiles: Fashioning the Future.

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PART TWO: CAD IN CLOTHING COMPANIES 1984-86

CHAPTER TWO: THE CAD CLOTHING RESEARCH 1984-86

To gain some understanding of Computer Aided Design as it was operating at the time (1984), three strategies were adopted. First, practical experience of the technology had to be gained[1]; second, knowledge of what was being offered by CADCAM suppliers to the clothing industry had to be acquired: third, some knowledge had to be gained of how CAD was being applied in companies presently using it.

This section of the research was written in 1985-86. It consists of a journal article[2] which summarised CAD developments shown at IMB (International Clothing Machiner Fair) in Cologne, June 1985, and unrevised extracts from a report[3] written for an MSC/DES Pickup project, (July 1985 - June 1986). The report research was focussed on local experience and needs in the field of computer aided design, However, to place the local information in a context, data collected for the Ph.D research study, on the use of CAD nationally, was included in the report. The whole of the text of Part Two is comprised of the journal article and unrevised extracts from the MSC/DES report, thus ensuring that my views, attitudes and personal knowledge and those of the participants, at that time, 1985-86, are expressed clearly.

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1 Courtaulds Leisurewear Division allowed me to work as a trainee on the Gerber System for four weeks in June/July 1984. They expected me to work within their parameters and contribute to the work in hand. Although the

experience was restricted to pattern modification, grading and lay planning, this experience was invaluable. Manchester Polytechnic also gave me permission to work on their Gerber System. In the early stages of the research I experimented with various architectural and engineering vector based CAD systems to gain some understanding of their design structures.

2 W.M.Aldrich, 'IMB An Alternative View', in Textile Horizons The Textile institute, Manchester, August 1985.

3 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986.

CHAPTER THREE: CADCAM CLOTHING SYSTEMS 1985

EXPLANATION

The majority of the work in this chapter was completed before the MSC/DES project began in July 1985. The data was collected for this PhD. project, but was included in the report because it was seen as contributing valuable background material. Substantial extracts from the report are included so that 'historically bound' text is offered for examination. The beginning of the chapter offers an unedited section from a journal article written in 1985.

EXTRACTS FROM THE JOURNAL ARTICLE: 'IMB: An Alternative View', a Report on an International Clothing Machinery Show, Cologne 1985.[1]

'Any description of developments in CAD/CAM technology or critical reviews of their deficiences in books or journals are faced with the problem of being out of date before their publication. This article, while acknowledging some specific new developments in CAD/CAM, is primarily concerned with an examination of the directions of its progress and some of the consequences that may concern designers and people responsible for design education.

Directions

Three directions could be identified from the stands of suppliers at the Cologne International Machinery Fair in June. First, there is a recognition of the potential market for the new technology for the small or medium-size clothing firm; secondly, CAD/CAM companies are showing an increasing interest in the made-to-measure trade; and finally, attempts are being made to bring designers into direct contact with the technology.

The CAD/CAM technology supplied by Gerber, Lectra and Investronica, which has been installed mainly in large companies, has demonstrated that it works effectively in areas of grading, marker making and cutting. These companies have continued to improve their software and all of them now claim to provide automatic marker-making without reference to previously stored markers.

While the Lectra system, designed in a modular form, has been successfully introduced into a number of medium-size firms, the three market leaders are now becoming very interested in the smaller manufacturer, offering smaller systems (Gerber MM5 and Baby Lectra) at prices these companies could consider. Low and single ply cutters and software programmes written for made-to-measure garments show how the new technology is moving on from large-scale mass-production into more specialised fields.

Innovation and Challenge

The monopoly of the British market by the three companies is beginning to be challenged. Other systems, many based on micro-computers, should be operating in a significant number of manufacturers by the end of the year. A system based on a micro-computer could be seen as an attractive investment by a small firm for a number of reasons outside the initial cost:

- o Micro-computer systems do not require air-conditioning and room temperature control.
- o Many of them are designed to be very simple to operate.
- o Service costs can be reduced on those which are serviced by local computer hardware suppliers.
- o They can be expanded as required, and many have modem links.
- o Systems based on popular hardware (IBM PC) have access to a range of other software programmes.

Many of the new firms entering the market are generating innovative ideas and new approaches. Cybrid and Texography use scanning techniques instead of digitizing. Cybrid have already developed an automatic marker making unit, and later in the year they will be offering PDS and a grading system which can be automatic or used for specialised grades.

New CAD/CAM suppliers who have entered, or hope to enter the British Market in 1985/86 are Cuttex, Cybrid, Datamonster, Microdynamics, Seco, Tecnoconf and Texography.'

EXTRACTS FROM THE REPORT: 'How New Technology can be made Available to the Clothing Industry'.[2]

'CAD CAM CLOTHING SYSTEMS

This, and the following section of the report; whilst giving a basic description of the equipment and functions of systems presently available in the United Kingdom (Appendix I), and those likely to be available in 1987 (Appendix II); is more concerned with an examination of their operation, the direction of their progress and the consequences of their installation.

The United Kingdom's Clothing Industry has a poor reputation with regard to spending on Research and Development[3] (R.and D.) its league position in the 1960's was next to the bottom (Appendix III). CADCAM innovation came to Britain in the early 1970's from America where CADCAM functions in the aerospace and defence industries (always high spenders in R and D) had been adapted for the Clothing Industry. The company most responsible for its spread throughout the large manufacturers in Britain was Gerber Scientific and they are now working hard to retain their position of market leaders. The patent on their cutting system, and the fact that the system was totally integrated into grading and marker making, has re-inforced their position.

Whilst in other industries small firms are often successful innovators in the field of micro-electronics, the small company faces serious constraints when embarking on large scale or radical innovation. Indeed, it was the shake out of researchers when Gerber took over their main rival, Camsco, that spawned a number of other systems which have revisions or have 'incremental innovations'.[4]

Two main directions which are relevant to this study can be identified in present CADCAM developments. First, there is a recognition of the potential market for the new technology for the small or medium size clothing firms; and second, attempts are being made to bring designers into direct contact with the technology.

CADCAM has been recognised by CADCAM associations, as being too crude a definition to describe the complexities of the technology, an intermediate stage is recognised computer aided design development. This stage can be appropriately applied to CADCAM clothing systems.

CAD - computer aided design: first sample and costing;
CADD - production patterns, grading, marker making;
CAM - computer aided cutting.

This study will proceed with its discussion with reference to these terms. Research undertaken prior to this survey, (Aldrich PhD. research 1985-86), has identified a clear divide between CAD and CADD. Functions associated with CAD are being operated by only a handful of companies and are using the features in a very limited way.'

'It[5] must be understood that the systems now available are 'visual image' systems, they have no facility for any further design functions which require measurements or mathematical functions. The production of finished presentation sheets are a problem at this stage; the technology, the screen resolution, the ink jet printers and thermal printers are not yet at a level which could be accepted by many designers. Buyers are wary of choosing ranges from designers 'on the screen' instead of from samples 'on the bench' the producers are not willing to take the risk of only showing screen design options.

Pattern cutting has been available for sometime on the production systems, but very few companies, including those who have the software, have made use of it even for their production patterns. The designers have not! The functional gap between the graphics and the construction of a first sample was identified in earlier research at Trent Polytechnic, this gap was seen as one element in the alienation of many designers. It is now being recognised by some suppliers and will merit further discussion.

Research into the application of three dimensional wire frame and solid modelling to garment design is now taking place in a number of countries. Gerber Scientific are following this route. The view that this mechanistic route is questionable has substantive support within the Clothing Industry, the research would be associated with this view, other innovatory approaches can be taken.

A number of competitive systems would like to gain a place in the British market, fierce competition in a limited field often results in confusion and casualties. This study argues that the small clothing company cannot afford to be left with the unsupported casualties of these systems.'

'PRESENT ACCESS TO CAD/CAM CLOTHING SYSTEMS[6]

'The intention of this section is to describe simply the means by which small - medium size companies can gain access to the new CADCAM technology. It does not intend to be prescriptive.

Buying a System

The price of the systems is dropping rapidly. The lowest access price (at the present time), for a full scale CADD pattern construction, grading and marker making unit is £38,500 (Appendix IV); other configurations and new developments, particularly those based on the micro-computer are likely to reduce this figure. This means that buying a system has now become a viable option for many more companies.

Buying Time on Another Company's System

This option was expected to become more available as smaller firms bought into the technology and wanted to offset costs. However,the option to buy the smaller micro systems may mean that fewer firms will have this spare capacity. Buying time on another company's system can leave the purchaser in a vulnerable position with regard to "priority under pressure". Some companies who have <u>sold</u> time have experienced conflict, and one company has stated that it has "cost them money".

Setting up a Consortium

A group of companies can form a consortium to buy a system for joint access. Conflicting experiences have been recorded when companies within groups have engaged on a similar procedure. <u>Some do work well</u>, others have found that competing demands, mistakes in communication and loss of control at the production point are tensions that have been difficult to resolve and have resulted in the abandonment and sell off of at least two CADCAM systems.

Bureaux

The history of CADCAM Bureaux offering <u>CADD</u> has been somewhat flawed, a number of efforts in the 1970's resulted in their early demise.[7] Most clothing companies were ignorant of CADCAM operations or suspicious of their benefits, the cost of the technology was very high, thus this type of initiative was a high risk investment.

A different type of CADCAM Bureau is coming into operation, its remit is wider than that of a commercial bureau. The City Council Initiatives in London, Birmingham and possibly Nottingham are offering or are about to offer CADCAM services, but see the service as being only a part of their operation. Their aims are the support and training of local industry, in fact to "push this industry into the 20th century" (David Jones, Hackney Fashion Centre).

Consultancy and Financial Support

Companies can obtain advice, general or specific, and obtain up to 75% of the cost by means of grants from the Department of Trade and Industry[8] towards reports and support during the implementation of CADCAM. The British Clothing Centre, HATRA, CAPITB and other organisations provide consultancy services; and some private consultants, i.e. Kurt Salmon, are specialists in this area. One can discern some correlation between the growth of the 'consultancy industry' and the availability of grants. Whilst money appears to be available for talking about new technology, many companies would prefer money to be available in the form of low interest loans for actually buying some. Money for hardware and software can only be obtained to support innovative new products[9]. DTI funds for the introduction of CADCAM hardware ended in 1984, few clothing companies took advantage of the scheme.

The different perspectives of support and self-help co-exist awkwardly and are frequently seen to be in conflict. It is also apparent that whilst the infusion of public money will increase the opportunities to use CADCAM technology, those who have the power to dispose of any largesse should be aware that their enthusiasm may result in small firms being prematurely persuaded into using inappropriate methods.

With recognition of all the cautionary perspectives it is clear that whilst medium size companies have increasing and diverse opportunities to obtain CADCAM technology; small firms, because of their financial position, mode of operation and skill base, will require access to some kind of supportive bureau operation to gain entry to the technology.'

'CONCLUSION[10]

From this point in the study, CADCAM will be used in the context of an accepted descriptive term for the technology; particular functions will be specified (CAD: CADD: CAM).

Hoffman[11] in his comprehensive study of technological change in the clothing industry states that the introduction of CADCAM technology into the Clothing Industry is by far the most radical technological innovation since the development of the sewing machine. He also believes that it will trigger a process of change that will be equally fundamental.

Whilst being careful to separate the producers' rhetoric from reality, the evidence of this study directs that his views, particularly with regard to CADD and CAM, should be taken seriously; but reserves its judgement in the area of CAD.'

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5 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 21-23.

6 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 34-39.

7 HATRA, the Knitting Industries Research Association considered this route in 1978, but the financial considerations aborted their attempts. Of fifty companies which expressed interest at that time, ten now have their own systems. A survivor from this period (through dogged effort and apparent expertise in the products of the local industry) Complan, operate a successful commercial bureau in Leeds and others have now followed in Scotland and Ireland.

8 The DTI in their Business and Technical Advisory Services offer grants for products and process consultancy and grants for new technology feasibility studies, see Support for Business Department of Trade and Industry, April 1985.

9 MAP (Microelectronics Application Project), offered assistance for the development of new micro-electronic products. Grants are no longer available for new micro electronic equipment to produce existing products more efficiently, see Microelectronics Industry Support Programme 2 Department of Trade and Industry, 1985, and Innovation: Support for Business, Department of Trade and Industry, 1985. Note that some funds are available through regional grants to designated Development Areas For a comprehensive list of grants see Government & E.E.C. Grants and Assistance to Business in the United Kingdom Hacker Young, London, 1986.

10 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 23.

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CHAPTER FOUR: A CATEGORISATION OF THE CLOTHING AND KNITWEAR INDUSTRIES 1984-6

EXPLANATION

The research undertaken for the MSC/DES project was concerned about local needs; therefore, a form of data organisation was constructed that could deal with the type of confusion that can occur if national data is used that simply lists companies as knitwear or clothing companies. The new form of categorisation was found to be useful for the later work for this thesis, which was interested in data from companies nationally.

EXTRACTS FROM THE REPORT: 'How New Technology can be made Available to the Clothing Inustry'.[1]

'A common sense view of the East Midlands Clothing and Knitwear Industries would state that its only consistent quality is its diversity, and a further complication in their structure appears to be a complex pattern of "cross breeding" between the industries. To understand the technological changes taking place within these industries it was decided that the initial task would be to attempt some categorisation on which a survey could be based. It was appreciated that this task was of daunting definitional complexity.

National surveys generally separate the Clothing and Knitwear Industries, they were therefore seen as marginally useful in understanding general trends and viewing the national structure within which local Knitwear and Clothing Companies are placed (Appendices V to X), but not very helpful when looking at the specific requirements for a technology which may be beneficial across both East Midlands industries in certain categories.

The use of national surveys[2] for obtaining local information was found to be limited because, first, there were differences in the geographical boundaries drawn and secondly, the product groups in national surveys were not categorised according to the product criteria which the research required.'

[3] 'Information on Clothing and Knitwear companies was collected from applicable sources (Appendix XI) and the information was cross referenced to provide the basic data base, this data base was continually refined during the study. The data base was constructed to contain the names of local clothing manufacturers and knitwear manufacturers. The first levels of categorisation were:

1. North or South Midlands;
2. Company unit size (no. of employees);
3. Clothing Industry or Knitwear Industry;
4. Categorisation by product.

The first two categories were straightforward, the last two, very difficult, some term had to be devised that would take account of the "mongrel" companies which exist particularly in the leisure market. It is possible to have two companies making identical garments but each company regarding himself as belonging to a different industry. Mergers, new managements and the chasing of new markets have produced anomolies. The fact that the Clothing Industry still operates a training levy may explain the reluctance of some "past" Knitwear Companies to acknowledge publicly their change of direction.

Table 1 shows the categories decided upon in each industry. In the Clothing Industry, rough groupings were made according to features which could affect the way CADCAM would be used, i.e. simple or complex patterns, slow or fast style changes, simple or complex cutting orders. It was recognised that in the Knitwear Industry, "clothing CADCAM technology" would only be used by knitwear manufacturers using "piece goods" (knitted fabric on the roll).

Manufacturers knitting body blanks and fully fashioned knitwear were using a different form of CADCAM technology that was directly linked to the knitting machines. Category E was therefore included in the main field of study of CADCAM clothing technology and a small supplementary pilot study of category F was undertaken to compare the features of the different forms of CADCAM technology.

It must be noted that the volatility of the clothing and knitwear industries, due to new businesses (the enterprise allowance is well used in these industries), mergers and closures, is well known. This volatility is particularly evident in the South Midlands, where the entrepreneurial skills of the Asian communities are providing growth of particular character within the Industries. This sector is made up of small businesses producing low cost products; it mirrors growth of a similar character taking place within the West Midlands Clothing Industry.

CONCLUSION

Although the data base (Appendix XII), particularly in the South Midlands, could not be seen as complete, it contained sufficient categorised companies to enable the researchers to obtain a representative sample for the field study.'

TABLE 1: PRODUCT CATEGORISATION OF THE CLOTHING AND KNITWEAR INDUSTRIES

THE CLOTHING INDUSTRY

CATEGORY	PRODUCT TYPE - CLOTHING MANUFACTURE
A	Dress, fashion separates, party, maternity, bridal wear.
B	Lingerie, swimwear, foundation garments, dance, nightwear (a).
C	Uniform, shirts, workwear, tailoring, weatherwear, leather.
D	Sport, underwear, leisurewear, nightwear (b).

THE KNITWEAR INDUSTRY

CATEGORY	PRODUCT TYPE - KNITWEAR MANUFACTURE - PIECE GOODS
E	Knitted fabric..circular knitting...cut & sew.

CATEGORY	PRODUCT TYPE - KNITWEAR - GARMENTS
F	Body blanks and fully fashioned knitwear.
K?	Knitted product of the company not known.

NOTE When the study was planned it was thought that categories D and E may be considered as a single group. It has been decided to retain the separation, the parameters for each group are:

CATEGORY D ...are companies who are concerned with producing goods for a market and will buy the fabric (a high proportion of which is knitted), which is required for the style demanded by fashion, their customer, contractor or agent. They usually consider themselves clothing companies.

CATEGORY E ...are companies producing garments from circular fabric produced by themselves or companies who have close links with fabric suppliers. The production is therefore linked closely to the knitting of the fabric, it is often knitted to specified body widths.

Confusion between the groups can occur when companies (category E) change direction and expand into the broader areas of groups D and A but retain their original Trade Association or Training Group.

CATEGORY F ... The CADCAM technology used by these companies is of a different form and poses different problems ... the field work was constructed as a separate supplementary.

REFERENCES

1 Extract from the MSC/DES report, W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 8-9.

2 Two recent reports have looked at the character and growth of the clothing industry in the West Midlands. The Clothing Industry in the West Midlands; Structure, Problems and Policies, West Midlands County Council Economic Development Unit, 1983: also An Investigation into the Technological and Management Education and Training Needs West Midlands County Council Economic Development Unit and Handsworth Technical College, 1985. These reports were useful, comparisons of the structure of the industry and the products produced in an adjacent geographical area gave some support to the findings of this report.

3 Extract from the MSC/DES report, W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 11-14.

CHAPTER FIVE: COMPANIES WITH CADCAM CLOTHING SYSTEMS 1984-86

EXPLANATION

Visits were made to sixteen clothing companies who had invested in CADCAM technology. The majority of these visits were undertaken in Autumn 1984 and Spring 1985 as part of this PhD. research and before the MSC/DES project began. It was again included in the report as background material. The procedure of using 'historically bound' text from the MSC/DES report is continued.

EXTRACTS FROM THE REPORT: 'How New Technology can be made Available to the Clothing Industry'.

'Visits[1] to clothing companies to view CADCAM technology in operation was an attempt to separate the "rhetoric from reality" and to record the experiences of companies who had been amongst the first to embrace CADCAM. The majority of the companies visited (Appendix XIII) belonged to large groups, the pace of the spread of the technology has been heavily dependent on these companies who were the pathfinders of its introduction. Units within groups could call on the financial support or the technical enthusiasm that was available; they were prepared to take a new level of decision, "decisions made in ignorance", technological decisions which bring unexpected demands, and more important, unexpected outcomes.[2]

Ten companies were visited to gain information[3] (Appendix XIV) for the field study report, five more were visited to obtain supplementary information. The types of systems covered in visits to the fifteen companies are shown in table 2, some companies were operating more than one system.

THE FIELD STUDY OF TEN COMPANIES

Installation and Use

The ten companies in the field study were situated in different

TABLE 2: NUMBER AND TYPE OF SYSTEMS INSTALLED IN THE FIFTEEN COMPANIES VISITED

CAMSCO	GERBER	LECTRA	INVESTRONICA	CYBRID	MICRODYNAMICS
3	10	3	1	4	0

NOTE Microdynamics have just installed its first system in their agent's factory.

areas of England, the earliest installation was in 1976, the latest in 1984. The site of the installation within the companies were positions of considerable contrast - in partitioned parts of Victorian factories, in modern units in industrial parks and in stylish or strident (according to your taste) Design Centres.

All the companies in the field study were using the system for the minimum of pattern grading and marker making, some manufacturers who were using more than one system had managed to interface them, particularly in the area of cutting. A table showing the use of the systems can be seen in Appendix XV. Three areas should be noted :-

CAD Only one company was operating CAD, it was not used in the form of innovative design, the company was using the PDS (pattern construction) function for first samples, but solely for those designs with recognised pattern cutting procedures.

CADD The opportunity to use PDS for production patterns was virtually ignored, even by those companies which had the software. The leading attraction of the systems was quite apparent, computer grading and marker making being the principal reasons for the technological purchase.

CAM Four manufacturers were using the cutting option; these were, as expected, in the companies with larger, more stable production runs.

CADD:CAM Staffing and Training

The staff numbers operating the systems (Appendix XVI) were found not to be in direct ratio to the size and type of production. Other variables intervened, for example: the stability of the management and its attitude to new technology, a recognition of the systems' potential and commitment to future development.

Reductions in skilled staff due to its installation was difficult to assess as most of the companies were in a period of growth, and market changes were demanding an increase in style changes. It was clear that the systems were coping with these pressures without proportionate increases of staff, in some cases it was actually reducing them. All the companies transferred existing staff with clothing skills into the systems. This factor is reflected in the lack of college training amongst the operators, particularly marker makers. As the "manual skill pool" has disappeared from the companies, new staff were manually skilled staff from "CADCAM free" competitors, CADCAM staff poached from other CADCAM operations or new entrants into the industry. It was noticeable that these new entrants had higher educational qualifications or came from clothing technology courses in industry.

There appeared to be a correlation between the sex of the operative and the higher level of education. This factor can be seen as historical, pattern cutters and graders are more likely to be college trained; this craft, except in menswear, was usually seen as a "woman's trade" and marker making and cutting a "man's trade". It will be interesting to monitor changes in male/female occupations as the technological occupations and the training required for them becomes established.

The sex and training of the managers of the systems was easier to analyse, although a few cutting room supervisors had inherited a system, the majority of the managers had considerable educational achievements and administrative experience. It was very apparent that the high flyers recognised the further potentials within the systems, and despite the resistance of some suppliers, were developing their own innovations and interfaces to the basic installation. All the managers except one were male, updated information reveals this total to be now 100%. The historical factor was again evident.

In comparison with other industries, using CADCAM technology, the educational level of clothing CADCAM operators is shown to be low. This can be seen as a product of the historical status and remuneration of clothing technicians and the short-sighted propagation by CADCAM suppliers (in their efforts to make the technology appear simple) that anyone with clothing skills can effectively operate the systems.

It was significant that the initial training by the supplier was more likely to be seen as inadequate by the more educated manager. It was also apparent that the supplier's training and support has deteriorated with the rapid increase in sales which has stretched their training reserves. Only one college (Hollings Faculty) has a system and is training in this area, many of the companies had to seek assistance from other units in their group or bring in consultants to supplement an evident training deficit. Training for staff replacements is expensive, most companies deplored the lack of training support from the colleges.

Finally, most managers complained that they were not given enough time to integrate the system into full scale production and some initial procedures have been revised, particularly where new managers have taken over.

Advantages and Disadvantages of CAD

All of the companies saw the installations of their systems as a 'good thing'. The main advantages stated appeared to be more restrained versions of the suppliers lists of benefits; i.e. better working environment, speed, accuracy and the organisation of pattern making; better cloth utilization and speed in marker making. However, they stated that all these benefits were very dependent on the skill of the operator.

One has to recognise that some companies (outside the field study) have been less enthusiastic about their installation and some have sold off their systems. Their main reasons appear to be problems occuring when procedures are centralised, and that the cloth utilization was not as good as that achieved by their on-site manual marker makers.

CAD:CADD Design to Production: the Interface

Almost every system differed in its procedure from style design to production on the system. Differing products, differing markets, and the capabilities and the attitudes of the existing staff affected the procedure (Appendix XVII). However, a direction could be discerned, it would seem necessary that the pattern technician skilled in manual techniques and trained to use the system, performed the crucial link in the smooth operation of the system. They are beginning to be "head hunted", a practice already taking place for system managers.

Most of the designers displayed a respectable caution towards the inadequate technology on offer, which misunderstands their work and the process of design. Companies are not prepared to invest in expensive equipment which ignores a large section of a designer's work, innovative pattern construction. A designer requires a less mechanistic system at a price which allows her to use it with discretion. Despite their reservations with regard to the present systems, many of the designers were aware that they should become involved in the research and debates which are examining the effects of using computer techniques in the design process. These debates are amongst and across many disciplines, craft skills, aesthetics, psychology, social studies, perception (Rosenbrock 1983: Cross 1977: Vickers 1978: Kaplinsky 1982).[4] The majority of the designers would welcome the opportunity to become more familiar with the technology and believe that it is essential that students should experience its use.

Designers are being affected by two pressures; the market demands more styles, new technology has shortened the production time, therefore, an increasing amount of routine work is being directed towards the pattern technician and the new technology.

CONCLUSION

One can recognise the inherent tension between an intuitive art or craft skill which offers personal control and the submission of this skill to a mechanised organisational format.

The installation of a system appears to result in a reduction of the manual skill pool and thus the old "spawning ground" of future technicians. Managements are increasingly expressing concern about this factor even amongst those committed to the technology.

Despite these reservations across all areas of the technology, it appears to be operating successfully in the CADD:CAM sectors and providing real benefits to large companies who have access to skilled personnel. It would seem necessary therefore, to examine the means by which medium and small firms can gain access to these benefits.'

REFERENCES

1 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 24-33.

2 D.Collingridge, The Social Control of Technology Open University Press, Milton Keynes, 1980.

3 The time spent with companies varied. Where a company was using their system simply for grading and lay planning, a one day visit was made. In companies using their computers for more complex procedures, two or three day visits were made. Four weeks training was undertaken at Courtaulds Leisure Wear on the Gerber System. The record sheet was constructed to provide headings under which the collected information could be structured.

4 Whilst the ideas of Rosenbrock and Cross have been concerned with the particular disciplines of architecture and production engineering, the work of other writers interested in micro-electronics has spread across a number of fields. For example R.Kaplinsky, Computer Aided Design Electronics: Comparitive Advantage and Development Frances Pinter,

London, 1982, and 'Is there a skill constraint in the diffusion of microelectronics' in Bulletin vol.13 no.2, March 1983: G.Vickers 'Rationality in Science' in On Aesthetics in Science ed. J.Wechsler, MIT Press, London, 1978, pp. 143-164.

CHAPTER SIX: A FIELD STUDY OF CLOTHING COMPANIES WITHOUT CADCAM 1985-86

EXPLANATION

The data collected for this part of the MSC/DES report was collected specifically for the project and was directed towards the training needs of the area. The research methods and most of the quantitative data have not been included in this work but can be obtained by reference to the report. However, some interpretations and qualitative data with regard to attitudes to CADCAM in 1985-86, particularly within product groups and towards training were seen as useful inclusions within the PhD. study.

EXTRACTS FROM THE REPORT: 'How New Technology can be made Available to the Clothing Industry.

'It[1] must be assumed that any research into how knowledge of new technology can be made available to the Clothing Industry must make some effort to find out if companies actually want it! It was decided that a spread of companies should be visited to listen to their views. Visits to companies with CADCAM had given clear evidence that the size of the company, the product, the market, the availability of relevant skills and the attitudes of management to new technology were factors which could affect its successful adoption.

THE FIELD STUDY OF EIGHTY-FOUR COMPANIES

These factors were therefore under particular scrutiny during the field study of eighty four companies without CADCAM. The companies visited represented the spread of manufacturers in the East Midlands which might use the technology with reference to size and product category (Table 3). Emphasis was given to group A which could be seen as a complex group under severe market pressures. Companies were selected at random from these groups identified by product and size.

The factual descriptive data was entered into the computer data

TABLE 3: FIELD STUDY - COMPANIES WITHOUT CADCAM TECHNOLOGY

NUMBER OF COMPANIES VISITED - LISTED BY CATEGORY

CATEGORY	PRODUCT TYPE CLOTHING	NORTH MIDLANDS	SOUTH MIDLANDS	TOTAL
A	Dress, Separates, Party, Maternity, Bridal, Fashion Wear.	22	9	31
B	Lingerie, Swimwear, Foundation, Dance, Nightwear (woven).	10	2	12
C	Uniform, Shirts, Workwear, Tailoring, Overgarments, Leather, Weatherwear.	11	4	15
D	Sport, Underwear, Leisurewear, Nightwear (knit).	4	4	8
		47	19	66
	PRODUCT TYPE KNITWEAR MANUFACTURE			
E	Knitted fabric garments ... circular knitted fabric for Leisurewear and Underwear.	7	11	18

base, whilst recorded comments and attitudes were manually catalogued.

Company size and product categories were seen as the main factors. Data in the study was generally examined with reference to company size, but each product category was analysed to identify any particular features which may be relevant to the adoption or rejection of CADCAM (Appendices XVIII-XXI)[2]. Finally, the data was examined to assess any common factors amongst those companies which displayed very positive attitudes towards its adoption.'

Skills Relevant To CADCAM Available Within The Industry

'It[3] is a rational observation that the adoption of any radical change in production procedures requires some form of training. It therefore seemed necessary to assess the amount of training taking place in the companies and to record the attitudes of trainers and non-trainers. 80% of companies stated that they were undertaking some form of training; however, further discussion revealed that in organised training the large companies are still acting as the "trainers for the industry". Training, where it exists in small companies, is still "sitting next to Nellie". This mode of training is often seen as a means of control. Where employees were sent off site it was for a particular purpose.

Four companies had sent girls from the cutting rooms on part-time or day release courses for the pattern cutting and grading, two complained that the content of the courses was too broad and that the girls were getting too ambitious.

Companies stated that relevant courses were not available in the mainstream educational sector. Employees were sent off site for particular knowledge; management to specially arranged technique or technical courses and technicians for specific training on new machinery about to be installed. Effective training is used as a strong selling feature by suppliers. Attitudes to training now appear to have a definite association with measurable gains.'

'The[4] Further and Higher Education of the staff employed to cover the areas of skill that are required for CAD/CADD introduction is shown in Appendix XXII (in small companies one person may be covering a number of tasks).

Once the factor of the skilled owner[5] is taken into account and one also recognises that, in small companies one person usually covers design, pattern cutting and grading, one can see the low level of college trained employees in these areas of skill. Amongst larger companies there appeared to be a policy for or against college training, few companies employed a mix of college and non-college trained staff in design, pattern cutting and grading. These three operations were often carried out by a designer who was college trained; the employees who were responsible for pattern cutting and grading, but without design responsibilities, were unlikely to have been college trained. It was apparent that lay planning and marker making were viewed as "in house" skills.

The number of companies accessing free-lance assistance was higher than expected particularly when one regarded the opinions collected on their ability and quality.[6] It could be recognised that a few small companies in category A were very dependent for their success on their free-lance designer.

The lack of high quality skills applicable to CAD/CADD, (technical design, pattern cutting, grading and marker making) was apparent. Whilst design was seen by companies as an esoteric form of education which they were incapable of imparting, colleges were seen as generally incompetent in all areas of technical expertise. Many companies thought it better to train 'in house' on their particular product. It was in this type of company that grading techniques were often complex procedures known only to a single employee. The acute shortage of skilled staff and the age of the present staff, many past retirement, was the most disturbing finding of this research.

The predicament in which the industry finds itself in its present operation, not allowing for the demands of new technology, must be seen as a crisis. The companies are accusing the colleges of not supplying appropriate full-time or part-time courses. Educationalists are accusing manufacturers of the devaluation of these skills by lack of status and remuneration within the industry. This results in them being unable to attract the right calibre of student into this sector of the industry and thus creates the present imbalance between innovative and technical design.'[7]

'Company[8] Use and Attitudes to Computers

A supposition can be made that the experiences a company has encountered in one form of computer technology may well effect its attitudes to proceeding further. Companies were therefore questioned on these experiences.

The attitudes towards computers, even amongst companies who had "torrid introductions", were positive. A[9] significant number of those without a computer were seriously considering its purchase.

CADCAM technology was seen as a purchase of a different form and scale. 25% companies were considering the purchase of a system, not all were companies of more than a hundred employees competing with the groups for large contracts. All the companies wishing to buy systems declared it to be a difficult choice and felt that they required advice, visits to see the systems were often inadequate and confusing. They saw the opportunity for their employees to try out a system in a local bureau as being particularly useful. The purchase was a large investment for the medium size, or private company and the decision maker was more likely to be actively aware of the consequences. The main reasons for the purchase appeared to be pressure to increase style changes, companies also saw it as a means of bringing order to anarchic pattern systems. More companies would consider its purchase if the price came into the £10,000-£15,000 range and was simple to use.'

Training[10] Options and Implications

The imbalance between the number of innovative designers available to the clothing industry and the number with technical skills has been recognised by industry, educational and examining bodies and numerous papers and reports addressing the practice of Further and Higher Education. Remedies have been sought for this problem principally through organisational forms, ie BTEC courses. The problem has not been resolved and concern and reports continue to flourish, Harwood[11] in 1986 re-stated the problem and 'Designer 2000' launched by CAPITB[12] with Paul Smith as chairman is currently and tardily in progress. It would seem that new attempts to redress the balance are about to take place, this time by re-organisation (cutting), status (technical degrees), and by financial incentive (four and a half million pounds is promised from the Government to update equipment after pressure from NEDO).

It would seem difficult to argue that these initiatives may not improve the current situation. However, Harwood, whilst particularly critical of post-school education also directs his attack towards design education in schools. The SIAD (1984) stated "the great majority of those teaching design in schools are not primarily designers". The closed shop policy operating in the school sector has precluded any utilitarian industrial influences from reaching children during their impressionable years; the low status and pay offered for technical skills has been an historic feature of the Clothing Industry. This combination, one may argue, is likely to defeat the most powerful of reforms. Courses can be re-organised, but students of the right calibre have to be attracted to them.

CADCAM Training Available to Local Companies

1. No full time fashion or clothing (Degree or BTEC) course in the East Midlands area offer either a substantial input of computer aided design or production pattern skills relevant to the technology. All the courses are broad in content.

NOTE Approximately 150 CADCAM clothing systems are now operating in Great Britain; only one college Hollings Faculty, Manchester has a system and is able to train students to any useful level in the technology or appropriate pattern skills.

2. No part-time courses directly relevant to CADCAM clothing systems are available.

3. General awareness (short session or one day) courses have been available through CAPITB and associations i.e. CFCI, BCC.

4. Direct training on the systems is only available as part of the purchase of the system by the supplier. Extra training or re-training is expensive. The training is concerned with the operation of the system, it is only marginally concerned with its applications to specific production procedures. Periodic seminars for system managers, to discuss new developments and problems, are arranged by some suppliers. Training in the transfer of manual pattern procedures and their organisation is minimal.

5. A variety of distance learning packages are available.[13] Some questions must be raised however, about cost, proliferation and duplication of a quantity of distance learning materials; the contents of which appear to be superficial, and any progression, revision or up dating not established. The methods and use of these materials and the means of operation should be monitored by the Clothing Industry in its evaluation of appropriate training methods.

Grant Support

Whilst grant support may work effectively if an appropriate training body takes particular interest in a sector of training, the situation for a small company, or an individual wishing to engage in re-training, has no mandatory stability on which to base a claim. The application is often time-consuming and its success dependent on esoteric judgements or area financial[14] positions.

The need for individuals to access grant aid directly was recommended in a recent NEDO/MSC report.[15]

CONCLUSION.[16]

'The concentration of CADCAM in public companies left a bias towards the private company in the field study of companies without the technology. This bias must be recognised in the figures which reveal the shortages of skilled staff and the inadequacies of their training.

The field study showed that the Clothing Industry is using and expects to use computers in administration and found that more than half of the companies would like to install or have some form of access to CADCAM technology.

The negative attitudes towards training and the positive attitudes towards the new technology appear diametrically opposed. The strength of support for access to CADCAM appeared to require further investigation.'

'The[17] colleges have been criticised during the field study for the irrelevance of their training. The inadequate funding of equipment and staffing reductions has made the task of training or re-training for this scale of innovation impossible. Discussions and trials with industrial users, with or about to purchase CADCAM equipment, have taken place during this research. They were unanimous in their demand that active training on the type of equipment used in industry today has to be undertaken by present students in college and has to be available for re-training and up-dating skills in industry.'

REFERENCES

1 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 40-41.

2 These appendices are concise assessments of factors, relating to a particular product group, which may affect attitudes to CADCAM technology. The material offers some insight into current practices of

clothing design within the different product categories.

3 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 44-45.

4 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986 pp. 46-48.

5 When looking at these figures in Appendix XVII, note must be taken of the significant number of the owners (23) who had the particular skills; also note that 52.2% of them were college trained. In many small companies the owners were the only skilled staff in these crucial areas. Many owners and staff in other companies termed themselves 'designers', but in fact a high percentage of their work was the modification or copying of styles.

6 Many of the small companies were employing designers who had just left college. Many of these designers were working for low fees in order to gain experience. Whilst recognising that they were inexperienced, the companies constantly criticised the colleges for their unprofessional methods and the low standard of their technical work.

7 All of the companies stated that it was easier to recruit designers than technical staff. One company stated that the ratio of applicants could be as high as 20:1. Reasons and remedies for this imbalance are being sought, a national study, 'Designer 2000', has been organised by CAPITB (The Clothing and Allied Products Training Board) under the chairmanship of Paul Smith. The report is to be published in 1988.

8 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 49-53.

9 51.2% of all the companies not using CADCAM were using computers for other tasks and 90% of them expected to extend their use and 56% of companies without computers were expecting to purchase one. Their primary functions were found to be wages (72% of users), accounts (46.5%), sales, records and costings (44%), tickets (32%) and stock control (26.5%). Only 14% were operating production control systems. The adoption of computers by companies with more than a hundred employees was almost total.

A number of small companies had made the decision not to grow above a certain level, it appeared to be about 50 employees, they recognised that expansion beyond that point would result in the adoption of new strategies, supervision and computers.

The existence and uses of CADCAM clothing systems were known at a primary level to the majority of the companies (above 11 employees), it was generally seen as a 'good thing' but unattainable. See pages 49-53 in the MSC/DES Report.

10 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 59-65.

11 R.J.Harwood, A Survey of Textile and Related Education in Britain a report written for the City Livery Companies, London, 1986.

12 CAPITB, Designer 2000, a report to be published in 1988 on industry's requirements of designers in the next two decades.

13 PROFITS, a Fashion Industry Technology Service based at the London College of Fashion has an audio tape, 'Patterns - Using Computer Services'. This is an example of useful introductory information that can be available by distance learning, particularly when in this case it is situated within a supportive structure that offers further entry into the technology. Some questions must be raised however, about the cost.

An OPEN TECH initiative undertaken by Hinckley Technical College has just completed a set of packages which includes an introduction to CADCAM technology in the Knitting Industry.

The Open University offers a range of general courses i.e. 'The Planning and Management of Change' and 'Implementation of New Technologies'. CADCAM training materials for short courses or distance learning have been produced principally by different sectors of the Engineering Industry. Although marginally useful for keyboard and peripheral skills, the confusion created by another industry's jargon can be counter productive.

14 The financial restraints in the educational sector means that one local college is having to reduce its subsidy to unemployed applicants for its part-time pattern cutting courses, a distressing course of action for the Department and its tutors. The sector of the clothing industry most in need of training in pattern skills appears to require targeted schemes directly funded by MSC grants.

15 NEDO, A Challenge to Complacency: Changing Attitudes to Training a report for the Manpower Services Commission, London, 1986.

16 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, p. 54.

17 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, p. 64.

CHAPTER SEVEN: A FIELD STUDY OF KNITWEAR COMPANIES 1985-86

EXPLANATION

The data collected on knitwear production for the MSC/DES report was not intended to be an in-depth study of the knitwear industry. The supplementary study (1985-86) of the CADCAM systems which produce circular knitted fabric, body blanks and fully fashioned knitwear was seen as viable only in terms of the insights it could offer to another industry (clothing) entering into a different but 'parallel' form of CADCAM technology. The information is also seen as useful for comparisons of the progress of the technology which is discussed later in the study.

EXTRACTS FROM THE REPORT: 'How New Technology can be made Available to the Clothing Industry'.

'CADCAM KNITTING SYSTEMS[1]

CADCAM systems for the Knitting Industry differ in form from those designed for the Clothing Industry in that they are directly linked to the production process. The production of mechanical V Bed power machines has almost ceased, this means that all companies investing in new plant are being forced into the new technology. CADCAM technology was in use in the Knitting Industry far earlier than its debut in Clothing Manufacture. Companies were using it for knitting fabric as early as 1965 and for knitting garments by 1972. Computer aided knitting machines are now integrated into the mainstream production or into any plans for the future development in all the major knitwear manufacturers in Britain. Pressure from the multiples and other customers for increased styling and sampling, and the speed at which this operation can take place on computer aided machinery, has meant that the smaller firms are investing in at least one new machine for sampling purposes.

It must be noted that the industry, before the introduction of CADCAM technology, had evolved traditional ways of working in design to production procedures. Knitted fabric designers expected, and were trained, to be closely involved with the process of manufacture; whilst the knitted garment designer relied heavily on the knitting mechanic, a trial and error procedure with a built in acceptance of repeated sampling.

The latest developments in CADCAM knitting technology include powerful graphic design options, which offer the designer a positive role in computer technology. The designer can work from first idea to finished sample within the system. The systems can convert shape, motif colour and stitch formations into mathematical terms which instruct the machine to knit the required piece almost automatically. Until the stage of mechanical conversion, the mechanic's role within the new technology can be seen in a more passive role, i.e. that of a technical consultant to the designer in respect of the most advantageous routes for high productivity and establishing quality.

The purpose of the following visits to knitwear companies (Appendix XXIII) was to find out if the availability or the introduction of the technology had changed directions, attitudes and methods of operation particularly with regard to the design "to sample procedure".

THE FIELD STUDY OF SIXTEEN COMPANIES

Sixteen companies were visited (Appendix XXIII); thirteen companies were using power machines, ten had computer controlled knitting machines and seven of these had CAD screens for designers and technicians. Of the three remaining companies only finance or impending retirement was impeding its introduction. The particular interest was focussed on the companies with the system capability for on-screen design.

It is recognised that a small number of designers are beginning to work on the systems, particularly those developed for circular knitting machines. In the majority of the companies visited, the designers were isolated from the technology by site position, lack of opportunity, lack of interest, apprehension or antipathy. This isolation was not stated to be deliberate company policy, or indeed, there appeared to be no evidence that any company had considered their position, the technology appeared to have been adopted into the traditional patterns of procedure.

Training in the use of the systems is undertaken by the system suppliers (as in the Clothing Industry). Companies stated that their equipment was now so far ahead of the colleges that the majority of technical courses which they were offering were at best out of date, or at worst, irrelevant. In all the companies visited it was the knitting technicians or associated technical staff that were sent on the supplier's courses. When the question of the designer also undertaking training for functions, which appeared to be directly their concern was raised, the reaction of the technical staff was mixed. Five of the companies felt it was not for the designer (they were seen as technically incapable) and that any use by the designer would have to be under their control. However, the remainder felt that a closer partnership would be to the benefit of the company, reducing sampling time and offering the designer more opportunity and control of the sampling process. The most disturbing factor in this survey was the difference in the perception of the practice of design between the technical and design staff. Yet companies who had a member of staff who could bridge these disciplines, recognised their value and often described them as "irreplaceable".

Two aspects of present procedures should be viewed with concern. First, having bought a powerful system, some of the repetitive design functions it offers, and does well, are still being done manually and painstakingly by the designers. Second, in companies where the first ideas are developed in London, the technical designers on site, who used to be responsible for the interpretation and development of a range, are by-passed when the first sketch goes directly to the technician. The development and alterations then become under his control, lack of actual communication can result in the old practice of repeated resampling or a 'fait accompli'.

Designers' Attitudes

Resistance to the technology was found in only a few designers. Most of them were intimidated by the technology from lack of knowledge, they considered themselves as having passed through an "educational gap" in computer training in both school and college. They thought it imperative that the present designers in training experienced CAD so that they could make informed choices in methods of design developments. It is ironic that all the designers were under pressure through the demand for style changes, (the new technology having provided the sampling capacity and the opportunity for manufacturers to produce styles in short runs), and stated that they would find difficulty in finding the time to attend courses and to develop their skills.

Many of the systems did not appear to be being developed to their full capacity, particularly with regard to their capability to fashion garments; it is in this area that a designer's skill is crucial. The interaction of pattern, colour and shape that can now be manipulated on screen does not appear to be being utilized. Although "garment price" was offered as the reason for its non-development, other small companies appeared to be doing extremely well in this market.

CONCLUSION

The lack of adoption of CADCAM technology by knitwear designers, the majority of whom were not averse to using the technology if given the opportunity, would seem to offer some explanation for the non-adoption of the CAD functions presented on offer to clothing designers.

If applicable technology has difficulty becoming established amongst knitwear designers; then any technology offered to the Clothing Industry, which is less than applicable is very unlikely to be accepted.'

REFERENCES

1 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986, pp. 68-75.

CHAPTER EIGHT: RECOMMENDATIONS OF THE MSC/DES REPORT 1986

The recommendations of MSC/DES report are included in this thesis. It was thought that some comparison could be made of the proposed requirements for the aquisition of knowledge of CADCAM and training when the report was submitted in 1986 and the opportunities available at the time this thesis is submitted in 1990.

The recommendations of the MSC/DES report were made in the context of a brief that was examiming an 'industrial need' for knowledge of CADCAM and CADCAM skill training. The thesis will need to explore, in the final chapter, differences or conflicts which may exist between ideas of educational aims and industrial aims, particularly in the field of design education. The 'place' of knowledge of CADCAM in the curriculum of colleges and schools will also be of interest.

EXTRACT FROM THE REPORT: 'How New Technology can be made Available to the Clothing Industry'.[1]

'RECOMMENDATIONS.

This study pursued the question of how CADCAM (design, pattern construction, grading and marker making) technology could be made available to the Clothing and Knitting Industries. Although it must be recognised that COULD does not <u>automatically</u> imply SHOULD, the findings of this research have led to the following recommendations being made from a commitment to both propositions.

It must also be recognised that the figures in this report are not given as statistical evidence but as illustrations of factors, found during the visits, which should be considered when recommendations on new initiatives are made.

Finally it must be stated that the following recommendations are dependent on CADCAM systems for the Clothing and Knitting Industries being available for collective use within the East Midlands Area. It is therefore important that colleges in partnership with Industry and the

Local Authorities pursue with vigour the DTI funding initiative for the provision of CADCAM technology for the Clothing and Textile Industries within colleges.

It is recommended that :

1. To accelerate and improve the level of technological education a merger of the DES and MSC should be considered. Meanwhile education establishments, Training Boards and Associations, The Manpower Services Commission, Industry and Local Authorities should work in co-operation to provide recognisable stages of access and training in CADCAM technology for the Industries.

THE EAST MIDLANDS CLOTHING AND KNITWEAR (PIECE GOODS) INDUSTRIES

2. A CADCAM (clothing) bureau should be made available in the area to enable any companies to have access to the use or experience of the new technology.

3. The courses set up to provide skills associated with the technology should be grant aided to enable individuals or small companies to access subsidised training directly.

4. The following types of training courses should be made available for companies who already have or are about to purchase CADCAM technology.

a. Seminars which provide general knowledge for staff who interface with the technology.
b. Training and experience of other functions for companies wishing to extend their systems. i.e. graphic design and pattern adaptation for designers.
c. Pattern cutting, grading and lay planning for CADCAM operators lacking these skills.
d. Methods of pattern preparation, data organisation and production procedures for CADCAM systems.

5. Training courses should be made available for the companies requiring bureau access. They should be constructed to be relevant to the type of access required and the abilities of the company's staff.

6. In-service courses should be established for college staff who are responsible for design and relevant clothing technology courses.

7. Short courses should be established for staff in colleges of Higher Education, Advisers, B.Ed students and school teachers to enable them to be aware of the different educational requirements and the different career opportunities now available in the Textile Industries.

8. A change of emphasis should be given in areas of design education. All design courses should have experience of all areas of CAD.CADD.CAM and have the option to pursue in depth an area of interest. Design students should be encouraged to assess and question the uses of CADD, to recognise where it can offer new ways of considering design problems, but

also where it may inhibit the design process. Students on BA Fashion courses should have the opportunity to attain a high level in both design and technology thus providing the industry with executives who can integrate these disciplines.

9. A dramatic change of emphasis should take place in the technological content of BTEC or technician level courses. Acquisition or access to the technology is required married to the development of professional pattern skills which take on board the implications of industrial design.

10. This level of expertise should be made available to staff in companies by means of short modular courses which take account of the level of knowledge of the student and the particular requirements of their sector of the industry.

11. Grant aided training courses in CADCAM should be made available to the freelance designers in order to up date their skills and enlarge the pool of technological knowledge available to the Industries.

THE EAST MIDLANDS KNITWEAR (BODY BLANKS AND FULLY FASHIONED) INDUSTRY

12. Further in depth research should be undertaken to investigate the problems identified in the supplementary report.

13. The acquisition of CADCAM equipment is required if the colleges are to offer design and technology courses which are relevant to the Knitting Industry.

14. Designers and technologists are produced who are capable of interrupting the present traditional practices, thus allowing design and technology to flourish.

15. The retraining of current staff in industry is undertaken after new methods of CADCAM training in colleges are proven.

REFERENCES

1 W.M.Aldrich, How New Technology can be Made Available to the Clothing Industry. A report written for a Local Collaborative Project No.703, MSC/DES Pickup Programme, Birmingham, July 1986.

PART THREE: A PERSONAL COMPREHENSION OF CAD 1984-86

CHAPTER NINE: A SEARCH FOR SOME COMPREHENSION OF THE CAD PHENOMENON 1985-86

INTRODUCTION

During 1985-86 CAD, as a phenomenon, was becoming of increasing personal interest to me. As a designer I could no longer take an objective view of CAD. Whilst accepting the exhilaration of its novelty and the mastery of a new skill to be a part of this interest, I remained eager to pursue an active research commitment in computer aided design instead of the observation and recorded research that was originally planned.

The factors which influenced the decision may be inferred from selected passages collected from books, journals and reports during this time. This literature is discussed in this chapter, it offers some insight into the social, political and educational climate of the time and demonstrates the 'selected' environment in which I chose to operate.

Interest in the emergence of CAD in the textile /fashion industry gave some impetus into a study of a range of literature which discussed various aspects of CAD and its part in the general process of technological change. These readings took place concurrently with the early stages of the software development. Once the pressures of execution and revision were imposed, effort became concentrated on the considerations of practical problem solving. In-depth or focussed study on ideas and implications were, to a large degree, abandoned and the collection of material became restricted to journal articles which had a direct relationship with the work in progress.

This sequence of events has produced a section of work of historical relevance, (the temptation to elaborate from hindsight has been resisted); ideas that were seen as important at that time became isolated and therefore can be identified. These ideas cluster into three themes: characteristics of CAD from differing perspectives; the character of decisions taken for its implementation; and implications of the introduction of CAD into a company. The following section is a discussion of these ideas, examining them in relation to some of the empirical research undertaken during the study of clothing companies and the experience of involvement in software innovation. Some bias will enter the editorial work of this section, but an attempt has been made to organise the material as a comprehensible statement of my understanding of the use of CAD at that time. There has been no further literature added to this section of work after November 1986.

The purest evidence of my understanding of CAD, as I entered the intense development stages of the software programme, can be assessed from the extract of an article, which I wrote in July 1986, (appendix XXIV). A quote from the extract is of particular interest.

> 'However, designers must share some of the responsibility for the operation of computer aided design in mass production by becoming interested in its development and the work being done in three dimensional design. Criticisms of its operation will only be seen as valid if they are made from a perspective of active research.'[1]

ONE: CHARACTERISTICS OF CAD

Most of the literature available appears to explore the characteristics of CAD technology within the context of economics. From this perspective, characteristics of CAD are categorised and placed within terms 'invention' and 'innovation'. There is, within this literature, some disagreement about the two concepts. Schumpeter[2] prefers to retain a distinction between the two; for him invention is generally seen as the generation of something new or an adaptation that creates new opportunities, whilst innovation is seen as as an entrepreneurial activity, the setting up of a new production function that facilitates and diffuses its use. He sees the social processes that produce innovation and invention as being economically and socially different. Usher[3] and Stroetmann[4] recognize a continuity of processes, they see innovation as encompassing all the activities of creation, research, development and diffusion. Freeman[5] recognises that, whilst at the extreme end of the process discrete elements can be identified that can be categorized as invention and innovation, a great part of any work that spans from a creative idea to industrial usage will be a grey area where the two concepts are inseparable. Rosenberg argues against the idea of some autonomous inventive activity that produces a 'shelf' of technologies that can be called upon to be developed practically in response to consumer demand. He states:

> 'interesting economic situations surely lie in that vast intermediate region of possibilities where supply elasticities are greater than zero but less than infinity!'[6]

Clark[7] believes that a more accurate analogy is that there are many technological shelves whose stocks are constantly being changed as a result of the direct investment action of firms and of the uncontrollable actions of others. This provides some reconciliation in the argument between 'demand pull' and 'science push'. He argues, however, that the existence of the shelves and their contents are not known about. In reality, therefore, all firms live in a world of great technological uncertainty. How to cope with this uncertainty is thus a major problem. It is unreal to imagine that firms exist in a world of given choice sets and well defined constraints. One could view firms as behaving like organisms in a Darwinian context, changing their form to ensure survival in changing conditions. Clark states:

> 'My own strong suspicion is that the weakness of economic analysis in this field is largely a function of its essentially deductive and Cartesian trappings.'[8]

Rosenberg[9] is interested in the period following the invention stage, that of 'initial innovation'. At this stage the product is often a very imperfect entity, full of bugs. Many companies will only invest in a mature product that has been tried out by their competitors. In fact, much R & D work is defensive in nature, not devoted to major new projects and processes but to change and modification of existing ideas. However, Freeman[10] believes that there is evidence during this century for the notion of 'science push' to be recognised.

Hann and Jackson[11] argue that there is a marked shift in the sources of inventive activity from the independent inventor to the large firm, and that significant inventions made by individuals have been developed by large firms. They quote Galbraith:

> 'There is no more pleasant fiction that technical change is the product of the matchless ingenuity of the small man forced by competition to employ his wits to better his neighbour.'[12]

Whilst this may be seen to be true statistically, there are still a significant number of technological advances made by the individual, even in the high-tech environment. When one follows up the history of such an event, the breakthrough has often occurred through connnections. Applications from a discrete part of a person's past personal experiences become linked unconsciously, but realised conciously and unexplicably.[13]

A number of theorists offer ideas about the emergence of invention: the transcendental flash of insight; the mechanistic stage by stage process; the cumulative synthesis approach. The problem of describing the process of invention or creation has been fully discussed in the chapter on design in this thesis; however, it may be that there is something particular to be said about the phenomenon of CAD and its diffusion into clothing and other design activities.

Characteristics of the CAD phenomenon may appear to be more apparent amongst designers who are using it in varying forms. John Lansdown,[14] an early initiate into this field, offers a descriptive faceted view. He sees it as a tool, a medium, 'a smart apprentice' and as a catalyst which can assist in the generation of new ideas or respond to demands unrealiseable in conventional forms. Whilst consideration of CAD must be more than its dissection or an addition of a sum of its parts, it could be of some value to first inspect the differing facets through ideas offered by practising designers. Lansdown's theoretical frame can admit the consideration of the nature of computing, the nature of designing and human nature.

A TOOL

In 1985 the principal use of CAD and the general view of CAD, in any field of design, was that it was a form of electronic tool.

> 'Of the 15,000 mechanical computer-aided design (CAD) systems installed throughout the world only about 1,000 are being used for design. The rest are employed as electronic drafting boards, the productivity of which is quite limited by corporate standards. Why?
> Simply put, drafting is quantifiable, while design is not... Most CAD systems are justified and installed via the path of least resistance; use the system for drafting only, since it produces measurable results.'[15]

Medland[16] is interested in the role that we expect CADCAM to play. He believes that industry should not be led by the aspirations of the computer industry and computer technologists. He argues that the major thrust should be in the development and implementation of design theory to real industrial problems. Many new ideas occur from work currently in hand or from requests to solve problems. However, his prescriptions stem from his original stated position regarding CAD, 'It is after all only a tool to help the designer.[17]' Cooley[18] sees in terms of a dangerous tool with obvious and hidden defects, he has written critically of the effect of the introduction of CAD in a variety of industries. He believes that it removes man from direct contact with materials and that work becomes an abstraction from the real world. Whilst one may demand from him some greater explanation of the 'real world' and perhaps stake a claim within it for all forms of phenomena, including CAD, his argument that skilled workers have a tacit understanding of how materials react and can relate to mathematical proportions and shapes has some validity. He concedes that a designer, having worked originally in the manual and tactile field can translate and interact with the computer, but argues that direct training on the computer would eliminate this skill. The defensive comment 'it is only a tool' was repeated many times during the CAD clothing survey. One began to wonder if it was expressed as a belief in the hope that it may deny control to something that could be, threateningly, far more than this.

Learning curve delays inhibit CAD as a flexible tool, complex and varying computer interfaces, continual software updates and high software extinction rates are intellectually terrifying to many designers and economically terrifying to many companies. The speed of technological advance means that 15% of the time has to be spent updating knowledge of the system itself.[19]

MEDIA

Before any descriptions of CAD as a medium are considered, the term 'medium' must be considered. Although generally accepted as the material of a finished product, a medium may be considered as a material which is used as a substitute for the actual material during a prototype stage; for many designers it is also a chosen vehicle for expression of ideas during this process of idea generation. It assumes great aesthetic importance, as many ideas have to pass through this interpretive and 'self-discussion' phase before realisation even to a tentative idea. To some designers, the 'marks made on the paper' on the way to the finished product are important to them and crucial to their design process; this can occur even if the finished product is in some unrelated material, for example clothing. The medium of expression has for many years been paper and implement, it is a point where art and design are often inseparable. The importance to the artist or the designer of the marks that he makes are lucidly described by De Sausmaurez:

> 'A visual art is concerned with marks to be seen. The marks must be made with an implement and in a material or medium. The implement be it stick, pen, chalk or brush, will make marks peculiar to its structure and nature and the material. ...An appreciation of the character and nature of these marks is fundamental to any attempt to build truly within the medium. But already it will be noted that there is a different pulse-rate in each mark, an inner dynamic which acts upon the surrounding space. The pulse rate differs with each individual and arises as a consequence of factors too diffuse and deeply embedded psychologically to be susceptible to analysis. With the merest spot we make contact with the dynamics of visual form and field

of subjective response.'[20]

An acceptance of the importance of a medium of expression does infer that there is an 'a priori' qualitative standard attached to any form of expression. An intermediate stage with paper and brush is, for some designers, irrelevant; their imagery and development are done in the head and they work directly with their material. Other designers find alternative means of expression become their aesthetic vehicles. CAD designers appear to have to defend or explain their chosen medium. Pritchett[21] argues that comparisons are continually made with other media using the benchmarks of existing values when photographic reality or comparison with other forms of imagery is not necessarily being saught. However, cliche ridden software tricks infest much CAD based promotional material, each trick superceded by its successor, flying logos signal 'attention images' seeking an impression. One quality of the medium, the speed of transformation, can be seen as an inhibition to development and consideration of an existing idea. Frazer,[22] a CAD designer and software writer committed to the medium, is still wary of the computer's ability to produce mindless work and endless doodling, 'it amplifies crass stupidity'. All media has limitations and hazards, I would argue that CAD designers, in Clothing and Textiles, appear to be stating their case from a defence position in which they seem somewhat obsessed with assuring others that they are aware of the limitations of CAD.

Many of the problems are particular to the type of software used, and many will disappear as more CAD designers become involved in co-operative ventures to develop bespoke software and fashion their medium to their aesthetic and thinking style. If one is constantly concerned with the operation of the medium to achieve the object, it implies interference with the design process. Cross[23] states that there is an assumption made by many computer aided design systems that designing can be separated into two divisions 'magic' and 'hackwork'. He states that this sub-division is both dangerous and mistaken. The danger is that the hackwork will come to dominate the design process. The boundary will be drawn too narrowly for short term convenience and what is left outside the boundary will atrophy; the focus can become the technology rather than the design, one may get excited about things that man can do with ease. Concentration and focus on its demands traps the mind and inhibits it from straying into apparently irrelevant domains of knowledge which are the designer's unconscious resource. Any programmes that make these kinds of demands are an antithesis to the design process. Cross argues that the fundamental structures of design software programmes should be dominated by the designer and not the computer technician. Lawson[24] also believes that it is essential for a designer to have a good understanding of the technology available in his field, but argues that this alone will not make a productive or successful designer, a designer must understand an aesthetic experience.

Starling[25] considers that sketching on the computer is a cerebral activity, he believes that tactile deprivation 'the lack of feel of the material' is a craft notion related to a particular culture and the idea of a particular kind of 'accepted' human enjoyment. He argues that if one is constantly concerned with the intermediate image, the drawing, rather than the finished artefact you are in fact judging the wrong product. However, if the image has to be a means of communication and a selection process by others, then the intermediate image stage assumes a different importance.

A SMART APPRENTICE

First, one has to ask the question, how smart is the apprentice? Many reserchers into expert systems or artificial intelligence have adopted what may be called a functionalist approach to the mind which may encompass a variety of positions. These may range from the idea that understanding computer operations may explain some mental processes: to the idea that mental states are the products of 'Turing machines',[26] where different experiences are seen simply as different complexities of function. Opponents[27] of the theory argue that what appears to be missing from this thesis is the idea of intention, a quality that could be considered to be the source of the design process. Expert systems provide a means of problem solving based on logic, and results from previous experience. In some areas of design the combination of these two factors can provide a very powerful tool that should not be underestimated, particularly as computational speed will become available cheaply. Lansdown[28] offers the following ideal conditions for such a programme: it should work within a limited area of expertise with a narrow focus; the work required should be compatible with rule action and probabilistic formats; the work should be amenable to classification, deduction and inference; there must be strict control on the quality of input.

Second, one has to consider the thinking style of the apprentice. Designers accept that in many design processes the thought processes involved are necessarily illogical and that metaphorical forms of thought are more illuminating. To produce a solution by AI there has to be some agreement on the requirement, if one is still looking for the question the means of solution is, at that stage, unknowable. Lawson[29] is interested in this reflexive position; he argues that the success of a computerised process is a function, not just of the characteristics of computers, but also of our ability to understand the process we are trying to computerise. Since we know so little about the design process, it may therefore seem foolhardy to attempt a computer aided design process. The paradox is interesting, because, in the design or application of computer aided design, techniques can force us to make explicit otherwise implicit procedures and make us investigate our assumptions about the way in which we make decisions. One could argue that too much emphasis has been placed on the ways that a particular end result can be obtained rather than an analysis of processes of design. Problem solving is often determined by the present state of knowledge about that particular problem type. Cross[30] believes that, if it is not known how to solve the problem; it has, by definition, to be solved heuristically. I would argue that the solution to a design problem, particularly in fashion and textiles, often rests on a unique decision selected by the designer amongst, an infinite number of solutions.

Third, one has to question the 'loyalty' of the apprentice. Cooley[31] argues that the knowledge that exists in the mind of the technician can become objectivised and absorbed into the computer and thence becomes the property of the employer. He believes that a person's craft knowledge can be an important part of self-identity and a measure of respect amongst his peers. The current position appears to be that it is an acceptable practice to de-skill people who perform describable tasks. Cooley takes a more extreme stance, he sees this procedure as the theft of knowledge. One has to consider that this view may contain elements of Luddism. Domains of knowledge have always suffered from changing market values; new forms of valued knowledge have arisen in the interface between a skill and its translation into computer operations or in the connectivity of different elements of CAD clothing and textile skills. As specialisms increasingly partition design, breadth is valued.

CATALYST

The catalytic nature of CAD programmes are not unique, any intervening medium or tool used by a designer in the production of any artefact will impose a degree of change. It is the power and the abstraction from control of many of the CAD procedures that creates unease. There has been interest and research[32], for many years, into the relationship between human cognitive styles and the design process. Including the 'thinking style' of CAD software programmes brings a new dimension to this research.

Cross[33] is interested in this work. He argues that the cognitive style of computers is restricted to certain, very limited aspects of propositional ability. This creates severe problems of mismatch between the cognitive abilities and those of people. He also states that the argument that a 'symbiosis' can be achieved, with greater capabilities than either humans or machines can manage, is a fallacy. Most comparisons made describe human abilities in machine terms and downgrade the human contribution. He argues that CAD software by the nature of its construction displays a particular serialist cognitive style. He suggests that in conventional designing, cognitive style between designers, (serialist-holist, convergent-divergent), does not matter much and that a designer is generally free to tackle a problem in his preferred style. However, most designers work on a solution and exploration strategy, which arises from the intrinsically ill-structured nature of design problems, rather than an analysis, step by step problem solving technique. If one looks at identified cognitive styles, there is a danger that only designers with a certain preferred cognitive style will find

CAD systems convivial.

> 'The result has been the introduction of computer systems - in industry, business and design - which degrade, deskill and de-humanise the complex tasks of which they are capable.'[34]

Rosenbrock is sceptical about many of the claims made about the future potential of CAD systems, he believes that human beings have properties not possessed by machines.

> 'We shall never, despite all advances in science and technology, be able to to build a machine which has the capacities equal or exceeding to those of a human being. It is self-evident from their writings that a great many scientists and technologists do not hold to either of these beliefs.'[35]

Rosenbrock[36] talks about real design situations which are not tidy and where it is impossible to specify what is wanted in any exact way. He quotes Cross; who calls it, 'wading through the swamp'. The solution, he argues, has to be a compromise between differing advantages amongst a multitude of constraints; there is always more than one satisfactory solution. Knowledge of any practical system is defective; any real system is not linear and our knowledge of non-linear behaviour is always approximate. Rosenbrock believes that these facts set severe limitations on what we can achieve by synthesis procedures. These are procedures which demand that the designer specifies what he wants in detail and provides a particular solution.

Present experience in textile programmes has shown that the more comprehensive the programme the tighter the area proscribed and the more complex the learning process. The easiest programmes to write or modify are those with explicit design procedures which have a repetitive core and describable variations. It is these types of programmes which have dominated the Clothing/Textile sector since the introduction of CAD.

What can be said about the speed and power of the computer as it accelerates beyond the current comprehension of the layman? Will its sheer pace generate stress for the designer? Lawson[37] feels that the designer, who needs to indulge in a certain amount of semi-conscious and even unconscious cerebration, will have his natural pace subconsciously over-ridden by the speed and availability of computer design options. Cooley[38] states that it has been found that there is an inverse relationship between the rate of decision making and quality. Unbroken spells of this type of activity appears to lead to further degeneration.

Rzevski has clear ideas about the design and structure of present CAD software, he states:

> 'Indeed the desire to eliminate uncertainty and human judgement is now extensive, systems being designed for idiots that eliminate the possibility of any symbiotic relationship between the worker and the equipment. Systems are made by human beings, if they are not creating what designers want we have the right and responsibilty to change them.'[39]

The message that appears to be coming from all areas of design is that designer participation is required in the development of the CAD programmes which they use. Indeed it is becoming apparent that designers who take part in the innovatory stages of the system, or participate in substantial modifications, often develop a sense of ownership.

SOCIAL ATTRIBUTES

The descriptive attributes of CAD given by Lansdown[40] ignore the social attributes that are attached to it. These are complex and contradictory. Technology is not neutral, it has underlying assumptions. In the design of technological systems, we are, in fact, designing social relationships. A classification of designers is increasingly a reflection of specialised technologies. It is ironic that these specialisms are largely based on the need to solve problems actually created by the use of the technology. Cross[41] believes that, because the concept of technological 'progress' has been relatively unquestioned, society has coped with the problems of technological change on the assumption that these will undoubtedly be outweighed in the long term by the benefits.

Lawson[42] is concerned that the un-self-conscious craft-based approach to design must inevitably give way to a self-conscious professionalised process when a society is subjected to a sudden and rapid change which is culturally irreversible. He states that the design process, as we know it, has come about not as the result of careful planning but rather as a response to changes in the wider social and cultural context in which design is practised.

Lawson's ideas reflect a normative view of craftsmanship that is rarely questioned. However, Frayling and Snowdon[43] examine many of the ideas that surround the craft enviroment, and note that the word crafted is used to beguile as well as inform; 'craft is trustworthy, microchips are not - at least not yet.' They seek to explode the myth of the 'Merrie England' artisan craftsman. They argue that whilst most accounts of craftsmanship depend for their support on sentimentality and conservatism, and most discussions of craft knowledge remain at the level of hippie folk-wisdom, proper assessment of craft and its contemporary value and significance remain obscured.

> 'Today, we have ascribed everything positive to the word craftsmanship, everything negative to technology... Can one really dispute the fact that there are innumerable handcrafted products which are loveless, indifferent, banal and superficial?... can one maintain that work aided by technology cannot be exceptionally inspired and concientious? If the difference between craft and technology is not a simple qualitative one... what is the actual difference?'[44]

REFLECTIVE COMMENT

If one believes that many philosophies, in the beginning, form from the attitudes that surround a new phenomena, then:

> 'We must not allow common sense to be bludgeoned into silence by technocratic and scientific jargon nor should we be intimidated by the determinism of science and technology that the future is already fixed.'[45]

Amongst these cautionary tales one can sense some optimism; Rosenbrock[46] believes that it is certainly open to us to develop computer systems which collaborate with the designers skill, augment it and make it more productive. Frayling and Snowdon[47] offer an example; they explain that there exists, within the crafts market, a marketing strategy of producing one-offs. They argue that the use of computer technology could allow craftsmen to create a 'batch produced' one-off; the personal production of well-designed pieces for a market which expects special attention.

Perhaps now is the time for the contemplation of future possibilities and connections. Romanticism can be as dangerous as prejudice. Very serious note should be taken of Cooley's statement:

> 'The genuine enthusiasm of a CAD specialist on a research project in a relative monastic quiet of a university, is unlikely to be shared by the designer faced with the harsh reality of its consequences in some high pressure multi-national corporation.'[48]

It was this statement that led to a new direction in this research in August 1988.

TWO: DECISION AND CONTROL

Irrespective of whether it is highly advanced technology or a craft-orientated technology, company use of CAD technology and managerial decision making appear to be integrated. Therefore,it is of interest to examine the types of decisions that are associated with the installation and use of CAD technology in the clothing industry and a range of ideas offered about the decision making processes within industry. Harrison[49] states that knowledge is applied to practical tasks (technology) by decisions that divide labour, identify and establish specialties and implement a formal task structure. He quotes Galbraith:

> 'Technology means the systematic application of scientific or other organised knowledge to practical tasks. Its most important consequence, at least for the purpose of ecomomics, is in forcing the division or subdivision of any such task into its component parts. ...technology requires specialised manpower... The inevitable part of specialisation is organisation... More even than machinery, massive and complex business

> organisations are the tangible manifestation of advanced technology.'[50]

Harrison also believes that the impact of technology is unrelenting, he sees it as the most dynamic part of the environment in which managerial decisions are made.

> 'Of all the environmental forces technology is the most likely to penetrate the permeable boundaries of the organisation and to effect change in the technical system.'[51]

The clothing industry has not been amongst the industrial leaders in the field of research and development, (Appendix III). It has gained a reputation for clinging to existing practices and has constantly demonstrated resistance to change. This quality of 'tenacity' is understood by Beer[52] as a means of allowing man to operate within his environment as he adapts and recognises regular patterns and yet can forecast and adapt to change if this change is slow and not too disruptive. He states:

> '...that so long as the social and industrial environments change slowly, the method of tenacity that our brains employ works well. We adapt. Today, however these environments are changing rapidly. The method of tenacity produces too slow an adaptation to cope with the revolutions that the world is undergoing in every sphere.'[53]

Gabor[54] states that the social innovations have not kept pace with the progress of science and technology and considers that there may be a mismatch not between institutions and technological change but in the nature of man. Practices and methods that have worked or been custom in the past take on the quality of apriority, a condition that is rarely questioned. One could argue that, as institutions are man-made constructions, the 'nature of man' is, therefore embodied within them. This perspective allows one to look at the comparitive data between industries in their response to technological change and to look at examples which can reveal the strength of 'tenacity' within different areas of the company.

The study found that whilst CAD technology appeared to be accepted within areas that were already associated with technical aspects of design, unease was shown in many discussions about CAD in design rooms.

> "I can't see me using a computer... after all they are for the men..."
> (a female clothing designer in a large company)[55]

Unease was also displayed by technicians using CAD at the possibility of designers working directly on the computer.

> "Its okay the designers using it as long as I am there, but they don't just come down here and use it. Well you know what designers are.... we could tell you some tales... "
> (a technician in a knitting company)[56]

When conflicts between existing practice and new technology become acute, the company may have to take dramatic remedial decisions. A company faced with continual war between factories, which before the installation of CADCAM graded patterns and cut lays independently, and the new central CADCAM facility, decided to remove the technology. They decided that the expertise of their staff was of greater value and wished to retain it.

Tenacity may be seen by some as a block to progress, by others as a natural evolutionary process that provides a brake on technological excess. Warner is critical of Gabor's position that social innovation has not kept up with 'the explosive progress of science and technology':

> 'The argument that technology is changing at an ever increasing rate, and that organisational adaptation must be as rapid, assumes a parallelism which is normative rather than analytical... There are no unavoidable responses to the rate of technological and social change.'[57]

A recognition of the 'correct' pace of change is as problematic as that of identifying a 'good decision'. Gilligan[58] et al argues that a manager's reputation is dependent on his ability to make good decisions, this pre-supposes that we know what a 'good decision' is. He believes that for many managers it is one which achieves an objective set in advance, and where the objective provides minimum disruption and conflict within the organisation. The study[59] revealed that the overiding measure of a 'good decision' in the clothing Industry, particularly within the small companies sector where short termism is the prevailing mode of operation, will be directly linked to a fairly immediate increase in productivity and profitability or even the immediate survival of the company.

The difficulty of distinguishing between quantitatively 'good decisions and qualitatively 'good' decisions is central to any decision which relates to the installation of new technology and the dynamics of environmental change faced by all commercial organisations.

Gilligan[60] identifies three types of decision:

1. Short term routine operating control decisions: these are routine frequently recurring decisions which can be handled by the company with in house expertise.
2. Periodic Control decisions: these are made less frequently and are concerned with resources; they are responses to relatively small changes in the economic, legal, technological and competitive environments.
3. Strategic Decisions: these, because of their unique nature, an absence of information, their high cost and significance for long term development and welfare of the organisation, require a highly detailed analysis, and in many cases, the use of a substantial element of judgement by the person or group making the decision. Areas where this type of decision take place are product development, large contract bids, market expansion, new plant investment.

In this analysis the decision to install a CAD system falls within the category of strategic decision making. Strategic decision making places emphasis on the need for organisations to develop procedures for handling decisions; an acceptance of a hierarchical structure of decision making implies levels of organisational hierarchy within the company and its management structures. The scenario looks clear cut but many decisions which have to be made spread across these areas and it is in these amorphus areas where unforseen difficulties take place. Increased specialisation and dependence on 'expert knowledge' precludes the holistic approach and reduces the capacity for intuitive decision making of the kind that Polanyi[61] sees as being rational yet creative. A hierarchy can also be restrictive in the speed of decision making that is required in many circumstances. Decisions in the grey areas, identified by Simon,[62] become a potential for conflict between management groups. Many large companies suffer more from internal than external competition as groups defend territorial decision making. The introduction of new technology can create new alignments and play havoc with existing structures.

This perspective also ignores the type of decision that is frequently faced within the clothing industry, the re-active decision. This is an immediate response to outside events, in many small companies the view is often not restricted to the next few weeks, but to the end of the day! Whilst it could be argued that in many companies a large proportion of events should be forseen and accounted for within its strategic decision making, crisis management may have to be seen as a part of an accepted way of life within clothing companies where vagaries of fashion, as well as unforseeable global and government decisions, can force companies into re-active decisions. Although continual decisions of this character can wreck a company, many successful small companies survive and prosper in that they can cope with both rational and intuitive decisions, and can respond with speed. I would argue that many closed system models of decision making, that pre-suppose clear agreed objectives and procedures for attaining goals, are often inapropriate to the operating conditions of these companies. This does mean that any kind of organised system of decision making is irrelevant. Simon[63] argues that for most companies to-day open systems of decision making are more relevant, these recognise that rational decisions and 'information' are often only a small part of effective decision making and that feedback, learning and adaptation to continual change have to be part of a dynamic approach in which judgemental issues play a significant role. Whilst decisions about investment in new technology, where there is uncertainty about the outcome, require detailed searches and evaluation, Gilligan[64] et al state:

> 'The rationale underlying the selection of alternatives once again contains a large element of heuristic behaviour, with the alternatives being evaluated in a variety of ways ranging from a hunch, through an inspired guess, to a rigorously analytical assessment.'

The process of strategic decision is usually activated by the recognition of a problem or a desire for new developments. The broad organisational objectives can be clear and readily defined. Little account is often taken of the role of personal objectives or the collective objectives of groups within the organisation. Theoretically this state is not a problem as long as they are consistent with the main objective, personal objectives are often only recognised when a conflict emerges. In practice it is difficult to find effective decision-making techniques which can explicitly incorporate the possibility of trade-offs between multiple objectives. Any trade-off requires that objectives have to be explicit. Personal objectives are often unclear or not admitted; these hidden objectives, collectively or personally implicit, can be more destructive than external pressures. Personal goals should not be viewed solely in a pecuniary sense, other personal satisfactions of interest and worth can overide egotism and monetary goals. The study[65] found that a number of highly skilled technical staff were working long after their retirement age because of the work satisfaction and their loyalty to the company. In any decisions that institute change, a judgement has to be made about the values of the participants and the emphasis that they will place on their own goals at the expense of the organisation. Two factors can make any judgement of this kind extremely difficult. The perception of a situation is an individual process, any response is affected by past experiences, capacities, beliefs and prejudices; these influences, 'the tacit dimension', are often below a person's level of awareness and therefore unexplicable.

In the implementation of new developments, particularly CAD technology, personal goals, defence of territory or personal survival are collective impediments, which are often unrecognised or under-estimated. Wilson and Alexis[66] state that managers rarely search for a larger number of opportunities or courses of action, but rather limit themselves to a smaller more manageable set of alternatives. Wide searches and new initiatives are expensive, input from outside the company is very expensive. Some government recognition of this is shown by the financial support given by DTI[67] and MSC schemes for consultancy advice particularly in areas of new technology. In evaluating proposals or deciding on a course of action a great deal of decision making literature places emphasis on the role of the concept of 'utility'.[68] Utility appears to be a theoretical concept that is useful in analysis, but difficult to isolate in practice. The notion of utility is marginally useful in decision making, it assumes that one can identify possible outcomes precisely. Many decisions, particularly those involving technological developments, require knowledge outside present experience, in fact, 'decisions made under ignorance'.

In many discussions the arguments become confused because there is a lack of understanding about the difference between decisions made under uncertainty, decisions made under risk, and decisions made under ignorance. The categories are quite different.

If one accepts the distinction between the categories, one can also argue that whilst risk analysis can identify problems, make estimates of their likelihood and consequences, and decide the level of acceptability; a project has to be in operation before the full consequences are realised. It may be that even then they may not be apparent, and that a 'lateral' approach to the data may be required to recognise the full consequences of a decision. A decision confidently made as a decision under risk, can often be shown to be a decision of a different character.

Confidence in the ability to project possible outcomes and weigh them by the probability of occurence and to derive 'values' for decision alternatives is expressed by Bayesian theorists,[69] 'probability obeys laws', in dealing with decisions made under risk and uncertainty.

> 'The main conclusion is that there is only one way to reach a decision sensibly. First, the uncertainties present in the situation must be quantified in terms of values called probabilities. Second, the various consequences of the courses of action must be similarly described in terms of utilities. Third, the decision must be taken which is expected - on the basis of the calculated probabilities - to give the greatest utility.'[70]

Howard[71] is more sceptical, he recognises the confusion between the terms risk and uncertainty.

> 'Current writings on managerial decision making contain a liberal scattering of the word 'risk' frequently in conjunction with the word 'uncertainty'. Traditionally a distinction has been made betweeen risk and uncertainty on the grounds that in the

> former case the probability of the various possible outcomes are known, whereas in the latter case the probabilities were unknown.'

> 'Unfortunately patterns of movement in many instances are neither regular nor prolonged and large number of determinants of most variables make many regular patterns pure coincidence.'[72]

He also argues that the confidence placed on the input into theorems or models is often misplaced:

> 'Models of organisations are becoming increasingly sophisticated. At the level of planning decisions the purpose of such models is more usually to 'examine' the future. If logical estimates of uncontrolled variables are not input to the models, then whatever the degree of sophistication of the model itself, the output will be illogical.[73]

Simon[74] argues that objective rationality is not possible because information and knowledge are always incomplete, and that consequences lie in the future which involve values that can only be imperfectly anticipated and that all possible alternatives are not available.

There are many situations where no single interpretation of the data can be considered the best. Many business decisions concerning CAD are unique, in that the decisions are taken in circumstances that are unlikely to have occurred in the past and that unexpected outcomes are the only safe projection that can be made. They are, in fact, decisions made under ignorance.

Collingridge[75] states that many decision making theories require factual input and require actions to produce expected results; Bayesian theories are expected to cope where factual information is sparse. However, he believes that applying Bayesian theories to decision making under uncertainty can only apply to decisions and problems where all possible outcomes and states of nature relevant to the decision are identifiable if uncertain.

> 'The historically dominant tradition and one to which Bayesian theory firmly belongs sees rationality as the acceptance only of opinions which are justified and sees a rational agent as one who justifies what he does.

> The rival fallibilist tradition denies the possibility of justification and sees rationality as the search for error and the willingness to respond to its discovery. It does not follow therefore that because decisions under ignorance cannot be justified, they cannot be made in a rational way. What is needed is a fallibilist account of rationality for these decisions.'[76]

Collingridge[77] has a number of interesting points to make about making a decision under ignorance; points which appear to have a direct relevance to decisions about CAD technology. He states that one must be able to discover information which would show the decision to be wrong and the ability to react to this information if it ever comes to light. Companies who have taken a 'theoretical point decision' about a CAD installation often have a vested interested in it being a 'good' decision, or have not got enough knowledge about the technology or alternative technologys to offer the information required. Collingridge offers a different initial approach which avoids this position. He sees a decision made under ignorance not as a point event but as a process. The corrigibility of a decision made under ignorance is crucial, it means being in control of a system whose behaviour through time is unknown. Whilst the decision must seen as a process in time, at the beginning there should be some agreement about the conditions which would justify its abandonment. This procedure offers an alternative position to the Bayesian approach where the decisions are point events which are assessed as rational or irrational.

Decisions which are to be judged as successful in achieving pre-determined and believed outcomes often result in a particular type of technology becoming entrenched. Collingridge states that many companies use hedging as a way of coping with ignorance. It appears to be enormously attractive when making decisions under ignorance because it means that at least the worst that can happen is avoided; however, hedges against the worst outcome rather than positive decisions often result in firms ending up with technologies which have little intrinsic attraction. He believes that entrenchment is particularly harmful in highly valuable, low variety, technological systems. He also believes that there are ways of avoiding it. One way is to insist that the variety is increased by the development of several technologies which perform the same function or to choose small controllable systems which are less sensitive to error and more amenable to change.

Many companies embark on the investment in CAD technology as an 'act of faith', then await the 'results' or 'pay-back'. CAD technology sits very uneasily in an environment where a 'point event decision' is made, and the event followed by individuals, not necessarily participants in the original decision making process, reacting to the ensuing situations.

REFLECTIVE COMMENT

This critical analysis of the notion of using the concept of utility in any decision making process, which concerns CAD technology, does not necessarily require its total abandonment. It simply accepts that the original preferred outcome is often not attainable and recognises that later alternatives, unable to be conceived at the start of a project, are often more creative than a prescribed goal.

THREE: DIFFUSION AND IMPLEMENTATION OF CAD

A strong argument is accepted by many economic and political theorists that the diffusion and implementation of technological change is inextricably linked to the economics of industrial production.

> 'Without technological innovation, economic progress would cease in the long term, there is a limit to the application of an existing stock of knowledge.'[78]

However, how it is linked is more problematic and speculative. From a conventional view, Hann and Jackson[79] offer the principal factors which they believe may determine the rate of acceptance, diffusion and implementation. First, the degree of economic advantage offered by the use of the innovation over older methods of production; secondly, the extent of uncertainty associated with the use of innovation; thirdly, the commitment to carry out subsequent adoption after the initial adoption.

Freeman[80] states that at the present time most R & D work is being centred in specialised institutions. He argues that the increasingly scientific nature of technology, its growing complexity and division of labour has created specialists with their own bank of knowledge. Technology has been seen in simple terms as the systemisation of the production of artefacts to satisfy a mass market. Computer technology is seen as a further stage along the technology route. Freeman, however, argues that this is a profound mistake; he believes that the newer technologies could revolutionise the relationship between science and society. It is the questioning of the autonomy of those who work with high level technology, and participation in its application, that is the means of its control and future directions. He also states:

> 'All improvements in machinery have by no means been the inventions of those who have had occasion to use the machines, they have often been the business of a peculiar trade... men of speculation ...or the philosophers of the trade of mechanics.'[81]

There are new challenges to these theoretical ideas that consider the acceptance of new technology as being the key to economic success. In the field more practical ideas abound.

> 'The possible wisdom of waiting is reinforced by observations, abundantly available to all would-be entrepreneurs, concerning the sad financial fate of innumerable earlier entrepreneurs who ended up in the bankruptcy courts because of their premature entrepreneurial activities.'[82]

Rosenberg offers this view in contrast to the Schumpeterian[83] perspective which sees the innovator as experiencing abnormally high profits whilst his innovators catch up. Rosenberg argues that rapid technological progress does not necessarily result in its implementation and may be the opposite of intuitive expectations. The idea that improvements are being made, may actually delay its introduction. 'A decision to buy now may be a decision to saddle oneself with obsolete technology'. He suggests that:

> 'entrepreneurs may be making appraisals of future pay-off to innovations of greater objective validity than are made by social scientists who invoke all

> sorts of extra-rational factors to account for the delay or "lag" on the adoption and diffusion of innovation.'[84]

A great deal of the literature enjoys discussion of the differences between the market demand 'pull' innovation and the technological 'push'. Rosenberg[85] is suspicious of many of these rigorous definitions, he believes a potential demand is only one that can be really recognised with hindsight. He states that there are myriads of deeply felt needs in the world, any one of which constitutes a potential market for a product. Successful innovation often depends on complementary technologies and the appropriateness of the concept. The alternative model of scientific 'push' appears to be equally suspect. Whilst innovation is often stimulated by technical and scientific information, it can only proceed if it is directed towards a predictive outcome. He quotes Langrish[86] et al; 'perhaps the highest-level generalisation that it is safe to make about technological innovation is that it must involve a synthesis of some kind of need with some kind of technical possibility'. If one accepts that the market is ineffective as a 'pull mechanism', but that a focus appears to be a crucial element of technological innovation, then it is apparent that it is in a country's interest that a government takes an interventionist stance. First, to intimate directions that may be required; second, to provide funds for independent predictive directions to be pursued.

Solo[87] believes that merging with and emerging out of the middle mass of technical skills is another sort of cognition which comprehends the interrelation of machines, materials, labour and information in processes of producing goods and services. This cognition of process is necessary to set in motion, to control or to further transform an advanced technology. I consider that central to the generation or use of new knowledge is its interaction with other knowledge, with changing knowledge and with other industries and applications. This state of change or even caprice is, I believe, the key to the imaginative spread and adoption of technological ideas, particularly in the field of clothing and textiles.

> 'We have to get hold of the fact that society

> changes continuously, bringing with it new tasks, new values, new customers. Successful industry is about change. If it is not changing it is dying.'[88]

In considering the implementation of innovation, Freeman[89] identifies six strategies; offensive, defensive, imitative, dependent, traditional and opportunist. Each of these categories has been affected to some degree by fear. That which is not understood is feared, producing a natural hostile reaction. If differing strategies exist within one company, then the implementation of any new procedure will be viewed through blinkered vision. I would argue that missing from this scenario is the 'explorative strategy'. This, I suspect, will only emerge when designers, the 'natural explorers' become involved.

Exploration at this time is hindered by the isolation of systems. Kaplinsky[90] states that, for obvious reasons, CAD vendors are anxious to prevent unpackaging; that is, the unbundling of hardware and software components of the system by users, (referred to by one vendor as a 'cottage industry'). Two major strategems are pursued to inhibit this. The first, is the universal policy of refusing to maintain the software or hardware of any system which contains 'unauthorized', unpackaged hardware; the second, is to modify the hardware or coded software which prevents the mating in of independently purchased hardware or software. A further competitive strategem pursued by most vendors is to 'oversell' immature software packages to end users. This has three major functions. The first, is to 'capture' a final user before it commits itself to a competitor, given that the costs of changeover from one CAD system to another are often prohibitively expensive. The second, is that it is difficult to simulate real operating conditions in the software laboratory. The third advantage is that the user partly incurs the cost of developing and de-bugging the programmes.

Rosenberg[91] argues that one can identify a form of knowledge not usually recognised in the learning processes. He contends that, whilst it is accepted that new knowledge is gained in the conception and development of the product, little is said about the knowledge gained from the utilisation of the product. I would argue that its value is also underated. The knowledge gained is often unpredictable from first concept or scientific principles or predicted from analogous technologies. The development of effective software is highly dependent upon user experience. The modification of software systems in response to this experience is now intrinsic to software engineering. The effectiveness of support services in improving the product after release appears to be very important in the competitive success of computer firms. Rosenberg sees, often highly priced, service agreements as an institutionalised exploitation by the computer industry of the 'learning by using' phenonemon. The value of this knowledge may have a general as well as a particular application. The 'learning by using' may hold the keys to productivity improvement in high technology industries. There is an intuitive familiarity that occurs in 'learning by using.'

During the course of this study, I have found that clothing and textile companies appear to be unaware of the value of their knowledge and see it as of little value in comparison with computer expertise. A 'computocracy' operates which places an unreal value on its own knowledge. Valuable textile experience is often given free to software houses, and many companies appear to be unaware of the value of their knowledge. I see this as a short term phenomenon. As costs reduce and a computer literate generation enters industry, the explorative strategy will demand service and flexibility at costs that they can assess for themselves.

Rosenberg[92] states that the literature of economics has exhibited a consistent disinterest in the development process. He states that one difficulty is the omnibus nature of the term which covers so many disparate things. He contends that one has to go into the 'low level' nature of technological change, where its nature, full of richness and diversity, is made up of innumerable small increments to the stock of knowledge. This, he believes, is an area in which scientists and economists have shown remarkably little curiosity, often dismissing it under the barbarous solecism 'know-how'. Good ideas usually acquire significance only when they are refined, elaborated and have gone through, what is often, an exhaustive process of patient modification and revision. Only then, do they become useful in an operational sense. It seems to him that we seriously underrate, not only the significance of these later stages in the process of social science innovations, but that we vastly underrate the sheer size and complexity of the task and therefore the magnitude of the intellectual accomplishment involved. Scherer[93] sees that published figures on R&D within industries take little account of the beneficiaries of the technology, once it is embodied in products which flow across industry boundaries.

The common-held idea that a product is invented, is developed to a stage of commercial viability and then sold is a simplistic view when related to most products. In computer technology, it is fantasy. The product may be found to require complementary work if it is to perform efficiently, and it may be impossible to reach its potential unless these complementary technologies become available. The more complex the outcome, the more dependent a project becomes on mutually reinforcing technologies. The importance of social and market changes is often ignored; an adoption may be rejected because of its uneasy fit into its present context.

For many technological software innovators, it can be frustrating to work for months developing a process only to find, a few weeks after completion, that it is available 'off the shelf' at low cost and that it is available to other competitors who took the risk of waiting. It becomes more and more important to know from the grapevine what is becoming available from the large software houses, the problem is that the waiting process can be a gamble. Projected new releases are notoriously optimistic. Barron[94] and Curnow are convinced that the price of hardware and software will continue to fall and there will be a decline in the level of software skills that are associated with today's unneccessarily complex computers. The cost will be in the interface of programmes and the purchase of application knowledge, this cost often exceeding that of the software.

The clothing industry is a latecomer to CADCAM, the rapid reduction in its price has meant that many companies have sat with existing plant expecting to invest in CADCAM when they perceive that there is a 'price plateau'. Access to the technology through bureau services has enabled them to make a start on a learning curve and hedge on CAD investment. This hedging is endemic in clothing companies, their expectations of CAD innovation are based very much on hearsay. Most of the possible investors are aware of the disruption of continual improvements in software, programme obsolescence and potential price reductions. They are probably less aware that early software is inevitably 'bug-ridden' and that there is a working out stage. A cynic may observe that by the time a programme is 'bug free', it is usually obsolete. The conflict between product stability and product development is an intrinsic characteristic of CAD technology.

CAD has to be sited in a context. CIM, (computer integrated manufacture, of which CAD is a part), to the vendors of systems, appears to be the marketing strategy aimed at selling 'total' systems to the large company. Dodsworth[95] suspects that the cost of a totally integrated system of factory production is not only prohibitive but that its idea is flawed. Elements of it would become outdated as other companies overtake the original supplier in specialist areas. Successful computer integrated manufacture has a communication system at the heart of the structure co-ordinating the elements of all sectors. The most successful operations gain their position by steady incremental improvements rather than giant leaps.

Small and many medium size companies are not buyers of advanced technology. Rainnie[96] states that low capital investment in many companies and the ease of entry and exit into the trade, contributes to the industry's hand-to mouth existence, whilst at the same time low profit margins, changing products and highly competitive markets often militate against further investment. Hoffman & Rush[97] explain the reluctance of the garment industry to invest in new technology, (he quotes investment as about 0.05% of sales), as being linked to the availability of skilled workers. They note that this is a diminishing resource. Their in-depth study of micro-electronics in the clothing industry notes that most of the technological advances have been made in grading, marker making and cutting. Hoffman[98] states that computer aided grading and marker making could prove to be the linchpin on which the future competitiveness of the industry, in advanced industrial nations, will rest. However, Hoffman and Rush, in an earlier paper, also stated that:

> 'Although technologically impressive, these innovations are associated with activities which give only limited increases to value added. And given the high level of investment required these can only be afforded by the larger firms.......'[99]

This confusion may be explained by Hoffman's apparent lack of knowledge of how the technology actually works in practice.

> 'Grading as an occupation in CAD user firms is well on the way to extinction. The use of CAD effectively eliminates the need for training in grading altogether.'[100]

This statement can only relate to garments that are repeated with only minor changes in style. In all forms of innovative design the elements of proportion and shape require design as well as technical expertise. The intricacies of refining design curves to mathematically generated curves through grade rules require a grading knowledge of the product and empathy with the new tool. In the field study of companies, undertaken for this thesis, it was shown that the quality of the technical staff and their grading expertise was crucial to the successful integration of the technology into present production.

> 'people do not understand that grading problems are still grading problems, the computer does not necessarily make them easier.'

> 'the system has worked smoothly because a highly competent design technician is responsible for all the preparation and input.'[101]

Hoffman appears to have almost totally ignored the design content of the industry, his only discussion of the design task in a long monograph is in the following form:

> 'Style changes introduced usually involve the manipulation of a stock of elements which the manufacturer already has on his pattern books or

has experience of dealing with in production.'[102]

This attitude is not unique, most of the literature in the clothing journals,[103] discussing CAD or advising on its implementation, totally ignores the design element. Segal does have something to say:

> 'for the most part designers do not know what CAD is, period.......most of them have not been exposed to the technology at all...... Designers frequently have the misconception that computers will interfere with their creative talents.'[104]

Frazier[105] sees this omission as neglectful, he considers that computer assisted design for rapid introduction of new styles could have the most far-reaching consequences of all the new technology on the scene today. The pioneer of the serious introduction of CAD into a design room, S.R.Gent,[106] after less than a year of using a Pattern Design System, estimates that it has already halved the time taken to produce a design. It was found, during the field study, that many designers dismissed the idea of using it whilst admitting to having no knowledge of it.[107] More considered opinions were also offered. Design is about quality and innovation as well as speed, design rooms are social environments, where a lot of time is spent in discussion. Working at a CAD screen is a solitary occupation. It may appear that a designer using CAD is more diligent, responding to the machine's pace, but Dewar[108] believes that this discussion in the design room must not be under-estimated or threatened, he judges that the technology is not yet appropriate. Rzevski's[109] ideas support this view; he states that the introduction of CAD methods into industrial organisations has not always been successful. There exists considerable evidence that the reasons for the observed adverse effects may be traced to the incompetent management of change and superficial problem analysis. Many companies have opted for systems that are much more expensive than the application warrants. To compensate for the unjustifiable costs designers have to increase their productivity and decrease their thinking time to respond to decisions offered by the system. Many systems are inflexible, they just do the job but do not offer the opportunity for extension or data exchange.

Attempts have been made and are still continuing to provide a 3D design system, but many people in the field are sceptical; Segal[110] states that soft goods designing mathematically in 3D is the most complicated application in the world. Gerber has abandoned its research but others are less deterred. Interesting solutions may arrive from unexpected sources. Ideas of making garments, which appear to be three dimensional, are already taking place in garment and textile design, by manipulating picture and photographic images on screen; this is a less taxing exercise. Some companies are using forms of artificial intelligence to enable a company to 'teach' their CAD system its own particular methods of pattern cutting. Freeman[111] argues that in comparisons between industries; whilst textiles are placed low in the table for their spending on R&D, it is within textiles that the small enterprises made a significant contribution to innovation in their industry.

REFLECTIVE COMMENT

Barron and Curnow[112] state that in practice, forcasts of the way computing will develop, have been relatively unsuccessful. This would not seem to be because the basic technological forecasts have been wrong, but because the implications of the technology have not been identified, and a variety of non-technological constraints have not been considered. The main barrier to UK exploitation of computing technology is likely to be LACK OF AWARENESS, in a sufficiently collective or focussed way of its potential.

I suggest that the most significant factor in the development of CAD will be the intuitive use of connections. It requires the designer to become involved in its use. The designers' 'attention to the rubbish of life....the inadvertant.....the unattended', and their ability to change direction, irrationally but surely, are characteristics that CAD technology and its present minders lack.

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with PDS, (pattern generation systems). However, many of the designers interviewed offered hostile comments about using CAD. When questioned further they admitted they had little knowledge of the systems and many had not seen one. It would seem that statements issued from such a position are of little value.

108 During the field study, people were interviewed who had knowledge and experience of both design procedures and CAD. Here there were mixed arguments. Ian Dewar at Slimma Ltd. felt that the technology was not ready. He felt that its cost made it 'precious' and he believed that the designers may have been forced to use it to justify its expense. He believed it had to be at a cost where a designer had unquestioned control of its use. He believed that the destruction of a 'design room atmosphere' was an under-estimated risk.

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CHAPTER TEN: AN AFFORDABLE COMPUTER AIDED DESIGN SYSTEM...SOME CRITERIA CONSIDERED IN 1985

This chapter of the study is an account of my ideas and my actions during the period 1985-86 written in retrospect in February 1989. I had, by the spring of 1985, decided to pursue the goal of developing, in some form, a software system. I wished to acquire it for my professional work as a clothing designer and for my research into the effect of the use of CAD on the design process. Few notes were recorded in 1985 on my reasons for any practical actions that were taken. This section therefore, is a record of facts of two kinds: first, information about equipment and its provision in textile companies in 1985; second, information about choices that I made and actions which I took. I recognise the problem of bias by selectivity, even in this sparse format, but feel that the danger is minimized by this procedure.

It must be stated that most of the decisions taken in 1985 were based on a very scant knowledge of the operation of computer systems or an in-depth knowledge of the construction of computer aided design software programmes. My knowledge in this field in 1989 is still marginal.

COMPUTERS

In 1985 computer aided design programmes were running slowly on 16 bit computers (IBM, Apricot XI, Sirius), but with the promise of affordable speed within two years. The speed of previous technological development in this field gave a reason for confidence in the personal computer's future capability to handle most of the clothing operations presently performed on the large computer clothing systems.

Whilst the MS DOS operating system had memory limitations, new computer architecture and memory extensions provided by some software programmes were providing interim solutions. New powerful operating systems were also promised, these were expected to extend present memory and operating boundaries.

The demise of some excellent but under-funded computer development companies or their subsidiaries[1], changes of company policy on product development[2], and the wish to be compatible with the mainstream computer clothing systems and other textile software[3], led to the decision in July 1986, by myself and a fellow collaborator, that any long term commitment to a computer project should be made on IBM compatible computers. It was also decided that personal computers would continue to be affordable, (£1,000-£5,000 approx.).

PERIPHERALS

The use of computer aided design in clothing design is highly dependent on the quality of the equipment responsible for input into and output out of the computer. Peripherals that are adequate for clothing design, printers giving good colour representation for idea generation or plotters producing paper garment patterns of the required size, can be expensive (£1,000-£10,000 approx.)[4] in comparison to the price of a personal computer. The wider a peripheral's general use, the more competitive the price and the higher the material value. The rate of its extinction is also likely to be reduced.

The original policy of experimenting with new interesting ideas from small entrepreneurs was interesting but my flirtations with obscure products[5] proved to be expensive in respect of the time and funds. As the project progressed it was decided to use equipment by proven suppliers. Empirically, it is clear that the most dramatic developments in most peripherals, have been made by the leading companies. The 'man in the tool shed' may still generate new directions for products but it is the large companies who have the large R & D resources required for their development. The quality of the input and output of material is crucial to any perception of CAD by a designer. It is by its hard copy that computer aided designs are usually judged. The computer image on screen is not necessarily the visual means of contact between commissioner and designer. An improved quality of this printed translation of the screen design image, in a range of media, is urgently sought by most designers working in the field. It must be recognised that the quality of the output, on any peripheral, is not solely dependent on the mechanics of the equipment; the software that drives the peripheral makes a significant contribution to the product.

The most unnerving aspect of working in this field is the fact that one may spend a great deal of time, money and creative energy on software to interact with a piece of equipment, only to discover that a new form of technology has become available that offers superior output. The event may not have been forseeable or the project may have been a commercial secret until its launch.

SOFTWARE

I could not and still cannot write CAD software programmes. Therefore, I had to find a company or programme writer who would write software to my prescription or to identify some software on which I could 'piggy back' and adapt. It was decided that it must be British so that I would have easy access to the work in progress.

Some further explanation is required of earlier statements (ref. pages 47-49) written about software programmes for the Clothing and Textile Industry. Clothing and textile programmes use two different forms of computer technology: 'vector' programmes, which use mathematical co-ordinates to provide screen images and control graphic changes; and 'raster' programmes, which use screen pixels to control similar operations. Most computer clothing and textile companies usually offer the different forms as different systems running on separate computers, (although it is possible to run both types of software on the same machine or even to have integrated raster and vector programmes).

Raster Programmes

Raster software programmes of the required basic quality, used mainly for idea generation, colour and graphic images, were available from a number of British and American companies in 1985, at an affordable cost (£1,200). They offered a screen resolution of 768 x 576 pixels and a colour palette of 16,000,000 colours. The output from a raster system to a type of printer peripheral reduced this number to approx 4,000 colours on any hard copy. The constraints inherent in raster programmes can be readily understood by the recognition that the only media available for manipulation are the screen pixels. It must be noted that information in pixel form is ideal for some textile operations[6], particularly, weave and knit processes where the pixel information can be related to thread or needle formations and translated into codes which can communicate directly with computer controlled textile machinery. Limitations are apparent in printing processes where good linear output is required, the resolutions available on low cost print output offer a line of unacceptable quality. Further limitations are the size of low cost hard copy (A3), the overwriting of repeat motifs and the huge amount of memory consumed by pixel images.

Vector Programmes

Any form of clothing design that is carried further than a sketch requires some form of mathematical measurement. CAD programmes for pattern construction, grading and lay planning fall within this category and are based on vector systems.

Vector software proscribes graphic shapes in terms of positions on an 'electronic graph', these are recorded with reference to X and Y co-ordinate positions. Drawings in many programmes can be constructed or measured to an accuracy of 0.2mm. Vector programmes with <u>a proportion</u> of the graphic functions required were available from £2,000-£5000. CAD vector programmes, on personal computers, had been developed principally for engineers and architects, the market was large amongst medium size companies working in these fields. I identified a significant problem at an early stage; each programme that was investigated for purchase lacked either a crucial group of functions, or the structure of the programme was too mechanistic, or the software house saw the project of a clothing adaptation as outside their area of operation or unviable.

Vector and Raster Programmes in CAD Clothing Systems 1985

This study is primarily concerned with CAD systems for clothing (cut fabric). Within this grouping, most CAD systems in 1985 were divided into the two groups of raster and vector programmes. Whilst it is possible to have both programmes on the same computer or even to have an integrated software programme, there were historical reasons for the division. Early CAD clothing systems were costly (the first installations cost approx. £200,000). Computer power was expensive, therefore, only the large companies could afford them. Large companies usually divide the design to production process into discrete categories, with their employees encouraged to specialise within a particular area. Although each company has varying category divisions, vector programmes have been sited in production areas, these are often some distance from the design room. The study of companies described in Part 2, found that investment in CADCAM by clothing manufacturers was concentrated in vector programmes for production. The pressure of work and the demand for screen time for production grading and lay planning had prevented designers becoming interested in the pattern cutting element of their work that could be done on screen. During the study, only one company visited had installed a vector programme within a design area. The programme was operated by pattern cutting technicians but the company had plans to integrate designers into its operations.

Raster based programmes known as 'Sketch Systems' were seen by computer suppliers as appropriate technology for design rooms. This may be a correct market assessment of future needs of large companies but in many medium size companies a designer's responsibilities extend further down the line of production than market intelligence and styling. Many designers have to take a design to first sample or even into sample grades and cost lay plans. Their CAD requirements will be for more than sketch systems, they will also require vector functions.

In 1985, only one clothing company[7] in Britain could be found who was using a raster system in clothing design. They were still seen as expensive paint boxes and not relevant to the type of repetitive design activity operated by the large manufacturers who had the finance to purchase them.

THE SOFTWARE REQUIRED

The task of creating a working system for a designer with a range of needs was seen as an interesting project. As a designer who would be regarded as member of this category, it became a highly personal project. It was apparent that a range of suitable computers, raster (paint) programmes and peripherals were available, but that the search for appropriate vector software, which would interact with a number of raster based paint programmes, was the principal concern. By this point in the project, I was convinced that the vector programme should have the ability to sketch in the manner of a paint programme. This was seen as the crucial link between the programmes; the link would enable the designer to work in continuity on a design, without changing into some mechanistic form of technology as soon as a measurement was required. I wished to have more involvement in fabric sourcing and fabric design, and to be able to integrate knit and print into ranges. A flexible design software could become a vehicle that, if it could not pass information directly to other computer clothing systems, the work would be produced in the style of the new technology so that communication was fast and effective.

Initial requirements were few but clear by June 1985:

* The purchase of a computer.
* The purchase of a British raster paint programme, with access to software writers who would modify or add options.
* The purchase of a British vector programme, with access to software writers who would modify or add options. Unless a sketch facility was available within the programme the project was not feasible.
* The purchase of a graphics card and colour monitor.
* A means of transfer of data between the raster and vector software programmes.
* The purchase of a vector plotter of A0 size for plotting garment pattern and lays.
* The purchase of means of print output for the raster images.

The early pessimistic encounters with software suppliers and a recognition of the costs, even for modest equipment, made the ensuing task look rather problematic. The development of the software programme is discussed in the next chapter.

REFLECTIVE COMMENT: FEBRUARY 1989

The interesting idea that emerges from reflections of this period, is that one was able to operate and enjoy working in the field of computers at a kind of sub-strata[8] level, and that one could have the confidence to embark on the above enterprise. I have, through contacts and passing interest, absorbed more knowledge but do not regard myself of having gone much further into the technical realms of computer science. It may be that entry into deeper levels have to be by interested intention and that any forced entry may destroy my interest and excitement in clothing design on computers. I realise that I have only sought technical information which is directly relevant to design needs, or has been of personal interest.

The decision has therefore been made, that the gaining of the 'technological respectability' which may be required to gain a Ph.D in an area of technology is secondary to my work as a CAD designer and my explorations in the phenomena of computer aided design.

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1 Victor and Whitechapel are examples of computers which were excellent products but which foundered in the market place, many companies find the price of isolated development just too expensive. Other manufacturers such as Amstrad and Compaq have produced IBM clones at a more competitive price or with better performance and have continued to prosper.

2 My initial work was executed on an Apricot computer, early Apricots had a system architecture that was respected for its speed and reliability. Market forces drove it into line as an IBM compatible and it

has now (1989) declared its intention of concentrating on high cost multi-user systems.

3 Most of the large computer systems used in clothing manufacture were based on Hewlett Packard or IBM computers. Many of the textile systems available will operate on IBM compatibles. The desire to have a design workstation that could encompass a variety of software was the main attraction of the original idea.

4 Most clothing systems are unbalanced by the cost of the plotter output. The large systems, that are used in production, require marker width plotters (202cm) and these are a high proportion of the total cost.

5 An experiment with the low cost Penman robot plotter, a pen head that 'scampered' around a sheet of paper, proved to be an expensive and time wasting exercise. Its operation was unpredictable and its registration of very low quality.

6 Raster programmes register any graphic information in pixel form, the manipulation of any image is restricted by this form. Any re-scaling down is proportionate and therefore, lines are lost and images distorted; complex overlays are restricted and measurements can only be made with reference to a grid structure.

7 A Sketch Design System was being used by Xetal Ltd, the company was offering a Bureaux service. Although a division of Lawtex Ltd, a manufacturing company, Xetal was also marketing the Microdynamics CADCAM system. It would seem therefore, that in 1985 no clothing manufacturer was using a Sketch Design System just for the use of designing their product.

8 Most computer clothing/textile systems are operated by people who know a lot about clothing but have little knowledge of their system. They operate within a narrow field of knowledge and are quite prepared to work comfortably within proscribed limits. Many software writers or system builders are more concerned with research and development than application. The possibility of working at a level between the two extremes 'sub-strata' could be seen as a recognised position.

CHAPTER ELEVEN: THE SOFTWARE PROGRAMME ORMUS-FASHION 1985-87

A lack of knowledge in the theoretical complexities of CAD allowed me to continue in what was seen, by some computer departments in polytechnics and universities[1], as a fruitless search for a type of software programme that was not viable. They surmised that it was impractical to include an innovative sketch line in a vector programme. It was, it seemed, an extravagant use of memory. In many fields of CAD they were probably right, but to a clothing/textile designer, the value of this vector sketch line was worth the memory expenditure. The software house, with whom I later co-operated, was able to manage the problem and make its operation viable.

However, my early search for a vector programme with a sketch facility was a wearisome business. CAD exhibitions and CAD software houses were exhaustively visited. The early enthusiastic recognition, that architects and engineers were ahead of the field in most aspects of CAD software programmes for the personal computer, began to be subdued by their lack of interest in the sketch facility. Trials with two CAD programmes, one without the facility[2] and one with a limited sketch option, proved to be too restrictive[3]. The trials were aborted forthwith.

At 4.30 p.m in April 1985 at the end of a tour of a CAD exhibition in Olympia, London, I saw a tall red haired man sketching freely on the screen in what appeared to be a vector CAD programme. He was Stephen Gray, the managing director of a fairly young and innovative software house, Concept II Research. His software product was Ormus. He listened to my ideas without derision, in fact, he listened with growing interest and enthusiasm. However, during meetings at the company, it soon became apparent that the other directors of the company were more circumspect. The outcome of many discussions was that the project of developing a low cost textile programme could be embarked upon, but agreed parameters would have to be observed.

THE AGREEMENT

The company's agreement to adapt their software to my requirement was based on a recognition that our aims may be in conflict.

My aim, primarily, was to acquire a software programme that I could modify and use as a design tool for use in fashion/textile design. Whilst purposely designed for personal use and from a personal perspective, it was subsequently to be used in research which was to consider alternative perspectives of CAD.

The aim of Concept II Research was to improve and develop facets of their present product and to find new markets. Its over-riding aim had to be to remain financially sound. Any system development had therefore to be brought into the market place as a product. An industrial system was seen as too ambitious at this stage, but it was agreed that a vertical market[4] could exist amongst colleges of fashion/textiles who were interested in computer aided design. It must be recognised that government money for textile education was not available at this time, and the purchase of large CAD clothing systems could not be considered by colleges; however a software programme, that could run on their existing computers, could be an attractive option. The company could see a possible return on their investment in a diversion from their current product range. A projection of a possible sale to ten colleges was used as a measure of the specific[5] development that could take place.

My personal commitment to the project had to be the purchase of the software and a share of the development costs.

THE DEVELOPMENT OF THE SOFTWARE

Trent Polytechnic Research Committee had a policy of not financially supporting part-time research. This was an understandable position, and the financial constraints were severe; the funds were reserved for full-time research, which had a better track record of producing results. The development therefore, had to be undertaken personally. Most of the hardware and other software had to be personally financed or acquired from external sources.[6] The Fashion/Textile Department of the Polytechnic provided me with workspace and the loan of a graphics card and monitor for three years. Whilst short of finance, the Dean of School gave support by his interest in the work in progress.

Finance, although important for the initiation of research and development, is, I would argue, of less importance in achieving a successful software product, than an application approaching the level of obsession. Its development is still continuing, its viability as a first stage product took two years to achieve. I consider it to be the most demanding task that I have undertaken. It must be understood that this project was unusual in that I was given, by Concept II Research (within the limits of financial and technical constraints), the freedom to direct the development of the software into a textile/fashion product.

Records were not kept of the individual stages of its development, but approximate time estimates can be made. After the original software programme was received, it required three months work to understand its operation in depth and to consider its potential. Before programming could begin on special options and adaptations, a further three months work was required to produce a skeleton frame within which the programme could operate. It required eighteen months of continual programming, test and re-assessment of options to bring the project to the first stage operating level, which could be considered marketable. Documentation was then completed. The software gained some recognition for its originality.[7]

The intentions that directed the design of the software were seen as intuitive, working from the belief that I was using personal experience as a clothing designer as the central consideration. The main requirement was that, once the basic operation of the system was mastered, I would be able to work as freely, though maybe differently, as I could work presently at the bench. Whilst I consciously rejected the basic premises and procedures of the design process on other CAD clothing systems, my experiences whilst working on these systems cannot be discounted.

The commitment to the project by Stephen Gray and myself was great. However, we recognised that whilst our aims converged on the production of a good working system, they differed, or even conflicted, with regard to the purpose of the work. My aim was an enquiry into the feasibility and future potential of the medium, research into methods of using CAD, and the attitudes to CAD of other users, was to run concurrently with its production. From this perspective limitations were interesting features for later investigation, whilst hostility or rejection by users were events of interest. The company's aim was to achieve a saleable product, promote it and make a profit. Our mutual respect for the differing positions alleviated the few but inevitable conflicts between academic idealism and commercial pragmatism. Our differing attitudes and approaches can be recognised in a biographical article published in the journal 3D, February[8] 1989, (Appendix XXV).

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1 I discussed my reservations of existing CAD systems with staff in the Production Engineering Department of Trent Polytechnic and with CAD researchers in the Textile Department at Loughborough University. My primary requirement, the ability to sketch freely in a vector system, did not appear to generate comparable concern or any enthusiasm for this research direction.

2 Early trials with a CAD software programme from Lucas Logic gave me useful experience of PC software programmes. However, its operation was however limited and its lack of sketch facility resulted in experiments being abandoned.

3 Autocad is probably the most widely used CAD drafting programme on personal computers. Experiments were made with the programme, but its restricted sketch facility and the difficulty of influencing the software writers, (the programme is American), resulted in this experiment also being abandoned.

4 A 'vertical market' is a term used to describe a market that is small, specialised and where the limit of potential customers can be accurately assessed.

5 The amount of development which I wished to take place was clearly over-ambitious when related to practical costs. A hierarchy of options was created, the scale of further development had to be in ratio to

pay-back from sales. This illustrates the dilemma of wishing to be objective about the software, yet reliant on its acceptance to continue the innovation.

6 A plotter was acquired as part of the local DTI Support for Innovation initiative.

7 The software was the winner of the British Microcomputing Special Award 1987.

8 'The Material World' in the journal 3D May 1989, pp. 17-22.

PART FOUR: OBSERVATION OF STUDENTS USING CAD 1986-88

CHAPTER TWELVE: BACKGROUND TO THE OBSERVATION OF STUDENTS USING CAD

INTRODUCTION

In the period 1986-88 I had the opportunity of using CAD with two groups of students and of closely observing their work. This part of the thesis describes the way that this was tackled and the outcomes.

The choice of study methods by any researcher is influenced by his own attitudes which emerge from exposure to literature, ideas and personal experience in his field of study. Earlier research work in areas of creativity have provided the plateau from which this research proceeds. Vast amounts of work on creativity erupted in the 1970s; it ranged from broad mechanistic quantitative procedures to esoteric tests and observation pieces[1].

This research rests heavily, sometimes in rather oblique ways, on the work of Gardner, Hudson, Eynsenck and Amabile. They appear at first sight to be improbable bed-fellows. I would argue that the eclectic use of particular strands of theories can succeed where a single theoretical process could fail. In simple terms, I am interested in Eynsenck's theories of defining personality traits; in Gardner's theories of cognition and multiple intelligences; in Hudson's ideas of creative thinking styles; and in Amabile's assertion that any assessment of creativity has to be situated in its context.

DIMENSIONS OF PERSONALITY

Eynsenck[2] states that Wundt rescued the Greek ideas of the Four Temperaments from oblivion: instead of seeing them in isolation, Wundt suggested that the choleric and sanguine types have something in common which sets them off from melancholic and phlegmatic types. Wundt called this quality 'changeableness', a quality now accepted as extraversion. Eynsenck admits problems with discrete descriptions of a person's temperament and states that we would not expect perfect agreement on the matter. He argues, however, that this can be overcome by the placement of a person's personality traits along dimensions of extraverion-introversion and neuroticism-stability. This appears to me to be reasonable, it is a description by degree. Eynsenck argues that hundreds of empirical studies have shown that these traits hang together in a way that exceeds chance by a large amount. His suggestion that two-thirds of this trait is due to heredity and one-third to environment must be questioned, it is a generality be-set with variable problems. There[3] are also formidable problems with his measurement techniques. First, in the generalisation from responses to questions that may be interpreted in a different way; second, that you can make general predictions that take no account of the context in which the traits may be demonstrated. I believe that it is astounding that so much research has used Eynsenck's questionnaire to provide the base dimensional measurements to under-pin their further applied research[4]. This is particularly questionable when the 'scores' recorded are then correlated with 'scores' of convergent-divergent thinking. Their conclusions are based on questionable validity co-efficients which are correlated against other questionable instruments.

This criticism of method does not invalidate his ideas. If a more valid method of assessment can be constructed, I consider that his theory of dimensions has great potential.

DIMENSIONS OF CREATIVITY

The first chapter of this thesis explored the design process, its impenetrability and its diversity. The interest of this study at this time is directed towards the thinking styles and personalities of designers and if these characteristics appear to effect the way designers approach or use CAD.

Behaviourist theories have contributed little to creativity research:

Gestalt theories have offered more useful territory in which to discuss the complexity of human thought in creative operations. Neisser[5] points out the difference between humans and machines: the selection, the rejection, the switching and changing perceptions are unique. Building on Wertheimer's[6] idea of productive thinking, Guildford[7] considered that two categories of thought could be seen as opposing dimensions: convergent thinking, which is deductive in character seeking the 'right' answer and divergent thinking, an open ended approach seeking alternatives where there is no correct answer. I believe that these ideas have been grossly over-simplified and that Guildford and Torrance[8] have confused intelligence and creativity. The concentration, by researchers, on verbal tests or simple shape manipulation, has confused the issues, and the association between intelligence and creativity has been questioned[9]. Whilst it seems that one needs to have a basic level of intelligence to understand a problem, Lawson[10] asserts that context and personal abilities used in particular situations are more important.

The notion of dimensions of convergent and divergent thinking is not invalidated because unsuitable test procedures have been associated with this idea. Hudson's research into the dimension of convergent and divergent thinking, whilst cunningly divested of the intelligence versus creativity argument, still based its measurements on verbal testing[11]. This, however, does not destroy the interesting points he asks us to consider. He asserts that whilst the dimension has validity, a general polarisation of divergent-convergent thinking is mistaken; it does not begin to see how subtle the inter-connections are. A great deal of Hudson's research has been in the area of career choice in the arts and sciences[12]. He states that most research assumes that the scientist is the converger, the artist the diverger. Hudson argues that there is an intellectual spectrum, in which each occupation attracts individuals of a particular personal type, and that each field has a 'range of openness' which is conducive to divergent thought. Other factors, than its 'appeared' restriction of creative thought, may motivate a person's choice of career and creative individuals in any field will find some space within the range offered.

Hudson also found that convergent boys can diverge if placed in a different situation. If they are given a set of defined parameters they can be remarkably divergent within that context. He also believes that some convergers unconsciously suppress parts of their persona.

> 'in choosing a career and a style of life, the individual is not solely concerned in acquiring skills at the expense of others, in picking a piece of corporate folklore and ignoring the rest. Rather, he is involved in a choice among selves that already exists within him.'[13]

So how much open space is being offered by the selection of a career in design? Gerard[14] believes there is a balance, that the combination of rational and imaginative thought is one of the most important skills required in a designer. Lawson[15] agrees that design involves both styles of thinking but he believes that, taken as a whole, design is a divergent task.

Gardner's intriguing theory of multiple intelligences signals caution in the acceptance of any research that considers the quality of divergent thinking in any general simplistic sense or out of context. He believes that individual biological differences allow us to think or perform creatively in one area of human endeavour and indifferently in others. He rejects the information-processing theories of intelligence as:

> 'studiously non - (if not anti) biological, making little contact with what is known about the operation of the nervous system. For another, there is as yet relatively little interest in the open-ended creativity that is crucial at the highest levels of human achievment.'[16]

Gardner states that his theories takes a position somewhere between Chomskian ideas of individual development and Piagetian views of general human development.[17] Acknowledging the influence of Bruner's[18] ideas he isolates three crucial characteristics in human intellect. First, <u>the flexibilty of human development</u>, its capacity to change, its plasticity; second, is the <u>identity</u>, or <u>nature</u>[19] of the intellectual capacities that human beings can develop; third, and probably the most important, is their potential for being involved in all manner of symbolic activity - the perception of symbols, the creation of symbols, the involvement with meaningful symbolic systems of all sorts.

> 'This immersion in the culture's Weltangschaung constitutes a final decisive aspect of the life of the human, defining the arena in which his several mature intelligences will be deployed in combination.[20]

He believes that Western civilizations have seen mathematical-logical intelligence as in some way the 'basic' intelligence. Gardner sees it as one among many and in no sense superior to, or in danger of overwhelming the others. The intelligences interact with, and build upon, one another from the beginning of life.[21]

Gardner in his identification of kinds of intelligence, has little to say about visual intelligence. He talks about spatial intelligence and bodily intelligence and appears to associate these loosely with artistic endeavour. He does not appear to recognise, that the intuitive shared experiences that are ascribed to those possessing musical intelligence, are of a similar character to those who are involved in artistic creation or aesthetic appreciation of visual forms.

ASSESSING PERSONALITY AND CREATIVITY ON THREE DIMENSIONS

Experimental studies which place creativity within its social and environmental influences are extremely rare. Creativity research has been heavily personality orientated; studies on the description and identification of creative personality and cognitive style have pre-dominated. Although the work has been of great importance and use, theories of the creative process must be seen to be incomplete unless set in context. This process is a means of accounting for the social-situational determinants. Munro is sceptical about the general classification of personality typing, he finds it particularly inappropriate in artistic fields.

> 'Every individual in modern civilization develops several "selves" or "personnae", different configurational aspects of his personality. These he habitually presents in different types of situation or to different types of person, including himself. An artist presents

> certain aspects of his personality in his art, but not his whole personality. Much depends on the social environment, what it requires of the individual, and how he adjusts his own desires to this environment.'[22]

Most of the experimental work on creativity has used one of two assessment techniques. A number of studies have had judges rate the products of participants, but the vast majority have relied on constructed creativity tests, dominated by verbal reasoning. Amabile[23] states that the major problem with these tests is that they are not tied to any operational definition of creativity. She states that a more stringent approach has been taken by other research; this centres on outcome, the resulting artefact, and proposes that the qualities of novelty and appropriateness differentiate creative from uncreative products. This research is also set in the context of the problem, or the audience to which it was addressed. Amabile still regards this as insufficient; she states, that despite the existence of such intuitively reasonable definitions, the creativity tests, and the studies built around them, are operating in a definitional void. There appears to be no useful assessment criteria for judging its novelty or appropriateness. Amabile's solution is, that, within the group or context, there is an agreed conditional consensus within the group and its situation. The most important features useful to this study are: first, that it requires that all the judges be familiar enough with the domain to have developed over a period of time some implicit criteria for creativity; second, the judges must make their assessments independently; third, other related aspects of their work, (technical and aesthetic should be considered). The most important factor is that the rating of the persons' creative thinking is centred in the products created.

One may accept that creativity tests and personality scales may prove useful, in general circumstances, amongst the general population. However, something much more specific, directed and context bound was required to assess students of above average intelligence (A levels), who had been selected for their creative abilities, and were working in a hot house of creative thinking, an Art College. The solution chosen was based on three dimensions: extraversion/intraversion, stability/neuroticism and convergent/divergent thinking. These were to be assessed on dipolar scales by individual judges using their common sense meanings of the terms in the context of their professional competence. Each student's positions on these dimensions was to be determined by several tutors and by the student, all making their judgements independently. I considered that tutors, familiar with the domain, and familiar with all aspects of the student's work, and the artefacts that the student had produced in the preceding two years, could be considered more than adequate 'judges'[24] for this task. It remained to be seen how far the student's own judgement concurred with those of the tutors. The work of Amabile was pertinent because it focussed on a specific context bound group.

The rationale for this approach is that there are human characteristics which can be scaled for individual people in particular contexts. The question is whether an individual's profile can be related to his or her ability as a designer using CAD.

PROCESSES OF DESIGN IN THE FASHION INDUSTRY

It must be recognised that the aims of the study are focussed on the process of design of fashion students. Understanding or eliciting from a designer their particular mode of operation, was shown in chapter one, to be very difficult, or even impossible. It is important that the reader has some understanding of the 'process' of a fashion design from concept to artefact. Whilst recognising that this process is not necessarily serialist, some recognisable stages, forced by commercial considerations and convention, are also reflected in fashion course structures; these can be offered as discussion points. These are: idea generation, idea development, toile development and design analysis, construction of sample, and idea communication.

Idea Generation

In mainstream commercial design, many designers produce story-boards which are influenced by 'design trends', these which emerge at the main fabric shows and from leading commercial forecast companies and leading design houses. Idea generation in this sense could be seen as mechanistic originality. However, unexpected trends emerge and confound, thus providing an engine of expectation which drives the market forward. Students are encouraged to develop their own sense of the 'new', and projects are set which expect them to generate, from sources, original perspectives within a brief.

Idea Development

Evidence of idea development is expected by most fashion courses. The conventional form, portfolio design sheets that develop the theme, are the means by which the major part of a student's creativity is judged.

Design Analysis and Toile Creation

The analysis of the design, involves decisions about the parameters for production, the method of creating the toile and an analysis of the qualities of the fabric and the design shape. The construction of a toile, (a pre-prototype garment made up in a similar, but much less expensive, fabric, i.e. calico), is the conventional practice. The shape is created by means of flat pattern cutting, modelling on the stand or a combination of both methods. Idea development usually continues during this stage. This offers an interegnum before the sample garment is made, it is time used for analysis and change. It was of particular interest to find the students' measure of importance of this stage, and the measure of change to the garment or range that is made at this stage. The means by which the student created a toile was seen as a crucial element for later consideration.

Sample Construction

The actual construction of the prototype is not always completed by the student. In many degree courses, which focus on design elements, a considerable part of the work is done by, or in co-operation with technical assistants. The work in this sector is usually seen as being of a particularly different status to the preceeding operations. However, there is a continuing explicit hierarchy of status that can be recognised in many fashion departments as one works 'down' through the design process. In company design departments the toile stage is often omitted; their past experience of their product means that the sample is usually made directly from a first pattern. Toiles or toile sections are constructed only when new innovative styles and shapes are under consideration.

Idea Communication

Illustration of the idea usually takes two forms; the provision of precise information for the production of the sample, and illustration as the means of marketing the idea. These are very different tasks. The latter can be very important if the product has to be sold without the production of the sample. There are conflicting opinions about the realism of the image with regard to its effectiveness as a sales medium.

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Gifted Students Wiley, New York, 1962.

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11 Liam Hudson, Contrary Imaginations Methuen & Co. Ltd., London, 1966. Hudson states that the critics of Getzel and Jackson's study missed the main point. They separated intelligence from creativity. He argues that seeking evidence of creativity I.Q. is of little help if you are faced with a form full of clever boys. By selecting as study participants, boys within the top 5% of intelligence, the factor of intelligence could be discounted in his study. His measurements of divergent thinking however, were 'Meanings of Words' and 'Uses of Objects'. See Liam Hudson, Frames of Mind: Ability, Perception and Self-Perception in the Arts and Sciences Methuen, London, 1968.

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CHAPTER THIRTEEN: AIMS OF THE OBSERVATION OF STUDENTS USING CAD

The over-riding aim was to identify issues that may be embedded in the practice of design for fashion/textiles on the computer.

Seven aims were identified at the start. These were:

(1) to develop a means of identifying individual divergent thinkers within a group of BA Hons. fashion students;

(2) to develop a means of identifying individual personality traits within a group of BA Hons. fashion students;

(3) to assess any relationship that may occur between divergent thinking, personality trait, and the use of CAD, or attitudes to the use of CAD, in the design process;

(4) to select means of identifying any other differences within a group of BA Hons. fashion students;

(5) to assess any relationship that may occur between any other identified difference and the use of CAD, or attitudes to the use of CAD, in the design process;

(6) to make an un-categorised examination of the student's use of CAD, and their attitudes to the use of CAD, and to consider the reasons for their practice and their views; and

(7) to record any unexpected outcomes arising from the study.

It was recognised that an observed field study on a design process was fraught with variable problems. However, it was believed that if some control could be imposed on important identifiable variables, some new knowledge may emerge.

CHAPTER FOURTEEN: METHODS CHOSEN FOR THE OBSERVATION OF STUDENTS USING CAD

INTRODUCTION

The participants chosen for the research were final year BA Hons. fashion design students, using CAD during their final collections. It was planned as a field study and the research method chosen was recorded participant observation. Any quantitative data recorded was to be seen as explanatory and descriptive. The selection of degree students, (A-level entry), diminished any confusion in the area of basic intelligence[1]. It was decided to run an initial study with five students during their summer collection term in 1987, and then proceed to a further study. This was planned to take place from Autumn 1987 to summer 1988. Two inter-connecting studios were used for the research, the room lay-out and equipment are shown in Appendix XXVI. The students worked alone in the studios or in small groups. After the initial training sessions, they were allowed use of the studios virtually on demand.

The participant observation of this research is mainly documented as case studies of individual students or groups of students using CAD. All methods of research have valid criticisms attached to them and objectivity is rarely obtainable in any type of research[2]. It is impossible to strip this research of all personal bias. The research attempts to avoid the documented explicit hazards of case study methods[3]; direct quotes of the participants are set into a simple descriptive context, to help the reader to distinguish data from the researcher's interpretation of the data and to make alternative judgements. Macdonald and Walker state:

> 'The case study worker is guided in his research by the pursuit of discrepancy. It is implicit in the notion of

> case study that there is no one true definition of the situation. In social situations the truth is multiple.' [4]

They believe that the case study worker is a collector of definitions. The collection is validated via a continuous process of negotiation with those involved. Wherever appropriate they believe that the case study should contain the expressed reactions (un-edited and unglossed) of the principal characters portrayed.

THE FIVE STUDENT STUDY

The student sample was selected by students who wished to take part in the study, (5 of a group of 20 students), drawing lots for the five places available.

The students were told that after experience on all parts of the technology available for one week, they could choose to have supported use of the computer for any section of their work. This open-ended choice was seen as important.

The students were given five days intensive course on the broad aspects of a raster 'paint' software programme, (DESIGNER), for image generation and a vector software programme, (ORMUS- FASHION developed for this research), for design analysis and pattern cutting. It was pointed out to the students that the work developed in the vector system could be transferred at any time into the paint programme. The training was not didactic, it aimed to give students basic knowledge of the operation of the software programmes and to let them develop their way of using the system. Support was always available as they explored differing directions. The students were then told that they were expected to cut one garment pattern from their final collection on the computer. After this, it was their choice as to the amount they used any of the software during the term.

A diary of field notes was kept by me during the study. This diary could not be kept as a minute record, but had to be seen as a reflection of general impressions, and notes of what appeared to be important, and of relevant instances.

Once the students had finished all their degree work and their assessments had been completed, they were interviewed to discover their ideas about using the technology. The interview took the form of a constructed conversation, (Appendix XXVII). Particular questions were asked but the students were allowed to divert the conversation to areas that they considered important. The interview was taped, this meant that the conversation was relaxed and not inhibited by note-taking. Any remark that they wished to retract from publication was immediately removed from the tape.

The personality and thinking style scale was completed by the students and by the students' tutors. They were asked to complete the scales independently and not to discuss their recordings until the scales had been handed in. The rationale for the construction of this scale is discussed in chapter 12, its means of operation is explained in Tables 4 and 5.

The students' previous education and industrial experience was made available from the college records.

THE TEN STUDENT STUDY

It was expected that the study would continue during the college year 1987-88 with ten student participants. It was envisaged that they would be selected by the same method as that used in the Five Student Study, by drawing lots for the ten places available. In preparation for this, an evaluation of the Five Student Study was planned. This was to relate to the aims set by the study. It covered five stages.

(1) An assessment of the viability of the dimension scales before proceeding.

(2) An identification of other factors which may have affected the students use or attitude to CAD, particularly during the introductory period.

(3) An assessment of any affects that might be made by these variables on students' use or attitudes which may merit further investigation.

TABLE 4: A DESCRIPTION OF THE PERSONALITY AND THINKING STYLE SCALE AS GIVEN TO STUDENTS AND THEIR TUTORS

DIVERGENT THINKING AND PERSONALITY TRAITS: A THREE DIMENSIONAL SCALE

The three dimensional scale model used for this research has been constructed as a means of recording the styles of thinking and the personality traits of a group of students. The students have had the opportunity to use two Computer Aided Design software programmes whilst working on their final collections.

The Scale Dimensions

1. Divergent Thinking - Convergent Thinking
2. Extraversion - Introversion
3. Neuroticism - Stability

The dimension of Divergent Thinking - Convergent Thinking is related, for the purposes of this study, to the students' work in the area of design and related studies.
The frame of reference which should be used when recording the measure of a student's divergent thinking is that his/her work is 'novel but appropriate' to the field of Fashion/Textile Design or related studies.

Completion of the Scales

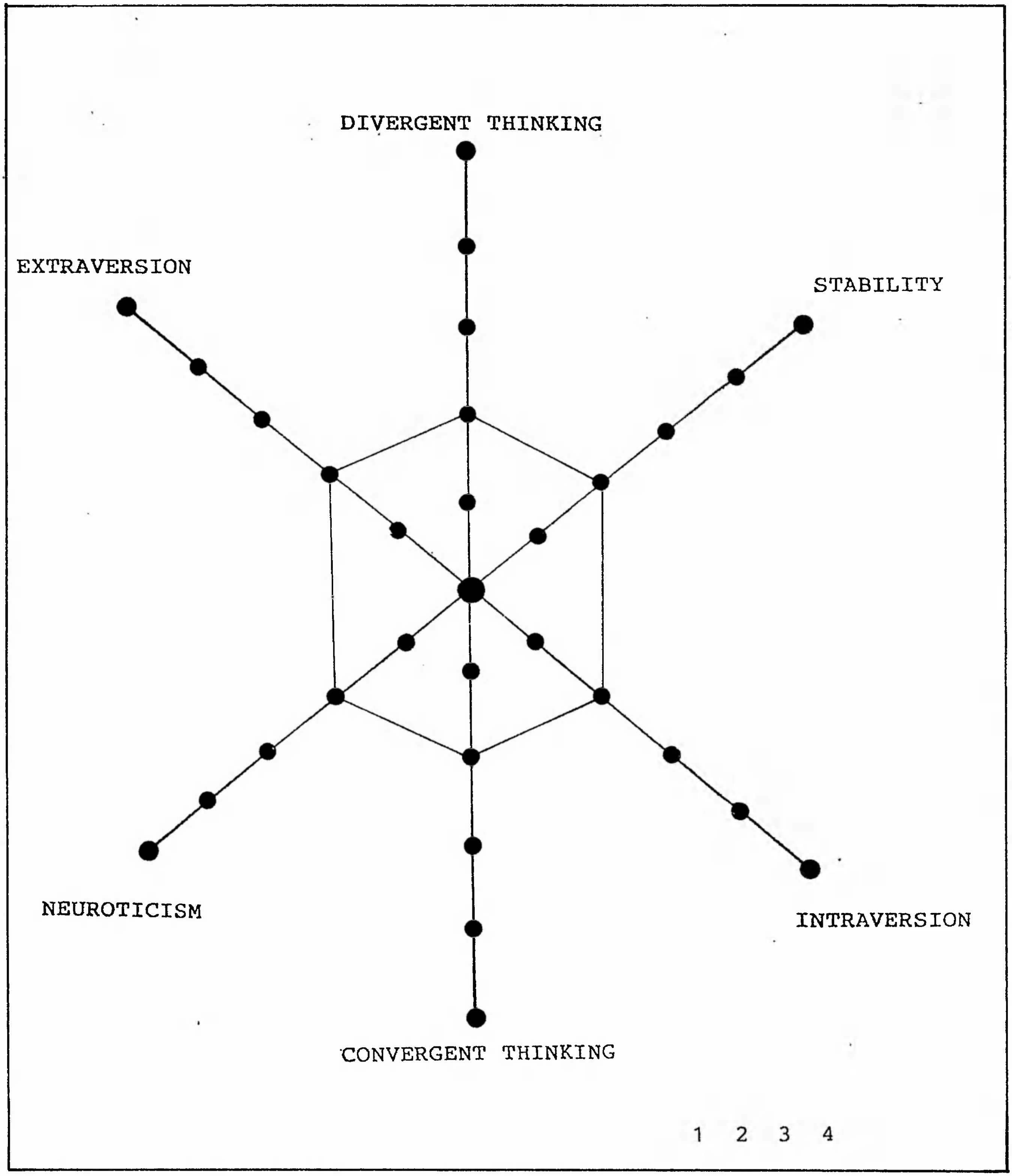
1. A scale is provided for each student.

2. Place a cross on each dimension in the position which you consider reflects the student's style of thinking and their personality traits.

3. Accept that the central point of the scale as the average for the general population and NOT as a relative or comparative measure within the group of students.

4. Complete the scales in the order shown at the top of the page. It is important that the measure of Divergent Thinking - Convergent Thinking is completed first.

TABLE 5: THE PERSONALITY AND THINKING STYLE SCALE AS USED BY STUDENTS AND THEIR TUTORS



(4) An examination of any curious or unexpected events or discussions that occurred during this period and to make an assessment of their relevance to this study.

(5) Preparation of a revised plan for the field study of ten students was envisaged.

The evaluation of this study, finally offered, can only be my perspective set within the context of this study. Stake asserts that every aspect of an educational programme holds at least as many truths as there are viewers. 'Each sees value in a different light. The evaluator has no cause to force consensus, but certainly to show the distribution of perceptions'[5]. In this research it is the perceptions of the students, many of them already practising designers, that offer us new knowledge and perspectives. It can be an individual or collective interpretation of features of CAD that they discovered. I hope that these are shown. I would argue that it is their 'truth' and, as such, is of value to us. This is a validity strongly distrusted by psychometricians.[6]

REFERENCES

1 See the relationship between intelligence and divergent thinking discussed in chapter twelve of this study. See Liam Hudson in Contrary Imaginations Methuen, London, 1966, pp.107-108.

2 David Hamilton in 'Educational Research: Francis Galton and Ronald Fisher' looks at other types of situation analysis. He believes that attempts with factor analysis, cluster analysis and classroom interaction analysis are fraught with bias. Hamilton suggests that it pre-selects data which are consonant with its theoretical and methodological assumptions, 'since the data are so theory laden they can do little more than complete a circle', Rethinking Educational Research ed. W.Dockrell

and David Hamilton, Hodder and Stoughton, London, 1980, pp. 167-168.

3 Many books on educational research list the general hazards of using participant observation as a research method. Supporters of the technique often operate a self-discipline that identifies the less obvious problems. See the problems identified by Barry MacDonald and Rob Walker in 'Case study and the social philosophy of educational research' in Beyond the Numbers Game ed. David Hamilton, Macmillan, London, 1977, 4.3, p. 184. See also Robert Burgess's 'Introduction' in The Research Process in Educational Settings The Falmer Press, London, 1984, and 'Case Study' by John Nisbet and Joyce Watt, Rediguide 26 ed. M.B.Youngman, Nottingham University Guides in Educational Research, University of Nottingham School of Education, 1978.

4 Barry MacDonald and Rob Walker in 'Case study and the social philosophy of educational research' in Beyond the Numbers Game ed. David Hamilton, Macmillan, London, 1977, 4.3, p. 188.

5 Robert Stake, 'The seven principal cardinals of educational evaluation' in Beyond the Numbers Game ed. David Hamilton, Macmillan, London, 1977, 3.26, p. 160.

6 Rob Walker in 'The Conduct of Educational Case Studies: Ethics, Theory and Procedures' in Rethinking Educational Research ed. W.B.Dockrell and David Hamilton, Hodder & Stoughton, London, 1980, p. 45. Walker states that how the world appears to the people in it is often seen as interference to the test designer; to the case study worker these truths are more important than the judgements of outsiders.

CHAPTER FIFTEEN: THE FIVE STUDENT STUDY

INTRODUCTION

This chapter examines five individual encounters with a new phenomenon, CAD. Concise descriptions of each student's experiences are offered. They are derived from: my recorded field notes of the students' use of the systems and their comments during training; and my recorded field notes of the students' use of the systems during the production of their collection; and the students' own descriptions of their experiences in a retrospective interview after their collections had been assessed.

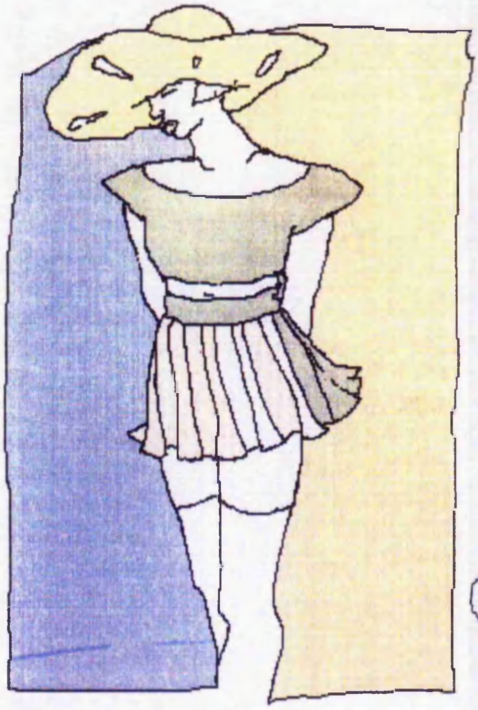
The research concentrates on their ideas which cluster around the particular areas of the design process in fashion; idea generation, idea development, design analysis and toile development, construction of the sample and idea communication.

The following pages give a report of each of the five students under these headings:

Student profile - personality and thinking style
The introductory training period
The collection
The future

This leads to a discussion of the outcomes of this study.

A collective example of the graphic work of the five students is shown in Figure 1.



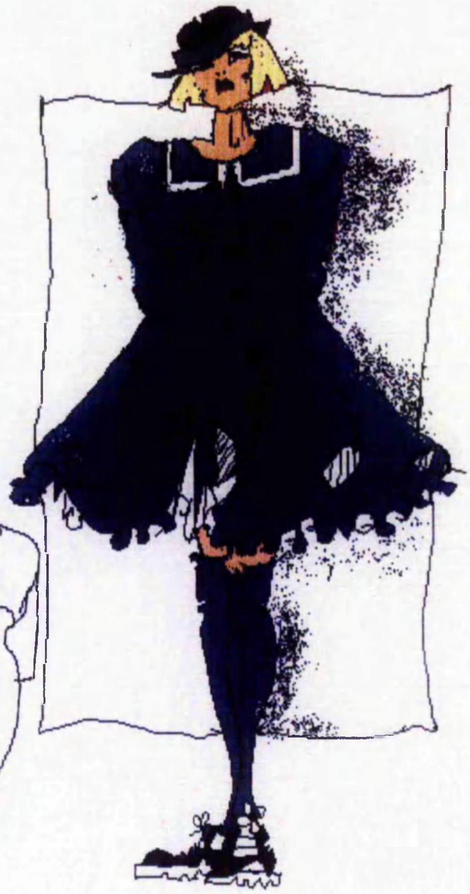


FIGURE 1: SAMPLES OF THE
FIVE STUDENTS' GRAPHIC WORK

FINDINGS: STUDENT A

Student Profile - Personality and Thinking Style

Table 6 shows the positions assigned to the student by the tutors and by the student herself. It showed almost unanimous agreement in slews towards dimensional extremes on each of the scales. The amount varied, but only slightly. The student offered two recordings for extroversion-introversion depending on her social or work interactions. Tutor 4, the technical tutor saw her as more introverted. This could be explained by the fact that she said she was hopeless at pattern cutting and got very uptight in practical sessions. The student's comments re-inforced this assessment, she must have relaxed during graphic work sessions where her competence was obvious.

In the context, (use of CAD in fashion design), in which I worked with the student, I agree with this descriptive data of her, recorded by the tutors' dimensions.

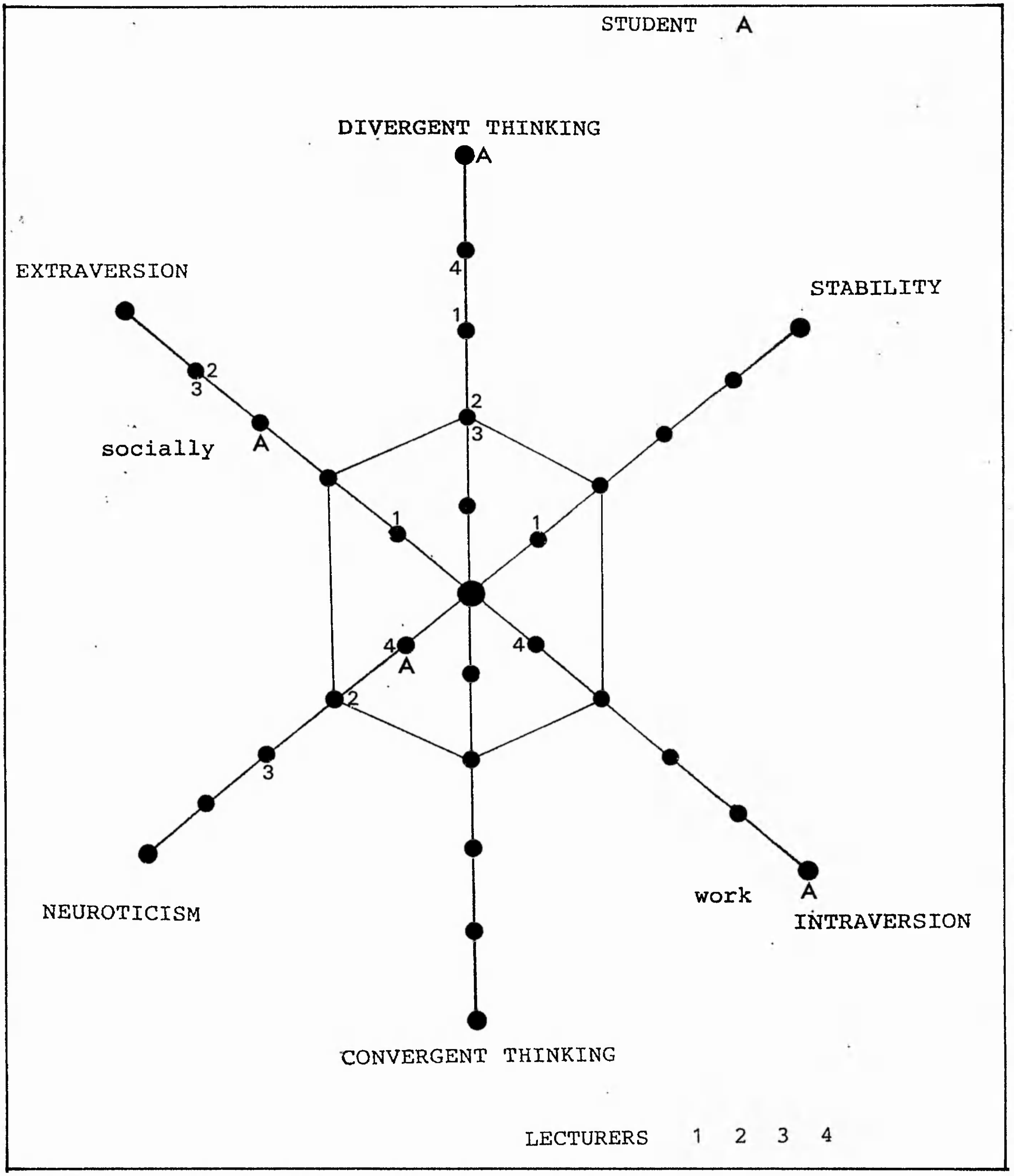
Introductory Training Period: Field Notes and Students' Comments

The student seemed to get an instant 'high' from her first experience of the raster paint system, 'I'm having so much fun', I haven't mixed colours like this'. She found that she could draw directly into the system with the fluency that she drew on paper. Her drawing skills and her confidence in them were apparent.

Her confidence was such that on the second period of training she brought a specific project to work on. It was interesting, that although her illustrative work was of a high quality and experimental, there was not the same fluency or innovation in the actual design of garments. Her rather rigid approach to design was not eased by the computer. This approach to the technology was repeated, prepared work was brought in, and the simple alternatives offered by the computer appeared to satisfy her.

As the training period progressed her first impression that, 'it is much more flexible than I expected', was tempered. As she became use to

TABLE 6: STUDENT A - PERSONALITY AND THINKING STYLE SCALE



the system she became more critical of its deficiencies. These, however, were graphic limitations; she found the pen stroke restrictive, she found the inaccessibility of the screen image frustrating.

> 'It's always a second hand image it would be nice to just take the glass image with you. It's unique... that image of light is really beautiful. I'd like to take that away.'

Her fascination and appreciation of CAD as a graphic media remained throughout and beyond the project.

The basic introduction to the vector system provided few problems but it was apparent that, when working for her collection, the problem was going to be the application of her pattern cutting knowledge.

> 'my major block is pattern cutting... couldn't be a pattern cutter... when you were using it, it looked so efficient I thought, "why don't people use this all the time"... I get so frustrated by the old way.'

The Collection - Field Notes and the Student's Retrospective View
The ideas on which the collection was based had already been formed 'curve cutting'. This was interesting as the idea was going to entail some very clever pattern cutting. When discussing the use of CAD in the generation of ideas. the student was dismissive of this element '... I generate ideas in my head often in the middle of the night... the technology actually creates a block between me and new ideas.'

The student used the paint system to look at colour effects and the use of textures and prints within the shapes. The alternatives were closely restricted to the fabric samples and the range of colours pre-selected. it appeared to be an exercise in fine tuning.

The translation of her graphic ideas into garments appeared to be a major problem for the student. The computer analysis gave her an opportunity to make some sense of this stage. A straight conversion of the graphic sketch showed that it would require a model of 8' 2" to wear the garment. When it was re-scaled to the dress stand the design looked ordinary, in fact frumpy. The proportions of the garment had to be quite dramatically changed to give it, in reality, the mentally conceived 'shrunk leggy' look.

In pattern creation, it was soon apparent that her difficulty with pattern cutting was going to be a problem. I was supposed to be operating a 'hands-off' approach except with regard to the technology. Her affection for the vector system and the desire to make her computer pattern the base for all her garments has, I suspect, an element of the Hawthorne effect and an element of escape from what she perceives as tedious work. I found it difficult to understand a student being so bereft of basic knowledge in her third year. The amount of help she was going to need was queried with the Fashion tutors. In practice the student with support did manage to create and understand the cut of the garment pattern. Her comments on this stage at the later interview were interesting.

> 'It was understandable to me at last what I was doing... it was logical... the best thing is that you can see all the piece at once, you can see everything on the screen... you can see that the armhole won't fit... it just seems silly when in the old way, you to have to do them so big and to wrestle with all that paper and stick them about, and you lose bits and forget what you have done. I found it so illogical... its a bit better on the dress stand; it, at least, makes sense.'

The student decided to do some illustration work for her assessment portfolio, she seemed to be relaxed now that the fashion show was over and she was working on illustrations, an area over which she feels she has control. She felt she could put only a limited amount of CAD work in her portfolio, as she was not sure how the assessor would react. This was a dilemma for her, she now found it 'artistically easier' to work on the computer and was finding it difficult to go back to manual methods.

> 'its easier with the computer and I think the results are nicer... when I've been drawing by hand I've been trying to simulate effects I've done on the computer... which is a bit odd and is probably why I now find it frustrating.'

The student was asked to summarise the most important features for her... its advantages and disadvantages. The illustrative element was of most importance to her. She stated that at first it is fun, then you get used to using it; you get over the novelty and then it gets to be another media. She is, however, still impressed:

> 'my computer work takes so little time and looks so fresh and spontaneous... I like the image and I can't achieve it with paint....the image is different, it's got a different quality.'

She is aware of the disadvantages, the mechanistic parts of it were frustrating for her,:

> 'I'm impatient... I can't do things impulsively... I have to go through the system... I forget to save it .... that's really frustrating.'

The computer enviromnent was discussed; whilst the student liked to work alone in a studio with the computer, after two hours she had to go out to talk to people.

The Future

The student came back after the end of term and asked to use the computer. She spent some time developing more work for her portfolio. She believed it would prove useful in her search for work. She wanted to use the technology if she could, but 'I can't see much chance at this time and I will just have to take what is offered.'

FINDINGS: STUDENT B

Student Profile - Personality and Thinking Style

Table 7 shows the positions assigned to the student by the tutors and by the student herself. It showed almost unanimous agreement in slews towards dimensional extremes on each of the scales. There appears to be no account for the 'stray' marker.

In the context, (use of CAD in fashion design), in which I worked with the student, I agree with this descriptive data of her, recorded by the dimensions.

Introductory Training Period - Field Notes and Student's Comments

Student B's first experiences with the technology were:

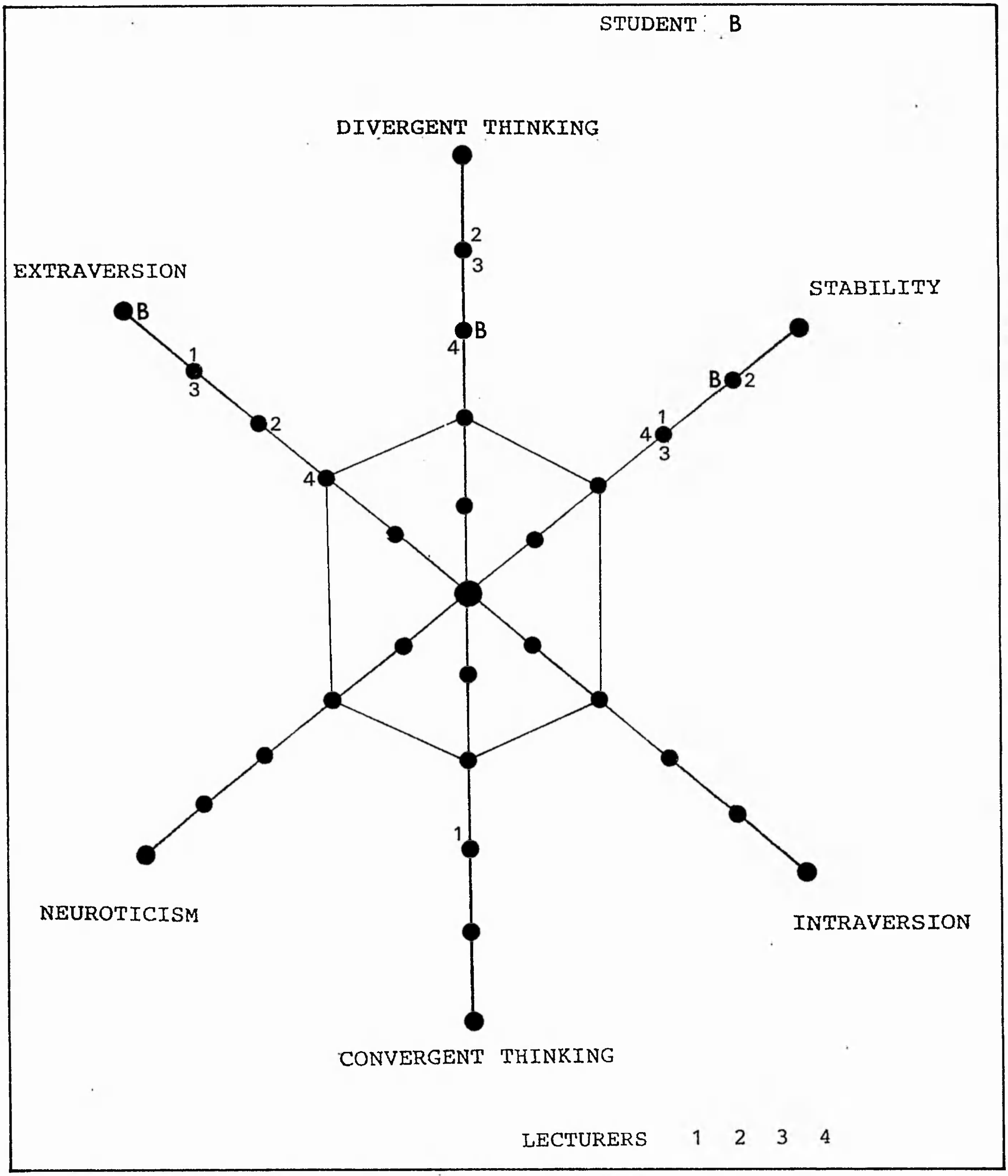
> 'aesthetically stimulating... it opens up new avenues and directions... it scares me... it could become addictive, I would have liked to go on and on... '

It was soon evident that the student was primarily interested in the characteristics of the technology, seeing it immediately as a media in its own right, not just because of its fashion or novelty. She was able to explore its capacities with confidence, her graphic skill was extremely sure, her drawing fluent, she rarely corrected a line. She had expected that drawing on a computer would be much more difficult.

As the training progressed it was evident that her work was centred on linear form; the quality of the line was important to her. In discussion on the nature of the line, and its dependence on the resolution of the system, she considered that the 'jag' was a characteristic of the media which gave her work an alternative dimension.

During the training period the student exceeded the amount of basic training time, she used the system for concurrent projects. This was interesting, as at first she expressed worry at joining the CAD project in case it interfered with her other work. She became the most

TABLE 7: STUDENT B – PERSONALITY AND THINKING STYLE SCALE



enthusiastic student of the group in terms of raster-paint systems.

She was unimpressed by her early introduction to design analysis and pattern cutting with the vector programme. She works competently, and almost entirely, on the dress stand and felt, at this stage that it would add little to her work.

The Collection - Field Notes and the Student's Retrospective View

The student's ideas for the collection, already formed, were always highly influenced by fabric and their tactile qualities. Again there was a dismissal of its attractions as a 'generator of ideas':

> 'I get more ideas with a pencil... I like my sketch book for jotting ideas... the computer is better for elaboration... for development, alternatives in colour and designs.'

During the development stage of the collection the student used the paint system to look at colour effects.

The translation of her graphic ideas into garments was a logical step to this student; the drawing style offered accurate representations of the clothes in both design and proportion. The translation onto the dress stand was only hindered by lack of experience in draping and cutting techniques. In the department's studio these deficiencies could be remedied by the access to tutors. She cut a pattern on the computer in the later stages of the collection when most of her problems had been solved. However, whilst developing the pattern she continually printed out intermediate stages, cut out calico shapes and worked with the dress stand in close attendance. She was only satisfied if she could see the development 'in the real' as she was working. She was satisfied with the toile which she constructed on the computer, but her description of her experiences were lucid:

> 'I'm not a mathematical person, I work mainly on the stand... I basically hate pattern cutting on the table so I'm hardly likely to enjoy it any more on the computer. Pieces of pattern laying around on the table is confusing... difficult to judge differences. I work

> with bits of calico chopping here, there and everywhere, building up the shape on the model. Using the computer was better than the table, in that you can see the shape clearer than on the table, it makes more sense. I would like to give it another go.. not enough time to make a complete judgement.'

The student saw the attraction of computer use in terms of its illustrative capabilities. She confessed that she found it difficult to apply colour to her manual drawings and preferred working on the system. She believed it had changed her work:

> 'Its changed my work but I don't know whether its backwards or forwards... You can't tell if my other work is better... I don't know how my work would be if I hadn't used the computer.'

Against her tutor's advice, she put a considerable amount of computer graphic work in her portfolio for final assessment. The other students were nervous about its reception. It was interesting to find that the assessor was impressed by her work.

The student's evaluation of the technology centred on the graphic capabilities of the software, she saw it primarily as a means of communication. She liked the fact that you don't ruin work if you make a mistake; however, she found it disturbing that the quality of colour she generated on screen was not attainable as hard copy. However, the student particularly liked the experience of working on the system.

> 'I know that when I am working on this computer I am totally absorbed... time flies here as if there was no tomorrow.'

The Future

The student said that she intended to use it in the future if there was any opportunity, she was going to investigate ways of extending her father's system.

FINDINGS: STUDENT C

Student Profile - Personality and Thinking Style

Table 8 shows the positions assigned to the student by the tutors and by the student herself. It showed almost unanimous agreement between the tutors in slews towards dimensional extremes on each of the scales. The student offered two positions for neuroticism and introversion, giving the qualification of circumstances. His recording showed that he disagreed profoundly with his tutors assessment in the dimension of divergent thinking. He commented, when handing in the form, that he usually had a stable temperament; 'but working in the studio was enough to make anyone neurotic'.

In the context, (use of CAD in fashion design), in which I worked with the student, I agree with the descriptive data of the student made by the tutors. It could be that coming straight from the studio I encountered some 'neurotic overspill'; but, on consideration, I felt that his agitation was centred on the high expectations he demanded of himself.

Introductory Training Period - Field Notes and Student's Comments

The student's first experience seemed to be positive, he grasped the operations of the system quickly; he appeared to like it. He was soon drawing fluently on the raster-paint system and said that it was more interesting than he expected. 'I enjoyed it, I didn't expect to'.

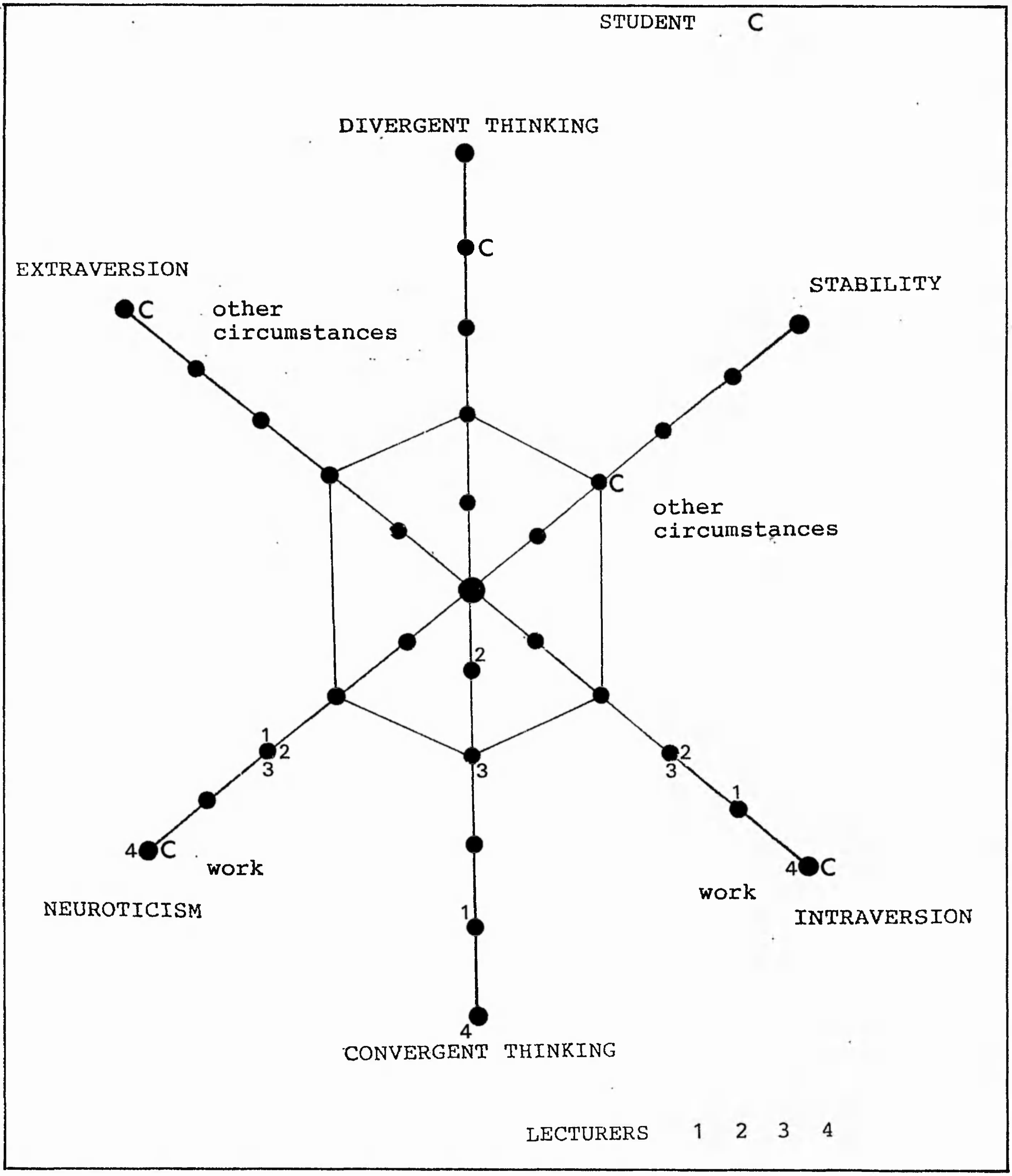
During the second training system, the student digitised a drawing into the system; he then used the options to create textures and different colourways. He saw this as a widening of options.

> 'when I'm working manually, I usually use only line and flat colour... and I usually use plain fabrics.'

He continually under-estimated everything that he produced, he even appeared to be disappointed by print-outs for which he expressed some appreciation. He continually said it was, 'a bad day'.

He did not have any experience of the vector system before he used

TABLE 8: STUDENT C - PERSONALITY AND THINKING STYLE SCALE



it for his collection. He did not have time to complete all his basic training, he felt that he had to concentrate more on his final collection work. His collection appeared to worry him considerably.

The Collection – Field Notes and the Student's Retrospective View

The student's ideas for his collection, because of the timing of the project, were again already formed, classical menswear with original cut. Although he did not use the system at any time during the development of his design ideas for his collection, he said that he would like to buy one if it were affordable, 'I would be able to try more things'. This seemed illogical; however, further conversation made it apparent that he liked the technology, but lacked the confidence to use it in such a crucial situation.

When developing his patterns; he had, like the other students, a great affinity for the stand. He explained his reasons:

> 'I like working on the stand, it's a matter of confidence, I don't know what I'm going to end up with, but I can see it appearing... if I found that working on the computer produced the same results, I would put the stand aside...'

The result, not the means, was seen as the deciding criteria for the principles on which he worked. He believed that his experiences with the computer had made him more methodical:

> ' before it just used to happen, I didn't know how it happened... I'm taking it in stages now... It's made me think about how I work, I don't know if it is a good thing.. if the result is okay, I'm happy.'

He felt that he would like to learn more about pattern cutting on the system. When it was suggested to him that it might be like using quarter-scales he opposed this idea:

> 'When it's on the screen, I don't see it as its actual size, I see it as huge... you don't look at the television and say, "look at those little people"... its like looking down on the pattern from a height.'

The Future

The student did not use the computer for any of his portfolio illustrations for assessment, but he saw it as being useful in the future. The attraction was the instant access to media, 'It cuts out all hassle with paper and finding the right paint before you can start'. He was enthusiastic about finding opportunities to use it in pattern development. He stated that if he joined a company, that had a system, he would want to know how to use it:

> 'I couldn't design and not make my patterns... I see the computer as a means of having more say in a garment's production.'

The student extended his use of the computer when he continued his studies at the Royal College of Art.

FINDINGS: STUDENT D

Student Profile - Personality and Thinking Style

Table 9 shows the positions assigned to the student by the tutors and by the student herself. It showed almost unanimous agreement in centering the recordings around the average. One tutor did not agree. This variation is discussed later in the piece. His recordings matched the recordings of the student. Note that the student gave two positions for different siuations.

In the context, (use of CAD in fashion design), in which I worked with the student I agree with the descriptive data of her, recorded by tutor 4.

Training Period - Field Notes and the Student's Comments

The student was, at first, attracted to the paint programme. She developed some embroidery designs for shoes that were very interesting in a remarkably short space of time. this excited her.

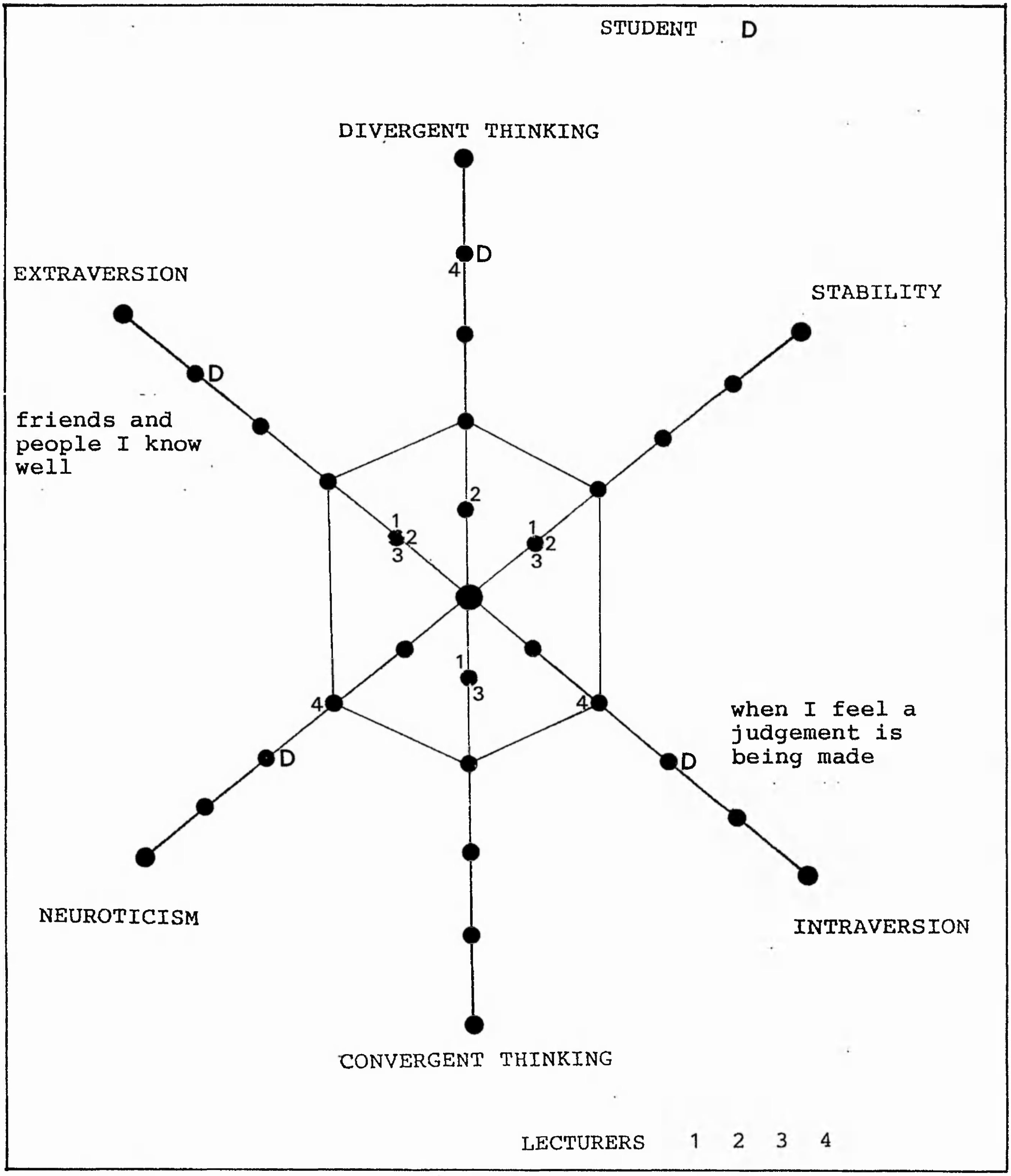
Her appreciation of the technology deteriorated when she attempted fashion drawings on the screen; there was some success in using other drawings and modifying them. It was clear that she hoped that the technology would provide the solution to a problem, but she found it disappointing.

> 'the design tutors only seem to accept stylised, accepted forms of fashion drawing which I cannot do... my ideas do not come in that way... I thought the computer might help.

The student was left-handed, this gave her added problems, forcing her into dis-jointed movements as she changed the options. Much computer software has not yet recognised the fact that a large proportion of artists are left-handed.

It was very apparent that this student understood, and was good at

TABLE 9: STUDENT D - PERSONALITY AND THINKING STYLE SCALE



both modelling on the stand and flat pattern cutting. She had very clear ideas about what she wanted to achieve. She spoke again about tensions between her and her tutors as she refused to modify her ideas, she knew how she wanted her garments to look and these did not necessarily have to be the currrent 'fashion look'. She had no difficulty using the vector system for pattern cutting, it was interesting that she related to the model stand and back to the technology, having no difficulty in fusing the differing conceptual procedures.

The Collection - Field Notes and the Student's Retrospective View

The student had clear ideas about her collection; her inspiration was from the tensions of mixing eastern and western fabrics. The textures were very important to her. Her ideas were developed in her head from the rich visual imagery that she gathered. The computer played no part in this.

The paint programme played no part in the development of her ideas. The vector programme was used extensively and creatively to develop her basic jacket shapes. She found the computer stand useful for defining the 'mental shape' and the pattern cutting options for their realisation. She was, however, only willing to see it as an addition not a substitution to her present methods.

> 'it's good for some things, particularly structured garments... and its fast... but I like to work on the stand with garments that I haven't fully decided how to work... like my skirts.'

The student did all her illustration work for her portfolio manually.

The Future

The student believed that she might use it for developing print designs, or, more likely, for pattern cutting.

FINDINGS: STUDENT E

Student Profile - Personality and Thinking Style

Table 10 shows the positions assigned to the student by the tutors and by the student herself. It showed almost unanimous agreement between the tutors as the scores cluster in the 'average' area. The student appears more uncertain, offering qualifications for most recordings.

In the context, (use of CAD in fashion design), in which I worked with the student, I agree with this descriptive data of her, recorded by the tutors' dimensions.

Introductory Training Period - Field Notes and Student's Comments

At first the student was apprehensive, she did not think that she could work with computers:

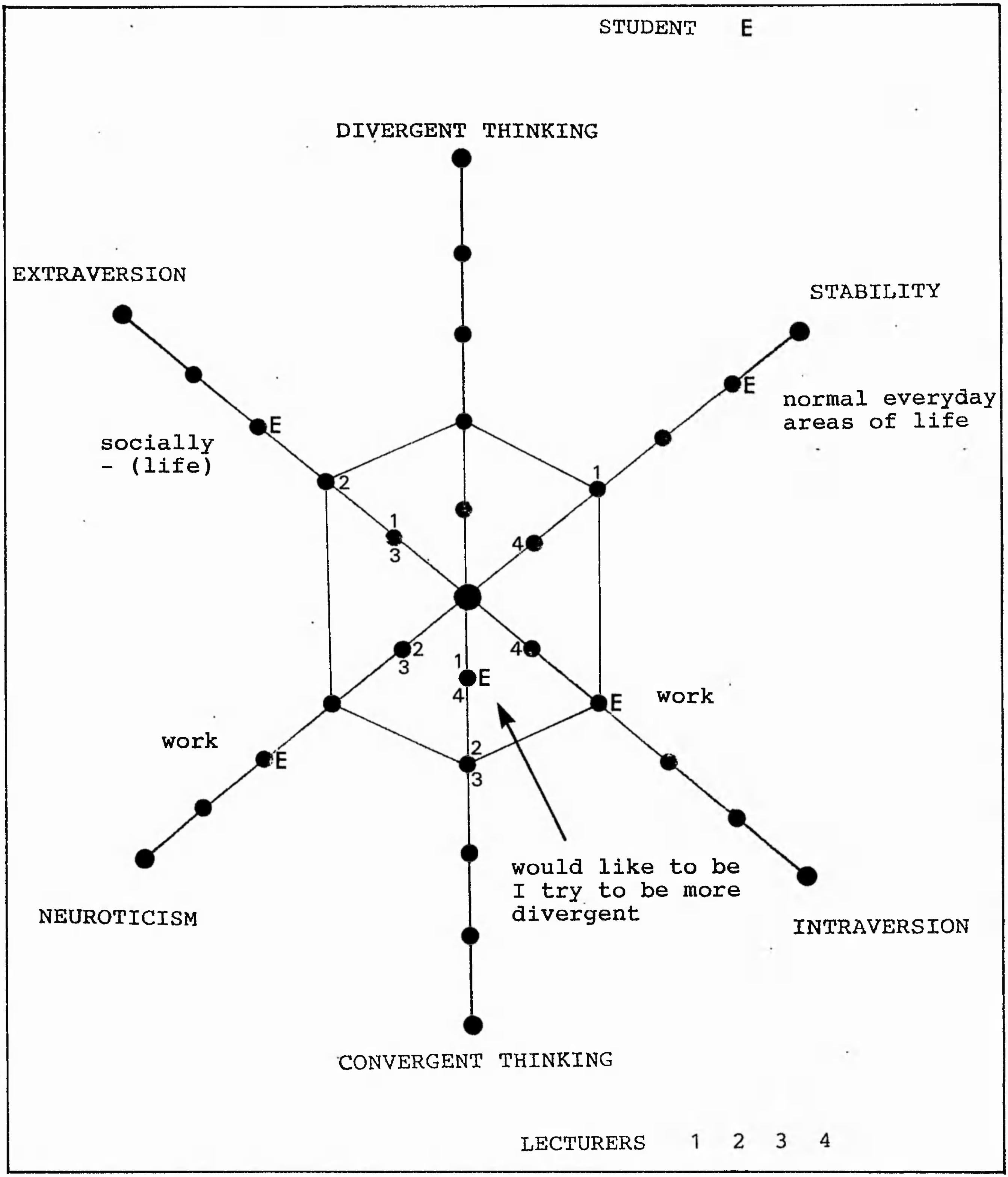
> 'I expected it to be a lot more difficult, a lot more complicated, I didn't expect to cope with it... It was an impulse, I just put my name in the hat'.

The student found it more interesting than she expected. She found drawing directly onto the screen a problem, she overcame this by digitising her own drawings into the system. In conversation with the student, it seemed that she had the same problem drawing directly with ink onto paper; she had to work carefully, editing pencil work, before she was satisfied.

The student did not expand the opportunities and the mechanical effects offered by the options on the paint system, she concentrated on the colour, brush and her own effects. She became very enthusiastic, 'nothing has made me work like this'. She believed her other work was improving, that her drawing was becoming more relaxed:

> 'the techniques used on the computer have given me the confidence to use other media, it has given me confidence with colour and prints... and it's made me think a bit

TABLE 10: STUDENT E - PERSONALITY AND THINKING STYLE SCALE



more about colour.'

The student's confidence continued to grow, she mastered the basic skills of the vector programme, although she was concerned about remembering the options. She said that when she was manually cutting patterns, she was now thinking about the whole of the pattern and taking more care with its accuracy.

The Collection - Field Notes and the Student's Retrospective View

The student was clear that the use of the computer had not been a part of the origination of her collection, it took its theme from schoolwear, 'I knew the look I wanted', but during the development stage:

> 'it helped a lot with my collection... it helped a hell of a lot really... I actually thought about what I was doing, far more intensely. Maybe its the novelty... but I did get ideas faster... I concentrated more... it was like condensed thinking. I usually concentrate too much on the illustration rather than the design, when I'm on the computer I'm thinking of the design so I generate more ideas.'

The translation of her ideas into pattern form presented little difficulty, the drawing of her designs matched the proportions of the dress stand almost perfectly, (Figure 2). The computer system just gave her confirmation of this fact and the data required to cut the pattern. Her greatest enthusiasm for CAD was in the area of pattern cutting:

> 'Oh that's brilliant..... the actual pattern cutting that's... ultra brilliant, its so much more accurate. I'm so scruffy with my patterns. It makes sense.'

It was interesting that four out of the five students found manual flat pattern cutting difficult; for most of their work they had abandoned its use in favour of the stand.

> 'In the first year, when I was given a flat pattern on paper, I just could not relate it to clothing... I got a sleeve and an armhole and did not know how it should

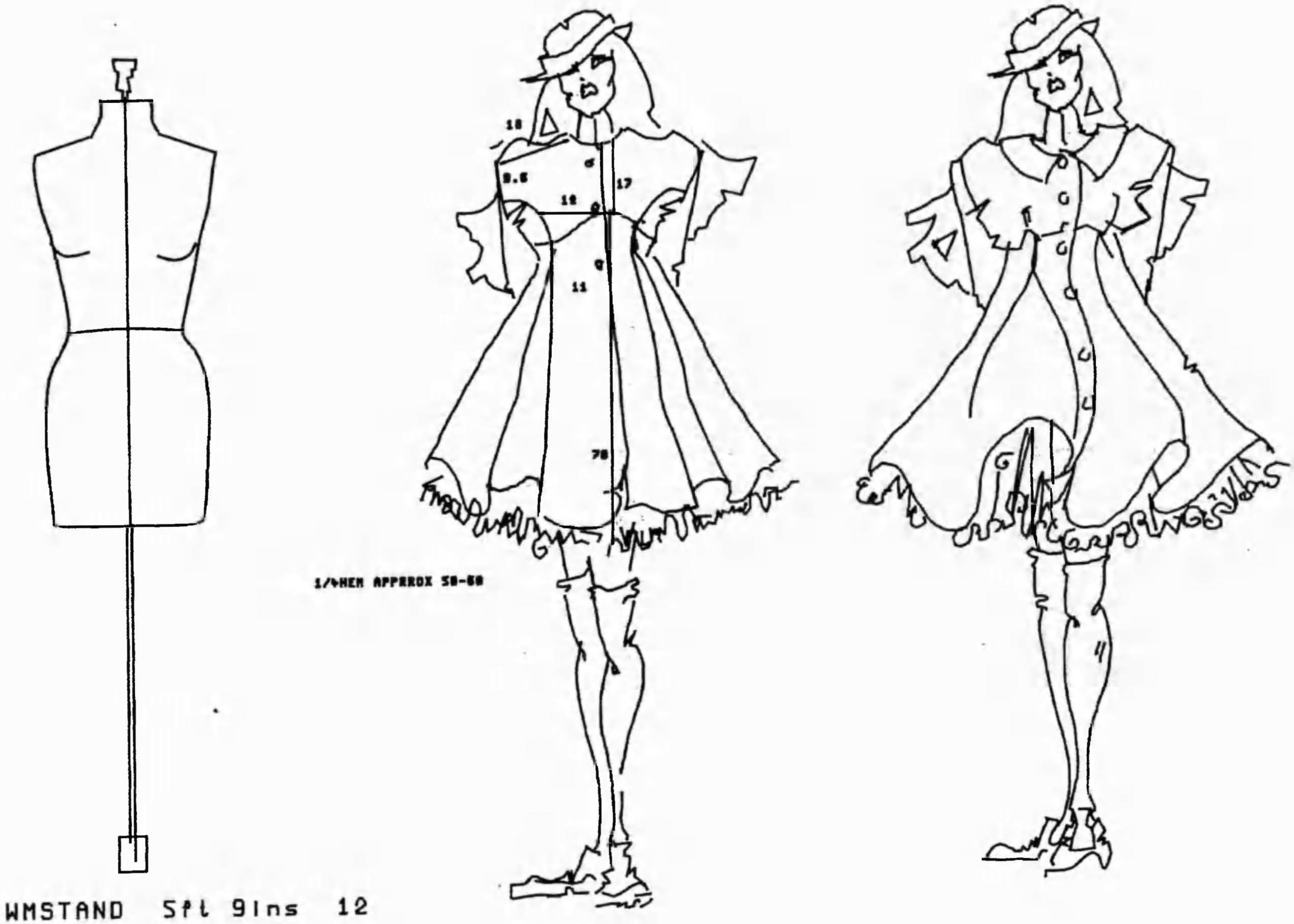


FIGURE 2: FIGURE DRAWING PROPORTIONS IN RELATION TO THE STAND

> be... I just couldn't relate it to clothing. When I got a piece of fabric on the stand I began to know what I was doing... it makes more sense because it's a body.'

The student used solely flat pattern cutting methods on the system relying on computer analysis for the measurements. She did not refer to the stand although it was always available. She said that the first toile required only minor alterations, some of which she decided to ignore. She commented on how accurate the patterns had been and how easy it had been to make up the garments. Figure 3 shows the student's pattern and a quick garment lay for cloth estimation.

The illustrative qualities of CAD were rejected by the student, 'its not real', but it was interesting that she thought that the use of it had improved her manual illustrations:

> 'its improved my illustration a bit... I'm more free... the system is good for computer illustration but you can't do real illustration... I mean you can to a certain extent, but its not personal, because it comes out of the computer.'

The Future

The student was positive about using it in the future stating that she would use it, both the raster and the vector, if she had the opportunity. She believed that everyone should learn it. She had some reservations, it was not a total committment; she would not like to be on the computer and nothing else' 'I would hate to be on it all day'.

The student came back after she had left the college and asked to use the computer for a week. She said that she was interested in print but had not had time during the term. She wished to develop a range of print designs for her portfolio.

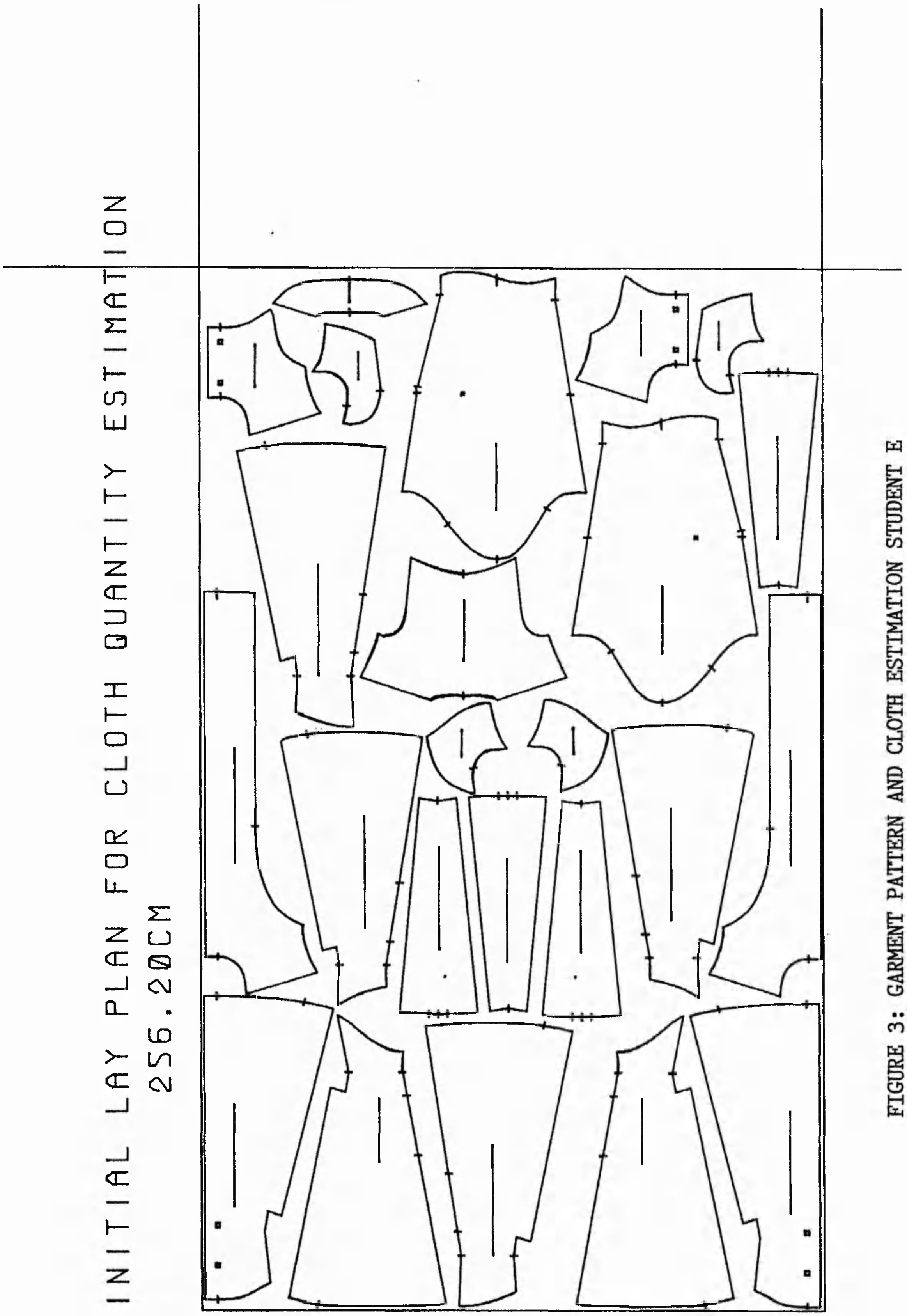


FIGURE 3: GARMENT PATTERN AND CLOTH ESTIMATION STUDENT E

DISCUSSION

Personality Traits and Thinking Styles

The first two aims of this field study of students were to construct a valid means of identifying traits that I believed might affect a student's first encounters with CAD. Although considered to be a supportive piece of work in this research, the construction of the variable scales for personality traits and thinking styles can be seen as a valuable outcome of this research. The rationale for their construction was discussed in Chapter 12, their practical application and their inferences are now explored.

The focus of 'context' is inescapable. I argue that it is only within a particular, narrowed and explicit context that one is able to consider, with confidence, design or art students' personality traits and thinking styles. Four of the five student participants had worked within the Fashion Department for more than two years, the fifth for almost that time. They were involved with the same tutors on the same enterprise, that of creating and developing new ideas in fashion. Three of the tutors were primarily concerned with design, the fourth tutor was responsible for the practical and technical aspects of creating garments. The tutors were asked not to collaborate or discuss the scale ratings they gave to the students.

The results of the scales are shown in tables 6-10. I felt that I was too involved in the research and the construction of the scales to offer an objective measure on the scales. Instead, I offered comments of agreement or disagreement based on my studio experiences with the students.

The rating scales showed a remarkable consistency of opinion amongst the tutors. The only divergence was that of tutor 4, who saw student D as remarkably more creative than his colleagues. This could be explained by the fact that student D had difficulty communicating her ideas to the design tutors, her innovation was essentially practical and three dimensional. It was only in a practical workroom context that she displayed this quality. My interactions with the students in a CAD environment did not appear to diverge in any significant way from those of the tutors. The most exciting result was the fact that, even within the narrow context in which this study was set, the students still wished to qualify their answers. These were all concerning context, they were further narrowing the boundaries. This raises grave doubts about the torrent of research spawned from general questionnaires, set in no particular context. The argument, that the students may have wished to show, that they had an alternative persona or wished to be thought of as having an alternative persona, become irrelevant if an agreement is reached, by all parties, that the recorded personality traits and thinking style operates in the particular situation under study. I regard these results as useful; useful in other contexts and in other applied research. The Ten Student Study is an opportunity to record further, to refute or support the procedures.

The third aim of the study wished to record instances where personality traits and thinking styles appeared to affect the use of CAD in the process of design. It was seen as reasonable to consider that a student had a strongly defined trait or particular thinking style if there was a consensus that she was mainly outside the spectrum of 'average', (Table 11 records students traits). A slew away from average towards a direction is marked in brackets. The work and the comments of the students was examined.

We very often assign human attributes to objects and then assign people to match the objects. Computers are seen generally as isolating, they are seen as boringly logical, they are thought of as being serialist in operation. This research was not interested in correlation, the numbers are too small, the variables too numerous and complex; it was interested, however, in how people of different attributes decide to use the technology and their explanations for its use.

Extraversion is often seen as a characteristic trait of fashion designers. This is not unreasonable, their apparel is often flamboyant and attention-seeking, their ideas are often derived from the social context, they make connections, they are communicators. All the designers appeared to enjoy working alone or in small groups in the CAD studio; they also appeared to enjoy the focussing of attention demanded by the technology. Students A and E commented that they would not like to work

TABLE 11: A DESCRIPTION OF THE STUDENTS' PERSONALITY TRAITS AND THINKING STYLES

STUDENT	EXTRAVERT/ INTROVERT	STABLE/ NEUROTIC	DIVERGENT THINKER/ CONVERGENT THINKER
A	average (E)	average(N)	divergent thinker
B	extrovert	stable	divergent thinker
C	introvert	neurotic	convergent thinker
D	average	average	average
E	average	average	average

on it continually (ref. pages 160, 176). It was interesting that the most extravert student, B, was the least concerned by her isolation (ref. page 161).

Only one student showed a distinct trait on the neuroticism /stability scale. His neuroticism seemed to be centred on his work. He was continually concerned about the effect of using CAD may have on his final result. He was not enthusiastic about the technology during the term. Surprisingly, he said in his final interview, that he was going to seek a means of using it (ref. page 168). Student A showed a swing towards neuroticism. She did get frustated by the mechanistic procedures imposed upon her (ref. page 160), but her fascination with the technology appeared to over-ride these problems.

Convergent/divergent thinking seemed to be the most intriguing trait to investigate. The recordings were not surprising. One would expect that in the context of design, where divergent thinking is seen as a main element in its process, that most of the students would display average, or above average, scores. It is widely assumed that the computer technology attracts convergent thinkers. It was the divergent thinkers that were the most enthusiastic about the technology (ref. pages 158, 164). When one explores their attraction to the technology, one finds that none of the students used it in the generation of the original concept for their collections; they were used it as an opportunity to extend their expression of their ideas or to help the execution of them. It was an average student, E, who saw the technology as active in the design process, forcing her to extend the production of her ideas (page 174).

Other Variables

The fourth and fifth aim of the study was interested in identifying other differences which may occur between students and their likely effect on their use of CAD.

Other variables seemed to be of equal importance in the students' determination of its use. Gardner's work on multiple intelligences and the acquisition of types of skill, which was thought might be of interest, proved useful. The diverse and particular variables were not as random as they first appeared. They could be categorised as student attributes. From Gardner's perspective these attributes could be further categorised into two types. One could see the first set as being predominantly biological, the second set as predominantly cultural.

Whilst some of the variables listed were expected to be of great benefit, i.e. mathematical ability, keyboard skills; they were, in fact, only minor annoyance or assistance factors. The areas that appeared to affect the students' use of and attitudes to the technology dramatically were: their graphic ability, their aesthetic ability, pattern cutting skills, and, I would argue, the most important, their process of design.

During the Five Student Study, these elements became apparent or were discussed during their use of CAD in creating their collections and in their final interview. It was thought useful, in the Ten Student Study, to record self-ratings by the students before using CAD, and then relate them to their descriptions of any changes made to their procedures after its use.

Other Issues of Interest

The sixth and seventh aims of this observed study were concerned with the identification of aspects that were likely not be to be covered by any form of categorisation, or aspects that might have an effect on the elements already noted.

The importance of context has been a continuing theme through this study. This is a complex theme. Context is not only about the space and the people operating within it, but about its inter-relationship with other contexts or its setting <u>within</u> a broader context. The CAD study was a sub-context set for assessment purposes within the broader context of the Fashion Design Department. The student's life context was wider than this. In chapter nine it was found that personal aims may differ from the group aims or the <u>expected</u> aims. The students' use of CAD could be seen to be substantially affected by the students' own motivation for its use and their idea of its importance, relative to other aims that were <u>dominant at that time.</u>

Probably the most important factor in the students' use and attitude to CAD was its outcome, its result. This had two facets. First, their reaction to it as a media was essentially emotional and intrinsic to their aesthetic response. Second, they had an unbiased interest in any means that could achieve a better result for them. The notion of visual or aesthetic intelligence must be discussed here. There is often a confusion between divergent thinking and visual intelligence. Like musical intelligence one can participate in shared experiences, idealise or recognise intuitively the marks of worth and elements of change within the form, without necessarily being able to perform them. These people are very essential in the design world they are often the selectors, the marketers, the predictors. In the kind of educational context of this study, students are asked to perform and they are assessed on this. It is, therefore, not surprising that tensions are created and that there is a focus on performance.

The students, once they had used CAD, had no awe of the technology or felt threatened by it; they thought it to be much easier to use than they had expected, and in no sense a competitor in their work.

Planning the Ten Student Study

First, the study was planned to cover the three terms. The first term to be training and practice, the second and third terms to be use of the system for projects and their collection. This was planned on the recommendations of the students on the Five Student Study.

Second, the Five Student Study demonstrated a wide range of variables that could have affected attitudes to any new experiences and also affect the way in which a designer uses any new medium. A table was made of the variables that were seen as the most important at that time. They appeared to be clustered around experience in other fields and talents in areas that were applicable to fashion design. It was expected that other variables would appear as the research progressed. The relationship of noted variables was to be examined during the study. Before any introduction to the computer was given, the students were interviewed to provide a self-rating profile of their abilities and attributes (Table

TABLE 12: FACTORS WHICH MAY AFFECT THE STUDENTS' ATTITUDE TO, OR USE OF CAD

FACTOR	RATING 1-10
LEARNED ATTRIBUTES	
Keyboard skills	
Prev. computer use	
P.cutting skills	
C.constr skills	
BIOLOGICAL ATTRIBUTES	
Male/Female	
Level of concentration	
Information retention	
Mathematical ability	
Manual dexterity	
Graphic ability	
Process of design	Structured interview
Spatial ability	Observation
Visual ability	Observation

12). It was evident that their personal design processes, when working on the elements of a design project, affected their attitudes to CAD use. It was decided to have an initial interview with the students, before using the computers, to record their own description of their personal design process in creating new fashion designs. This was to cover the generation of ideas, the development of ideas, the toile development, design analysis, and design construction. Any students using CAD, who demonstrated noticeable positive or negative qualities of visual or spatial ability[1], would be recorded in the field notes.

Third, the Five Student Study demonstrated that, probably the most important factors in the student's use and attitude to CAD were its importance to them relative to other interests and demands, its outcome, and its results. This latter element was dependent on its attraction to them as a media, as a tool or in combination. Particular interest in these facets will be continued during the Ten Student Study observations and conversations.

It was decided that the questions used in the structured interview, at the end of the project, would remain unchanged. The questions covered the main points of interest and it was found, during the Five Student Study that the richest material emerged from the students' elaboration of the points raised or by their diversions from the proscribed topic. It was thought that added questions would have reduced this kind of response.

REFERENCES

1 A means of assessing students spatial ability was explored. Other research in this field looked promising, see R.N.Shepherd and J. Meltzer, 'Mental Rotation of Three Dimensional Objects', Science 171, 1971, pp. 701-3, and M.I.Smith, Spatial Ability University of London Press, London, 1964. Some small experiments were made with adapted procedures. However, pattern cutting is a more complex operation, it was decided that any real difficulties in translating shapes would be apparent as the students worked, and it was thought that other variables that may be causing the difficulties would be more readily identified.

CHAPTER SIXTEEN: THE TEN STUDENT STUDY

INTRODUCTION

Places were offered on the CAD field study of ten students. Seventeen of the twenty-four students expressed interest. Lots were drawn for the places. The first term was to be concerned with training and self-selected use, the second term with use of CAD, and the third term with the use of the computer for a part of their collection. Before the students used the system, they were to be asked to fill in a self-rating profile, which listed factors that may affect their use of CAD. Their process of design, when working on a design brief, was also to be discussed. The personality scale recordings and constructed conversations were to take place at the end of the year.

The research during the Autumn Term proceeded smoothly, the new data recorded and expanded many of the ideas explored in the Five Student Study. At the beginning of the Spring some disruption to the study took place which is decribed below.

Spring Term 1986

At the beginning of the Spring Term, staff changes were made in the fashion department which affected the context of the study and therefore, the operation of my research. This research then became unremittingly autobiographical. This drew in further hazards: autobiographical accounts are, by their nature, selective and retrospective. However, Burgess[1] suggests that this type of research should be more reflexive; he suggests that, to the accounts of the situation by the researcher and the researched, should be added accounts of the research practices in operation. Hence, the following account.

The work on this part of the research was abandoned in its planned form in the middle of the Spring Term. The field research encountered a variable that was uncontrollable.

This research started from the point that <u>context</u> is a very significant variable in any examination of thought or creative processes. The study was set in a fashion department where the six lecturers held a range of views about the technology from mildly sceptical to enthusiastic. However, all were interested and supportive of the research project. This continued through two Course Leader changes within the existing staff.

There was a further re-organisation of the Fashion/Textile Department at the beginning of the Spring Term. The Fashion and Knitwear departments were merged, the new senior position being filled by a principal lecturer from the knitwear department. The January appointment of a new Course Leader also transferred from the knitwear department resulted in the kind of 'general turmoil' that often accompanies a change in a power structure, particularly where personal philosophies and careers are affected. Strong conflicts had been taking place in the knitwear department with regard to the value and role of CAD technology in the design process.[2] These conflicts were now transferred to the fashion department. The conditions that began to prevail during the Spring and Summer Terms in the fashion department, swiftly became incompatible with the stable, 'ambivalent' situation in which the research was set. The changes proved to be too interruptive to continue the study in its proposed form. It was believed that elements could be salvaged. The personality and thinking style studies could be completed, and the studies made during the Autumn term contained some useful material for discussion.

Sheldrake and Berry[3] state that the dominance of the hidden curriculum within a department, the fact that it is there, makes it, in one sense, easy for the researcher looking at the social issues of innovation.

> 'As we moved closer to looking at the social processes especially within the staff groups in the departments studied, so we became more threatening, and the

> attractions of looking at the students' views only grew much greater.'

There was a temptation to divert into explorations of the effects of introducing innovation into this volatile situation. However, this was rejected. The situation appeared to be a complex interplay between idealism and defence of territory; a dilettante excursion into this area would have been mistaken.

It must be recognised that the situation described above did not prevail. The Course Leader in Fashion changed yet again in 1989; the interest and commitment to CAD technology also changed yet again. Knowledge and use of CAD is now one of the aims of the department and new courses[4] in this field are being generated. The change of perspective from ambivalence to hostility to CAD, (whilst this technological research programme was in operation), which took place in the Fashion Department, demonstrates the volatility of research in educational environments. It also shows that any unexplained quantitative research undertaken, in these environments of change, must be considered suspect.

The findings from areas of the Ten Student Study, which were not affected by the disruption, are given below. Of particular interest is the study of the students' process of design that took place during the Autumn Term. The findings are in the form of a collective report of the students working with CAD; they are given under the following headings:

Personality Traits and Thinking Style
Self-Rating Profiles
Processes of Design
Experience of CAD in the Autumn Term
Conversations with Students on the Completion of Their Course

This leads to a discussion of the outcomes of all the field study work, 1986-1988.

FINDINGS

Personality Traits and Thinking Style

The study was interested in a group of students using CAD in their third year of a fashion design course. The study is related to their behaviour, work and attitudes in these circumstances, and is disinterested in applications in a wider field. Personality change, outside the department, was noted on the scales by many of the students. The context of the study could be seen as enclosed in the sense that it could be recognised and defined.

Three of the four tutors in the Fashion Department, who completed the scales of cognitive style and personality traits in the Five Student Study, were still working with third year students at the end of the summer term. It seemed useful to repeat this section of the study, as this was not affected by any other controversy. The results are shown in Appendices XXVIII to XXXVII. The consistency of the recordings, shown by this group of scales, appears to correlate with the consistency found in the recordings made during the Five Student Study.

If one accepts that the scales offer valid profiles of personality traits and thinking style, the following comments are of interest. First, the results portrayed a very 'average' group of students, particularly from the tutors' perspective. Second, the students appeared to concur with the direction of a trait but saw their personalities in an exaggerated form and all but two of the students ascribed to themselves higher levels of divergent thinking.

Self-rating Profiles

The self-rating profiles were a useful contribution in a negative sense, (Table 13). The students awarded themselves above average scores in most of the areas. This was to be expected, they were students originally selected by the Polytechnic on the basis of their intelligence, capability and design flair. The consistency of the ratings helped to dismiss from the study problems of extreme diversions from the

TABLE 13: FACTORS WHICH MAY AFFECT THE STUDENTS' ATTITUDE TO, OR USE OF CAD

FACTOR	RATING 1-10									
LEARNED ATTRIBUTES										
Keyboard skills	Y	Y	Y	N	N	N	Y	Y	Y	N
Prev. computer use	Y	N	Y	N	N	N	Y	Y	Y	Y
P.cutting skills	8	8	7	4	8	4	8	3	7	8
C.constr skills	8	9	8	4	7	4	8	7	7	8
BIOLOGICAL ATTRIBUTES										
Male/Female	M	F	F	F	F	F	F	F	F	F
Level of concentration	7	8	8	5	7	7	7	7	5	7
Information retention	7	8	8	5	7	7	6	8	5	7
Mathematical ability	8	7	7	3	7	6	5	6	7	7
Manual dexterity	8	7	7	5	8	6	7	7	7	8
Graphic ability	6	7	6	8	8	8	7	5	6	7
Spatial ability	6	8	8	5	7	6	7	7	6	6

group norm. However, it should be noted that three of the students showed lower score diversions in the area of pattern cutting and clothing construction skills. Two students awarded themselves a low score on information retention. It was useful that there were six students with keyboard skills and previous computer knowledge, their induction to CAD could be compared with the other students.

Processes of Design

An attempt was made, to elicit from the students their design process. This was not easy. When asked directly, the students found that it was a difficult, and sometimes impossible, operation to explain. Some of them did not know how they arrived at their ideas. The students' means of elaboration and idea generation took a variety of forms.

> 'I think about it, and record ideas graphically with lots of rough sketches...
>
> I let things simmer... mess around... look at pictures books... I won't do any written or graphic work... I find ideas just come to me, like a click... then everything will flow...
>
> I can't just sit down and start drawing... I have to wait until the idea hits me... I then have to work up rough sheets, which is silly really...
>
> I don't do many roughs... I have had to do them this year so that I have sketch books for the end of the year... people like to see them, its a convention...
>
> I have to work graphically... I need lots of images... I draw, I photocopy, I develop ideas through a series of drawings.....
>
> My ideas are in my head... first comes the thinking then there is a natural progression onto paper... the drawings are esoteric... the expression of the idea...
>
> I don't do much drawing... I prefer to write... it's only when I have got things thoroughly sorted out that I start to draw... and then only if I want to... (this student was graphically talented).
>
> I have to get materials... I have to work in colour, with

> textures... then I can see the shapes... I don't enjoy drawing really...'

Some students found that they did not get their ideas to flow until they started to create shapes in calico on the dress stand.

> 'I take only the roughest sketches to the stand, because they always change anyway...
>
> If I go to the stand with a fixed idea it always changes anyway... working on the stand makes sense.'

Other students went to the stand to achieve a particular shape or to correct, refine and evaluate.

> 'I want to get my sketches, but it always changes whilst I am working because the sketch is different from the stand.
>
> I do set out to get the sketch as near as possible... I change it if it doesn't work.
>
> Your idea changes on the stand because you can't get it, or you like it better...
>
> I start from a flat pattern but I have to put it on the stand to check... '

Yet others went to the stand because it was the only way they could realise their ideas, they were defeated by using flat pattern cutting methods.

> 'I usually start with flat pattern cutting... then I have to get onto the stand... but I'm so confused about cutting the pattern... it's beyond me... a disaster area.
>
> I used to flat pattern cut because I thought that it would be easier... but I just got in more of a mess... I should have started on the stand from the beginning.'

It was interesting to note that a majority of the students, and that included some who felt they were competent in this field, disliked flat pattern cutting onto paper, yet flat pattern cutting is a major part of many design careers in fashion. There was a distinct difference between students who wanted to work with pattern from first idea to finished product, being directly in charge of all procedures; and others who, as long as the finished result matched their mental image or 'got the sketch', would like the machine to take over from the sketch and produce the pattern.

There appeared to be active and passive students; active students appeared to be in a constant state of idea generation and used the projects as vehicles of expression; passive students waited for the projects, then proceeded to research appropriate material. Whilst active students appeared to work more intuitively, their means of idea generation and elaboration was not necessarily tied to a particular design process.

Experience of CAD - The Autumn Term

The initial training period followed the pattern of the Five Student Study. In the initial stages the students were encouraged to experiment with the media; they were offered the basic brushes, colour and textures; they were given time to develop their own style before they started experimenting with the more mechanistic options. A selection of drawing styles taken at random during the first half of the year are shown in Fig. 4.

The students who were lacking keyboard skills or computer knowledge were not unduly hindered. Both of the software programmes were menu driven and almost all the input was done with an electronic pen. This surprised the students, most commented that it was much easier than they expected. I believe that the ease, with which they found that they could work with CAD, contributed to the initial 'high' that most of them seemed to experience. The students with lower levels of memory retention experienced some frustration.

The students had their initial training in groups of three or four, they were self-selected. The groups developed their own characteristics and created their own working context. One group worked in an isolated way, each individual working with immense concentration, their only interaction being with the computer. Another group seemed able to work on two levels discussing their work with the others whilst working on the

FIGURE 4: SAMPLES OF
SOME OF THE TEN STUDENTS'
GRAPHIC WORK

computer. They were restless and had extra long breaks in their work pattern. The final group appeared to work in different ways at different times, this being dependent on the circumstances. Five students started to stay later than the planned times; they were given permission to come into the studio when they wished, and three students took great advantage of this, despite their overloaded work schedule. One student commented that she would like to spend all her time on it.

The students' individual use of the paint system seemed to mirror their personal design process. This was illustrated when a project on printed textiles was set by the department. Eight of the ten students made use of the CAD paint programme, and different ways of working were clearly identifiable. First, students came in and worked from their thoughts directly onto the screen with work requiring few modifications before they were finished. Second, they came with rough ideas from source material or in sketch form that were elaborated, changed, and refined over a number of days. Third, they came in with set ideas that were almost completed, drawings were carefully traced in and the system used only for the final stages of colouration, scale and repeat. Fourth, they worked directly onto the screen but found the media frustrating as endless alternatives presented themselves. The students basically adapted the computer to their methods, only diverting where there was a positive extra attraction to them.

The attraction of the computer, as a graphic media for fashion illustration, appeared to appeal to four of the students. Two of the students stated that their design tutors had commented on a marked improvement in their manual drawings, 'they had loosened up', and a third student was told to concentrate on computer drawings as she appeared to work better in the media. It was interesting that during the final weeks of the term and during the Christmas holiday period, when the students were working on their thesis, eight of the ten students used the computer paint system for some area of their work, i.e. illustration, cover designs and text design. They brought in other students, not chosen for the project, and helped them to use the computer for their thesis.

The students were given the opportunity to cut a pattern for a style of their own choice. The pattern cutting sessions came towards the end of term and most of the students used the opportunity for personal work for themselves or for free-lance work. Most of the students thought it to be more flexible than they expected. They thought it effective and accurate if you wished to cut flat patterns, and most of them preferred it to the usual methods of flat pattern cutting. Their personal use of it to achieve their samples was a far more complex picture. The students who used flat pattern cutting methods were very enthusiastic. Students who found the production of patterns by any methods difficult, were also enthusiastic; the latter finding must be received with caution. The students who worked partly by flat pattern cutting and partly on the dress stand were ambivalent and wished to experiment more before judgements could be passed. The students who were trying to 'get' their sketch found it the most interesting. Students who used the dress stand for idea generation and the development of the style felt that the computer offered them little, the transpositional gap appeared to be too wide.

The most important finding of this term was, that given free choice and free access to CAD, the students differed in their use of it and in their attitudes towards it.

Conversations With the Students at the End of the Summer Term

The students were interviewed after they had completed their degree and when their inhibitions about their results were no longer a factor. It was recognised that discussion of any work during the Spring and Summer terms would be emotive. Although many commented on the situation and pressures within the department regarding CAD, these were not recorded as study material and attempts were made to ascertain the students' attitude to CAD by focussing on their future plans.

Three students continued to use the computers prolifically during the late Spring and Summer terms despite the expressed displeasure of the new Course Leader. They used CAD prolifically with the development and execution of their collections (Figures 5 and 6). I was concerned. The students said that they wished to work with CAD after leaving college; they argued that their experience on a CAD system was more important than perhaps jeopardising the grade of their final result. One student said

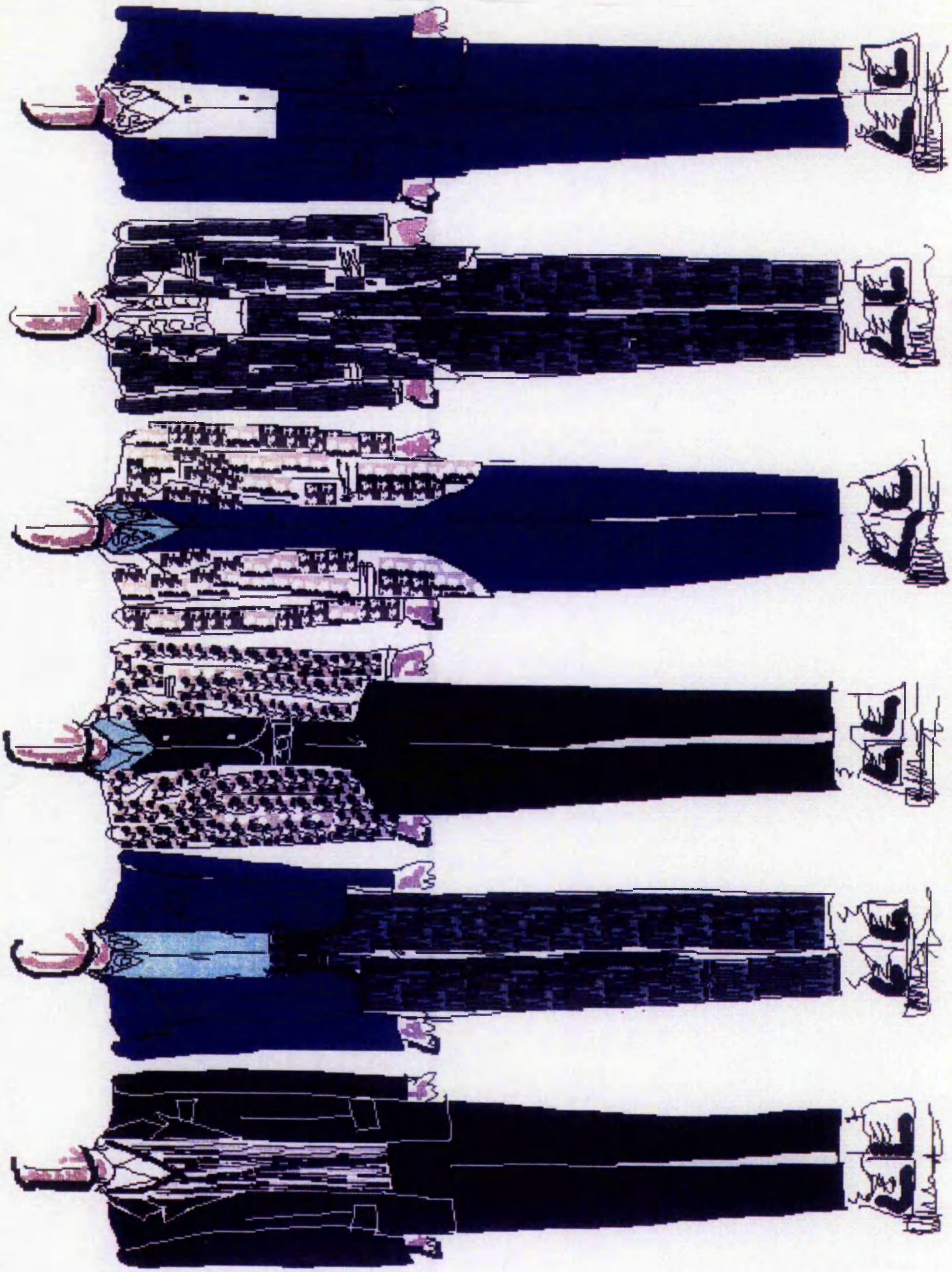


FIGURE 5: STUDENTS' COLLECTIONS - EARLY DEVELOPMENT WORK

FIGURE 6: STUDENTS' COLLECTIONS - EARLY DEVELOPMENT WORK

that she had been about to leave the college because she was bored with the course, and that it was only having use of the computer that was keeping her there.

The students took a very realistic attitude to their future employment, stating that, unless totally unsuitable, they would have to take what they could get in order to gain experience. Two students said that they would definitely not accept positions that involved computers. Most of the remainder, who had found it politically expedient[5] to avoid any CAD work during the Spring and Summer term, were, in fact, quite enthusiastic (in areas of work that attracted them) about the use of computers, This only 'apparent acceptance' of a prevailing departmental philosophy, is similar to that found by Madge and Weinberger in their study of art students. The three students, who continued to use CAD throughout the whole year, were actively seeking work in computer aided design. The idea of owning a CAD system in the future was looked on by many as a realistic aim.

DISCUSSION

Personality Traits and Thinking Style

At this point of the study, one now becomes interested in the measure of the influence of these characteristics that could be posited on the students' use of CAD.

Eight of the ten students were placed, by the tutors, in average positions. If correlations were seen as this study's priority, one could suppose that it was average students that were most likely to be attracted to the technology. However, two other factors should be considered. First, seventeen students out of the class total of twenty four students opted to use CAD. Lots were drawn to select the final ten and therefore, chance was a significant factor. Second, in the Five Student Study, a more diverse group were attracted to the research programme. There was a value in having so many 'average students' in the second study, in that it reduced the variables remarkably; this was particularly important when the students' design processes were considered.

The few students who had a direction of neuroticism showed slightly more irritation when losing control of the system but that effect appeared to be the case with all of their design work, which they discussed freely. Neuroticism appeared to be closely associated with the match between their aspirations and their performance. Other facets of the technology overode the minor irritations. The student scoring the highest on the scale of neuroticism (A) was the student who was the most attracted to the technology.

The students were in control of their working practice, they constructed their own working environment and pattern. The three groups developed their own characteristics. In the restless talkative group were the two students who scored highest on the extravert scale. These two students also came in the evenings to work alone with the computers, they said they also needed 'some of their own thinking space'. A number of the students noted their need for a thinking duality depending on the context of their work. Dewar's exploration of the design room, decided that the interaction between designers was so important that any of the advantages of installing CAD could be over-ridden by the isolating characteristics of it. This study found that, once the students were in the situation of unconscious correction of mistakes, some of them could talk, or pick up, or ignore pieces of conversation. As in a usual design environment, some students could work on two levels of operation, unconscious of the surroundings unless the brain picked up a signal which interested them. There was no evidence that any tendency towards extraversion affected the students' attitude to CAD, as long as they had control over its pattern of use.

Variables

The classification of variables was seen as a descriptive exercise; with the acceptance that, correlation does not argue causation, any observed relationships should only been seen as interesting ideas to be pursued and discussed.

Memory retention may have some relationship to how CAD is used. Students became frustrated when they had forgotten a feature they wished to explore or an effect they wished to reproduce. Forgetting to save data was the ultimate frustration. The faster one becomes familiar with the operation of a system, in whatever form of use, the faster one achieves its integration into 'unconscious use'. When the designer is working on the bench or at the drawing board, many small errors are corrected unnoticed; the wrong pencil is selected... lines are drawn and erased... measurements are retaken... the familiarity of these procedures allows one to self-correct without being aware of it. Heiddeger[6] believes that the greater part of our lives passes un-noticed, with whole activities becoming transparent; knowing how dispenses with activity which requires intentional input and leaves us free to explore more exciting ideas. It was useful to note, that this method of unconscious correction, was arrived at with speed in the simpler graphic operations, and the students' enjoyment of its use was their ability to work interactively on their visual ideas. An eidetic memory and kinaesthetic intelligence, rather than logic would seem to be of more value in a graphical or manipulative use of CAD.

Students who lacked graphic skills or disliked drawing drew little solace from the use of CAD,

> 'I don't like drawing anyway so using the computer is just an extra thing and not helpful....'

However, it did appear to improve the drawing skills of some students. Their work was described, by their tutors, as becoming more free and more assured. As in the Five Student Study, an emotional response to the media was found to be the most important factor.

> 'I'd get a project and everything was a chore, when the computers came, I got back all the enjoyment of the first year of the course.'

The majority of the students disliked pattern cutting, and this appeared to correlate with their proficiency. Some students coming from BTEC courses arrived at the college, skill proficient, but with a very 'organised' approach. Students coming from General Art & Design courses, with no experience of pattern cutting appeared to be overwhemed with the immensity of the task. Repeatedly, the inability to cope with the size of the paper was expressed. The computer screen seemed to help them make sense of the confusion.

> 'If I see a big piece of paper... I can't cope with it... on the computer screen it somehow just looks like a jacket. It makes me more adventurous because I can see what is happening.'

The fact that these students are a 'screen educated' generation, which transposes screen images into reality with ease, is a new dimension that teachers of pattern cutting could explore, particularly for students who appear to lack spatial ability, and find 'large pieces of paper' unintelligible. Tansposition of a three dimensional shape to a two dimensional pattern shape is not easy, as anything 2D is an abstraction. The majority of the students appeared to construct their patterns on the stand. There appeared to be a distinct division between those for whom, working on the dress stand was a natural expression of their own design process, and others who seemed to use the stand as a retreat from the inexplicable.

General Overview of CAD and the Process of Design

Unexpected outcomes are intrinsic to the genre of Field Study, they are often sought for if not apparent. Outcomes can also be too unexpected and unwanted. A strong external factor can affect a person's re-action to CAD or any other experience if it interferes with a primary goal. The students' immediate goal was their degree. CAD was only a small part of the term's experience and its attraction was dependent on the 'fit' into other circumstances happening concurrently. The disruption to this study in the Spring and Summer terms was not as disastrous as it appeared at the time. The personality scales operated outside the sphere of any conflict. The material gained during the Autumn Term, when the students were introduced to the technology, was very useful, particularly when comparisons were made with their usual design process. Much of the early field study research undertaken in the Autumn term extended the work of the Five Student Study. The observations and discussions offer rich material for exploration and further research. The students' evaluation of the technology, and their proposed use of it in the future, was illuminating.

I believe that the method of establishing the personality and divergent thinking styles devised for this study to be a useful addition to this particular field of research. If one is seeking validity then a larger project has to be initiated. One must also be clear that the scales are only valid in that context at that particular time. It is a recognition that change is the only stable feature of the human condition and that concepts are human constructions that are subject to the same biological imperitives.

Three factors appeared to overide any variable, personality trait or practical skill. The first, was the unexplained emotional appeal of using the system and its resulting graphic or pattern form. The second, was the 'fit' of any part of the technological process with the students' own process of design, or its ability to divert or extend this process. The third, was the practical advantages CAD offered to their current work; the students' first interest was the 'work in hand', its outcome was their primary goal.

The student's form of visual intelligence appeared crucial in their interaction with CAD in the design process, both in their skill competence and their forms and means of expression. There were startling contrasts between students producing immediate realisations of ideas, students who worked structurally, and students who almost endlessly refined work. These emotional and expressive responses to the media were shown to be repeated when a group of mature artists confronted and used the technology[7].

One must not see any design or artistic process as a fixed procedure, the process of design is a changing and developing feature, both the students and the artists were prepared to accept forms of change, but not, in their view a diminishing of their work. How CAD could integrate into their process had to be their judgement, it had to be part of the expression of how they needed to work. Gardner[8] believes that personal intelligence, the sense of self, is an overall metaphor for the rest of the person which understands, directs and modulates the other capacities. He believes that there are universal features of any sense of personal self but also cultural nuances reflecting a host of historical and individuating features.

Originality can come out of a creative leap in the dark, it does not have to be so. It can come from re-arrangement of what is already known or it is also possible to carry out step by step procedures and come to unexpected conclusions. Gardner believes that little work has been done to match teaching programmes or learning experiences to the differing forms of intelligence and thinking styles of students. A number of the students were explicit in their criticism of the conformity and conventions of fashion design departments.

> 'I don't think we should be told how we should work... how we should solve design problems... how we should arrive at a solution...'

They were just as critical of the computer if it did not respond to their thinking style.

> 'If you work in your head, your media is in your head and that's part of the enjoyment... computers don't do anything for me...'

They were dismissive of it hampering their ability to generate ideas, they did not see it as threatening.... they used it only if it performed for them. At first, most of the students showed considerable disdain for the mechanistic tricks and demonstrated a low boredom threshold when they were invited to explore them. If, when they were working, unexpected happenings occurred that excited them, they were enthusiastic. However, invitations to explore mechanical functions were largely ignored. There is an interesting corollary to this behaviour; the students must have registered many of the effects demonstrated, because when they were working on their thesis they came in to use their own versions of these functions. Some had mentally transposed and arranged visual computer images in their head and had ideas of changing them into new forms. Others came in and applied the procedures directly. The modes of thought, that were demonstrated by the students during the print project, were repeated.

Gardner[9] also shows interest in how different forms of intelligence may interface with the computer. He states that the computer is a product of Western thinking and may prove to be an agent in perpetuating just that form of logical intelligence that led to its division. This may be the case in some areas of work, 'it has made me more logical'.... 'I now think about what I am doing'. However, the use of a computer is not necessarily the same operation as that of programming it. Designers are quite adept at using many logical forms of media or tools in 'illogical' ways.

REFERENCES

1 Robert G.Burgess, 'Autobiographical Accounts and Research Experience' in The Research Process in Educational Settings The Falmer Press, London, 1984, p. 167.

2 The two tutors from the Knitwear Department appeared to see CAD

technology as a mechanistic process and its visual form as ugly. CAD was accepted for the production of garments, but the tutors took a pessimistic view of its value in the initial processes of design. It was their personal view. It is not the purpose of this study to investigate the personal constructions or the external pressures that formed their view. It is only necessary to record its effects on the study.

3 P.Sheldrake and S.Berry Looking at Innovation NFER Publishing Co Ltd, 1975, p. 136.

4 A new course BA (Hons.) Clothing Studies with Textiles begins in September 1990. The content of this course includes a high proportion of CAD in design and production.

5 A politically expedient 'apparent' acceptance of a department's attitudes or philosophphy is described in Charles Madge and Barbara Weinberger's study Art Students Observed Faber and Faber, 1983. They portray a Fine Art department where a strong, 'cerebral' philosophy of explanation, dominated the course. Many students had differring views and only 'apparently accepted' the art form that was valued in the department. One student imported live chickens into the department to set up a 'Chicken Movement' project, simply as a cover story, whilst he worked independently on his own work outside college. When he was awarded the only First Class Diploma of the year, he decided not to reveal the true nature of the chicken project. In this CAD study, a student, who did not appear in the CAD studio at all during the Spring and Summer terms, used the toiles made on the CAD system during the Christmas vacation as a base for her collection, but found it politically expedient to hide the fact that they were 'CAD patterns', from the new course leader.

6 A discussion of Heiddeger's theories are interestingly discussed in The Great Philosophers Brian Magee, BBC Books, London, 1987, pp. 254-277.

7 'Painting With Light', a BBC 2 television series, March/April 1985, offered six artists the opportunity to use the Quantel Paintbox system, Each found different advantages and disadvantages in its operation and each re-acted to its visual qualities in different ways.

8 Howard Gardner, Frames of Mind: Theory of Multiple Intelligences William Heinnemann, London, 1984. p. 276.

9 Howard Gardner, Frames of Mind: Theory of Multiple Intelligences William Heinnemann, London, 1984. p. 390.

CHAPTER SEVENTEEN: REFLECTIONS ON THE TWO FIELD STUDIES

The re-iteration of detail found in many studies often obscures the main issues. This study is not testing a hypothesis in which I am seeking verification of a theory. At this stage one has to bring into focus the main idea of the study, the seeking of knowledge of the phenomenon CAD. I believe that understanding and knowledge is gained in a context, bound up with activity, in which the spectator is also an agent. Observation is always selective, it is directed, it has intention. The fascination of the study is the recognition that knowledge is selectively changed, intentionally changed, individually changed, collectively changed, experientially changed, unconsciously changed, inexplicably changed, continually changed. It is very rarely changed by directive. The students' experience of using CAD, and CAD programmes, was only for a short period, but each students' present knowledge of CAD is different. When given choice each students use of CAD was different. It is quite credible that people find it impossible to grasp ideas that others find quite sensible, capacities to understand are personal. There is no access to things as they <u>are</u>.

The craving for generalities and method would be misleading in this study. This study, of students using CAD, was rather a clearing of the path, an elimination of the kind of myth that classifies people in relation to objects on the basis of studies that are themselves falsifiable. This is not to dismiss classification in all forms. To make sense of the world, classifications are a means of sharing, to a degree, with others common perceptions and definitions of occurrences; yet there has to be implicit acceptance that personal awareness of them is unique and transient.

The concentration on individualism in the design process within this study may appear to sit uneasily if one compares the study context with that of design rooms within clothing companies, with or without CAD. It seemed that this study would be incomplete unless the study was removed from the 'monastic cloisters' of the Polytechnic and taken into the commercial world. The field study of fifteen design students' perceptions and use of CAD allowed me to make a more objective, though still value-ridden study, of my own use of computer aided design in an industrial environment. This is reported in the next part.

PART FIVE: OBSERVATION OF PERSONAL USE OF CAD 1988-90

CHAPTER EIGHTEEN: PERSONAL DESIGN WORK 1988-90

THE CONTEXT

The decision to work as an independent commercial designer using CAD in August 1988 was not a difficult logistical decision. A re-location of the Nottingham Fashion Centre resulted in a number of clothing/textile studios becoming available within the new building. The Centre's excellent business and library facilities were available to all occupying businesses. A flexible design studio was designed and constructed and CAD facilities were installed, (Figure 7). The philosophy which directed the planning of the studio was that the 'furniture' of CAD should not dominate the concept. Computer hardware and peripherals were integrated, so that their use could be selected when it was seen that they would play a valid part in a design project; but the studio was designed so that it could function, just as adequately, in a manual form.

Commercial design projects were accepted, and they were subject to a number of criteria[1]. First, enough work of high commercial value had to be undertaken in order to cover the overheads of the studio. Selectivity in this field had to be of secondary importance, although certain categories of work were not accepted. Once the financial position requirements for the year were attained, the work was determined by my interest as a designer, the opportunity to pursue the potential of CAD in a wide range of textile applications, and the development of the software programme.

EXAMPLES OF THE USE OF COMPUTER AIDED DESIGN

Two portfolios of work are offered with this thesis.

FIGURE 7: THE DESIGN STUDIO, THE NOTTINGHAM FASHION CENTRE

PORTFOLIO ONE: includes a description of the software ORMUS-FASHION, it also contains design briefs for a selection of companies who wished CAD to be examined and evaluated when it was applied to solve their design problems.

PORTFOLIO TWO: includes personal explorations of design work which has interested me and which offers new alternatives for future design ranges. The work has been directed mainly towards textiles; CAD offers the fashion designer a way to get closer to the 'fabric' of a design range, one can intercede and influence the range earlier in the design cycle.

EXTENSIONS OF THE FIELD STUDY

In any evaluation of my use of CAD, it seemed appropriate that I should also become a subject of the personality/thinking style scale. The 'judges' completing the scale were academic and commercial design associates and my associate from the software house. The resulting scale and the self-rating attribute table, (Appendix XXXVIII and XXXIX), are offered purely as descriptive material, any discussion of them in this thesis would be too subjective. In the use of aesthetic intelligence I consider that, although I may not be able to generate an original visual expression or make an original 'mark', I can recognise one.

I believe that a description of my process of design is, in a limited way, possible. The process will vary to some extent, this being dependent on the particular project, but its general direction can be identified. I work mainly in the 'head'. I consider myself to be a subject of the category, described by Hudson[2], who requires a set of parameters in which to be creative. I require 'rules' or supposed restrictions as a beginning. This state enables me to have rules to break or a means of making connections with obscure periphery, (I seem able to store them in vast quantities), which I then access and apply. The main solution to a problem usually occurs 'visually' in my head. The gestation of the best solutions requires that I become engaged, on an undemanding task, usually of association but not directed specifically, in fact, what appears to be 'messing about'. The solution comes when thoughts are directed away from the problem, but still held in some unconscious form. A deadline is often not the problem it would appear to be: in fact, it seems to provide the engine of discovery. Work that is protracted often appears to be of an inferior quality. Work in 2D graphic form, in 3D on the dress stand, or textile experiments, follows the idea formation; but this is usually seen as a refinement and an expression of the idea.

I appear, in the practice of my work, to exploit the chamelion characteristics of CAD, its amorphous qualities and its capacity to be changed and moulded into many different directed forms. This is a part of its appeal. I am also attracted by the intrinsic quality of the media, glass and light, I am intrigued by the opportunities to transform a graphic idea, made on the screen, by the use of different forms of output and by its integration with other media. These possibilities are my next area of exploration. I appear to squander large amounts of time exploring elements of software with no immediate application, it is this time that is probably the most valuable. The possibilities are mentally recorded or merged into the software; they may be the connections for the design problem that has not yet been conceived.

The self-observations of the practice of design, within the tensions of a commercial environment, have showed that CAD need not be a restriction or an unacceptable complication in a commercial environment. However, in one's own work, there has to be a high degree of personal control over the 'seductive revision' and 'insistent pace' of the technology.

> 'because you go on and on... all that happens is that you just keep altering the picture, you suddenly take something out again... I'd have gone on and on... the horse would have gone.... and there might have been another car over there... or something else... there's a point where maybe you just think its dense... and so you stop.'
>
> David Hockney

> 'for me the enormous, and in the end, crippling disadvantage of using this technique is that you have to think so quickly... the concentration is totally different from when you are using gouache or acrylic, for example, or any kind of paint. It is only when you are doing this, that you realise what a lot of time is spent washing out the brush, mixing the colour, and

> applying it to the paper... time in which you can consider and think, and, no doubt, feel.'
>
> [3] Howard Hodgkin

But the technology only offers alternatives and speed. The selection of work, and a rhythm of work, that allows the mind to wander, is a skill; it is a personal knowing 'how' and a resistance to the continual visual prompts. The use of CAD has, in fact, given me more time to work with ideas; it has widened my visual and practical experience; it has given me access to a new media and to some textile practices that I would have been denied if I had been working manually.

REFERENCES

1 I decided that I would accept only design or design application work. There was a lot of business available to size grade other company's garment patterns, but I had no wish to become a grading bureau. My interest is in original or technical design. If grading patterns had been the only CAD work available, I would have preferred to remain in manual design. However, enough design work using CAD has been available, it has been immensely varied and very stimulating. It has also been profitable.

2 See Liam Hudson's view that many people only become divergent thinkers when they are set a task which has proscribed limits, in Frames of Mind: Ability, Perception and Self-Perception in the Arts and Sciences Methuen, London, 1968.

3 These qualities of endless refinement, and the seemingly insistent pace of decision making, are described by David Hockney and Howard Hodgkin. The quotes are taken from notes recorded from 'Painting With Light', a BBC 2 television series, March/April 1985.

CHAPTER NINETEEN: FURTHER SOFTWARE DEVELOPMENTS

INTRODUCTION

The way the software was developed changed quite dramatically from 1986 to 1990. A decision was taken, by the company Concept II Research in 1988, to change the software from being a peripheral interest, one might even call it a whim of one director, to it becoming a major product of the company. This meant that my role, and my influence on its direction, was undulating and closely affected by the perceived commercial interests of the company. This period, for both of us, was complicated. The following diary of events of the software development, must be read with a recognition of the differing, but valid aims, that each of us held. The company required a good viable product to market broadly and successfully in a field that was new to them. I had more complex aims, I wanted something personal, a design system that worked for me[1]. I also required software that offered choice for others, this was determined by its necessity for this research programme. Commercial success, although very attractive and a means of obtaining more equipment, was of lesser consideration to me.

A DIARY OF MAJOR EVENTS IN THE DEVELOPMENT OF THE SOFTWARE

1986–87

The vector software programme, ORMUS-FASHION, was developed during 1986; it was a slow and rivetingly painful process[2] for me, but by the summer of 1987 a useable and interesting new form of garment analysis and pattern cutting system emerged. Lawson Noble, of IO Research, who had pattern cutting system emerged. Lawson Noble, of IO Research, who had written an excellent low-cost raster paint system, DESIGNER, provided me with a special version of their software that I could use in conjunction with Ormus-Fashion. Colours could be transferred to the vector system, line images from the vector system could be transferred to the paint system. It was the first stage of the connections that I saw as vital if any CAD design system was to be used in any way comparable to the methods available to a designer working manually. A wide range of line and paint media, or tools are available to designers working on the bench. Although primitive in form, an integrated form of a design system was useable by the summer of 1987.

It was marketed as an educational design and pattern cutting system. Other educational options were added, a form of cost-lay planning was possible on the system; but grading, at this stage, was limited to explanation and example. The first system was purchased by a college in June 1987. In September the vector programme won the 1987 British Micro-computing Special Award.

1988-89

By April 1988, eight colleges had purchased systems, price was probably the main criteria for its purchase. It did not aspire to compete with the mainstream CAD production systems, and the initial issue of the software was somewhat experimental.

The software was updated and options added as the company realised its sales were reaching the original estimated target of ten sales.

It was at about this time that the company decided to up-grade the software to an industrial level, for small companies, by adding the additional options of grading and marker making. A new software writer was added to the team, she was to be responsible for writing these new additions. I was very reluctant to continue into this field, it was the design aspects that interested me. Production marker making and cut order planning is not my field and the specification, required to produce the software in this area, needed different expertise. However, one of the directors persuaded me to continue with the direction of the grading element. The added options made the software more attractive to colleges and sales in this area continued to grow.

Publicity regarding the launch of the industrial software began in the Autumn of 1988. A sales manager was appointed in December 1988, and systems began to be sold early in 1989. This period was the beginning of a change of relationship between myself and the company. It was a natural development, the commercial element had to dominate, they had to respond first to commercial requirements rather than the experimental ideas that I wanted to pursue.

When a division occurred in the company IO Research, (the company which provided the 'companion' paint software programme DESIGNER), Concept II set off to look elsewhere for a new paint programme. I was still interested in the textile and graphic software work that Lawson Noble was pursuing in his new company, Noble Campion. I bought his low-cost VGA paint programme, CAMEO. The next six months were exciting for me, the focus returning to my requirements rather than the immediate commercial demands of one company. New contacts in graphic companies were sought. New connections were made between other software programmes and my printer, giving me 'almost' all the integration that I required for getting high quality linear graphic work, from my colour thermal printer.

Continuing work on the design, grading and pattern cutting elements of ORMUS-FASHION meant that there was continuing, though less intense, contacts with the Concept II. I discussed my other work with them and they were helpful in providing any software links that I needed to integrate programmes. By September 1989 they also saw the potential of CAMEO, and decided to use it themselves. They also re-focussed their work in the design area, recognising the potential of getting accurate vector line drawings and good colour matchings out through colour printers.

1990

Concept II have completed a programme HI-RES that increases the capacity for good linear output. Noble Campion has just released new interesting textile options. A rather complicated relationship now exists as I work with the two software houses, who are in a sense, also competitors in the same field. My interests in all forms of textile design, and the demands of my customers, mean that I have to seek solutions that cross the software boundaries[3], of accurate mathematical vector lines, of raster paint freedom and of high quality text output. I need access to the programming of both software houses.

If one wishes to measure the success of an original idea by its success in the market place, the current tally of installations of ORMUS-FASHION software, (September 1990), is 45 different educational sites in Britain and Australia and Hong Kong, and 22 industrial sites in Britain, Cyprus, Northern Ireland, France and Australia.

THE FUTURE

The future development of Ormus-Fashion will be directed by commercial interests, it has to be. But those commercial interests will now be very influenced by designers. Some of the designers, who have purchased the combination of ORMUS FASHION and CAMEO software, are designers of high reputation who own their own companies or work in colleges with design students. They will have control over how it is used and demand of Concept II and Noble Campion new directions in their products. Some designers find great attraction in working with a software product; software can appear to be 'organic' in the sense that they can act 'god-like' over its continuing change. This is seductive. Software becomes limiting and an irritant where there are no possibilities for change. I find the future exciting, who can even imagine, now that ORMUS-FASHION has many imaginations to influence it, where it will be taken.

REFERENCES

1 I wanted a design system that I could use as an independent designer;

it had to flexible, it had to allow me to work in the way that I chose to work on differing briefs. It had to work simply at the basic level, its complexities only there to be activated when required.

2 The checking and re-checking of the software was like running round an endless spaghetti road junction with signs constantly changing. Every time the software writers incorporated an option that I wanted, all other options had to be checked in conjunction with all sequences of other options to see its effects.

3 For example: the designer does not have to do the work again if one wishes to add colour or graphic effect to linear work; on the bench the designer is able to measure accurately any form of graphic work.

PART SIX: FASHION DESIGN AND CAD 1990

CHAPTER TWENTY: CAD IN THE DESIGN PROCESS

The CAD Phenomena

What we are discussing here is a relationship between man and a man-made object. The start of this journey began in the refectory of the then Trent Polytechnic, (now Nottingham Polytechnic), in 1984, when I, in a crude and inelegant way, tried to explain to my potential supervisors the interests of examining what happened, when the complexities of continual change within the human mind worked with a machine that contained some of the characteristics that were believed to be embodied within the human mind. It seemed to be a very abstract and esoteric idea to pursue in a very commercial and practical world of Fashion and Textiles; but this world, itself, operates in a continuing conflict between the abstract and the unsayable, and the manifestation of the product.

Artificial intelligence, (AI), tries to use computer programmes to model human abilities. The strong AI position believes that a computer thinks if it acts in a way that is indistinguishable from the way people act when they are thinking. A weak AI position shows interest in psychological aspects where it is hoped that, by trying to imitate the brain, more will be understood about the brain of man, and far more ambitiously, it is hoped that it may offer some insights into philosophical questions of the concept of mind. Somewhere between these positions, interest in AI focusses on its advantages in imitating or even surpassing elements of brain functions, these are attractive to any commercial enterprise. In robotics, which reduce an unpredictable labour force; in expert systems, that capture and hold knowledge and expertise; in application systems, that add formidable calculative and modelling powers to human constructs.

It is of first importance that we establish if the man-made object can replace the man. Penrose addresses the strong AI position, he asks; 'will these high powered devices be intelligent, will they think, feel, have minds?'[1] He states that the Turing machine perspective believes that the difference between the functioning of the human mind and that of the computer is only a matter of greater complication, that thinking, feeling, intelligence and consciousness are features merely of the algorithm being carried out by the brain. AI supporters see individuality in terms of the configuration of the person's brain which it may be possible to capture. Searle[2], a critic of this position, argues that two elements are missing, the mental attributes of understanding and intentionality. He believes that mental phenomena are biologically based. Penrose[3] accepts some of Searle's argument but finds it insufficient; he believes that it places humans in the position of being biological computers, the difference only being by degree, or it could be argued 'machines made of meat'. I believe that he misunderstands the complexity of Searle's argument and his use of the term 'biological'. Searle appears to be saying that the powerful elements of emotion, understanding and conscious free will are unique human capacities.

Penrose[4] offers a number of powerful arguments against the claims of AI, he states that his ideas are the reversal of many commonly held ideas. Many of the features of human consciousness, that he finds unrepeatable in algorithm form or answerable in any quantum form, are features that have been identified during the course of this study: the plasticity of brain activity, its holistic capacities, the way the brain processes ideas concurrently, the varying levels of consciousness that allows new ideas to emerge and new connections to be made, that language is not a pre-requisite of idea generation. However, he also offers the powerful argument that human beings carry with them a kind of philosophical baggage which forces them to ask why?

> 'It is when one sees others behaving in this strange philosophical way that one becomes convinced that one is dealing with individuals, other than oneself, who indeed also have minds.'[5]

Finally he concludes that beneath all this technicality is the feeling that it is indeed 'obvious' that the conscious mind cannot work like a computer even though much of what is actually involved in mental activity might do so.

I feel the argument is not finished. Although, at some points, Penrose talks briefly[6] about the constant change within the human mind, the idea is not fully explored. The human capacity to initiate change, that is appropriate yet not deliberately sought or reasoned, has been a central theme of this research from 1984. The fact that human beings, both individually and collectively are in a continuing state of change, within a context, in which the collective human knowledge is also in this position of instability, is crucial. Human consciousness is therefore unknowable, and one cannot construct an algorithm of the unknowable.

The uniqueness of our consciousness makes it quite conceivable that some people can consider AI as equivalent to the mind. It is very likely that minds are incapable of grasping aspects and kinds of thought that others can experience because those concepts are not internally available to them. One can listen to a number of highly intelligent people having a conversation and realise that some are quite unable to grasp ideas or symbolic nuances that are available to others. The notion that one could construct an algorithm that could produce aesthetic idea is, I think, just conceivable, but how could it understand what it had created? There are no eternal truths for those who have not glimpsed them.

The conviction that a computer is not the equivalent of a human being does not mean that it is inferior, just different. It may be, that it mimics very closely certain aspects of human thinking and is superior in some respects. What seems to me to be of greater importance, are the qualities of CAD, which differ from human capacities and the freedom of human beings to choose how they interact with them.

This thesis started from the belief that many software programmes had been written to rigid specifications for precise and complex tasks, they were efficient but offered limited interaction with the user or his thought processes. It was suspected that the potential capacities of the available software were not being utilized by either the software writers or the designers. The work of this thesis has demonstrated that it is possible for a designer to intrude into the mathematicians' domain to change the forms of software and to integrate personal ideas.

Lansdown's categorisation of CAD characteristics, discussed in Chapter nine, is I believe insufficient. This field study of many designers' use of CAD showed that, when given choice, designers select and create their own complex forms of use. It was rarely used in any isolated way, CAD can never be a thing in itself, it will always be bounded by the activity itself. Its use appeared to have only a minor relationship to personality traits and mental attributes. Rejection, selection, or forms of use appeared to be more closely tied to personal processes of design. Over-riding all these influences was the practical factor of it producing what they required or their emotional response to the media. The most intriguing aspect of this phenomena is the personal finding that a relationship can develop between flexible computer software and the user. Flexible interactive CAD programmes can allow the user to fashion the phenomena into unique forms created by its constantly changing use. Some designers in the study found CAD limiting, in any of its forms; but more of them found their experience worthy of further exploration.

CAD and the Clothing Industry

Industry models itself on human beings in that its first will is the need to survive. The British clothing industry maybe surviving, but it is failing to thrive. Compared with the rest of the Common Market, its clothing exports show the lowest increases of all the EEC nations.[7] Economists constantly show, statistically, that an indifference to the level of education and training is a significant factor in an industry's decline. Simply investing in new technology guarantees nothing, without training and education, potential benefits are never achieved.

In many of the larger clothing manufacturers, interest in high technology is focussed on Computer Integrated Manufacture (CIM), it is seen as the remedy for recovery, and in this pragmatic context artificial intelligence has few philosophical problems.[8] However, Off[9] states that true automation is not here today nor will it be here tomorrow. The difficulty is often picking out the sense from the hype. The largest proportion of high technology work is not, as one would believe from its image or new discoveries, but incremental technology or applied technology; the reality of CIM is highly dependent on mechatronics,[10] connections[11] or specialist support services.[12] Whilst many companies are, at last, recognising the cost, and often crippling inefficiency of the design sector of clothing, many CIM concepts are concentrated in the production areas.[13] Manufacturing is quantifiable, design is not.

Efficiency in the design room is a different concept, speed and quick response have always been crucial to the fashion market, but the quality, the novelty and the appropriateness of design, are human factors, The technology can only play a part in the game. Whilst visually dramatic new innovations create interest[14] and attention, and stimulate some purchases by large companies, it can be mundane incremental technology, better screen resolution,[15] improved hard copy output, increased computer power and dramatically lowered costs that causes rapid increases in installations. 80% of the companies visited in the field study in 1985-86 and re-contacted in 1989, had recently installed graphic stations, or were seriously considering the purchase of one. The board rooms of companies are now seeing graphic stations as more than a 'designer's toy',[16] they now see them as practical marketing tools and a means of developing their own textile ranges for their collections. But the full potential of CAD will never be tapped unless the designer can 'toy' with the system and expand its capacities.

The computer realisation of the sketch, diagram or specification, to a flat pattern form, has attracted many research hours. There has been some success with garments that closely mould the human form,[17] or can be described relative to a basic shape.[18] The former offers many attractions for a new sculptural form of garment design, using many of the new textured fabrics.[19] This appears to be an innovation of new promise. However, it appears to take vast amounts of programming to even begin to achieve the primitive beginnings of innovative pattern cutting from a sketch. Innovative pattern cutting involves the infinite capacity to modify shapes, the idea changing as it proceeds. My solution, at this stage, has been a release from proscribed commands, to an 'electronic pattern cutting' table and basic tools, with a swift capacity to work from either the actual dress stand or the computer dress stand on demand. Complex problems can often be solved simply by using oblique solutions that marry human thought and a computer algorithm.

One must beware of the idea that anything innovative or efficient is 'good'. Efficient for what? It is just as mistaken as assuming that because many individual craft pieces are an aesthetic pleasure, anything associated with the idea of handcraft is 'good'. In many small design studios, CAD is not seen as alien to the production of small batch or individual aesthetically valued work. The contemporary working craftsman or designer often sits uneasily in the 'folk' concept, created by the advertisers to market nostalgia.

CAD and Design Education

Sparke[20] states that in recent years design education in Britain has received few injections of vitality. The ambiguity between vocational training and education remains. Ad hoc links with industry and additional instruction in management... ergonomics... psychology... have been grafted on to existing courses. She believes that they remain based on an idealism which derives from a historical moment which has little contemporary relevance and it fails, for the most part, to confront the whole question of design for industry and to reformulate its ideals in the light of economic and social changes. Throughout this century, design education has tended to swing between the two poles of utopianism and vocationalism. Russell[21] believes that any objectivist approach to the concept of design has been regarded by many art educators as antithetic to the concept of 'art education' and a sinister threat to its survival by the technologists. There are educators who at the moment stand with an uncomfortable foot in either camp, they reject either polarity, they see art and design activity as part of a continuum of creative processes, their stance is contextual in nature.

The rationale, offered by the validating bodies,[22] for the introduction of CAD reflected the ambiguity that Sparke identifies. It appears to have been an immediate response to the criticism, by major designers, of British manufacture. They accuse the clothing industry of lacking technical and organisational skills that are found in Europe. As Conran states:

> 'What interest am I to anybody if I can't deliver, no matter how nice my ideas'.[23]

The colleges were seen as being inefficient in equipping the students for their prospective careers.

> 'I prefer to think of fashion as a verb... When will the educators learn that you can't divorce design from technique?'[24]

This factor was a valid but not sufficient reason for its inclusion in the curriculum. CAD technology has, I believe, to offer some extension of the design process itself, to those who wish to pursue it. I would argue that this thesis shows that for some designers it offers them more than technical expertise. CAD cannot be viewed simply as an additional tool, its inclusion in the curriculum merits more than simply low level technical additions to a syllabus. The recommendations offered from the MSC report listed in Chapter Eight, are now seen as insufficient, they concentrated on recognised technical expertise and knowledge.

Some colleges appear to be afraid of giving the students something technically or theoretically difficult within a course. Many students, are in fact, disappointed at the lack of rigour in practical subjects.[25] They read in the college prospectus that they will have access to new technology, but all they are often given is a superficial tour of equipment. If a college department does not believe in the value of new technology, or is unable to provide it, or wishes to offer only introductory courses, it should say so. It is an honest position, they can offer their rationale and their justifications for their position. There would be more respect for this position than that of, 'just get the validation document through, what you do doesn't have to be what the document says you will do... '

Sale[26] states that pressure for results produces the attitude that the design of the curriculum is only the proper concern of the teacher. He believes that the student is well placed to identify his or her learning needs and should have some say in its development. He argues that industrial design education is about evaluation and independence and preparing students to construct their own frames of reference. This is a shift of power from the provider to the learner.

Offering CAD technology to a high or individual level is not easy, many tutors simply do not understand the technology. They see it simply in terms of flash images of already designed products, or mechanistic productions of artefacts that remove design decisions from students.[27] Skillful action is 'knowing more than we can say' it is that our knowing is in our action. The opportunity to reach this level means that a student must have the opportunity and the support necessary to reach this level. It is only when the fusion of mind and machine produces holistic areas of thought that the potential of the technology is released. Some colleges and universities are exploring these new concepts, the ability to work in three dimensions on the dress stand may offer new directions and new visions in fashion design.

> 'perhaps only when such images are the norm will we finally break free of the tyranny of flat paper design.[28]

If we return to Sparke's[29] view, she states that, instead of a clear rationale, all that has happened to courses is that some industrial and academic respectability has been tacked on to courses, by the addition of management studies and social science studies. Consider Gale's statement.

> 'We cannot educate designers to-day in disciplines which they will need in twenty years time because we do not know what will be needed in twenty years, instead we must teach them to think.'[30]

This is a reasonable argument, and fine judgements have to be made. Introductory technology may be applicable to students taking courses in the general management of design, but it is hardly enough for those students who wish to choose a technological career. This thesis has been centred on change, but to move to a new position one has to accumulate some form of knowledge to have a position to change from, or to apply to. Working within technology, as within any design discipline, print-making, photography, or pattern cutting, one usually has to reach at least a position of familiarity and 'knowing more than one can say', to break new ground. Are fashion and clothing technology students being allowed to attain a degree level in practical technology if they choose to?

The government grant of four and a half million pounds, has not provided a solution. First, it was a 'point decision' instead of an on-going commitment that could have related to technological change. Second, it concentrated on equipment; Chapter nine of this study elaborates on the ensuing problems that occur when inflexible decisions are taken and when people and their context are not taken into account.

This thesis focuses on difference and change, it now argues for pluralism in technological and design education, some marriage between the technology and the arts, and also for opportunity and personal choice. It therefore rejects Rzevski's[31] idea that there has to be a distinct separation between CAD designers and manual designers. It may be that one college cannot offer all that is required, however, colleges could stop thinking parochially and co-operate instead of competing like corporate raiders. The experience gained in the preparation of this reearch and the study observations made, leads me to argue now for modular forms of degrees and diplomas; this would enable students to gain differing technological or design expertise in differing centres of technological or specialist excellence.

Final Reflections September 1990

In 1984 I had no knowledge of CAD. In the present context, at the present time, with my current software, on a great deal of my current work, I believe that a form of CAD has become an integrated part of my present process of design. But this is one point in time, and there are unlimited possibilities for me to change my mind..........

REFERENCES

1 Penrose states that the AI lobby accepts that this algorithm would have to be a stupendous thing, but the AI supporters claim that in

principle it could be run on a computer. They also claim that whenever this algorithm was run, it would, in itself, experience feelings, have consciousness, be a mind. Roger Penrose, The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics Oxford University Press, Oxford, 1989, p. 17.

2 John Searle discusses claims for artificial intelligence and offers his argument against possibilities of creating a 'mind' with Geoffrey Hinton in the programme 'Inside the Chinese Room', one of six programmes in the series Voices: The Trouble with Truth Channel 4, 19th April 1988. He addresses the problems of understanding and questions McCarthy's work which sees thermostats as having systems of beliefs similar to that of man. The transcripts are available from Brook Productions, London.

3 Roger Penrose in The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics Oxford University Press, Oxford, 1989, pp. 17-23, discusses Searle's 'Chinese Room' argument, which he partly accepts. He is more dismissive of Searle's theory of intentionality. John Searle discusses the intrinsic feature that he believes distinguishes the human mind, that of consciousness in Intentionality Cambridge University Press, Cambridge, 1983, p. ix. 'On this view, consciousness and intentionality are as much part of human biology as digestion or the circulation of the blood'.

4 Penrose sees consciousness as being required for common sense, judgements, understanding or artistic appraisal; consciousness is not required for the automatic following of rules, mindlessly programmed activity or algorithmic problems. In judgement forming, whilst the unconscious may put up many ideas, it is the conscious which selects or rejects its validity. Mathematical truth is not something that we can ascertain by use of an algorithm, one has to see its truth. In his own world of mathematics he has found words almost useless for mathematical thinking, he has had difficulty in communicating his ideas to others who have different modes of thought. They may have similar conclusions but different modes of achieving or understanding the problems. Roger Penrose, The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics Oxford University Press, Oxford, 1989, pp. 411-412. His discussion of other features of human consciousness are continued throughout the book.

5 Roger Penrose, The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics Oxford University Press, Oxford, 1989, p. 409.

6 Penrose when discussing Hofstedters's argument about the possibility of constructing an algorithm for Einstein's brain, says, 'After all, normally when we are aware of something we receive information from the outside world which affects our memories, and the states of our minds are indeed slightly changed.' Roger Penrose, The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics Oxford University Press, Oxford, 1989, p. 23. He also focusses on the plasticity of the brain, he states that there are some other points of difference between brain action and computer action that seem to be of much greater importance than the ones so far mentioned having to do with the phenomenon known as brain plasticity. It is not legitimate to regard the

brain as simply a fixed collection of wired up neurons. The neurons are not fixed as in the computer but are changing all the time; this takes place, according to leading theories, at the synaptic junctions (the means of storing long term memory) where communication between different neurons actually takes place. If this is so, then brain plasticity is an essential feature of the activity of the brain. p. 396.

In 'How to teach the computer to act naturally', Jane Bird talks about software 'neural networks' which have the ability to make idealised abstractions - they can learn concepts - like 'cat'. Computer scientists are testing the robustness of the software in holding the concept if the 'cat' image is changed or distorted. But 'cat' is a concrete concept, how will it cope with the affective domains? Sunday Times August 9, 1987, p. 58

7 Michael Hinchcliffe in 'Imagination is more important than knowledge', Textile Horizons February, 1990, states that compared with the rest of the Common Market, UK clothing exports increased by only 26% over the period 1980-87, the lowest of the twelve EEC nations. Compare Britain's balance of trade in clothing, which deteriorated by 124% whilst Italy's grew by 94%.

8 Christian Tyler quotes Dr. Peter Mowforth, 'People in AI labs are pragmatists. We can construct machines that do things. Its up to the user to say whether they're doing their job properly and up to the philosophers to say whether they are intelligent or not.' 'Making way for the thinking machine' in the Financial Times: WeekendFT June 30/July 1, 1990. p. I.

9 From a paper 'Research and Technology' given at The International Conference on Industry and Education for Fashion and Clothing, by J.W.A Off, Cambridge, September 1990. He gave a description of the work done at TC , a major USA training agency specialising in new technology. He offered a useful, if somewhat distinct, categorisation of the innovation process: high technology, alternative technology and basic technology. During the discussion at the conference, it was interesting to hear that the new CIM project at Leicester Polytechnic had been looking at the American experience. It will be interesting to examine the Leicester focus of activity, with regard to rechnology type and company size, as the project becomes established.

10 See an interesting article by Lynton McLain, 'Computer's brain takes the strain' on tapping the the collective creativity of designers and technologists and applying these ideas to create intelligent systems. Mechatronics is a process which crosses the traditional boundaries of electronics, mechanics and computer software design. McLain quotes David Dawson, deputy director of the University of Lancaster's centre for mechatronic systems, 'Interdisciplinary product teams can operate using a brainstorming approach at the very early stages of conceptual design'. Financial Times September 21, 1990.

11 It is unlikely that any CADCAM clothing company, despite their claims, could offer a full CIM system to suit a company's individual requirement for the manufacture of his specific clothing products. Links are increasingly being formed by buy outs or co-operation between

companies of differing expertise. For example, the Kurt Salmon purchase of Microdynamics Inc. Clothing companies are increasingly demanding links between systems purchased from different CADCAM companies.

12 The growth of specialist support companies is extending rapidly. Buying in expertise as required can ease the introduction of a major innovation. Buying services eliminates the 'risk decision taking' that haunts and immobilises middle management intent on corporate career moves. It also eases the staff poaching problem that was found, during the company field study of this thesis, to have caused tremendous difficulties on CAD grading and marker making systems. See 'Making the most of it', by Godfrey Golzen, Sunday Times June 17, 1990. See also, an article on facilities management by John Fowler, 'FM - bridging the skills gap', IBM Computer Today February 28, 1990.

13 The Kuris CIM concept has no recognition of the design process. 'Computer integrated system in operation', Apparel International August, 1990.

14 Probably the innovation that made the greatest impact in publicity and interest in areas of design, was the appearance of the CDI textile and graphic system. However, the clever simulation of cloth on the body form was quickly copied by competitors at a remarkably lower cost. For a description of the system and a cost comparison with another textile system AVL see 'Computers weave a new fashion', Johnathan Beard, New Scientist, February 10, 1990.

15 Whilst most companies are thinking of screen resolution in terms of pixels on screen, other technologies, i.e. liquid crystal technology (laser smectic liquid crystal light valve), will be improving the visual quality of the image. It is kinds of tactile, visual and operational innovations that excite the designer. I await the pocket sketch book complete with floppy disk for recording and transferring images for later work.

16 The term 'designer's toy' was expressed by a number of senior managers during the field study of companies. It was an example of the lack of knowledge that exists about the practice of design. Clothing is a particular sector of the British Industry that can ill afford this kind of ignorance.

17 Many 3D wire frame attempts to create garment patterns have collapsed, or seem to be too mechanistic for the innovative designer to contemplate. But, different, interesting work is taking place in this field. The University of Loughborough can simulate the human body accurately on screen for accurate measurements by using data points instead of a wire frame model. Drs. McCartney and Hinds at Queens University, Belfast, are linking this research to translating three dimensional body shapes into 2D patterns.

18 Expert systems are being introduced into pattern cutting, (Investronica) in which the designer's own practice can be learnt by the system. This is early work and judgements cannot be made yet on this work.

19 New fabrics are appearing, creating new concepts in clothing; the fabrics could only originate in computer technology; for example fabrics made from micro-fibres and weave constructions that produce 'organic visual forms'. The fabrics are the antithesis of the 'throw away' culture, they are fabrics that are lasting in quality and outside of fashion.

20 Penny Sparke, Introduction to Design in the Twentieth Century Allen & Unwin, London, 1986, pp. 172-176.

21 Anthony K.Russell, 'Design education and economic development', Design Policy:Education The Design Council, 1984, p. 23.

22 The rationale offered by the validating bodies is discussed in the Introduction to this thesis, see the references in the chapter.

23 An article by Sarah Mower, 'Is British Fashion Good Business' Vogue August, 1988, discusses the problems of British designers having to go to the continent and the Far East to obtain the technichal skills required to interpret and produce their goods. They are finding that quality practical expertise is not valued or available here.

24 Jean Muir, the British Designer offers her strong views on technique in 'SO Simple', Designer March 1985.

25 I train designers for companies, many of these designers enjoy the technology, and say that they saw equipment in their college, but that they were rarely allowed to use it. One middle manager said that he had been on a CAD course for managers, but hadn't understood a word of it, because of his lack of basic knowledge. He found that many others on the course were in the same position.

26 R.C.Sale, 'Curriculum development in design at Further Education level' Design Policy: Education The Design Council, 1984, p. 54. A conference paper.

27 The discussion session during the conference Computers and Design Education Design Council Conference, June 1988, demonstrated a difference of views about what in fact constitutes creativity and the practice of design. These differences were very apparent in arguments, the value of CAD was continually reduced to the surface qualities of computer images because this appeared to be the only part of CAD which could be understood by many lecturers. John Frazer and Roger Breakwell, of Ulster University talk about some lecturers' superficial views of CAD in 'Education', Computer Images March/April 1988, p. 46. 'The role of a university is to turn out thinking designers... '

28 C.A.Graeme Webster, 'Computers and 3D product design education - an overview', conference papers published by the The Design Council, Computers and 3D Product Design Education 1985 November 1984.

29 Penny Sparke, Introduction to Design in the Twentieth Century Allen & Unwin, London, 1986, p. 172.

30 Roger A.Gale, 'Design education for industrial managers', Design Policy: Education The Design Council, 1984, p. 52.

31 George Rzevski in his paper 'The Role of Information and Information Technology in Design' at the conference Computers and Design Education The Design Council, June, 1988, sees a distinct split between manual and CAD designers, he believes that you cannot be both. It takes '...ten years to be an effective CAD designer'. This does not explain why you cannot marry the disciplnes. This view seems to return to the outdated view of the division of arts and sciences.

APPENDICES

APPENDIX I

ADDRESSES OF CADCAM COMPANIES OPERATING IN GREAT BRITAIN IN 1986

		Contact
GERBER/CAMSCO 0274 495811	Gerber Scientific UK Ltd Cumberland House Greenside Lane Bradford Yorkshire	Trevor Parker
INVESTRONICA 0924 260021	Computer Clothing Systems Spa Street Ossett Wakefield West Yorkshire	David Worgan
LECTRA SYSTEMS 0274 589090	Lectra Systems Ltd Thomas Duggan House Manor Lane Shipley West Yorkshire BD18 3DR	Charles Ross
MICRODYNAMICS 061 678 0234	Xetal Systems Chamber Road Oldham Manchester	Richard Price
CYBRID 01 481 4925	Cybrid Ltd P O Box 235 London E1 95S	David Walters

APPENDIX II

CADCAM CLOTHING SYSTEMS EXPECTED IN GREAT BRITAIN DURING 1987

<u>DATAMONSTER - SWEDEN</u>

Complan (Leeds) will be marketing a pattern adaptation, grading and marker making system which will be available on a mini mainframe or micro computer. The systems will offer an option of paper marker plotting or high speed laser pattern cutting.

Each system will be marketed at a competitive price (eg. the price of entry for a micro system with plotter for approx £45,000).

The system is expected to be available in January 1987.

(Contact: Tony Walsh, Complan, Wira House, Clayton Wood Rise, Leeds. Tel: 0532 781234)

<u>EUROLOG/KURIS</u>

G. E. Macpherson will be marketing the Eurolog system for pattern cutting, grading and marker making from January 1987.
The system interfaces with KURIS CUTTERS for which Macphersons are the UK agents.

(Contact: Roy Burfitt, G. E. Macpherson Ltd, Lenton Lane East Industrial Estate Nottingham. Tel 0602 868701)

CADCAM CLOTHING SYSTEMS WHICH MAY ENTER GREAT BRITAIN.

TEXOGRAPHY - GERMANY, SECO - SWITZERLAND, CUTTEX - SWITZERLAND, NECCHI - ITALY, TECHNOCONF -ITALY.

APPENDIX III

Research-intensity by branch of industry, expenditures on R & D as a percentage of net output, UK, 1968-9.

INDUSTRY GROUP	R&D EXPENDITURE AS % OF NET OUTPUT	R&D EXPENDITURE £m	PERCENTAGE OF R&D FINANCED BY GOVERNMENT
total industrial	4.2	648.9	30.4
aerospace equip	39.1	191.6	72.3
electronics & telecommunications	19.6	121.9	40.0
mineral oil refining	12.2	12.6	
ind & marine engines	8.3	7.3	24.8
plastics	7.9	13.1	
pharmaceuticals	7.0	20.2	
scientific equip.	5.5	15.2	19.0
electrical machinery	5.3	17.2	
chemicals	4.6	48.2	
motor vehicles	4.2	45.7	3.2
general elec.eng.	3.9	12.7	7.1
industrial plant	2.8	9.3	39.2
general mech.eng.	2.3	24.7	7.3
rubber products	2.2	5.9	
textile machinery	2.2	2.4	
agricultural machy	2.2	1.0	
machine tools	2.1	5.4	5.0
stone,clay & glass products	2.1	12.6	
domestic appliances	2.0	2.7	
non-ferrous metals	2.0	6.2	
mech handling equip.	1.4	3.5	
iron & steel	1.3	10.4	
textile & m.m fibres	1.1	12.3	
food,drink & tobacco	1.1	20.9	
gen. metal products	0.8	7.6	
shipbuilding	0.8	2.4	30.1
other manufactures	0.8	2.9	
railway equipment	0.5	0.3	
timber,furniture, paper & printing	0.5	8.0	
clothing,ftwr,leath	0.2	1.1	
construction	0.1	3.3	

SOURCE: Economic Trends (1970), Board of Trade Journal (1969),

APPENDIX IV

CADCAM CLOTHING SYSTEMS NOW AVAILABLE IN GREAT BRITAIN - FUNCTIONS

FUNCTIONS	GERBER USA	INVESTRONICA SPAIN	LECTRA FRANCE	MICRODYNAMICS USA	CYBRID GREAT BRITAIN
GRAPHICS SKETCH DESIGN	yes Stand alone system palette. 16 million colours $23,000	yes Stand alone system palette. 16 million colours $25,000	separate program works on existing hardware. No extra cost in monochrome Colour + £10,000 palette.	yes stand alone system palette. 16 million colours matches colours to Munsell textile colour system $49,000	in review
PATTERN ADAPTATION	yes used by a small no of cos for pattern modification.	yes very effective proved in company operation.	principally an effective pattern modification system only single pattern pieces available at a time	yes program options now competitive with other major systems	in development expected Sept 86
PATTERN GRADING	yes very effective on standard prod. interactive or grade rule library	yes effective and adaptable. interactive or grade rule library	yes effective and adaptable . interactive or grade rule library	yes good reputation USA track record to be estabd UK. production system intro UK Spring 86	in development expected Sept 86 interactive grading
MARKER MAKING 'AUTOMATIC'	yes costing and prod yes	yes costing and prod yes major system no micro system	yes costing and prod yes-all systems	yes costing and prod in dev late 86	costing available prod system in development expected Sept 86 as above
PLOTTING (marker width)	paper markers flat bed pen 1.6 width	paper markers drum-ink jet 1.82m wide flat bed pen 2.2m	paper markers flat bed pen 1.8m width will plot on card for manually cut patterns.	paper markers flat bed ink jet	costing available prod systems in Sept 86 paper markers.flat bed pen 2.1m width.
CUTTING - CARD AND PLASTIC PATTERNS	yes plastic and card patterns	yes plastic and card patterns	yes special laser cutter required. cuts card and fibre board £17500	card patterns	in review
CLOTH CUTTING HIGH LOW-MED SINGLE	yes knife knife	yes interface to other cutters knife knife plasma jet	yes interface to Gerber & Bulmer cutters knife laser	interface to Gerber systems	in review low cost cutting system.
CUT PLANNING	yes	yes integral to the system.	in development expected Nov 86	no	in review
OTHER FEATURES	fabric saving made to measure Gerbermover handling system stand alone system	check matching system. made to measure Investmove handling system stand alone system	made to measure in development expected Nov 86	made to measure standard	

APPENDIX IV continued

CADCAM CLOTHING SYSTEMS NOW AVAILABLE IN GREAT BRITAIN - EQUIPMENT

EQUIPMENT	GERBER USA	INVESTRONICA SPAIN	LECTRA FRANCE	MICRODYNAMICS USA	CYBRID GREAT BRITAIN
SYSTEM TYPE	mini Hewlett Packard (micro interface to system only)	mini Hewlett Packard / micro IBM Compat	Mini - Microlec computer	Micro IBM PC/AT	Cost Plan Company - micro PDS/Grad/M Making Micro -Whitechapel /MGI
MODEM LINKS	yes	yes	yes	yes IBM Network	yes
DATA STORAGE	Hard Disk Tape	Hard Disk Tape / Floppy Disk	Floppy Disk Hard Disk Data Bank	Floppy Disk Hard Disk	Cost Plan Floppy Disk PDS/Grad/M Making Hard Disk
. RAM SYSTEM. MEMORY.STORAGE .ADD. TO .FLOPPY	24 - 55 Mb	1.5 Mb / 1.5 Mb 24 - 132 Mb / 20 - 50 Mb	512K 10 Mb + 40 Mb (data bank)	512K 20 Mb (interface to data bank storage)	PDS/Grad/M Making 1 Mb 20 Mb
MODULAR	yes	Basic system other functions & micro-systems will integrate into system.	yes Autonomous work stations can work independantly or simultaneously.	yes Autonomous work stations can work independantly or simultaneously.	yes
EXPANSIBLE	yes Basic grading system upgrades into the larger systems.	yes Large capacity Easy data comunication between stations.	yes - Lipgrades 301-single screen 303-two screen 305-many operation	yes Unlimited expansion work stations data storage.	yes
INPUT	digitiser	digitiser	digitiser	digitiser	Scanner claims to reduce input time by 60%.
COLOUR OPTION	yes (plus $10,000)	yes (£7,000 less)	yes (plus £10,000)	integral to system	no
BUREAU SERVICES AVAILABLE	yes Private & Local Authority funded bureaus- Leeds, Birmingham,Scotlnd	yes Private & Local Authority funded bureaus- Ireland London,Nottingham	yes Bureau run by the company in Shipley Yorks.	no	no
PRICE AT ENTRY (SYSTEMS ARE NOT DIRECTLY COMPARABLE)	Pattern adaptation pattern grading marker making $87,000	Pattern adaptation grading & marker making main system £70,000, micro system £45,000 Wk station £24,000	301 system sketch (monochrome) patt adaptation grading marker making (automatic & interactive)single operator £38,500	Pattern grading marker making & plotting $78,000 Pattern adaptation $116,000	Scanner £20,000 Grading & M making £34,000 Plotter £13,000
NO OF PROD SYSTEMS SOLD MAY 86 UK E.MIDLANDS STUDY AREA	121 18	10 0	31	1 0	28 2
THE COMPANY'S STRONG SELLING POINTS	Credibility of a large company. Excellent track record.Production expertise. Speed	Ease of operation designed by a clothing company Wide range of functions. Speed. Pattern adaptation excellent. Large data storage capacity. Micro option.	Flexible system. Independent modules.Good track record.Experience of use in small-medium size co.s Bureau support. Price	Ink-jet fast plotting.Flexible modular system. Interface into existing CAD systems. Latest software technology - will progress with IBM Easy to use. Low service cost Easy communication worldwide.	Ease of operation Speed of input. New form of technology. Price. British product Interactive for small-med co.s with specialised production.

APPENDIX V

BRITISH CLOTHING INDUSTRY
EMPLOYMENT BY PRODUCT CATEGORY 1984

PRODUCT CATEGORY	NO. EMPLOYED	NO. OF COMPANIES	INCLUDING N. IRELAND NO. EMPLOYED	NO. OF COMPANIES
weather/outerwear	11,500	246		
mens,boys tailored outerwear	33,200	711		
womens,girls tailored outerwear	19,500	418	FIGURES NOT	
work clothes mens,boys jeans, shirts,underwear	31,800	681	AVAILABLE	
womens,girls light clothing lingerie & childrens wear	70,200	1,504	IN CATEGORIES	
foundation,swimwear	27,600	591		
TOTALS	193,800	4,151	210,100	4,500

SOURCE: British Clothing Centre 1984.

APPENDIX VI

BRITISH CLOTHING INDUSTRY 1984 (INCLUDING NORTHERN IRELAND)

THE CLOTHING INDUSTRY STRUCTURE

PRODUCT CATEGORY	SIZE OF PLANT BY OPERATIVE					
	up to 50	51-100	101-200	201-500	over 500	TOTALS
weather/outerwear	204	29	21	11	3	268
mens,boys tailored outerwear	586	85	62	31	8	772
womens,girls tailored outerwear	344	50	36	18	5	453
work clothes mens,boys jeans shirts,underwear.	562	81	59	30	7	739
womens,girls light clothing lingerie childrens wear	1237	179	130	65	16	1627
foundation,swimwear	488	71	51	25	6	641
TOTALS	3421	495	359	180	45	4500

SOURCE: British Clothing Centre 1984.

TABLE 19

TABLE 19

EMPLOYMENT BY REGION 1981 (REVISED) (000's)

	S.EAST	EAST ANGLIA	S.WEST	W.MID	E.MID	YORKS/ HUMB	N.WEST	NORTH	WALES	SCOT.	G.B.
All Industries & Services	7224.6	680.5	1545.5	2033.4	1465.5	1842.8	2454.2	1119.4	936.7	1990.7	21314.1
Manufacturing	1683.5	186.0	395.7	800.7	533.4	578.9	799.8	339.4	238.2	502.0	6057.5
Clothing, Hats, Gloves	50.8	4.2	9.2	12.4	25.8	27.5	36.9	16.2	9.4	23.9	216.2
Weatherproof Outerwear	1.8	0.3	0.3	0.8	0.6	1.3	4.3	1.3	0.5	1.5	12.7
Mens & Boys Tailored Outerwear	6.0	1.6	1.3	2.5	2.2	10.6	4.3	3.5	1.7	4.5	38.2
Womens & Girls Tailored Outerwear	11.8	0.3	0.6	1.3	2.3	2.2	3.1	1.2	1.6	2.5	26.8
Working Clothing, Mens & Boys Jeans	2.8	0.4	0.6	1.3	1.1	1.6	5.1	1.0	0.3	4.2	18.4
Womens & Girls night, Outerwear, Lingerie and Infants wear	19.2	0.5	1.3	4.9	14.3	8.2	14.5	7.0	2.9	6.5	79.4
Mens & Boys Shirts, Underwear, Nightwear	2.1	0.1	1.9	0.3	1.1	2.8	3.1	1.5	0.3	1.6	14.8
Hats, Caps, Millinery	1.6	0.2	-	0.3	-	0.2	0.8	-	0.1	0.2	3.5
Gloves	0.2	-	1.1	0.1	0.1	0.1	0.3	0.3	0.1	-	2.3
Other Dress Industries	5.3	0.7	2.1	0.8	4.2	0.6	1.4	0.4	1.9	2.8	20.1

SOURCE: Department of Employment Gazette December 1983 Occasional Supplement No.2

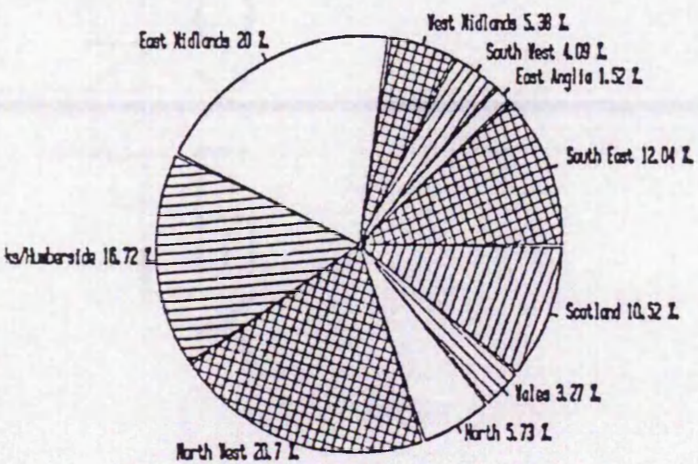
NOTES:
1. - means under 100
2. Based on new SIC (1980)
3. Based on 1981 Census of Employment

SOURCE: HOLLINGS APPAREL INDUSTRIAL REVIEW, SPRING 1986

APPENDIX VIII

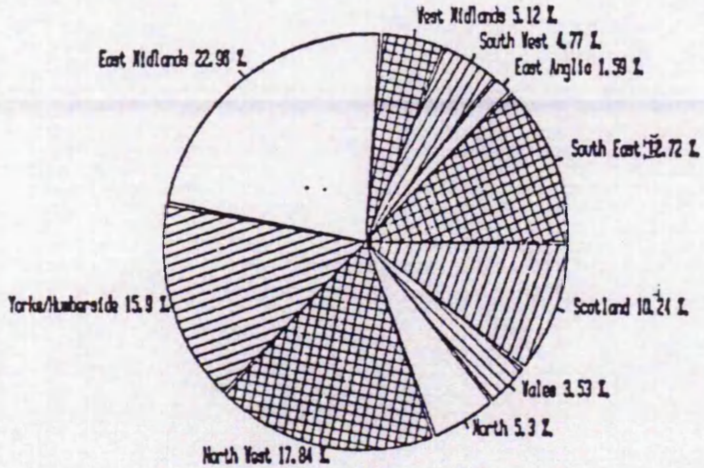
REGIONAL DISTRIBUTION OF EMPLOYMENT

1978



REGIONAL DISTRIBUTION OF EMPLOYMENT

1983



APPENDIX IX

It is difficult to obtain figures for the garment sector of the Knitwear Industry, the data is included with the figures for knitted textiles.

KNITTED GARMENTS AND KNITTED TEXTILES

DATA	1979	1983	
TOTAL EMPLOYMENT	112.7	87.9	thousand
NET OUTPUT PER HEAD	5188.00	7770.00	

These figures represent growth in output in the industry.

EMPLOYMENT FIGURES CALCULATED FROM THE ABOVE DATA FOR KNITTED GARMENTS

ESTIMATED NO. - 66.3% of those employed 1983 = 58.3 (thousand)

SOURCE: NEDO UNPUBLISHED FIGURES

APPENDIX X

Employment, labour costs, output, net capital expenditure and stocks and work in progress by size of total employment, 1983
All United Kingdom establishments classified to the industry (a)

Size group	Estab-lish-ments	Enter-prises (b)	Employment			Wages and salaries (c)			
			Total, including working proprietors	Opera-tives	Admin-istrative, technical and clerical	Operatives		Administrative, technical and clerical	
						Total	per head	Total	per head
	Number	Number	Thousand	Thousand	Thousand	£ million	£	£ million	£
1–9	355	345	1.6)						
10–19	250	241	3.5)						
20–49	144	144	4.6)	14.2	3.0	56.2	3,965	19.3	6,447
50–99	108	102	7.7)						
100–199	72	64	10.4	8.5	1.9	35.3	4,155	11.9	6,330
200–299	32	31	7.8	6.3	1.4	25.1	3,971	10.4	7,200
300–399	18	15	6.2	4.9	1.3	24.6	4,973	9.2	7,031
400–499	8	8	3.5	2.8	0.7	11.5	4,095	3.6	5,523
500–749	17	14	10.0	7.9	2.1	35.0	4,422	13.7	6,477
750–999	7	6	6.1	5.0	1.1	17.4	3,496	5.6	5,094
1,000–1,499	5	5	5.5	4.3	1.2	19.1	4,458	5.2	4,449
1,500–2,999	3	3	5.2	4.0	1.2	15.9	3,963	7.4	6,324
3,000 Plus	3	3	15.8	11.2	4.6	43.3	3,858	22.0	4,772
Total	1,022	902	87.9	69.2	18.5	283.4	4,098	108.3	5,871

(a) Establishments employing fewer than 20 persons are not required to complete census returns. Because of this, data for these establishments should be regarded merely as the best estimates available and used with caution.

(b) The count of enterprises shown in each row represents the number of enterprises, irrespective of size, owning the establishments shown in each size group. Because an enterprise may own establishments in more than one size group, the sum of individual enterprise counts may exceed the total for the industry.

(c) The cost of employers' contributions to the national insurance, pensions and welfare schemes and the running costs of canteens are excluded from the table but were estimated for the industry at £50.7 million. The remuneration of outworkers on returns received – also excluded from the table – was £1,322 thousand.

(d) Gross value added data relates to establishments employing 1–199.

APPENDIX XI

THE CONSTRUCTION OF THE DATABASE - SOURCES OF BASIC INFORMATION.

The preliminary level of information was gathered from and appraised (*) by :

Dunn and Bradstreet
* The Hosiery, Allied Trades Research Association
* The Knitwear and Lace Industries Training Association
The Knitting Industry Federation
Leicester District Knitting Association
The National Union of Hosiery and Knitwear Workers
* The Clothing and Allied Products Training Board
The National Union of Tailors and Garment Workers
* The Nottingham Fashion Centre
Nottingham City Council
Leicester City Council

APPENDIX XII

NORTH MIDLANDS

COMPANIES CATEGORISED BY PRODUCT AND SIZE

CLOTHING COMPANIES

Co. Size	Product Group	No.	Group Total
OVER 500 EMPL	A	0	3 (2G)*
	B	2	
	C	0	
	D	1	
101 - 500 EMPL	A	24	53 (28G)
	B	14	
	C	11	
	D	4	
51 - 100 EMPL	A	16	54 (2G)
	B	21	
	C	10	
	D	7	
11 - 50 EMPL	A	79	138
	B	16	
	C	18	
	D	25	
1 - 10 EMPL	A	11	27
	B	5	
	C	7	
	D	4	
	TOTAL		275

these figs are lower than estimates due to rapid expansion & the difficulty of obtaining data

KNITWEAR COMPANIES

Co. Size	Product Group	No.	Group Total
OVER 500 EMPL	KNIT MFR		9 (8G)*
	E	4	
	KNIT BB & FF		
	F	3	
	K?	2	
101 - 500 EMPL	KNIT MFR		53 (33G)*
	E	35	
	KNIT BB & FF		
	F	9	
	K?	9	
51 - 100 EMPL	KNIT MFR		21 (2G)
	E	6	
	KNIT BB & FF		
	F	9	
	K?	6	
11 - 50 EMPL	KNIT MFR		41
	E	15	
	KNIT BB & FF		
	F	3	
	K?	23	
1 - 10 EMPL	KNIT MFR		12
	E	2	
	KNIT BB & FF		
	F	2	
	K?	8	
	TOTAL		136

K? Knitwear Companies whose product category is not known.

(G)* denotes the number of companies in the total which belong to large groups. Many companies or company units belonging to groups are now operating a relevant form of CADCAM technology.

APPENDIX XII continued

SOUTH MIDLANDS

COMPANIES CATEGORISED BY PRODUCT AND SIZE

CLOTHING COMPANIES

Co. Size	Product Group	No.	Group Total
OVER 500 EMPL	A	2	2
	B	0	
	C	0	
	D	0	
101 - 500 EMPL	A	5	9 (7G)*
	B	2	
	C	1	
	D	1	
51 - 100 EMPL	A	12	22 (2G)*
	B	0	
	C	2	
	D	8	
11 - 50 EMPL	A	73	107
	B	5	
	C	6	
	D	23	
1 - 10 EMPL	A	10	23
	B	1	
	C	4	
	D	8	
		TOTAL	163

these figs are lower than estimates due to rapid expansion & the difficulty of obtaining data

KNITWEAR COMPANIES

Co. Size	Product Group	No.	Group Total
OVER 500 EMPL	KNIT MFR		6 (4G)*
	E	6	
	KNIT BB & FF		
	F	0	
	K?	0	
101 - 500 EMPL	KNIT MFR		62 (12G)*
	E	29	
	KNIT BB & FF		
	F	17	
	K?	16	
51 - 100 EMPL	KNIT MFR		69 (3G)*
	E	29	
	KNIT BB & FF		
	F	9	
	K?	31	
11 - 50 EMPL	KNIT MFR		312
	E	63	
	KNIT BB & FF		
	F	21	
	K?	228	
1 - 10 EMPL	KNIT MFR		45
	E	9	
	KNIT BB & FF		
	F	2	
	K?	34	
		TOTAL	494

K? Knitwear Companies whose product category is not known.

(G)* denotes the number of companies in the total which belong to large groups. Many companies or company units belonging to groups are now operating a relevant form of CADCAM technology.

APPENDIX XIII

COMPANIES WITH CADCAM WHICH WERE VISITED DURING THE FIELD STUDY (10) AND COMPANIES VISITED FOR SUPPLEMENTARY INFORMATION (5)

1. Burton Tailoring Ltd
2. Celestian Wood Ltd
3. Peter Blond Ltd
4. Corah Plc
5. S R Gent Plc
6. Courtaulds Clothing Ltd
7. Ladies Pride Ltd
8. Two Steeples Ltd
9. Levi Strauss Ltd
10. James Seddon Ltd
11. Abbey Knitwear Ltd
12. Slimma Ltd
13. Warehouse Ltd
14. Richard Stump Ltd
15. James Smith Ltd

Note 1: There is no relationship between the order of the above list on the following appendices.

Note 2: 60% of the above companies were visited prior to the study, the ongoing research was extended during the study. More visits and the monitoring of those firms already visited will continue after the project's completion.

APPENDIX XIV

COMPANY

ADDRESS

CONTACT

EQUIPMENT

TEL

DATE OF VISIT

INSTALLATION

DATE OF INSTALLATION

SITING

STAFFING	ORIGINAL STAFF	ADDITIONAL STAFF	
POSITION	PREVIOUS POSITION	TRAINING	SEX
1			
2			
3			
4			
5			
6			
7			

COMMENTS ON INSTALLATION AND STAFFING

Staff changes at installation

Production changes

Staff induction into the system

APPENDIX XIV continued

DESIGN TO PRODUCTION PROCEDURE

	METHODS	STAFF
design sample		
production pattern		
grading responsibility		
grading procedures		
grade rule libraries		
digitising		
pattern modification		
costing		
marker making		
plotting		
distribution		

COMMENTS

APPENDIX XIV continued

PROCEDURES ON EQUIPMENT

---

digitiser

grade rule library

grading methods

model making

orderloading

marker making

plotting

PDS

COMMENTS

APPENDIX XIV continued

DESIGN PROCEDURES

---

previous procedures

present procedures

future procedures

CAD design training expected by the company

Value of CADCAM systems in colleges

COMMENTS

APPENDIX XV

FIELD STUDY - COMPANIES WITH CADCAM TECHNOLOGY

THE USE OF THE SYSTEMS (INFORMATION UPDATED JUNE 1986)

	CAD		CADD			CAM
FIRM	GRAPHIC/ SKETCH	PDS PATTERN ADAPTATION 1ST SAMPLE	PDS PATTERN ADAPTATION PROD PATT	GRADING	MARKER MAKING	CUTTING
1	NO	NO	NO CONSIDERING	YES	YES	YES
2	NO	NO	NO	YES	YES	YES
3	NO	YES NOT INNOV. DESIGNS	YES	YES	YES	YES
4	NO	NO	SIMPLE ALTERATIONS TO PROD.	YES	YES	NO
5	NO	NO	NO	YES	YES	YES
6	NO	NO	NO	YES	YES	NO
7	NO	NO	NO	YES	YES	NO
8	NO	NO	NO	YES	YES	NO
9	NO	NO	NO	YES	YES	NO
10	NO	NO	NO	YES	YES	NO

APPENDIX XVI

FIELD STUDY - COMPANIES WITH CADCAM TECHNOLOGY

THE STAFFING OF THE SYSTEMS IN THE DETAILED FIELD STUDY AT THE TIME OF THE VISIT

FIRM	STAFF-NUMBERS		STAFF-OPERATIVES				STAFF-SYSTEM MANAGER			
	NO.OF STAFF	STAFF LOSS OR INCREASE AT INSTALL-ATION.	PREVIOUS RELEVANT CLOTHING SKILL.	COLLEGE TRAINING RELEVANT SKILL.	SEX M	SEX F	PREVIOUS RELEVANT SKILL	COLLEGE TRAINING RELEVANT SKILL	SEX M	SEX F
1	6	+ extra prod	2 D:PT 1 G 2 MM	2 1 0	1	2 1 1	PA	YES	1	
2	8	0 extra prod incr.styles	1 PT 3 MM 3 O	1 0 1	2 1	1 1 2	MM	NO	1	
3	15	+ extra prod incr.styles	2 D:PT 7 PT 5 MM	2 5 3	1 2	2 6 3	PA	YES	1	
4	4	- reduction of graders	2 G 1 MM	0 0		1 1 1	MM	NO	1	
5	5	0 extra prod incr.styles	1 PT 2 G 1 MM	1 0 0		1 2 1	MM	NO	1	
6	3	0 extra prod incr.styles	1 D:PT 1 MM	1 0	1	1	PA	YES		1
7	4	+ extra prod incr.styles	2 PT 1 MM	2 0		2 1	PA	YES	1	
8	3	+ extra prod incr.styles	1 PT 1 MM	1 0	1 1		PA	YES	1	
9	2	+ extra prod	1 PT	1	1		G:MM	YES	1	
10	6	- reduction of graders & MM	2 PT 1 MM 2 O	0 0 2	3	2	PA	YES	1	

RELEVANT SKILL : O: no skill; D: designer; PT: pattern technician
G: grader; MM: marker maker or cutter (supervisory).
PA: production administration (managerial).

APPENDIX XVII

FIELD STUDY - COMPANIES WITH CADCAM TECHNOLOGY

CAD : CADD DESIGN TO PRODUCTION - THE INTERFACE
(AT THE TIME OF VISIT)

	FIRST SAMPLE	PRODUCTION PATTERN	GRADING INCREMENTS	GRADE RULE LIBRARY	INPUT DIGITISING	MARKER MAKING
1	D	* PT	* PT	PT	PT	O
2	D	* PT	* PT	PT	PT O	O
3	D PT	PT PT	PT	PT	O	O
4	D • PT	PT	PT	O	O	O
5	D • PT	PT	PT	O	O	O
6	D	D	* PT	PT	O	O
7	D	PT	* PT	PT	PT	O
8	D • PT	* PT	* PT	PT	O	O
9	D	D • PT	* PT	PT	PT O	O
10	D • PT	PT	PT	PT	O	O

D = designer

PT = pattern technician

O = system operator

[ ] function - manual - staff not computer trained.

[*] function manual - but pattern technicians computer trained.

[ ] function - computer.

APPENDIX XVIII

FIELD STUDY - COMPANIES WITHOUT CADCAM TECHNOLOGY

CATEGORY A - DRESS, SEPARATES, PARTY, MATERNITY, BRIDAL, FASHION WEAR

FEATURES OF THEIR SITUATION WHICH MAY EFFECT THEIR ENTRANCE TO CADCAM

MARKET.

A buoyancy could be identified in sections of this category after some years in decline, its structure, never known for its stability, seems to be in the process of further change. Marketing strategies in the High Street can be seen to be affecting the manufacturing sector; Next and its clones, whilst bringing style to the High Street, were seen as the perpetrators of the decline of the provincial 'Madam' shops. The medium size 'own label' manufacturer has found his outlets reduced dramatically. Design appears to have become a buzz word that has frightened the large multiples who are putting pressure on the suppliers for an increased sample rate, short runs and shorter throughput times.

The medium size company with a specific outlet i.e. bridal or career apparel were experiencing growth, the 'Madam' companies were looking for alternatives. Some were moving up market (the quality market is under expansion); capitalising on a high skill base, they had found that by upgrading fabrics and styling high prices could be charged for garments which used to be available in the middle price range. This market however cannot be seen as long term, it is a reflection of social and political conditions which are usually transitory. Demand appears to be running parallel in up market childrens wear with a shortage of garments in the £100 range.

A number of medium size companies were competing for contracts from the multiples, they showed particular interest in CADCAM technology, being aware that they were in competition with company groups where CADCAM is central to their production.

The large number of small companies has always been a feature of the clothing trade. The study found that the design and pattern cutting skills available to a company in this category was a significant determinant of the type of market a company could enter. Many of the successful companies had owners with these skills or access to high quality freelance support. Companies which had lost these skills were taking on CMT contracts to survive.

A new feature was found to be the emergence of more Design companies who source their manufacturing amongst the smaller firms. The Design groups stated that had difficulties controlling quality and sizing standards and could see CADCAM as a means of addressing this problem.

Finally in a market place where trends are transitory and success can be achieved by filling gaps in the market and acquiring particular temporary support, the smaller Asian companies in this sector appeared to be enjoying a parallel expansion to that achieved in leisure wear. One small company visited had twenty employees and had been operating for more than twelve months with one '501' jeans pattern.

PRODUCTION FEATURES

Discounting the CMT companies, this is the category that relies heavily on design and even more important, pattern skills; even the copyists had some problems without access to technical expertise.

The large companies pressured for increased 'design productivity' are flirting with CADCAM graphic systems, or using designers purely for styling with pattern cutting support (it appears to need two or three pattern cutters to service a designer's output), or setting up Design Centres in London to produce hot house environments and easy communication with their contractors. This type of organisation is one in which CADCAM plays a very significant role in reducing sample, sample to production, and sample to store time. Concern was expressed about the reluctance of their present designers to use the technology and all companies stressed the importance of the new entrants from colleges having these skills. "We would pay a high premium for any designer that could lead us sensibly into the new technology."

The increased pressure to produce styles appears to have resulted in a famine of technical designers and pattern cutters. Medium and small firms are finding great difficulty acquiring them or keeping them, the shortage of skill and technology can be a crucial factor in a medium size firm's growth.

In this category the smaller firms greatest asset appeared to be its flexibility, this flexibility was in its organisation rather than its devotion to technology. The technology in its present state is neither flexible nor simple enough to give them apparent gain and its price at this time puts it outside consideration. The small business in this sector however gave the greatest support to the idea of access to a bureau, their enthusiasm however was dependent on access to skill and support in the crucial areas of design, pattern cutting and grading.

CONCLUSION

The demands on this sector of clothing are considerable; they experience the international, financial, political and bureaucratic pressures expressed by other sectors, but they are especially vulnerable to fickle fashion changes. This study has demonstrated that there is particular support from this sector of the garment industry for a CADCAM bureau which would alleviate the present pressures and add to the long term process of raising the level of training in areas of key skills.

Many companies however stated that the colleges were not discharging their responsibilities, course structures were aggravating the imbalance between design and technical skills. They were unsure whether this was by deliberate policy or incapacity.

APPENDIX XIX

REPORT ON COMPANY VISITS MADE DURING THE FIELD STUDY - K.CLARK

FIELD STUDY - COMPANIES WITHOUT CADCAM TECHNOLOGY

CATEGORY B - LINGERIE, FOUNDATION GARMENTS, SWIMWEAR, DANCE AND NIGHTWEAR.

FEATURES WHICH MAY AFFECT THEIR ENTRY INTO CADCAM TECHNOLOGY.

MARKET

This sector of the industry is expanding in terms of contract work, due to an increasing number of retail outlets introducing lingerie departments into their stores. Because of this, the majority of companies visited were found to be working to contracts, supplying fashion chains as well as multiples and department stores.

The design content of these garments is held to be important, and many of the companies commented that their customers are also becoming more quality conscious, apparently to compete effectively with the well established brand names and market leaders.

Two of the companies visited concentrated mainly on the export market, whilst some others relied on mail order for the bulk of their customers, this being a traditional outlet for some brand name swimwear, and for foundation wear and lingerie.

Some companies were also beginning to diversify their products into eg. bedding, leisurewear and childrens partywear.

PRODUCTION FEATURES

The majority of companies had college trained designers, pattern technicians and graders; a reflection of the complexity of pattern cutting and grading in this category. Some companies said they required more trained staff in this area. During the field study of companies with CADCAM Technology, a company in this category, stated that because of the complexity of the grades, their pattern technicians had to work directly onto the system. Only two companies were found to be employing the skills of freelance graders, one of these companies was quite large.

Those companies producing swimwear required designers with more technical skills, especially one company who stated that their style changes were within the fabrics, as the silhouette remained basically the same. This company's designers had to work within a 'range policy' and on fabric development, therefore, a certain amount of technical knowledge is required.

As expected, the majority of the lingerie and foundation garment factories used paper markers, which, when produced by hand, are very time consuming, due to the size and often complicated shapes of the pattern pieces.

All companies stated the need for multi-skilled machinists, and some companies even operated a make through system. Most of the companies visited complained of the lack of skilled labour on the market for employment - whether they were machinists, cutters, pattern technicians or management. One small company had cut out middle management totally because they could not find anyone suitable. This was the case with the few small companies whose owners were designers, marker makers, cutters and even supervisors; or to those who were using freelance services.

In the area of new technology, the medium sized to large companies were well established, mainly in production control. Two large companies were operating the GSD system of wage payment; and these same companies were also considering purchasing a CADCAM system, having had experience of using one.

Only one smaller company was using a computer, for office purposes; some others were contemplating purchasing computers. However, it was surprising to find one large company whose management had a total mistrust of computers, and could not imagine a CADCAM bureau coping with their rapid style changes.

CONCLUSION

This category group was found, therefore, to have a concentration of college trained designers, pattern cutters and graders, which were necessary due to the nature of the garments. Many respondents stated that such trained personnel were difficult to find; and said that colleges should concentrate more on the technical side of design, which is especially so if they to are interface with CADCAM systems. The respondents saw the potential benefit of CADCAM technology, especially in grading and marker making due to the intricacy of the shapes and the time factor involved.

APPENDIX XX

REPORT ON COMPANY VISITS MADE DURING THE FIELD STUDY - W.ALDRICH

FIELD STUDY - COMPANIES WITHOUT CADCAM TECHNOLOGY

CATEGORY C - UNIFORMS, SHIRTS, WORKWEAR TAILORING, OVERGARMENTS, WEATHERWEAR, LEATHERWEAR

FEATURES OF THEIR OPERATION WHICH MAY EFFECT THEIR ENTRANCE TO CADCAM

MARKET

Whilst this sector of the industry is usually identified with stable outlets, regular orders and established customers, all were feeling the increasing pressures of the demand for high quality and style change, this is apparent even in workwear and uniforms. Two of the directors had design training and more than 50% of the companies employed design consultants, this included the large companies. All complained of the cost of the services, but said that it was the only way they could obtain the quality they required, two stated they had to go to foreign consultants to achieve this quality.

PRODUCTION FEATURES

Most of the consultants provided a range of services, from design to the production of grade rules and production specifications, and a number of companies relied on the consultants to provide the interface between the company and the CADCAM bureau they were using.

This sector of the clothing industry stated that it relied heavily on the complex tacit skills in its design to production process. The finding that the majority of the technical staff in the companies were approaching or past retirement age, with no support staff in training, appeared to be alarming. Companies complained that they could not replace trained staff, the colleges appeared incapable of training to a high level in technical skills and that young people they had tried to train on site left the company. These factors were propelling companies towards external support, CADCAM bureaux and increasing consideration of buying their own system. One company was modifying his own micro CADD system, he reflected some suspicion, that exists amongst companies, of bureau operations. This suspicion is based on a fear of other firms pirating their styles, blocks and sizing systems.

The majority of the small companies stated that they required a period of intense technical support for short periods, although this group appeared less subjected to seasonal pressures.

CONCLUSION

The age and retirement of key staff are creating a crisis within this sector, however their retention and their methods may be a factor in a company's problem. The 'Luddite' attitudes of some of these staff were found to be inhibiting new production procedures and the cause of new staff leaving, some of their methods could be questioned and their grading procedures rationalised.

Many of the most successful CADCAM systems are operating in this sector of the clothing industry. The problem is only becoming a crisis because the education system and industry has consistently failed to recognise by status, payment and training the value of the pattern technician and technical designer.

APPENDIX XXI

REPORT ON COMPANY VISITS MADE DURING THE FIELD STUDY - W.ALDRICH

FIELD STUDY - COMPANIES WITHOUT CADCAM TECHNOLOGY

CATEGORY D - SPORT, LEISURE, NIGHTWEAR (KNIT) UNDERWEAR AND
CATEGORY E - KNITWEAR MANUFACTURE

COMMON AND DIFFERENT FEATURES OF THEIR OPERATION WHICH MAY EFFECT THEIR ENTRANCE TO CADCAM

MARKET

Both of the company categories supplied a wide market, the large retail chains (usually dealing with the larger manufacturers), supermarkets, cash and carry, wholesalers, mail order and market stalls. The growth of garments in knitted fabrics in childrens wear, nightwear, sport and leisure wear has been extraordinary; this combined with a reduction in imports has resulted in a proliferation of small companies particularly in the South Midlands (Appendices XVII and XVIII). The crucial difference between what seemed to be companies making identical ranges became clear during the research (with a small number of exceptions).

Knitwear manufacturers (E) producing garments out of piece fabric (cut and sew) had close links with their fabric source or were knitting it themselves. Their design and marketing was closely linked to the fabrics available from their knitting capacity and the tubular fabrics were often knitted to specific garment widths (i.e. tee shirts, vests). The garments made by this group were simple in design and construction and less subject to fashion changes.

Companies in category D making leisure wear were subject to fast changing markets and were sourcing fabric, woven or knitted, according to market demand. The new smaller companies, particularly in the Asian communities, were operating a flexible response policy to market demands. This flexibility however has been subject to criticism by the unions and their more conservative competitors. 'Networks' rather than company groups appear to operate, their links tenuous and complex.

PRODUCTION FEATURES

LARGE AND MEDIUM SIZE COMPANIES

Large companies in both categories, particularly those belonging company groups were conversant with the technology and considering its purchase. The technology can cope with tubular fabric lays and is especially useful for compensating for different percentages of relaxation which can occur in jersey fabrics, this is important if working to retail specifications. The technology is attractive to companies working to tight margins and requiring increased production with existing capacity, and its operation is particularly suited to simple modifications and repetitive grading operations associated with jersey and sportswear products.

Medium size companies could see that a bureau would be useful for 'off loading' grading at times of pressure, but stated that its response would have to be fast and efficient.

SMALL COMPANIES

A significant amount of the growth in the leisure market has come from the small company, many new businesses have been set up by knitting mechanics or people with some particular production knowledge. Those in category E generally produced a narrow range of product which required a minimum of technical skills in pattern cutting and grading. Styles and sizing were often copies from goods bought in stores or offered by the contractor. Whilst this mode of operation was evident across both industries, clothing companies saw the proposed Bureau as a means of extending their skills and being able to take on new marketing opportunities.

Companies (category E) expressed the need for low cost computer aided cutting developments which address the problem of simple volume production.

CONCLUSION

The nature of the study, precludes definitive conclusions in an area which straggles two different industries. However some surprise must be registered at the amount of garments being produced with virtually no trained designers or pattern technicians. The surplus skill required by these companies is acquired from freelance operators which they state are of dubious quality. It would seem that to expand outside their present narrow area of production these companies, particularly those in category D, will need to have access to expertise that at present they cannot afford or obtain.

Some observations must be made about the nature of the expansion in these two sectors of the garment industry. Fashion is fickle, the machinery, and the limited technical skills that are operating in this area, could not transfer easily to other manufacturing if jersey fabric lost some of its present appeal.

APPENDIX XXII

FIELD STUDY - COMPANIES WITHOUT CADCAM
RELEVANT TRAINING - SKILLS AVAILABLE WITHIN THE COMPANY

CO SIZE	NO	COMPANIES UNDERTAKING STAFF TRAINING	COMPANIES AWARE OF TRAINING GRANTS	KEY STAFF AND RELEVANT COLLEGE TRAINING												OWNERS RESPONSIBLE FOR D P G M	COMPANIES ACCESSING FREELANCE SKILLS
				D	Dd	d	P	Pp	p	G	Gg	g	M	Mm	m		
OVER 500 EMPL	1			1													
101-500 EMPL	23	21	9	16		5	13	1	8	8	0	8	1	0	17	2	6
51-100 EMPL	20	20	7	10		4	8		9	8		10	2	1	13	1	0
11-50 EMPL	33	24	3	16		14	16	2	11	14	1	12	6		17	15	6
1-10 EMPL	7	2	0	4		2	5		2	5		2	4		2	5	4
TOTALS	84	67	19	47		25	42	3	30	35	1	32	13	1	49	23	16

NOTE: Key staff are people who would operate or interface with the CADCAM technology.
D = designer   P = pattern technician   G = grader   M = marker maker
Capital letters denote college training ie:
D = company - all designers college trained, Dd = company - some designers college trained
d= company - no designers college trained.

NOTE 2 : Companies with one person covering a number of skills are recorded in each skill section.

APPENDIX XXIII

COMPANIES INTERVIEWED DURING THE KNITWEAR PILOT STUDY

Charles Austin Knitwear Ltd
Pabla Knitwear Ltd
Christopher Day Ltd
Dalkeith Knitwear Ltd
The Ewe Hosiery Company Ltd
Ginafiori Ltd
Meridian Group
Atkins of Hinckley Ltd
Barbara Ann Knitwear Ltd
Bent and Sons Ltd
Curzonia Knitwear Ltd
Craftslate Ltd
Lucien Knitwear Ltd
Owen Blower Ltd
Riddington Fashioned Knitwear Ltd
Tikiknit of Leicester Ltd

CADCAM KNITWEAR SYSTEMS VIEWED DURING THE VISITS

Stoll
Ducad
Shima Seiki
Universal
Steiger
Bentley RTCE

APPENDIX XXIV

Journal Article 'IMB: An Alternative View', a Report on an International Clothing Machinery Show, Cologne 1985.

Pattern Design Systems have been available for sometime, but very few companies, even those who have software, have made use of it. The introduction of a CAD/CAM system into a company appears to take the designer further away from practical grading and garment production; pattern technicians interface with the systems creating a buffer between the designers and production.It may be that a simple flexible system in small companies, where the designer has a spread of responsibility, may provide the medium which will allow PDS to take off.

Garment design on the screen with graphics software is being offered as a means of generating rapid changes of style, colour ranges and fabric design, and of listing costing and production data. Microdynamics claim to have a programme which has a colour-matching function based on the Munsell system.

From a simplistic view these systems appear to be an easy answer to the demands of the multiple retailers for fast-moving 'jazzed-up' fashion ranges and short production runs. But Dr. Nigel Cross at the Open University sees the step-by-step logical approach demanded by computers as the process by which most scientists solve problems, and he argues that designers work in a historic way, integrating many ideas in complex patterns.

Professor H.H.Rosenbrock of UMIST is concerned about the loss of tacit knowledge and the exercise of human skill. 'The abilities of machines and of people are different and complementary, and a suitable design of the system will pay due regard to these different qualities.'

The experience of working directly with the fabric medium and with the human form may be found to be an essential requirement for a designer to be able to work above a routine level of style of piece manipulation that is available on present CAD systems.

Colleges have difficult decisions to make as they introduce computers into fashion design departments. While they cannot remain isolated from the production procedures of the industry, they must consider their aims in introducing CAD into the curriculum and define their relationship to the design content of the course. For example, are the computers to be used as tools or as practical experience of industrial practices, or, more contentiously, are they to become an active part of teaching and experiencing principles of design?

Shared Responsibility

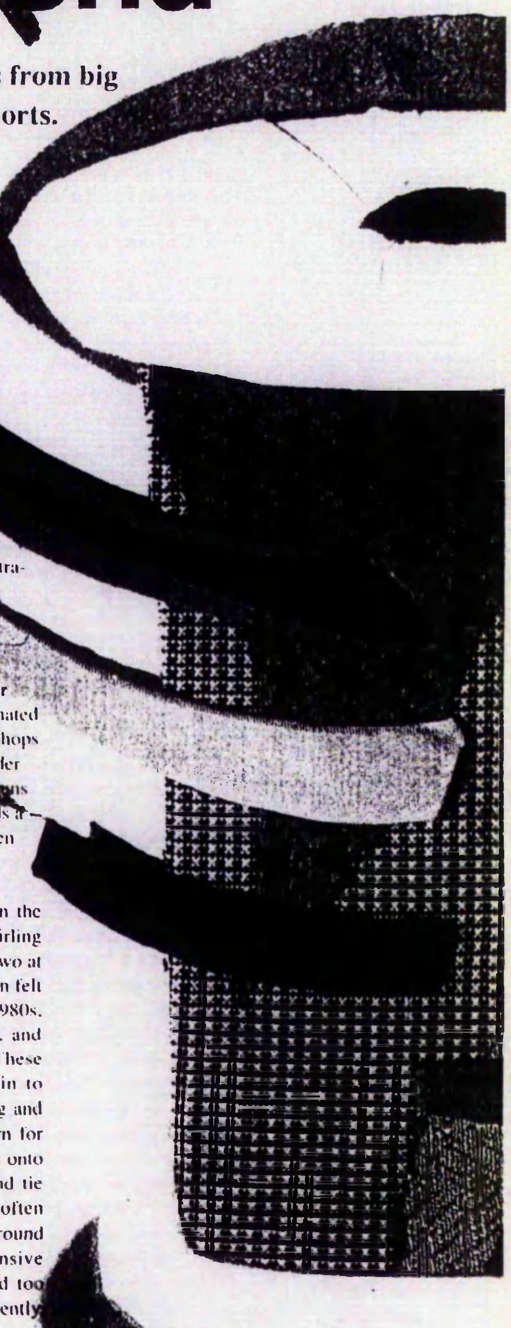
The Fashion Industry is diverse and unpredictable, designers have to be survivors, robust defenders of their art, yet adaptable to market and production pressures. Designers will require to be convinced that gains in efficiency in garment and pattern design are not over-ridden by a deterioration in the process of design, and they would argue that efficient production potential requires a stimulated market.

However, designers must share some of the responsibility for the operation of computer-aided design in mass production by becoming interested in its development and the work being done in three dimensional design.

Criticisms of its operation will only be seen as valid if they are made from a perspective of active research.'

The material world

PC-based designers in the textile industry did not inherit tools from big system users; they had to invent their own. Stewart Bickel reports.



One day in 1985 a disheartened clothing designer was close to winding up a fruitless day trawling around a London computer show, when she rounded a corner and spotted a tall red-headed man apparently doodling at will in a vector-based CAD package. The designer stepped onto the stand and peered over the exhibitor's shoulder for several minutes, fascinated. 'Show me that again,' she demanded. The surprised CAD vendor invited her to pull up a chair...

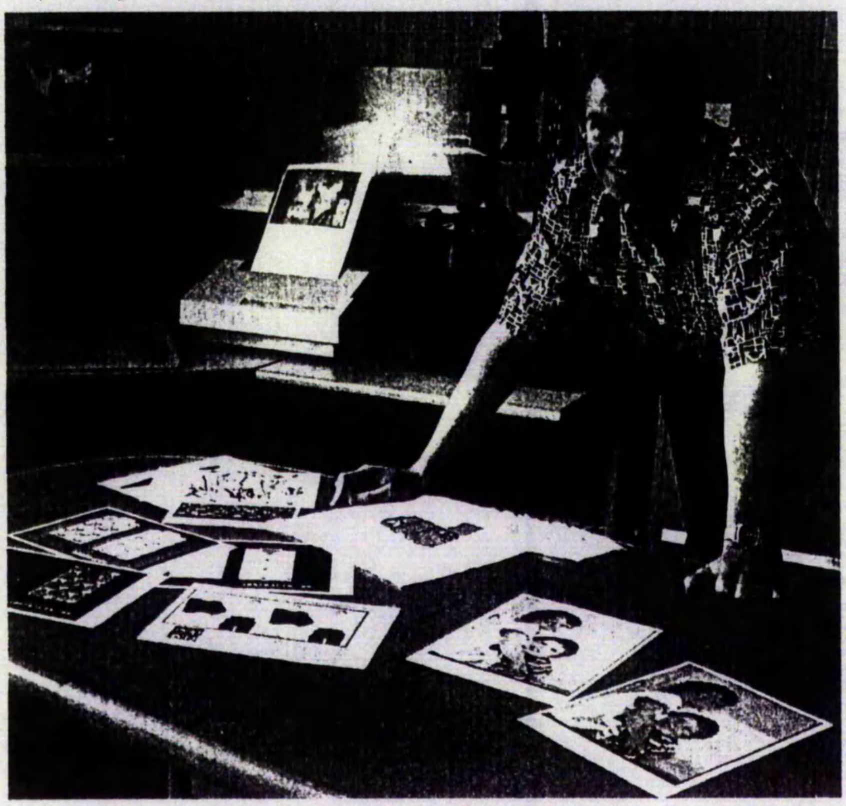
Last month a tense meeting got underway in the offices of a clothing plant in Rumania. The bosses of a British design company were over to discuss production prices for a range, for which the East European operation had quoted using a minimum of 1.37 metres of material per garment. The negotiations became delicate when one of the British delegation pulled out a set of computer plots which showed that the item could quite easily be made from 78 ce[illegible] of cloth...

These two events bracket four years of de[illegible]cated development involving designers, software writers, students and educational institutions, culminating in one of the most ingenious micro-based clothing design solutions yet seen. Ormus Fashion – the end result of that first meeting between Winifred Aldrich and Concept II's Stephen Gray – is a mixture of raster and vector formats which spans initial designs, modifications, final sketches and pattern sizing and cutting, through to colour separations and plotted graded patterns for production. Most of the elements in the system already existed in some form in the industry: the trick the Ormus team pulled was to combine the paint and pre-production stages, fill in the gap – creative use of precise vector drawing – and bang the whole package out at a hitherto unheard of price. And good value design productivity tools are badly needed in this sector at the moment.

Textiles is one of those old, sprawling and vital industries which is continually being mauled. Competition has never been stronger from subsidised or cheap labour-based foreign competitors (witness the story of a UK trade exhibitor who found his overseas neighbour showing a finished track suit for less than it would have cost him to buy the cloth), and the erratic ebb and flow of fashion is still taking casualties among those caught with big investments in the wrong sort of lines: knitwear majors in particular, such as Courtaulds and Corah (a Marks and Spencer supplier), have had a painful time recently and the bleeding has yet to stop.

These two problems have been endemic for some time; a newer pressure on design and production costs and response is the arrival of the 'total look' spearheaded in the high street by groups such as Next. Textile designers have traditionall[illegible] worked in self-contained speciali[illegible]ps in areas such as clothing [illegible]. Now the Next generatio[illegible]ftly by more [illegible]nerable [illegible]rks and Spencer [illegible]ebenh[illegible]es co-ordinated [illegible]. The shops are [illegible] numbers o[illegible]wider ranges. [illegible] more designs, s[illegible]ns and quicke[illegible]e. This situation demands a lot more flexibi[illegible]nd co-ordination between disciplines at the design stage, and a much faster turn around of ideas, for less cash.

Although computers have been around in the textile industry for some time, from the whirling reel to reel cabinets which filled a room or two at Burtons decades ago, their presence has been felt more in CAM than CAD. Until the mid-1980s, textile computing was for big companies, and came in big boxes with big price tags. These mini-mainframe systems were brought in to crunch finished designs through the grading and layplanning stages (that is, redraw a pattern for each size in the range, and fit all the pieces onto the smallest possible piece of material) and tie them in to production machinery which often came from the same manufacturers. At around £30,000 just for an extra terminal, expensive dedicated equipment was usually deemed too expensive to waste on designers. More recently there have appeared paint packages, good for the early stages of fabric design but not much more, and £100,000 plus systems such as the American CDI, which uses grabbed photographic images of real models and powerful Silicon Graphics workstations to produce immaculate visualisations of patterns in place. Dazzling though these are, they are really aimed at the marketing departments of companies big enough to afford such indulgence. Small to medium-sized operations remained frustrated in their search for a complete design tool that did not cost the earth.



This frustration led to small pockets of innovation among interested parties who decided to work out their own solutions rather than wait for others to provide them. The personal computer had just come of age, and graphics-based design on the desktop was becoming a reality. Designers, part-timers, lecturers and sympathetic software writers began to collaborate. What they wanted, and what their resources imposed, was something cheap and easy to use, non-dedicated, which could be pulled together from the whole grab bag of off the shelf PC-compatible hardware, software and peripherals, and honed into a textiles-orientated solution. Judy Foulsham, profiled in the debut issue of 3D in April 1988, was one; Winifred Aldrich was another.

Aldrich had been through the mill at Courtaulds and Corah, observing big mechanistic systems in action, but being denied access to all that power as a designer. Her first experience of any kind of personal computing was when a friend lent her a Spectrum (remember that?) to work out some measurement formulae for one of her pattern books (she writes and lectures as well as designing). Aldrich realised that if her blueprint for a computerised design system was ever to be a reality, she would have to find out a lot more about the CAD business and start stirring the pot herself. She bought an Apricot Xi, and undertook a PhD at Trent Polytechnic in Computer Aided Design for Clothing (still unfinished).

STEPHEN GRAY: 'I HAD TO THROW AWAY A LOT OF IDEAS ABOUT THE PURITY OF CURVES TO GET IT LOOKING RIGHT.'

It was at this stage that she had her fortuitous meeting with Stephen Gray at the Olympia-based Computers in Manufacturing show. Gray's company Concept II Research was showing a lookalike of the then nascent AutoCAD, aimed mainly at the architectural and space planning markets. One notable feature of Ormus, as it was known, was its ability to offer a vector sketchline which took up very little memory – what Gray calls a 'bells and whistles' feature as far as architects and engineers were concerned, but it was this which brought Winifred Aldrich onto the Concept II stand.

At first Gray took Aldrich for yet another time waster, an educationalist with no buying power on a sightseeing visit. But he was fired by her enthusiasm and intrigued by the challenge of what she wanted.

Aldrich wanted a system which she could use for both ideas and illustrations of styles, for print designs, and for detailed pattern preparation. This meant something in which she could switch between vector and raster at will, and use vector drawing as freely or as precisely as she wanted. And it had to be easy and cheap enough to use in education.

Gray's partner for one was not impressed by the potential commercial returns of an educational product in an unknown market, but Gray himself (pictured left in a natty shirt whose pattern and print were originated in Ormus) was willing to back a hunch, with his own time at least. Winifred Aldrich bought a copy of Ormus as an act of faith, and persuaded Trent Poly to shell out for a pen plotter.

Working evenings and weekends, stopping for frequent phone conferences with Aldrich, Gray began to strip out the unnecessary architectural and engineering tools of Ormus, translate what was left into the clothing designer's language, and add some new features. He recalls: 'Winifred came up with a wish list, 50 per cent of which was more or less the same as what we already had, we just had to change the prompt and the menu, but the other 50 per cent required a lot more thought. I found that the way clothing designers want to join curves to lines or draw around objects had to be approached rather differently to the scaling and dimensioning of a conventional CAD package. I had to throw away a lot of mathematical ideas about the purity of curves, and change algorithms to get what looked right. Curves ended up part B-spline, part Bezier and part some of my own stuff to get them to pass through the correct points.'

Still unable to commit Concept II's day to day resources to the package, Gray had to use a YTS trainee to help iron the creases out of his amendments. The basics were ready by Christmas 1985.

Progress in 1986 was painfully slow. Six students were given testbed systems, and Aldrich and Gray monitored the feedback, tweaking the program as they went along. Christmas had rolled around again before Concept II were ready to commit themselves to six months solid commercial backing of the product. Gray took a crash course in textile jargon, and the company went to market.

Although to Gray's chagrin most of the DTI's £4.5 million handout to colleges for textile technology had already been spent by the time Ormus hit the road (mainly on big production systems), interest was high – the basic cooking version running on cheap clones without sophisticated paint facilities or output was hardly expensive. Gray explains: 'Five colleges were interested straight away. They were using Winifred's pattern books as teaching aids, and all those patterns were now available on the system, so they had a ready made syllabus for it. We won the British Microcomputing Special Award for 1987, which got us some good publicity and a lot of enquiries. So we thought, we'll run a seminar on it, and invited 125 art and design college to come and have a look. About half of them actually turned up.'

Even Gray and Aldrich, with their evangelical zeal for the product, were taken aback by the hand-in-pocket response. Fifty colleges have bought Ormus systems so far – but Gray found that commercial users were also sniffing. Concept II now had enough faith to back an industrial version of Ormus Fashion, with a new interface assuming much more experience on the part of the user, and a larger spread of options. The companies he canvassed were told that this was going to be an industrial tool, but with more emphasis on design than they were used to. They replied that their priorities were going to be affordability, and the ability to undertake both drawings and illustrations, and emulate precisely the curves and joins characteristic to the business – items that Gray had already taken care of. As far as affordability went, the response to Ormus Fashion Industrial from the UK, Europe and markets as far afield as China and Australia has probably as much to do with the system's rock-bottom pricing as its cost saving effects in use.

A fully-loaded Ormus system with video or scanner input, paint system and thermal printer

O R M U S   I N   U S E

Steeped in hard earnt craft and black arts, the iterative stages that traditionally turn a designer's first sketches into cloth are painfully labour intensive. Furthermore, three quarters of the results of these time and material consuming experiments often end up in the rag bin.

Pattern preparation was an obvious candidate for CAD's ability to slash repetition and monotony while making accuracy more achievable, but Aldrich was strict that the system should free the designer without influencing the actual outcome of the design process: even lay-planning, which could have been automated, has been left computer-assisted.

By the time the designer has chosen the sketched styles he or she wants to take to the pattern stage, the computer has already conferred an advantage: unlike freehand pen sketches, the vector sketch, superimposed on a standard dress stand shape from the program library, already offers guide measurements. The first pattern effort is built up from pattern blocks, also from the library, which can be used as seen or adapted. The first full size hard copies of the pattern pieces are then plotted off.

The next decisions are made on a real life dress stand, where the pieces are tried for fit and shape to show where areas need to be lengthened and shortened, and where elements such as pleats and darts need to be added or adjusted; new versions are plotted, and the process is repeated. Working on a computerised pattern, designers no longer have to calculate, re-draft and retrace the pattern after every single adjustment: the software does this for them. Seam allowance calculation, a mandatory but tedious manual process, is also handled by the program.

The loop continues, culminating in a 'toile', the 'hard copy' of the design in white callico which is used to fine tune the pattern. The next stage is the sample garment in the chosen fabric.

If the designer is not using an off the shelf fabric, then another aspect of the program is brought into play. Designs for printed fabrics can begin life in either vector or raster formats (see Winifred Aldrich's comments below): 'found' designs can be scanned in for adjustment to inch them onto the right side of plagiarism (a common practice in the textiles business), or new ones created in either format. Both can be used to scale and repeat patterns, although vector allows much freer manipulation. The designer can then call up the paintbox's standard colours, their own pallette of favoured shades, or customise new colours, to impose various colourways onto the print design.

Once these have been selected, they can be displayed on the garment. Ormus cannot match the combination of high definition video input and complex grid analysis used in the expensive CDI visualisation systems, but areas of the on-screen fabric can be manipulated 'by hand' in the paintbox to produce a basic visualisation of folds and tapers; one advantage of the Ormus version is that it is much quicker. Gray has written a set of printer drivers for thermal proofing, in conjunction with sheets of coded colour cubes for colour matching. (These thermal prints are limited to screen resolution, but the program will also drive a thermal printer/plotter in vector format at full device resolution).

Most printed fabrics are silk screened. Producing colour separations for each dye used is another labour intensive stage which has been made speedier and more accurate by computerisation. Output can be set to produce solid blocks on acetate, or outline via a flatbed plotter armed with a blade cutting onto rubylith, a two layer medium from which cut areas can be peeled – the latter route is much faster for larger block patterns or cartoon characters. Once a print is in the system, it can be adapted for re-use on different garments, or in different formats, from knitwear to lampshades.

The third arm of Ormus takes it into the realm and plotter output is still around £30,000, less than the most basic grading and layplanning system from the established production majors. Gray has achieved this by keeping the core of the system as device independent as possible and sifting the PC parts bin for bargains: if one paint system, printer, plotter or digitiser looks better value, it can be pulled off the shelf and substituted: Ormus systems go out on clones, Tandons, Mitacs, you name it, whatever's on offer (a game that can't be played in the Apple environment, which means a Macintosh version of Ormus, which designers would probably like for its friendliness, is unlikely for some time on cost grounds).

The entry level system costs around £9,000. This gets you a 286 or 386 PC with VGA, EGA or Hercules display, software for vector drawing, patterning and grading and layplanning, and a digitising tablet. A token VGA-based paintbox is offered, but Gray is not surprised that its low resolution has so far failed to tempt a single buyer. Adding print design to pattern design means a decent paintbox and high resolution graphics display, plus a thermal colour printer. On these two bases, users can mix and match as they please from video or desktop scanner input, bigger digitisers, thermal plotter/printers, or full size plotters (in this business, the A0 plotter is considered a modest device; top line machines are up to six feet wide).

Smaller companies are unlikely to afford the more exotic input and output devices, but they can lay their hands on them at a steadily growing band of bureau services, or colleges freshly under obligation to pay their way.

Stephen Gray still has three or four conversations a week with Winifred Aldrich, who has just become a company in her own right. The two of them are looking to take Ormus towards true 3D visualisation, rather than the pseudo-3D of existing workstation-based systems. But Gray concedes that this could be the biggest challenge yet: 'This started as what looked like a terrible business proposition, and turned into the most personally enjoyable project I've ever worked on. Nevertheless it's taken four years to pay off, and all that without entering the third dimension. But at the moment, the technology isn't right, and the speed is not attractive at the right price. In terms of draping fabrics, the FEA route is not the answer: I know of only two research teams in the world who are looking into it, and it's years away. What we probably need is a combination of fluid dynamics and materials science. And that's one thing I've learned: making clothes is a science.' ■

ORMUS IN USE

of the old mini-mainframe systems – layplanning to optimise cloth and cost. This means the finished pattern has to be graded for each size in the proposed range: a lengthy manual process made trickier by the fact that as sizes change to accommodate different shapes of wearer, the movements of key points on the pattern are not necessarily linear. Gray had to write in an extensive grade rule library of the increments for each size stored as x and y co-ordinates.

That is as far as the design studio's responsibility goes: all that remains is for the cloth to be cut by the manufacturer. Most currently translate the Ormus data into traditional pattern pieces, but according to Gray, 'there is no reason why Ormus could not control the cutting machinery directly. All we need to know is the format of information required by the particular machine in question and the control signals it uses for moving the blade or laser'.

Winifred Aldrich comments: 'I wanted to be free. Before, working in a vector system, as soon as you got away from pattern grading, where you were putting in numbers to make sizes, you were lost. For pattern cutting or prints you need a sketchline, but on the big industry systems, although you had the patterns in the machine, you couldn't draw on them. They were only designed for pattern modification, so the edges of the pattern were more difficult to adapt, more rigid. I can lock Ormus patterns together later for pattern cutting and seam allowances and so forth, but until then, they are all free lines that I can move around.

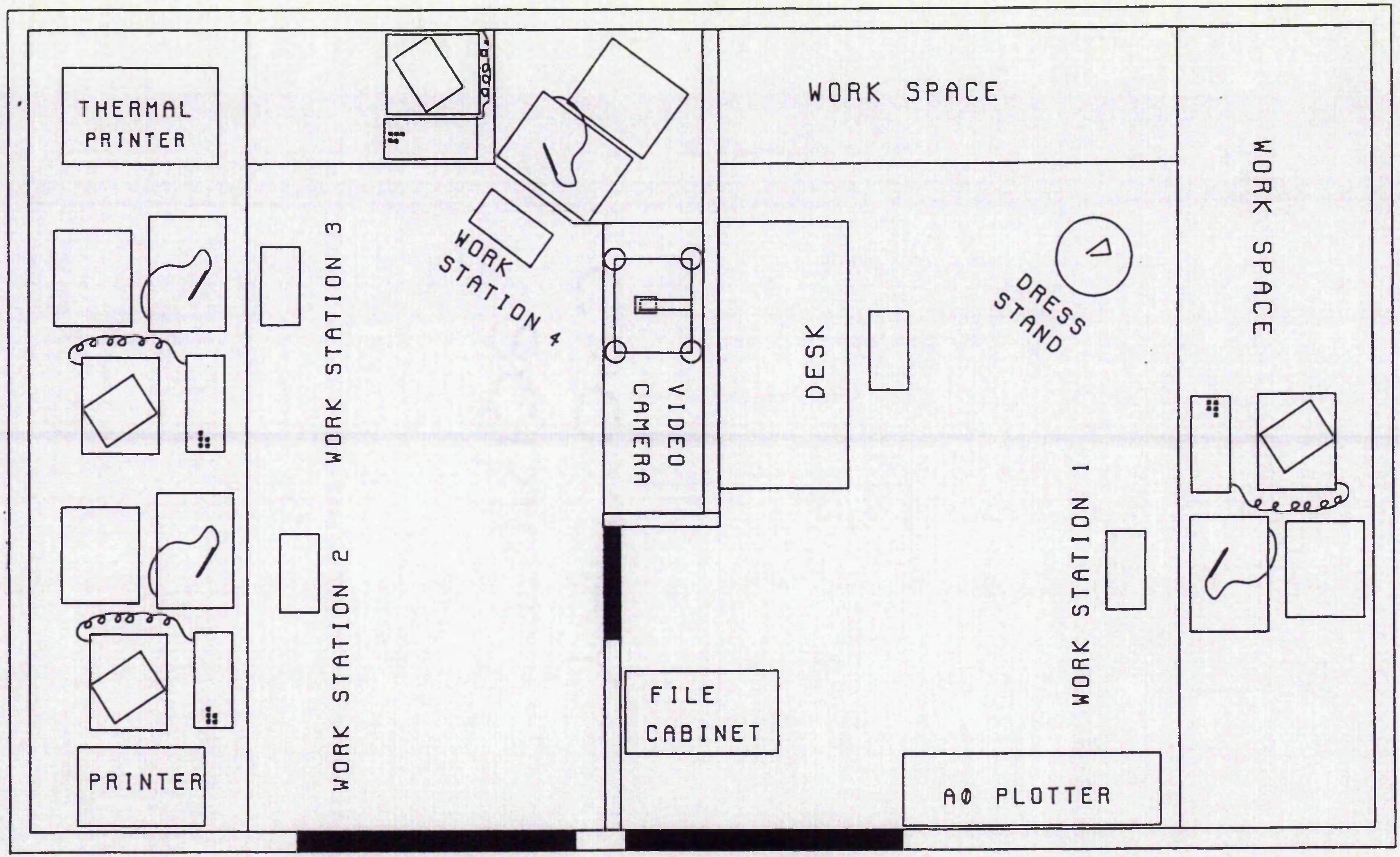
'The beauty of this system is, you can sketch and sketch, and use very little memory, use different thicknesses of line, pick items up, stretch them, shrink them, manipulate whole groups of items or alter them individually, or lock shapes into other shapes just as you can on the bench. Yet these are still mathematically-based lines, prescribed items, so you can get very complex and intricate from a very simple idea without

running into trouble. You couldn't do all these things in a raster system without all sorts of bother and saving loads of copies of everything in case you muck it up. In raster, many patterns can take a long time, and it can be a very mechanical process. So, strangely, what's usually looked at as a very mechanistic technology – vector – is actually being turned on its head. It's actually much more flexible in use because you've got all these individual items to work with. So I can be as free as I want, or I can work to .2 mm theoretically. All I've got is a sketch line and some mathematics, and that does a hell of a lot of work for me as a designer.

'I can access all the paint colours from the vector system, but there are times when I will go straight to raster. If I'm just doing a quick visual for somebody as information, which will come out via the thermal printer, I'll use raster. If it's knit or a print where I can produce the segments in raster, such as a torn paper type print where you don't need a strong line, I'll go straight there too, whereas a detailed print like a paisley would be done in vector. And if I think I'm going to need to pull some measurements off later, I'll start in vector and move it over to raster, because I don't want to enter everything twice. Basically, you just have to think, what is the job and what output do I want? Raster is good for visualisation, knitwear, certain prints, prints for information, and assessing different colourways.

'As far as visualisation goes, whereas expensive systems actually distort the print to a grid you've put over a shape, and told them where the warp, weft and wrinkles are, we can only select a piece of pattern, do a rough distortion of the area and replace it. But it only takes three or four minutes, compared to about half an hour on a CDI, and as a designer, I enjoy it much more than simply feeding in information: it feels more as if you're physically handling the cloth. But visualisation is an aspect which we do need to develop to handle more complex shapes and shadows.

'This is going to become the language across the industry: if someone comes along with a pencil sketch, it won't be a language that people can use. And there will soon be a lot of computer literate people coming out of the colleges. One of the main obstacles to this technology is the time it takes to train people, but when these designers come onto the market, there'll already be halfway along the road.' ■



ROOM LAYOUT AND EQUIPMENT IN THE CAD STUDIOS

APPENDIX XXVII

STRUCTURED INTERVIEW WITH FASHION STUDENTS

1.1 Has your experience of working with CAD differed from your expectations? YES NO
Details............

1.2 Has it continued to change?

---

2. Can you offer reasons for using or not using CAD in your collections?.

3.1 Did the use of CAD in the Autumn term or during your collections change your method of working? YES NO

usual method..............

method using CAD..........

personal advantages.......

personal disadvantages....

practical differences.....

perceptual differences....

3.2 Did using CAD appear to affect your drawing skills?

3.3 What kind of developments might change your attitudes to its use?

3.4 Would you like to give it more control or less?.

3.5 Do you use it as a tool, or as a medium, or both, or as something different?

4.1 Which area of the fashion industry do you wish to enter?

4.2 Will you use CAD in the future if offered the opportunity?

......idea generation: pattern development: textiles: graphics: other areas.

APPENDIX XXVII continued

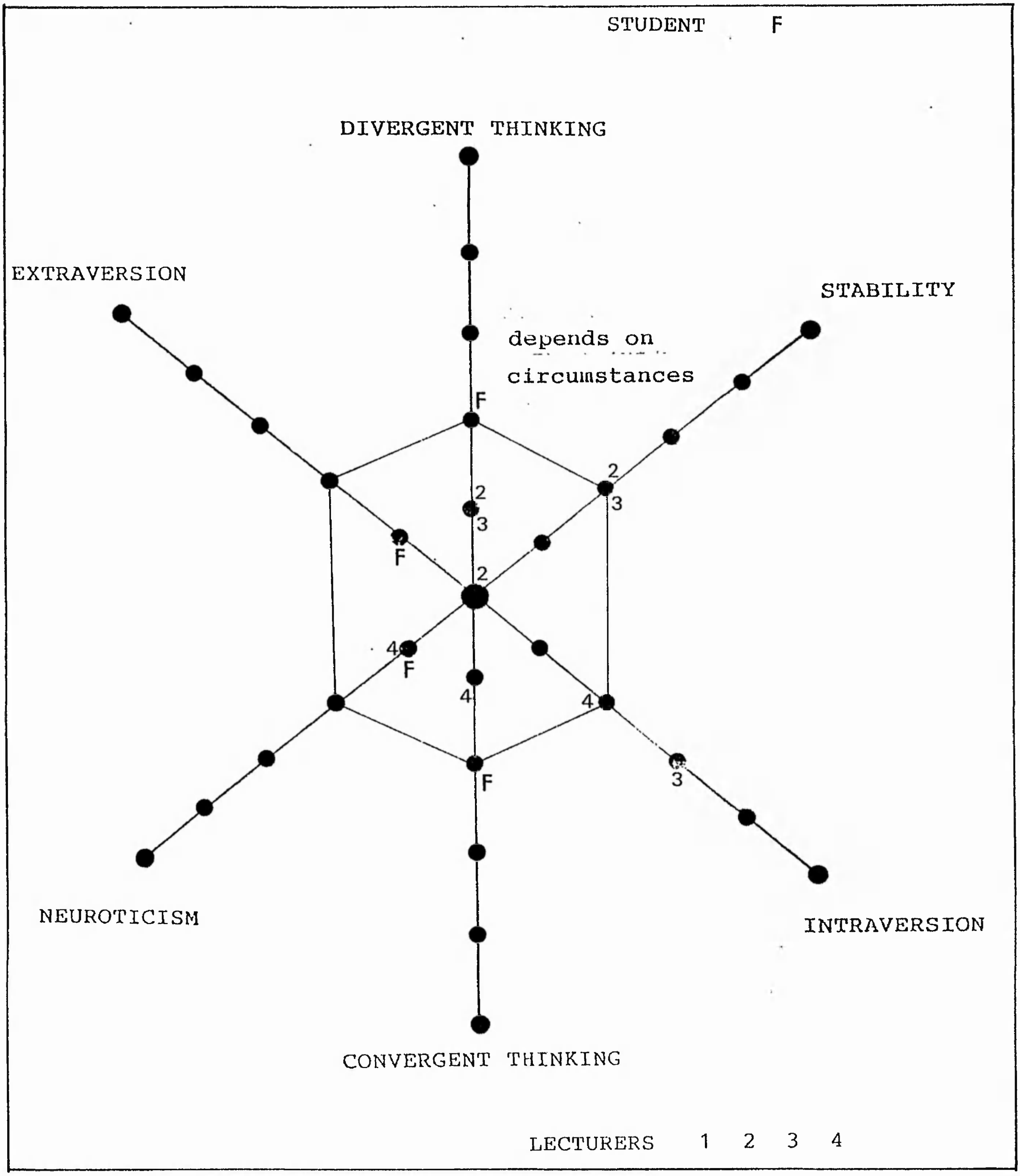
4.3 Will you SEEK opportunities to use CAD?

5.1 How should it be used by a designer?

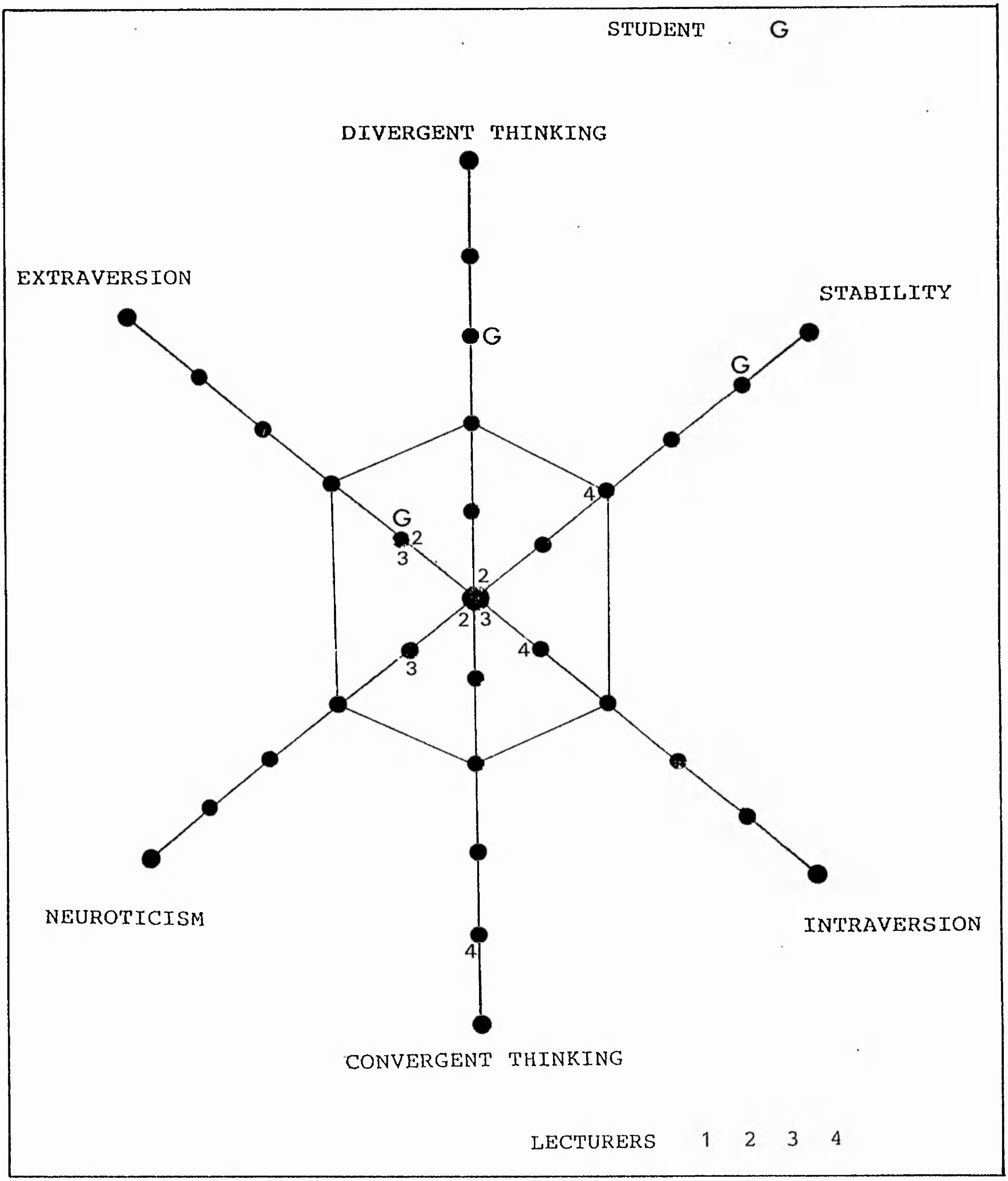
5.2 How would you like to use it?

6.1 How would you have liked CAD to be included in your course?

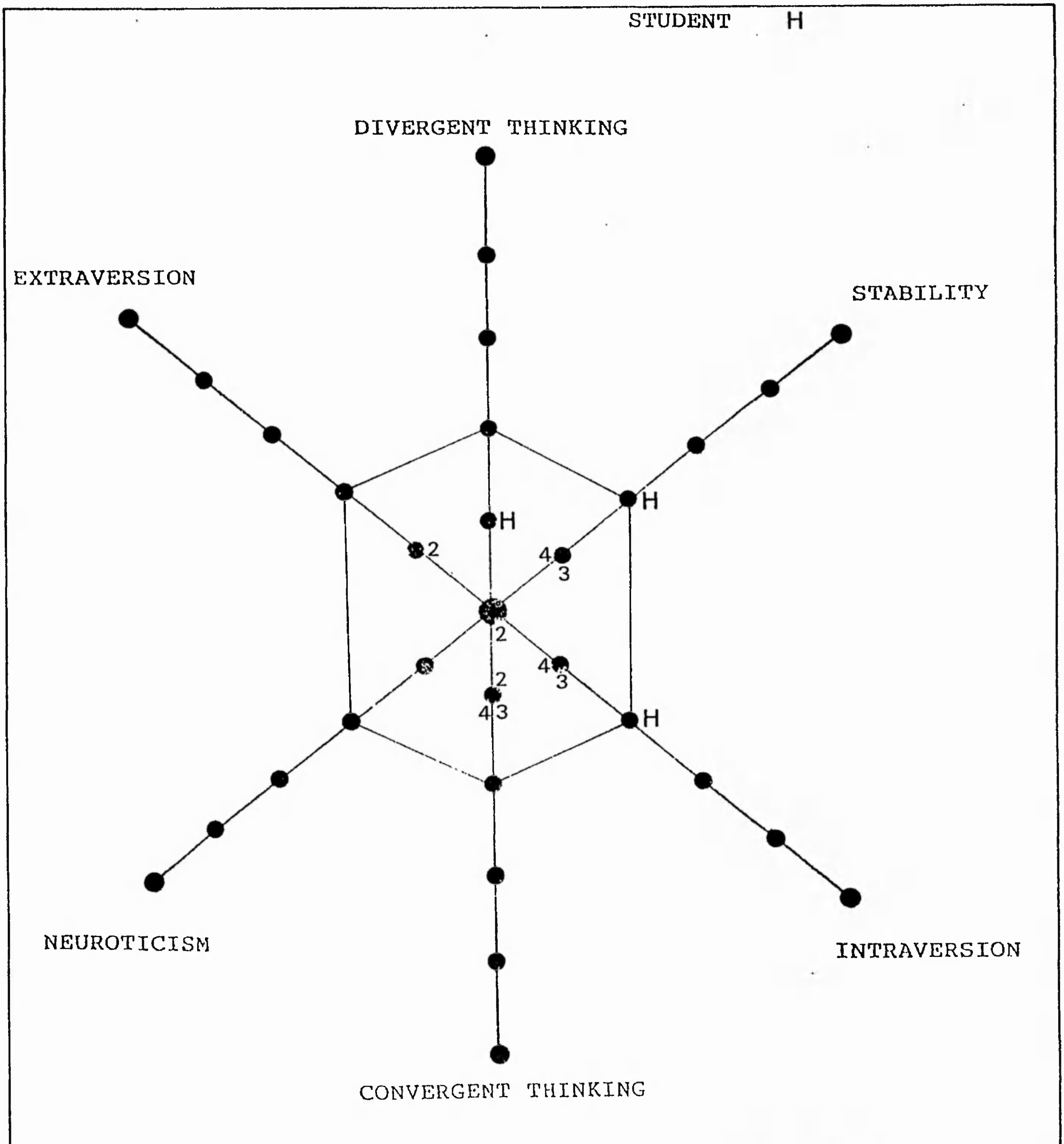
APPENDIX XXVIII



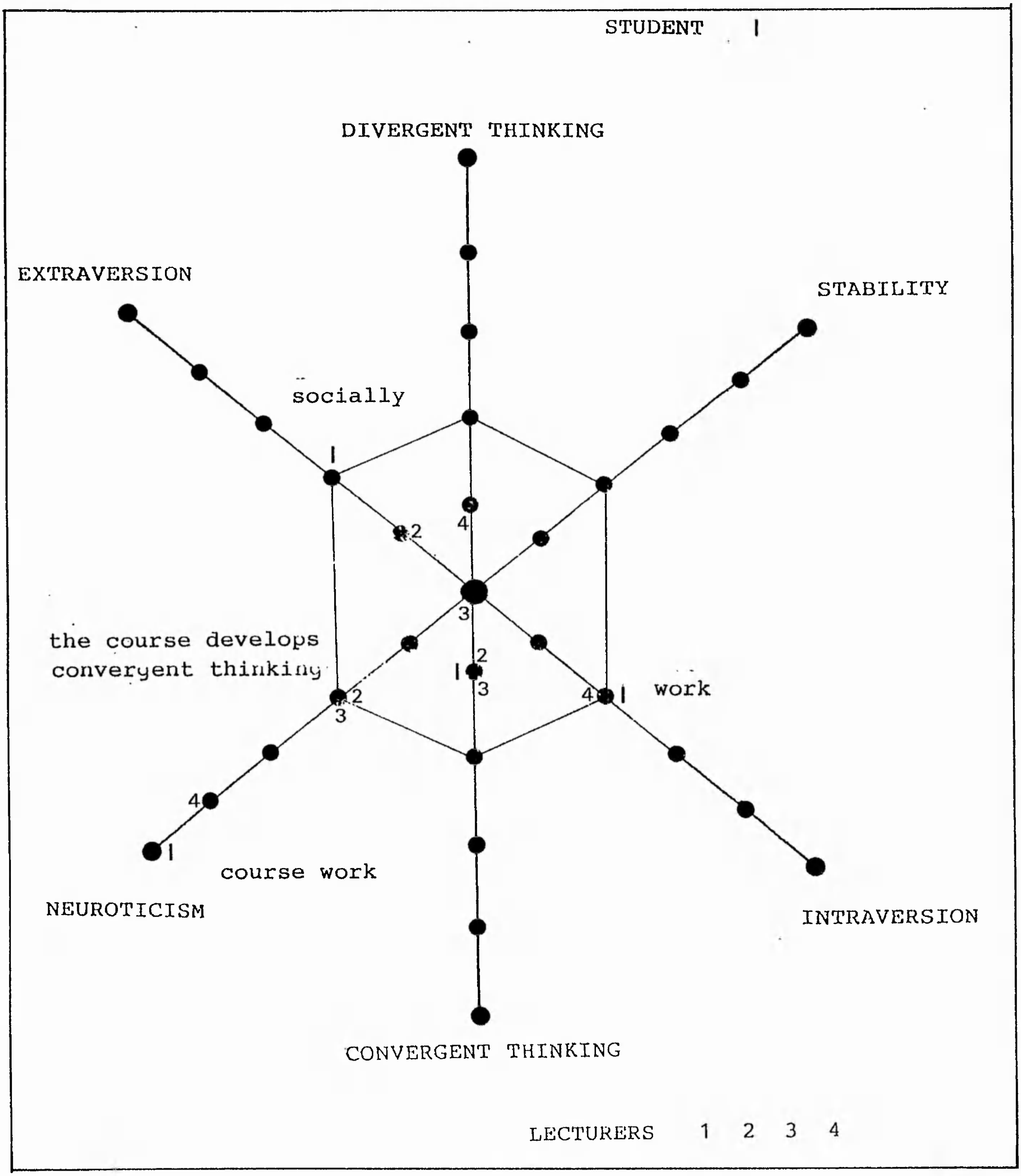
APPENDIX XXIX



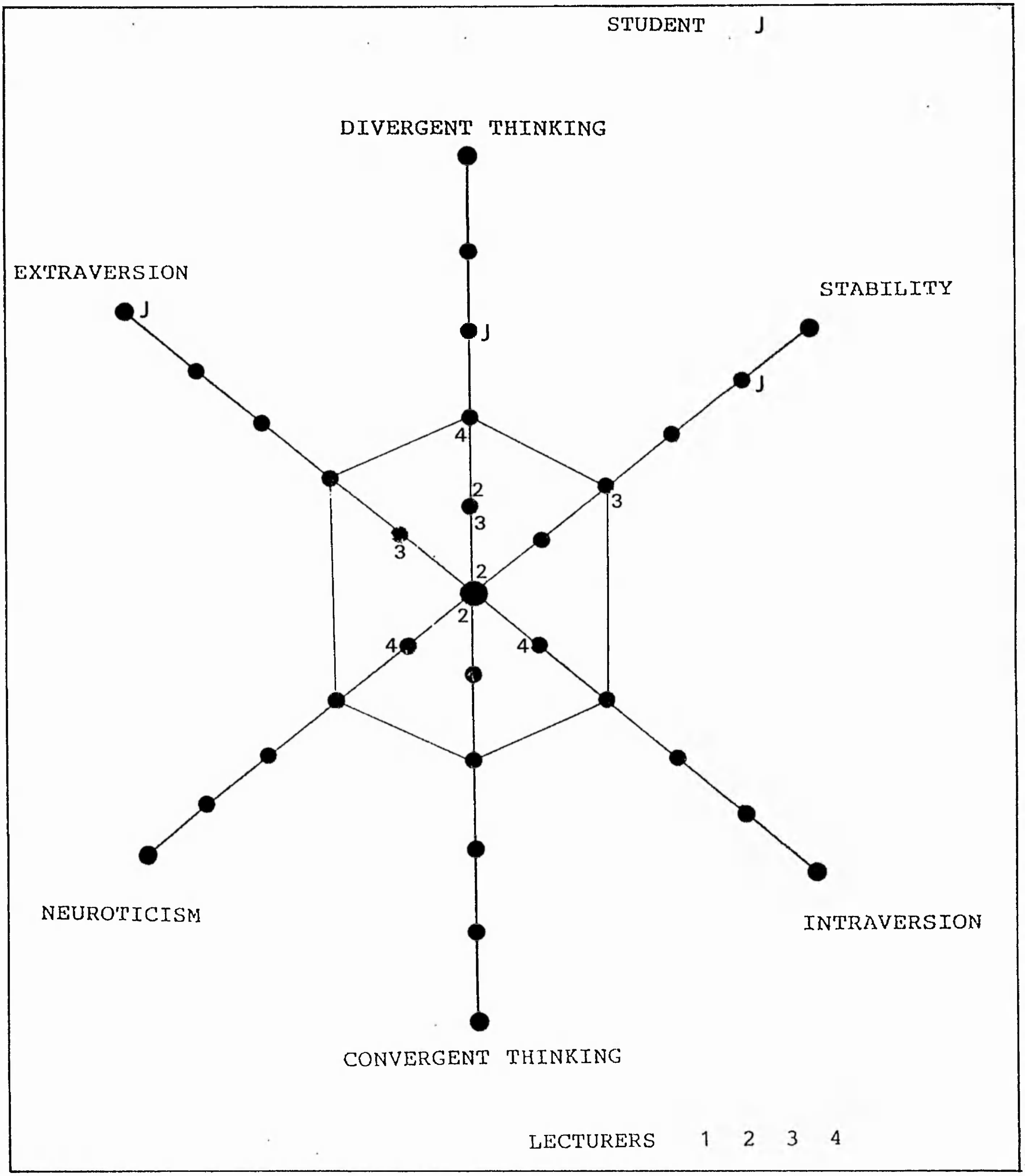
APPENDIX XXX



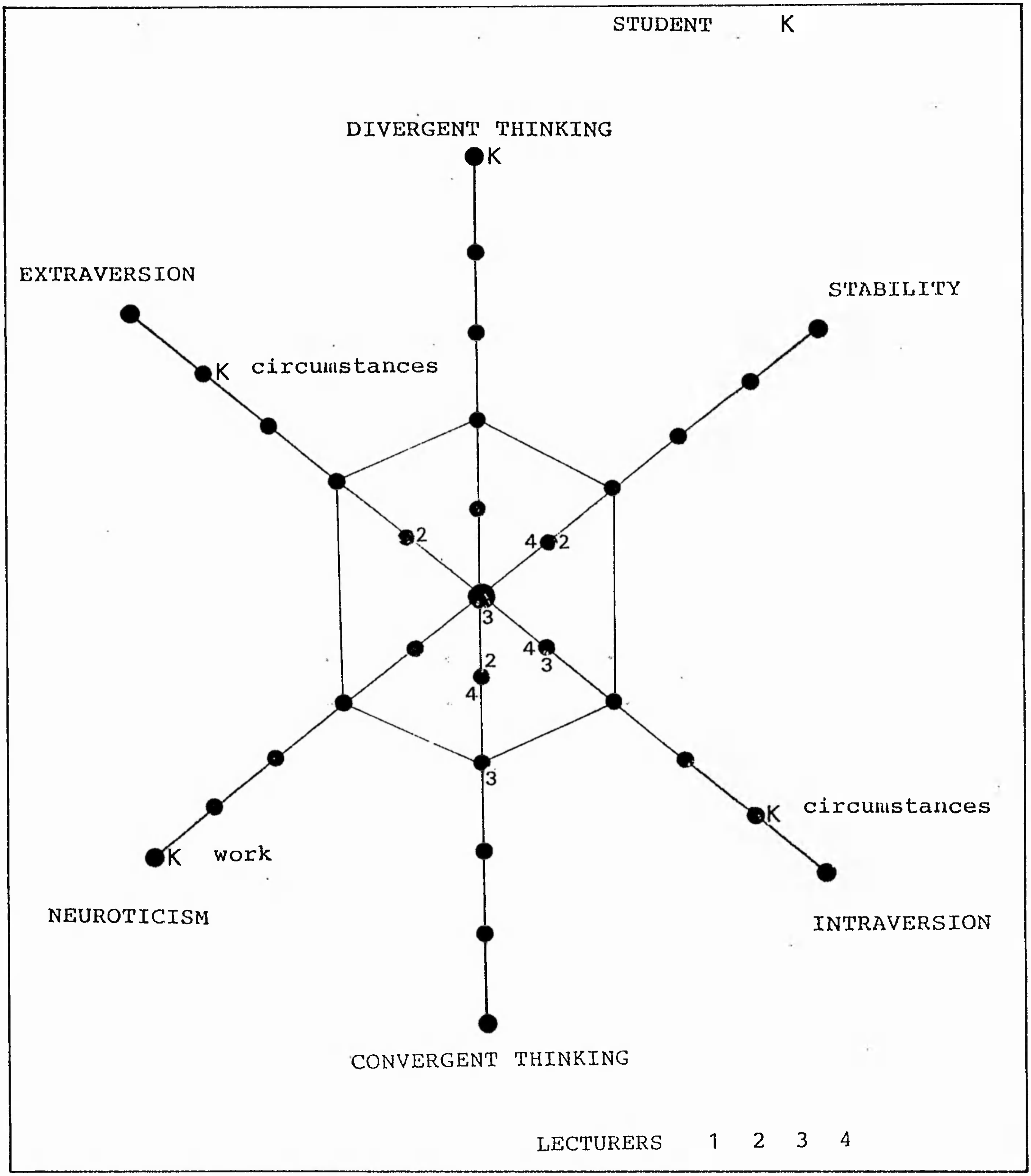
APPENDIX XXXI



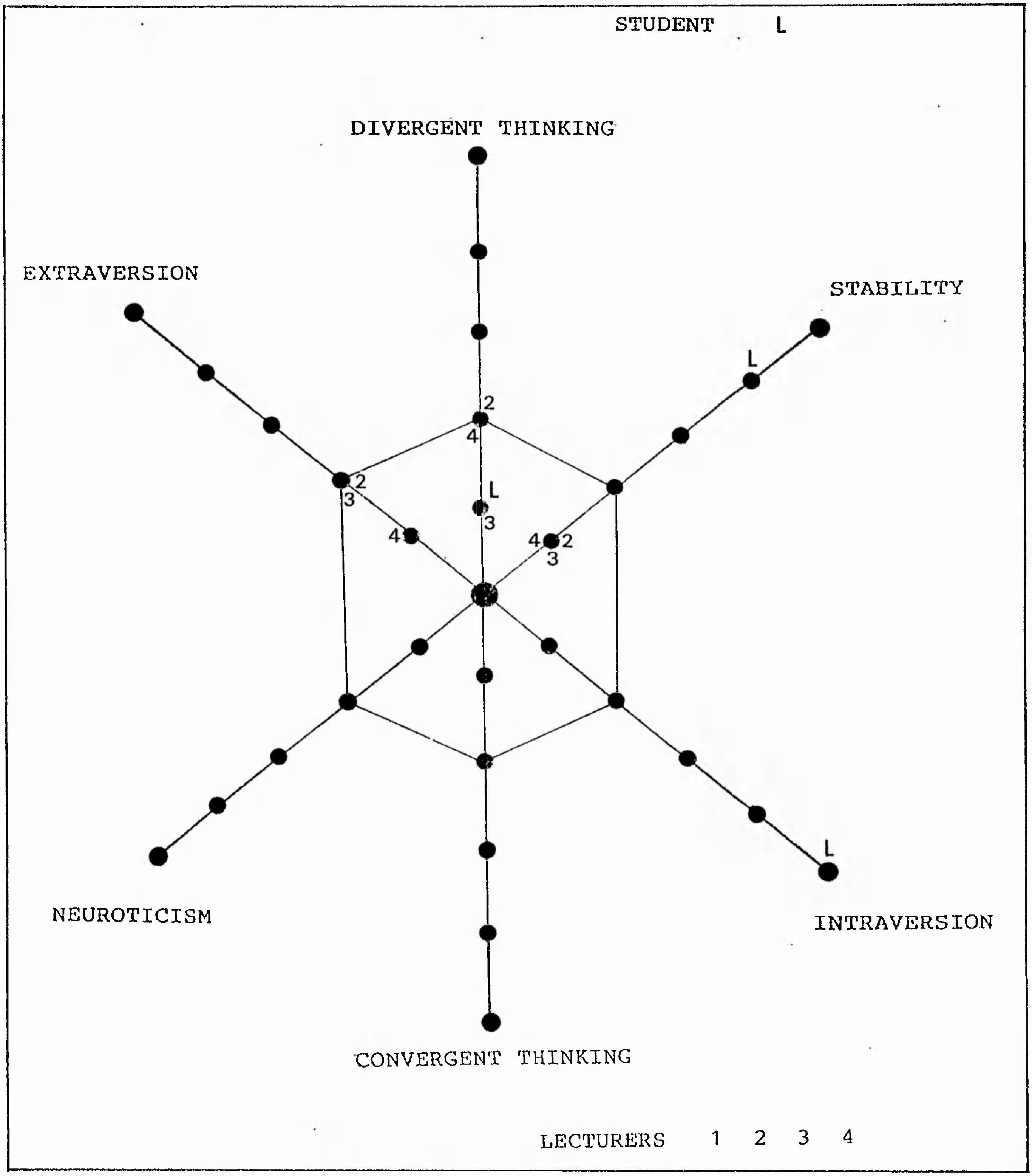
APPENDIX XXXII



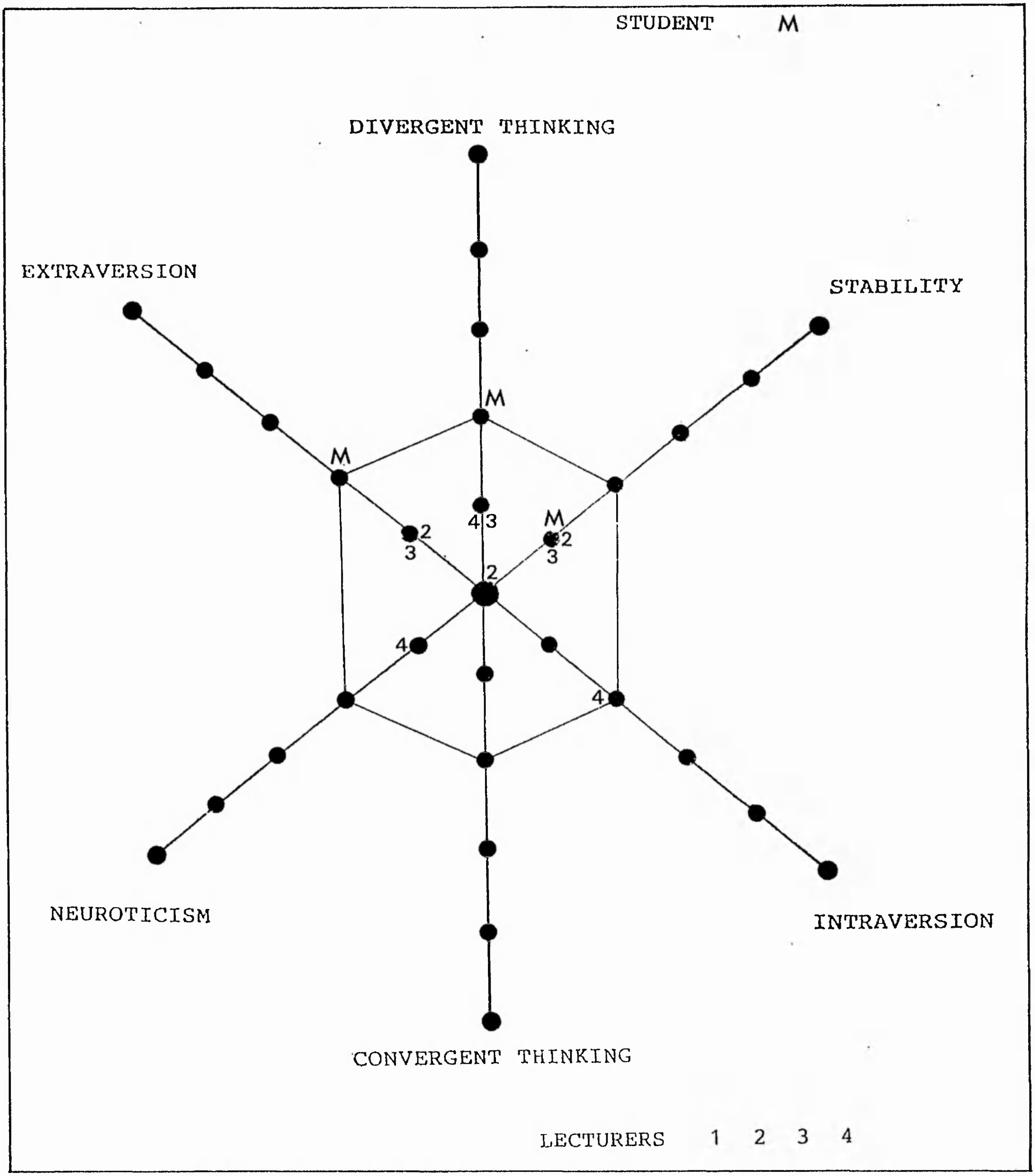
APPENDIX XXXIII



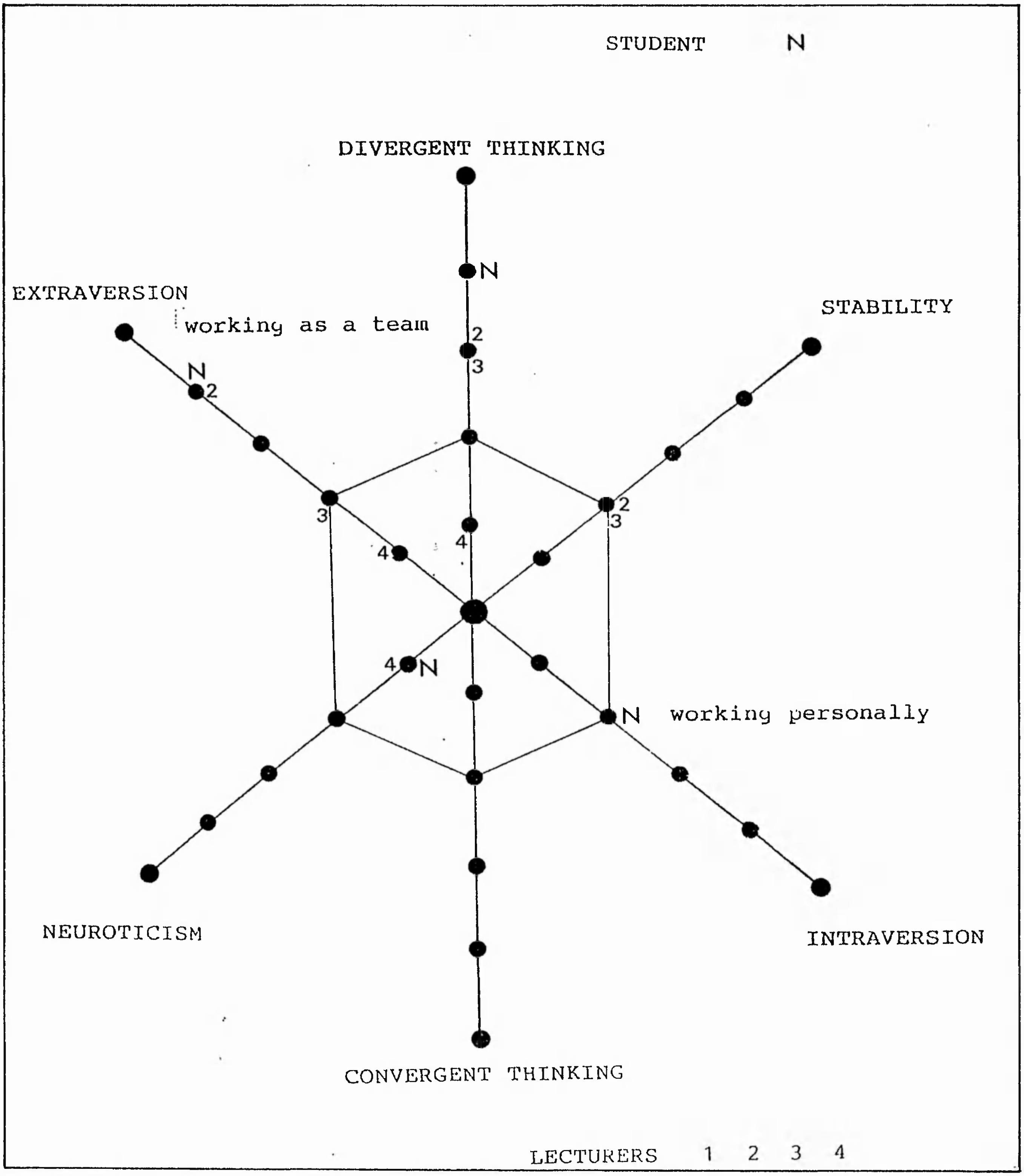
APPENDIX XXXIV



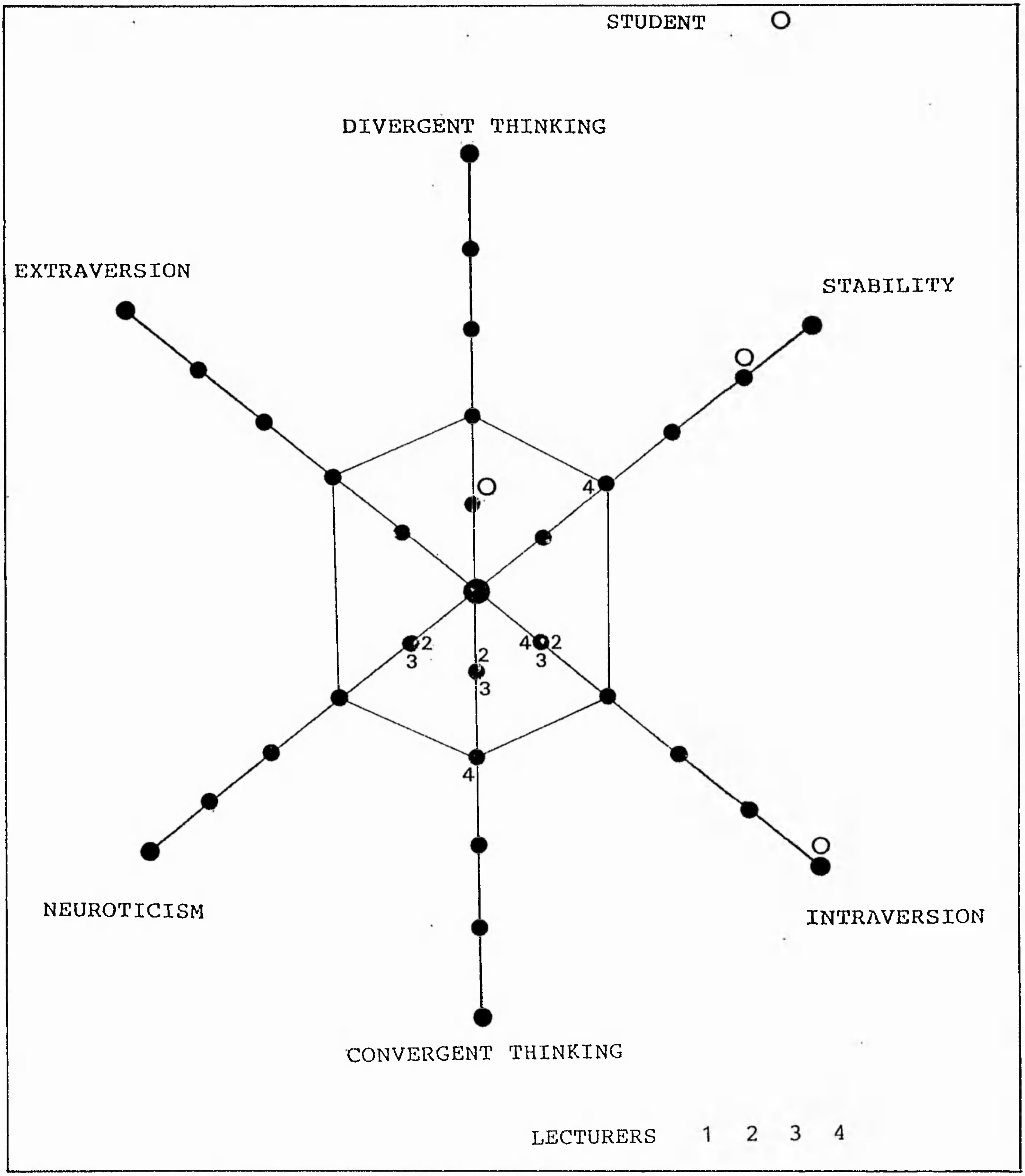
APPENDIX XXXV



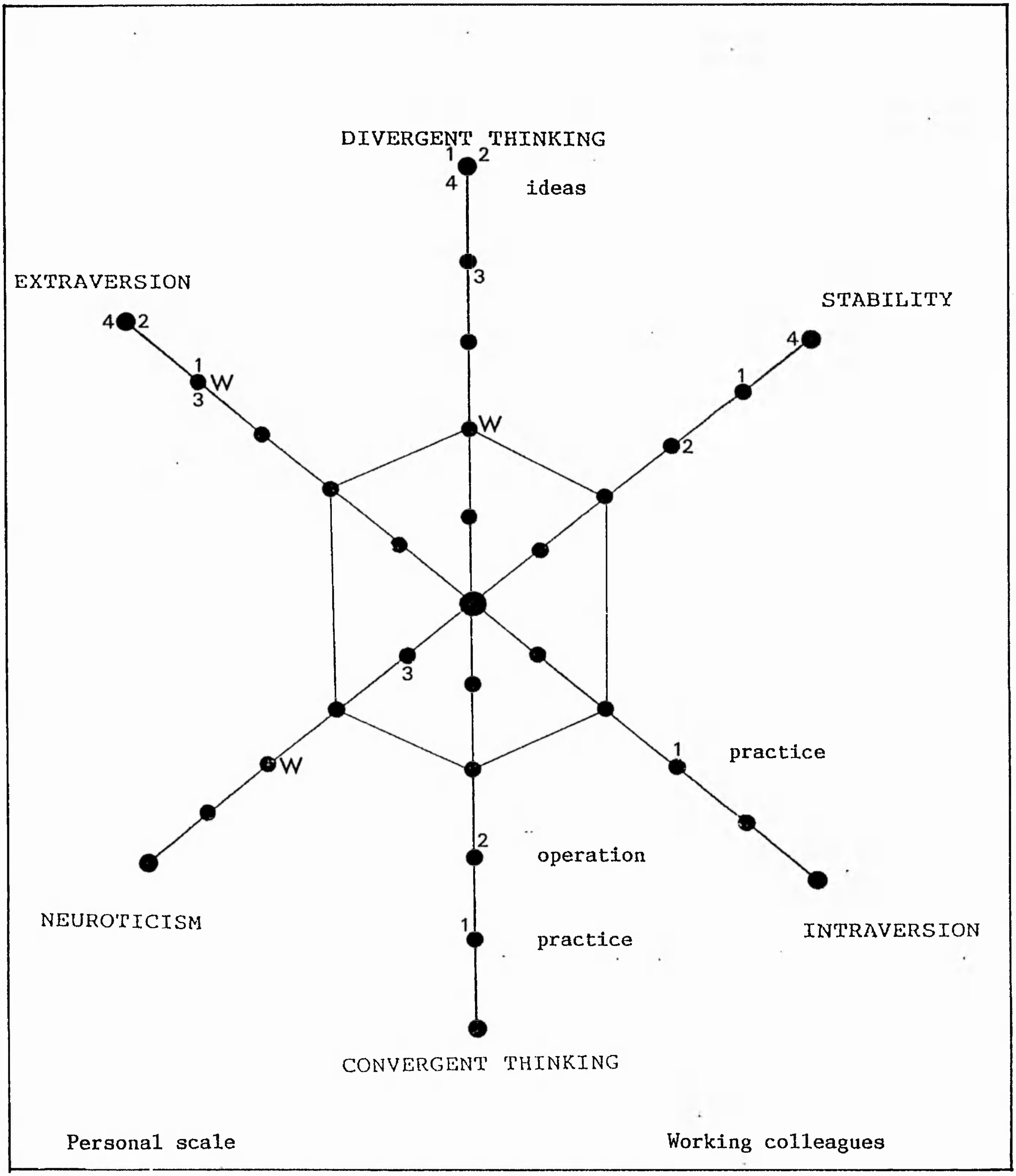
APPENDIX XXXVI



APPENDIX XXXVII



APPENDIX XXXVIII



APPENDIX XXXIX

TABLE 12: FACTORS WHICH MAY AFFECT AN ATTITUDE TO, OR USE OF CAD

SELF-RATING W.ALDRICH

FACTOR	RATING 1-10
LEARNED ATTRIBUTES	
Keyboard skills	8
Prev. computer use	1
P.cutting skills	9
C.constr. skills	5
BIOLOGICAL ATTRIBUTES	
Male/Female	F
Level of concentration	8
Information retention	5
Mathematical ability	8
Manual dexterity	7
Graphic ability	6

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