

Weaving Codes / Coding Weaves:

Penelopean Mêtis and the Weaver-Coder's Kairos

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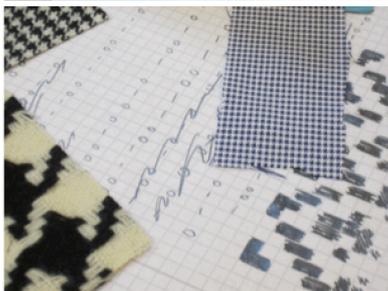
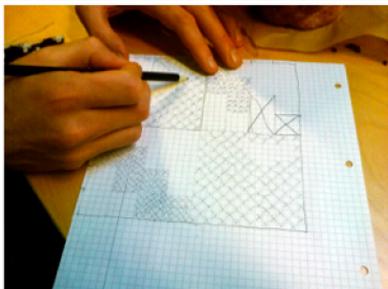
Penelopean Mêtis and the Weaver-Coder's Kairos

Drawing on her experience as ‘critical interlocutor’ within the research project *Weaving Codes / Coding Weaves*, in this article Emma Cocker reflects on the human qualities of attention, cognitive agility and tactical intelligence activated within live coding and ancient weaving with reference to the Ancient Greek concepts of *technē*, *kairos* and *mêtis*. The article explores how the specificity of ‘thinking-in-action’ cultivated within improvisatory live coding relates to the embodied ‘thought-in-motion’ activated whilst working on the loom. Echoing the wider concerns of *Weaving Codes / Coding Weaves*, an attempt is made to redefine the relation between weave and code by dislodging the dominant utilitarian histories that connect computer and the loom, instead placing emphasis on the potentially resistant and subversive forms of *live* thinking-and-knowing cultivated within live coding and ancient weaving. Cocker addresses the *Penelopean poetics* of both practices, proposing how the combination of *kairotic* timing and timeliness with the *mêtic* act of ‘doing-undoing-redoing’ therein offers a subversive alternative to—even critique of—certain utilitarian technological developments (within both coding and weaving) which in privileging efficiency and optimization can delimit creative possibilities, reducing the potential of human intervention and invention in the seizing of opportunity, accident, chance and contingency.

Keywords: *kairos*, *mêtis*, *technē*, *Penelope*, thinking-in-action, live coding

This article elaborates ideas emerging from my experience of operating as a ‘critical interlocutor’ within the research project *Weaving Codes / Coding Weaves* (2014–2016), where I was invited to attend and participate in many of the research residencies undertaken by principle investigators Ellen Harlizius-Klück and Alex McLean, working with collaborative developer Dave Griffiths. *Weaving Codes / Coding Weaves* addressed the historical and theoretical points of resonance between ancient loom weaving and computer programming, exploring the insights gained if we bring these activities together (See Harlizius-Klück and McLean 2017a). Without explicit expertise in either coding or weaving, my approach—as interlocutor—has not been one of providing detailed technical account and analysis in relation to how these practices might interweave. Rather, I address the concerns of the project from my perspective of a writer-artist interested in the endeavor of creative labor and the epistemological value therein. My own recent research focuses on diverse practices that seek to make tangible the often hidden, undisclosed micro-movements of decision-making within the creative process, with a specific concern for how such practices might operate as contemporary manifestations of the Ancient Greek concept of *technē*, a species of subversive

knowledge combining the principles of *kairos* (opportune timing) and *mêtis* (wily intelligence). The research generated within *Weaving Codes / Coding Weaves* has allowed me to consider live coding through its (technical, conceptual and also metaphorical) proximity to weaving, enabling further reflection on the performativity of *technē*, and its attendant wiliness and timeliness within both practices. This article develops ideas—specifically exploring the *kairotic* dimension of live coding (Cocker 2014)—initially generated through my involvement in a previous AHRC research project (led by co-investigators Alex McLean and Hester Reeve) entitled *Live Notation: Transforming Matters of Performance*, for exploring the possibilities of relating live coding (performing with programming languages) and live art (performing with actions). In this new article, I further reflect on the human qualities of attention, cognitive agility and tactical intelligence activated within both live coding and ancient weaving with reference to the concepts of *technē*, *kairos* and *mêtis*, arguing how such practices might have the potential for cultivating a more critical—even resistant—mode



Figs. 1 a – 1 c. Documentation of workshop by Dave Griffiths, Ellen Harlizius-Klück, and Alex McLean at the Centre for Participatory IT, Aarhus University, 2014. Photography: Emma Cocker.

of human agency and subjectivity. However, before elaborating on the *kairotic* and *mêtic* principles that connect live coding and ancient weaving some indication of the research context is required.

The fieldwork for this article was generated over the duration of the *Weaving Codes / Coding Weaves* project between 2014 and 2016. In October, 2014, we—myself, Griffiths, Harlizius-Klück, McLean—visited Copenhagen’s *Centre for Textiles Research* where we were introduced to the warp-weighted looms, explored the pattern book archives and engaged in discussion with other researchers at the centre. We then travelled to the Centre for Participatory IT, Aarhus University, to work alongside Geoff Cox and students at the Centre for Participatory IT, Aarhus University, to scrutinize, read and notate the structure of dogtooth fabric, before exploring the nature of weaving notation systems using prototype software created by Griffiths and McLean (Figs. 1 a – 1 c). In Sheffield (November, 2014) I first encountered and tested Griffith’s pilot attempt at a

tangible programming or live weaving-coding device (subsequently known as the ‘pattern matrix’). My initial reflections on the project—a paper entitled *Connecting Threads: Penelopean Mêtis and the Weaver-Coder’s Kairos*—were presented as part of the *Threads and Codes* symposium at Goldsmiths

College (March, 2015), which provided a critical frame for sharing and expanding upon these emergent findings—these ideas were later tested within the frame of the *International Conference on Live Coding*, University of Leeds, 2015, and in turn form



Figs. 2 a – 2 c. Documentation of residency at the Museum für Abgüsse Klassischer Bildwerke (Museum for Plaster Casts of Classical Sculptures) Munich, 2015. Photography: Emma Cocker



Figs. 3 a – 3 c. Documentation of residency at FoAM Kernow, Cornwall, 2015. Photography: Emma Cocker.

the basis for this article. In May, 2015, I joined Griffiths, Harlizius-Klück and McLean for a research residency in the Museum für Abgüsse Klassischer Bildwerke (Museum for Plaster Casts of Classical Sculptures) in Munich, in conjunction with Harlizius-Klück's exhibition, *Textile Matrix*, where I witnessed a virgin live coding performance by Harlizius-Klück with *slub* (Griffiths and McLean) in the museum itself using McLean's *TidalCycles* and Griffiths' *Schemericks* software to generate sound, with code visually projected onto a transfixed 'audience' of classical statues (Figs. 2 a – 2 c). In parallel, a version of an ancient warp-weighted loom encountered in close proximity to a plaster cast statue of Penelope, wily weaver of the Ancient Homeric text, *The Odyssey*, provided provocation for reflecting on the *Penelopean poetics* within the project (which I develop further in this article). During October, 2015, as part of a micro-residency at FoAM Kernow, Cornwall, I witnessed a live coding / live weaving

performance with *slub* coding sounds to weave by (Figs. 3a – 3c), projected 3-D digital procedural rendering of an evolving weave meeting the physicality and materiality of live tablet and loom weaving, the close up visuals of actual threads on the loom generating an abstract backdrop for improvisation. In January, 2016, I participated in a workshop exploring tablet-weaving and live coding with Julian Rohrer and researchers at the Institute for Music and Media (IMM), Dusseldorf, which enabled reflection on the capacity of both looms and computers as algorithmic environments for creative work with sonic pattern, exploring different tactics for the sonification of thread language.

What follows in this article is my account of observing the research process, framed by my own interest in the human qualities of attention, cognitive agility and tactical intelligence activated within live coding and ancient weaving; the potential therein for a form of resistance to certain utilitarian technological developments (within both coding and weaving) which in privileging efficiency and optimization can delimit creative possibilities, reducing the potential of human intervention and invention in the seizing of opportunity, accident, chance and contingency. Whilst increasing accessibility to and engagement in both code and craft is one aim of

Weaving Codes / Coding Weaves, the research enquiry itself is technically specific: to provide a simulation of the warp-weighted loom to use for demonstrations and exploration of ancient weaving techniques. Harlizius-Klück's own research has long explored the relation between ancient loom weaving and mathematics, where the staging and activation of an ancient warp-weighted loom (or 'Penelope loom') has been a key component for making this complex enquiry tangible to a wider audience (Harlizius-Klück 2014, 2014a, 2015). However, the process of loom-weaving is slow and laborious—the quest for a simulation software thus emerged from a desire to make the 'thinking-process' of ancient weaving more immediately (if virtually) communicable to others, alongside the need for a more effective problem-solving method 'off the loom' which does not diminish or detract from the nature of 'on loom thinking' cultivated within the process of weaving itself. Existing software packages provide inadequate insight into the ancient weaving process, for example, most digital procedural renderings of weave (indeed, many pattern book samples) present only a 'section' of the fabric, *as if* cut from an infinitely expanding textile field. To a certain extent, this practice has been shaped by modern mass-production methods (modeled on the Jacquard loom), where fabric is woven but invariably cut to size once off the loom. Not so for the ancient weaver, whose fabric is not cut to shape after the event of weaving, but rather produced as a completed artifact in-and-through the process itself, with the selvedge—the hems and edges—intricately integral to the design. One question that *Weaving Codes / Coding Weaves* addresses then is how can computational rendering account for the selvedge (and how the weft actually 'turns' at the edge of a weave) as well as the pattern (underlying structure) of the fabric itself? Here, it is perhaps worth noting that 'pattern' refers to more than the visual appearance of a fabric; indeed, the notion of pattern runs across the structure, notation and perception of the resulting fabric of a weave, and they can 'look' very different from one another.

Whilst simple in its physical construction, the ancient warp-weighted loom provides special challenges for the coder seeking to model its use. Specifically, the weaver working on a warp-weighted loom is able to switch between different weaving techniques; moreover, one weaving technique has the capacity to set up the working conditions for another. Within ancient weaving, different processes are thus conceived as distinct yet inherently interwoven. For example, the weaver might create the initial fabric band at the start of the weaving process using a tablet-weaving method then use warp-weighted loom weaving to produce the main 'body' of the fabric. Furthermore, in tablet-weaving this initial band, the weaver extends the lengths of the weft thread, which subsequently become the warp for the next stage in the loom-weaving process. One action has the capacity to set up the conditions or scaffolding for the next—what is at first the weft will later become the warp. In turn, this could be considered in relation to how some live coder's 'scaffold' for future action by creating 'stubs' in a command line, which will be later returned to and activated. But, how might these complex interwoven procedures of ancient weaving be addressed through coded algorithms, when the tendency within digital rendering of weave is often one of attending to and defining a discrete (isolated) operation or function? How can a virtual simulation accommodate the possibility of two or more weaving techniques within the same

fabric? Moreover, how might a procedural rendering or simulation articulate the sense (and value) of the decisions made ‘on the loom’ so central to ancient weaving? Can computational approaches capture and communicate the sense of the tacit knowledge necessary for weaving, the critical deliberation, the tactile and embodied processes of trial and error, the weaver’s work with the resistances, tensions and even unexpected surprises of both the loom and thread?

Central to the *Weaving Codes / Coding Weaves* project is an attempt to dislodge the privileged model of ‘working out’ where an idea is *applied* to material (having been conceived in advance), in favor of a model wherein various levels of operation and cognition are activated live *within* the process itself. The project’s research challenge involves the development of a modeling language capable of reflecting the multiple technologies operating in combination within ancient weaving—the weft to warp transition, the different directionalities, the inter-dependent relation between tablet-weaving and warp-weighted weaving techniques. Throughout the project, Griffiths and McLean have worked on the development of technical hardware and software prototypes in response to these questions, searching for a computer language and code to describe the complex processes within ancient weaving (Griffiths and McLean 2017). This has ranged from the construction of a tangible pattern matrix that brings a level of physicality, tactility and public interactivity to procedural weave rendering; to the development of a coded ‘behavioral’ language that describes a weave from the point-of-view of a continuous single thread, specifically addressing the ‘turn in / out’ instruction necessary for the selvedge, as much as the ‘over / under’ relation of the weft to the warp; moreover, the manner in which—within ancient weaving—an original weft thread has the capacity to become the warp. Whilst other experiments have included describing weave structures from the actions of the weaver, the setup of the loom and the structure of the fabric, this focus on following the path of a single conceptual thread is an innovative coding solution modeled on the idea of process continuity, rather than the discontinuous approach of attempting to explain and notate each separate method according to its own discrete functions and parameters. What has emerged through this research is a sense of the complex, combinational properties of ancient weaving, which renders any singular system of notation or simulation inadequate, for the weaver works with multiple notational languages at the same time, live weaving them together as a singular experience or even Gestalt. Additionally, different systems of notation can illuminate or privilege different facets of the weave process, where the tendency is often one of attending to the operational settings of the loom (the heddles, the lift plan) alongside the notation of the product—the resulting weave structure—itsself, rather than the temporal, tactile and even sensuous movements of either the weaver or the thread.

Within conventional notational systems the tendency seems one of giving articulation to the visible properties of the weave, with the ‘over’ operation rendered ‘positive’ and the ‘under’ given a negative value, a binary logic reinforcing the distinction between presence / absence, visible / invisible, front / back. However, within both live coding and ancient weaving practices, this binary relation is somewhat collapsed, as the back and the front of both the process and the product remain a visible part of the work. There is no visible / invisible within these practices: preparation is not

concealed but becomes folded into the practice itself, is part of—and not prior to—the process. There are no cuts to be made after the fact—all is present, all part of the work. The act of assigning a positive and negative value to the over and under of the thread effectively describes weaving in spatial, abstract and discontinuous terms (a panoptic orientation on or overview of the process understood), whereas the act of following the thread articulates the process from *within*, as a relative, temporal *and* material continuum. This shift in focus might be considered akin to Michel de Certeau's distinction between map and itinerary; whilst the map spatializes, the itinerary emphasizes the journey or story from the ground: "What the map cuts up, the story cuts across. In Greek, narration is called 'diegesis': it establishes an itinerary (it 'guides') and it passes through (it 'transgresses'). The space of operations it travels in is made of movements" (1984: 129). In one sense, the *Weaving Codes / Coding Weaves* project seeks to make tangible that which conventional notational and simulation languages fail to account for but which the weaver knows all too well: the importance of timing, timeliness, tension, rhythm, the negotiation of different and even competing forces within the process of weaving, the tactility of weave's three-dimensionality, the textural properties of thickness, roughness, density, stretch. Both ancient weaving and live coding involve a live and embodied process of decision-making that operates in excess of or perhaps even between the lines of conventional notational systems. Within each practice, there is a sense of oscillation or even 'shuttling' between 'discontinuous' systems of abstract notation and the 'continuous' experience of a lived process, between the importing of source codes and pre-existing patterns and a mode of invention that actively modifies the process as it unfolds. What then are the cognitive and bodily intelligences operating in this space between the discontinuous and continuous, activated at the point where abstract algorithm meets with the lived experience of the weaver-coder?

Weaving Codes / Coding Weaves draws attention to the specificity that live coding brings to the research challenge of designing a simulation for the warp-weighted loom and ancient weaving process. Not just computer software developers, Griffiths and McLean have both been instrumental in the development of live coding as an emergent, creative field of practice. Broadly speaking, live coding describes the improvisatory real-time composition of predominantly computer-generated audio-visual material, where the writing of the code itself (or other executable instructions) is presented as a live event for an audience. Alongside witnessing the coder engaged in the live act of coding (laboring at their laptop), the code itself is also presented—often projected—real-time as it is being worked on, as a visible part of the performance. For the live coding collective *slub* (a collaboration between Griffiths, McLean and Adrian Ward), "the preferred option for live coding is that of interpreted scripting languages, giving an immediate code and run aesthetic" (Collins *et al.* 2003: 321). Here, audiences encounter projected code as a running command line whilst it is being modified and rewritten by the programmer. Live coding involves the presentation of a textual or graphic interface—using existing, hacked or self-built programming languages—through which the live-ness of the decision-making and *working out* within coding is revealed. The focus is on the real-time writing of code simultaneous to its use, as Nick Collins *et al*

note, live coders “work with programming languages, building their own custom software, tweaking or writing the programs themselves as they perform” (Collins *et al.* 2003: 1). What qualities, capacities and even knowledges are cultivated through the practice of live coding, and what do they share with ancient weaving? What is the specificity of thinking in action whilst improvising within a live running code (Cocker 2016), and how might it relate to the embodied ‘thought-in-motion’ (Hawhee 2004: 75) activated whilst working on the loom? Moreover, how can attending to the practice of ancient weaving offer new insights into the critical potential of live coding as a creative and even epistemological endeavor? What are the points of shared resonance between these two (temporally disconnected) practices, and how might an engagement with the past (the historical practice of ancient weaving) open up new ways of thinking about the future (of live coding)?

The *Weaving Codes / Coding Weaves* project attempts to retrieve a sense of ‘lost’ or buried connections between coding and weaving, by disrupting or dislodging the privileged position of the Jacquard loom in the historical conceptualization of these practices. First demonstrated in 1801 by its inventor Joseph Marie Jacquard, the Jacquard loom served to simplify and accelerate the manufacturing of textiles, using a system of punch cards to control a mechanized process of weaving, a development often credited as a key precedent in the evolution of computational hardware (See Harlizius-Klück 2017). However, the *Weaving Codes / Coding Weaves* project reflects on the points of resonance between weaving and coding from a different perspective, conceiving *ancient* weaving practices as effectively pre-figuring the dyadic or pythagorean arithmetic necessary for computational logic. Whilst Harlizius-Klück’s research has focused on this specific relation, my own interest is more concerned with how certain forms of knowledge contribute to the potential of active—even critical and resistant—forms of subjectivity and citizenship, or perhaps conversely, how the erosion of certain forms of knowledge serves to incapacitate, generating the experience of disempowerment. For example, what human knowledges or capacities have become lost or devalued through the privileging of speed, productivity, economic efficiency and standardization that technological developments such as the Jacquard loom facilitate? How might these knowledges and capacities be recuperated or retrieved? Indeed, certain technologies actively create the conditions of ignorance or alienation, where a technology has the capacity to be used or operated in the absence of any knowledge of underpinning process, principles or structure. In doing so perhaps, what becomes cultivated is a reliance on templates, on a received standard or model developed for a specific (predetermined) purpose or function. The possibility of deviation from the norm, for bespoke options, for modification or adaptation becomes increasingly less of an option. In time, the capacity to imagine other ways of doing things might dissolve or dissipate; possibilities conform to the standard fit. Here perhaps, it is possible to argue how the acceptance of standards or templates alongside ignorance of underpinning structures and causes within one context, facilitates the same in other aspects of lived experience. Or else perhaps, more affirmatively, *can* the questioning of standards or templates alongside increasing awareness of underpinning structures and causes within one context facilitate the same in other aspects of life?

The connections between live coding and ancient weaving that I seek to excavate are less directly to do with the shared technology (the relation between the computer and the loom), nor shared notational systems (pattern and code) or mathematical algorithms, nor even the relationship or resonance between the resulting weaves (whether digital or textile). My own interest is in the capacities, knowledges and modes of attention cultivated within practices such as weaving and live coding, practices that require heightened alertness to the live circumstances or ‘occasionality’ of their own production; moreover, my assertion is that these qualities (identified and *practiced*) have the capacity to be applied to other situations, indeed to the living of a life. My starting point for connecting the practices of live coding and weaving has been through the concept of *kairos*, extending the argumentation developed initially through my previous interrogation of the points of resonance between live coding and live art (Cocker 2014). Admittedly, as Thomas Rickert argues, “the meaning of the Greek word *kairos* is itself murky because of its various usages” (2013: 75); its definition shifting, contradictory and therefore lacking direct or exact translation. Additionally, its various accentual forms—*kairos*, *kairos*, *kairós*—give rise to a play of meanings as Debra Hawhee notes, from “*kairos* as opening, as weaving, as timing, and most notably, as critical, delimited places on the body” (2004: 67). Hawhee indicated a specific connection to weaving, “A key term in the art of weaving, *kairos* indicates variously, the place where the threads attach to the loom; the art of fastening these threads (*kairoō*); a web so fastened (*kairōstis* and *kairōstris*). The related *kairoseōn* is used to describe that which is tightly woven” (2004: 67). Interestingly, as Harlizius-Klück notes, *kairos* is the name given in weaving to the lower rod on a warp-weighted loom that holds one half of the warp threads in order to create a natural shed.

Drawing specifically on the Ancient Greek rhetorical conceptualization, the term *kairos* is often taken to mean ‘timing’ or the ‘right time’, a ‘decisive’ critical moment whose fleeting opportunity must be grasped before it passes. It describes a qualitatively different mode of time to that of linear or chronological time (*chronos*). It is not an abstract measure of time passing but of time ready to be seized, an expression of timeliness, a critical juncture or ‘right time’ where something *could* happen. For Eric Charles White, *kairos* has origins in two different sources: *archery*, where it describes “an opening or ‘opportunity’ or, more precisely, a long tunnel like aperture through which the archer’s arrow has to pass”, and *weaving* where there is “a ‘critical time’ when the weaver must draw the yarn through a gap that momentarily opens in the warp of the cloth being woven” (1987: 13). Drawing on these different references, it is clear that both the practice and the metaphor of weaving are central to the conceptualization of *kairos*. However, the significance of *kairos* is that it not only describes the quality of the ‘opening’ or ‘critical time’ ready to be seized, but also the quality of attention and perception needed in order to harness that opportunity. Indeed, *kairos* has little power on its own, for it requires the perceptions and actions of an individual capable of seizing its potential. As Debra Hawhee states, “*kairos* entails the twin abilities to notice and respond with both mind and body ... the capacity for discerning *kairos* ... depends on a ready, perceptive body” (Hawhee 2004: 71). For Hawhee (drawing on sophistic rhetoric), *kairos* emerges as a kind of “rhythmic, embodied practice” (2004: 67), based

on the principles of movement and fluidity, where “it is precisely the moment when learning is connected to performing that the art’s embodied aspects come to the fore” (2004: 70). She argues that *kairotic* practices necessitate a sense of “immanent awareness”, “embodied thought-in-motion” and an “instinctual ... bodily capacity for instantaneous response” (2004: 75). These embodied aspects of *kairos* are also elaborated by Janet Atwell who states that, “‘knowing how’ and ‘knowing when’ are at the heart of *kairos*” (1998: 59). However, at Hawhee states, this capacity for ‘knowing how’ and ‘knowing when’ “is difficult to gauge, let alone teach, and it must be achieved through practice” (2004: 70). She further argues that whilst not exactly *transmittable* as knowledge it is still possible to become sensitized to the potential of *kairos* through the cultivation of a quality of attention that includes “different modes of thinking aside from the noetic, diagnostic, rational” (Hawhee 2004: 70).

Whilst *kairos* has been used to refer to the notion of ‘due measure’, propriety and decorum, my own interest is rather more oriented towards what Hawhee describes as an “embodied, mobile, nonrational version of rhetorical *kairos*” (2004: 68–9). Ancient loom weaving and live coding are *kairotic* in the sense that they do not simply involve the machinic execution of code or instruction, but rather require a level of embodied knowledge, a tactile—even tactical—system of physical and cognitive dexterity, the interplay of hand, eye and mind, alongside the practice of timing and timeliness, of invention and intervention. In live coding and ancient weaving an algorithmic operation is not simply imported, set in motion and allowed to run its course. Both require a capacity for improvisation and decision-making activated whilst *within* the process itself, rather than being determined solely on the basis of a design conceptualized and applied from without. Here, form emerges through its own production. As White states, “*kairos* thus establishes the living present as point of departure or inspiration for a purely circumstantial activity of invention” (1987: 13). He refers to Gertrude Stein’s writing as an example of such ‘occasionality’, a form of “speculative thought alert to its own occasion” (Stein 1935: 180). Both ancient weaving and live coding operate through what White (1987: 14–15) describes as a *kairotic* “will-to-invent” that involves “adaption to an always mutating situation. Understood as a principle of invention ... *kairos* counsels thought to act always, as it were, on the spur of the moment” (1987: 13). The improvisatory principle of invention and intervention during the live process of weaving might correlate to what has been described as ‘loom thinking’ (Jefferies 2001), a process of decision-making performed through the live activation of tacit knowledge. Likewise within live coding, code is often written *as* it is performed; a practice often referred to as ‘coding on the fly’ or ‘just-in-time coding’ or what I would propositionally name ‘*kairotic* coding’ (Cocker 2014). To improvise within a given structure requires skillfulness and attention, a capacity for biding one’s time and knowing when and how to act. Here then, rules or coded instructions are not to be diligently followed but rather have the capacity to be modified or adapted even while they are being executed, the tension of an unfolding thread of weave or code varied as it is being woven/written, or else undone and rewoven, enabling the possibility of a change of tack.

The research challenge for the *Weaving Codes / Coding Weaves* project is not one of simplifying and streamlining the complex ancient weaving method through algorithmic means, but rather a quest for a modeling system capable of accommodating its complexity. The project involves a radical recuperation of a largely ignored relation between ancient weaving (as a mode of thought-in-motion) and computational thinking, emphasizing the epistemological connection between these two practices above the habitually foregrounded technical evolution of their respective hardware. Moreover, central to this reappraisal is an implicit subversion or even critique of the dominant utilitarian ideology that has come to be associated with technological development in the field of both weaving and coding. Rather than conceive the connection between weaving and coding through the prism of machinic mass-production and its privileged concepts of optimization, efficiency, productivity and standardization, the research emphasis within this project has been towards that which resists the standard template: technical processes that require the interweaving of multiple methods not possible to accommodate within standard mass production design; techniques involving the complex collaboration and co-operation between human and machine, moreover, that are predicated on the activation of embodied knowledge. Within both live coding and ancient weaving, the use of technology is based on knowledge of its specific affordances and constraints, which enable possibilities within a creative process rather than as a means for greater efficiency and utility, precision and speed. For Erin Manning and Brian Massumi, an “enabling constraint is positive in its dynamic effect, even though it may be limiting in its form/force narrowly considered” (2014: 93). In this sense, the tensions and resistances of a technology are not to be smoothed away in favor of greater productivity, but rather harnessed as integral to the process itself as a form of desirable leverage. Arguably, this principle of enabling constraints can be witnessed in examples of live coding where the novelty of seemingly complex programming environments are eschewed in favor of a more pared back, even restrictive, programming language. Both live coding and ancient weaving foreground an active rather than passive relation to technology; a more complex, nuanced or even entangled human/machine relation, where technology is not so much put to use as *worked with*, the process unfolding through attending to—even collaborating with—the resistance exerted by the technology or apparatus rather than conceiving it simply as a tool that needs to be brought under control, *mastered*. For example, this entanglement of body and technology becomes exemplified in the back-strap loom where the weaver’s body becomes part of the loom itself.

Rather than replacing or reducing the role of the human operator, the technologies used within both ancient weaving and live coding require heightened levels of dexterity, attention, cognitive agility and tactical intelligence. Creating the right tension—the process of improvisatory working within both practices emerges through cultivating an understanding of tolerance, how far something can be pushed or pressured before it breaks, indeed, when to instill breaks or rests. Practical knowledge of a working process enables it to be stretched and tested to its limits, whilst nurturing the necessary confidence that can support, accommodate and even welcome the unexpected resistances and contingencies that a particular method or material brings.

For Gilles Deleuze, the power to affect other forces—*spontaneity*, and to be affected by others—*receptivity* (1988: 60). Somewhere between spontaneity and receptivity, somewhere between control and letting go, somewhere between affecting and being affected: the weaver-coder navigates a course of action by intuiting when to yield to the rule or code or even the technology itself and when to reassert control, by knowing when to respond and when to interrupt. Rather than fully giving over responsibility to the algorithm's logic, within live coding and ancient weaving practices the weaver-coder consciously adopts a medial position, actively maintaining the conditions that will keep the unfolding of action dynamic. Hawhee conceptualizes the medial position of “invention-in-the-middle” as a *kairotic* movement involving “simultaneous extending outwards and folding back”; it is a “space-time that marks the emergence of a provisional ‘subject’, one that works on and is worked on by the situation” (2002: 18). My own wider research has considered this medial position in relation to other practices—the helmsman steering the boat, navigating the competing pressures and forces of the water and the wind, or else the artist-pencil drawing. Loom, like boat, like laptop—each an extension of human capacity, embodied prosthesis. Within these various practices, where does the capacity of body end and prosthesis/apparatus begin? Within live coding and ancient weaving, the working potential emerges somewhere between the embodied ‘know how’ of the operator and the resistances and affordances of the technology itself; moreover, in the capacity of the operator for converting the unexpected and contingent within a given process towards opportunity.

Within both live coding and ancient weaving, knowledge of the process is required before it can be truly experimented with, however, knowledge of the process is developed only through experimentation. A form of deep working knowledge developed then through use and experiment; tacit knowledge cultivated through the accumulation of trial and error, innumerable versions and iterations, tests and attempts. Whilst the residue of code from a live performance—like the instructional code retained within a weave—might allow for the possibility of repetition and reworking, both live coding and ancient weaving are somehow less about approaching the situation with a plan or design having been made prior. A *kairotic* practice is not one of ‘scripting’ in advance or designing from a distance; *kairos* involves the making of the situation at the same time as deciding how to act. A gap is made in the weave at the same time as deciding how (and when) to shuttle the thread through. A coding language is written simultaneous to its execution. A live and present practice then: the live toggling back and forth of the cursor and the shuttle, decisions made from inside the weave, from within the continuity of a process (a running code) rather than applied by as a process of design from without. The live running code/thread is modified through a process of imaginative adaption based on the principles of *what if*, through the testing of the possibility of *this* or *this* or *this* or *this*, the repeated labor of trying something out. Certainly, through practice it becomes possible to gain knowledge and understanding of a given process, however, within both ancient weaving and live coding the necessity and value of thinking-through-*doing* remains. The subtlest of modifications within the process—small changes to the organization of the thread or code—has the capacity for affecting unexpected change. By paring their technology back to basics, both practices

draw attention to these micro-movements in decision-making and action. Indeed, within both practices, unexpected effects emerge that cannot easily be predicted nor planned for in advance, that only arise through a live and physical manipulation of constants and variables within a working process. It is not always possible to anticipate the results of a given modification. For example, within ancient weaving the relation between structure and pattern is not always self-evident or predictable: the weaving of a spiral or meander pattern arises somewhat unexpectedly from variations made to a standard ‘tabby weave’ combined with twill weave, involving the alternation of the colored threads on the loom (Harlizius-Klück 2016: 761–763). The meander pattern emerges from interactions between the structure of the weave and the colors of threads that independently have no visual correspondence. Significantly, conventional notational systems for describing the organization of the heddles and lift plan give little indication of the resulting pattern. Within the *Weaving Codes / Coding Weaves* project, the development of various simulation prototypes (See Griffiths and McLean 2017) has enabled different color thread combinations to be tested without the need to physically weave them. Moreover, this digital weave rendering was underpinned by a live-coding ethos that retained the sense of experimentation through the testing and changing of functions and values in order to see ‘what happens if’.

Both live coding and ancient weaving operate at the threshold or meeting point between the prior knowledge of a process (what can be predicted or anticipated in advance); the tacit knowledge (an embodied ‘know-how’ activated in its performance), and a *kairotic* knowledge (a ‘know when’ yet arguably *known-not* knowledge that emerges simultaneous to—unique and in complete fidelity to—the emergent situation). Somewhere between the known and the not yet known, between the predictable and serendipitous, both live coding and ancient weaving demand a level of process fluency that comes only with practice. Each practice retains the desire to be surprised by unexpected combinations and possibilities arising from within a seemingly familiar language, receptivity to the potential for encountering something new. However, whilst the exploratory process of trial and error—the generative testing of *this* or *this* or *this*—appears central within both practices, knowledge of a process and how something works or is structured might also be acquired through the ‘undoing’ of an existing product, reverse engineering of a weave or code necessary for seeing the underpinning structure, not only the visual, surface pattern. Code and weave store a sense of their own process of production, procedural operations encrypted into the structure itself, each a representation or notation of its own making. Within the *Weaving Codes / Coding Weaves* project, parallel to exploring loom/computer prototypes to test out different weave configurations in virtual terms, there has also been a focus on understanding the weave structure through a physical handling of the fabric itself. For example, by scrutinizing different samples of dogtooth cloth—or even meander pattern—with magnifying glass and tweezers, it becomes possible to gain some understanding about the relation (often surprisingly complex relation) between the fabric’s visual pattern and its structure.

Arguably, this capacity for differentiating the pattern (visual appearance of a fabric) from the structure has an implicit political imperative or application, cultivating

awareness and a potential ability for discerning an essential sameness within certain options offered, for recognizing how certain choices are effectively cut from the same cloth. In one sense, this is the reality of neoliberal commodity culture, where an illusory sense of difference and choice is really the same basic offering colored (or marketed) in different ways. The politics of reverse engineering a product to better understand its structural principles can be identified within numerous live coding practices. Live coding is a practice known for its acts of appropriation, hacking and backtracking as a means of taking back control, or perhaps rather for *resisting* control, for reasserting the potential for creative improvisation within a seemingly standardized process, for recuperating human agency within systems whose options seem increasingly closed, prohibitive. In one sense, the revelation and live reworking of digital code through the performance of live coding involves showing and sharing the unfolding logic of a language so instrumental to contemporary life, but in which few are fluent. Both live coding and ancient weaving foreground an understanding of process and structure, refusing or even undoing the logic of a given, accepted model or concept in order for it to be reworked or modified. Here then, existing patterns, rules and codes are not to be taken as given (as fixed or unchangeable) but rather are to be appropriated as a found material with which to work, rework. A form of “creative consumption” (de Certeau 1984) or the cultivation of a “minor language or practice” (Deleuze and Guattari 1986) wherein the prescribed ‘codes’ and patterns of the dominant culture are appropriated (hacked), modified or inverted (creatively reverse-engineered), and then redirected towards other (often less utilitarian) ends. Not so much the Beckettian “fail again, fail better” model (Beckett 1999: 7)—a doing and undoing for reflecting a relation between utility and futility—but rather an affirmative *and* resistant practice.

A central figure within the *Weaving Codes /Coding Weaves* project has been that of Penelope, wily weaver of Ancient myth, wife of Odysseus in Homer’s *Odyssey* (Fig. 4 a - b). The ancient warp-weighted loom is sometimes referred to as a ‘Penelope Loom’ (for this is the kind of up-right loom that Penelope would have used in Ancient Greek times); indeed, Harlizius-Klück’s own research has involved demonstrating that this seemingly simple technology has the capacity for weaving the complex designs depicted in various imagery related to the Homeric tale.



Plaster cast of Penelope (foreground) alongside Artemis (Plaster cast of The Diana of Versailles, a Roman copy a Greek sculpture by Leochares), at the Museum für Abgüsse Klassischer Bildwerke (Museum for Plaster Casts of Classical Sculptures), 2015. Photography: Emma Cocker.



Fig. 4 b. Plaster cast of Penelope (background) alongside a reconstruction of a Penelope loom within the frame of Ellen Harlizius-Klück's exhibition, *Textile Matrix*, at the Museum für Abgüsse Klassischer Bildwerke (Museum for Plaster Casts of Classical Sculptures), 2015. Photography: Ellen Harlizius-Klück.

By way of a brief précis, in Homer's *Odyssey*, when Odysseus fails to return from his travels, his wife Penelope is put under pressure to re-marry. However, she manages to initially resist the advances of her various suitors, stating that she will only marry once she finishes weaving a burial shroud for her father-in-law. Penelope weaves the shroud by day, whilst by night she unweaves, willfully undoing the work such that by morning the task might begin afresh. Hers is an act of weaving and unweaving to avoid the completion of a task, for refusing the teleology of outcome or commodity, of a product and its consequences. For Penelope—the stakes of whose weaving were indeed quite high—the practice of unweaving and reweaving was performed as an act of quiet resistance, so as to thwart the terms of a situation from which there would seem to be no way out.

Certainly, the act of doing and undoing

within both live coding and ancient weaving might be undertaken as a device for repetition, for generating the embodied knowledge that comes from a process *practiced*, cultivation of the art of knowing *when* as much as how. However, drawing on the Penelopean exemplar, the repeated act might also be conceived as more than just a means for understanding how a process works, and performed instead as a mode of deviation or subversion, of purposefully non-productive labor intent on resisting the pressure of commodity or completion. For the contemporary live coder, this process of resisting the teleology of a completed product might be conceived as an attempt to thwart or subvert capture by capital, refusing the terms of easy assimilation. Indeed, for some live coders, a commitment is made to the periodic deletion of source code, emphasis placed on a practice of starting from scratch. This emphasis on the non-utilitarian, non-productive and non-bankable aspects of both code and weave arguably has a political imperative, operating as a critique of the habitual instrumentalism of certain technological developments, which in their privileging of efficiency and optimization, effectively delimit unexpected creative possibilities by eliminating the potential for accident, chance and contingency within a given process.

In developing various kinds of digital procedural weave rendering, the focus within the *Weaving Codes / Coding Weaves* project has not been one of making the process of ancient weaving more efficient or productive, by speeding up the decision-making activity, eradicating the time-consuming necessity of physical experiment, the repeated act of doing and undoing weave on the loom. In fact, some of the simulations have even reflected a sense of Penelopean labor, the privileging of incompleteness and of the unresolved therein. In one simulation example, an untethered digital weft of a very limited length is used for testing the results of various notational weave patterns, where the unfolding weave is made visible but never remains as a 'product'. As the weave is woven at the bottom of the simulation screen it is simultaneously unwoven at the top. In one sense, this research project emphasizes the sense of code and weave as verb rather than as noun, drawing attention to the process, performance and play within weaving and coding (and the modes of knowledge and intellectual movements operating therein) rather than privileging the resulting artifact. A Penelopean 'doing-undoing-redoing' akin to the Deleuzian conceptualization of *plier/déplier/replier*, where the act of folding, unfolding and refolding "no longer simply means tension-release, contraction-dilation, but enveloping-developing, involution-evolution" (Deleuze 2006: 9). Not the repetitive practice of sameness then, but rather one of attending to difference, to the potential twists, variations and permutations of the thread or code. For Barbara Clayton, the Penelopean poetics of weaving and unweaving are generative, where "undoing does not signify loss or nullity, but rather life affirming renewal and the constant possibility of new beginnings" (2004: 124). Moreover, she argues that there is an inherently feminist politics and poetics to the Penelopean emphasis on process: "Penelope's web is first and foremost a process, i.e., weaving in order to unweave in order to reweave. And as a process, it participates in a network of ambiguities that undermine stable and fixed meaning" (Clayton 2004: 39). According to Clayton, "ambiguity and multiplicity are marked by the feminine in the sense that they undermine a system based on an absolute binarism in which one term must define itself by negating its opposite, a system which functions through the suppression of difference" (2004: 40). Indeed, for Hélène Cixous, upon whose writing Clayton draws, "a feminine textual body is recognized by the fact that it is always endless, without ending: there's no closure, it doesn't stop, and it's this that often makes the feminine text difficult to read" (Cixous 1981: 53). Referencing both code and weave, Luce Irigaray also reflects on the challenge of the 'feminine textual body' to certain kinds of logic when she states:

Contradictory words seem a little crazy to the logic of reason, and inaudible for him who listens with readymade grids, a code prepared in advance [...] One must listen to her differently in order to hear an 'other meaning' which is constantly in the process of weaving itself, at the same time ceaselessly embracing words and yet casting them off to avoid being fixed, immobilized (1980: 103).

The Penelopean reference also draws attention to a further quality of intelligence operating within both live coding and ancient weaving, related closely to the *kairotic* principles of timing and timeliness, of invention and intervention. In addition to mental

skill, dexterity and tacit knowledge, Penelope's subversive act of weaving and unweaving demonstrates a certain resourcefulness, ingenuity or even cunning, a form of wily intelligence referred to in Ancient Greek terms as *mêtis*. As Clayton states, "Penelope's web trick, which is her opportunity to weave *mêtis*, is predicated on a literal reversal as she passes her shuttle through the warp threads in reverse, walking back and forth before her loom at night, retracing her steps to return to the point at which she began her day's weaving" (2004: 32). For the Ancient Greeks, the term *mêtis* described a form of practical, cunning or skillful intelligence capable of seizing the opportunities (*kairos*) made momentarily visible as the prevailing logic within a given structure or system yields. Akin to Clayton's description of Penelopean poetics, Marcel Detienne and Jean-Pierre Vernant reflect on the role of this wily intelligence within Ancient Greek rhetoric and society, outlining the field of *mêtis* as:

(A) world of movement, of multiplicity and of ambiguity. It bears on fluid situations which are constantly changing and which at every moment combine contrary features and forces that are opposed to each other. In order to seize the fleeting *kairos*, *mêtis* had to make itself even swifter than the latter. In order to dominate a changing situation, full of contrasts, it must become even more supple, even more shifting, more polymorphic than the flow of time: it must adapt itself constantly to events as they succeed each other and be pliable enough to accommodate the unexpected ([1978] 1991: 20).

Harnessing the properties of dexterity, watchfulness, sureness of eye and sharp-wittedness, they argue that *mêtis* "attempts to reach its desired goal by feeling its way and guessing"; it is a "type of cognition which is alien to truth and quite separate from *episteme*, knowledge" (Detienne and Vernant [1978] 1991: 4). Detienne and Vernant describe *mêtis* as a "state of vigilant premeditation, of continuous concentration on activity that is in progress" ([1978] 1991: 14). They assert that *mêtis* involves:

(A) type of intelligence and of thought, a way of knowing; it implies a complex but very coherent body of mental attitudes and intellectual behavior which combine flair, wisdom, forethought, subtlety of mind, deception, resourcefulness, vigilance, opportunism ... It is applied to situations which are transient, shifting, disconcerting and ambiguous, situations which do not lend themselves (Detienne and Vernant [1978] 1991: 3-4).

For Detienne and Vernant, *mêtis* is inherently tactical; it is the art of preparing for what could not have been anticipated or planned for in advance, "where every new trial demands the invention of new ploys, the discovery of a way out (*póros*) that is hidden" ([1978] 1991: 21). Along with the hunter and angler, the carpenter and navigator, the "backtracking of a fox and the polymorphism of an octopus" (Detienne and Vernant [1978] 1991: 2), the figure of the weaver exemplifies the properties of 'cunning intelligence', with the concept of *mêtis* finding expression in "anything that is twisted together, woven, plotted, arranged or contrived" (Detienne and Vernant [1978] 1991:

115). However, in spite of its pervasive presence within every area of Ancient Greek life and thought, Detienne and Vernant observe how,

(A) type of intelligence and of thought, a way of knowing; it implies a complex but very coherent body of mental attitudes and intellectual behavior which combine flair, wisdom, forethought, subtlety of mind, deception, resourcefulness, vigilance, opportunism ... It is applied to situations which are transient, shifting, disconcerting and ambiguous, situations which do not lend themselves (Detienne and Vernant [1978] 1991: 3–4)

My reflections on the *Weaving Codes / Coding Weaves* project attempt to draw attention to and re-assert a value for those *other* modes of thinking and knowing operative within practices such as live coding and ancient weaving—tacit knowledge, sensuous knowledge modeled on experienced continuity of process rather than discontinuous abstraction, ‘not knowing’, the value of trial and error and of ‘feeling one’s way’, even *kairotic* and *mêtic* forms of intelligence—that have been habitually eclipsed or even marginalized by a knowledge economy that favors a form of abstract, rational logic; moreover, the principle of ‘knowledge exchange’ where knowledge is something that can be transmitted, traded and ‘banked’ as a product, rather than activated as a live and embodied process. Drawing on my role as project interlocutor, my own research interest has focused on how live coding and ancient weaving might display the properties of *technē*, a species practical knowledge combining the principles of both *kairos* (opportune timing) and *mêtis* (cunning intelligence). Here, *technē* is not used in its habitual sense, where it is taken to simply mean the skillful art of *making* and *doing*, the technical facility of craftsmanship. Making a return to how the term was used within Ancient Greek culture, *technē* can be conceived as a disruptive—even subversive—kind of tactical knowledge, capable of dealing with contingent situations and fully harnessing their capricious force (for example, a knowledge capable of seeing and seizing the potential of chance, randomness and indeterminacy and converting this towards unexpected direction). Janet Atwill notes how *technē* refers to a particular mode of ‘knowing’ or *art* capable of responding to situations that are contingent, shifting or unpredictable, in order to affect a change of balance or power by steering the direction of events through wily—even somewhat deviant—means rather than through force. For Atwill, *technē* often emerges at the point “when a boundary or limitation is recognized, and it creates a path that both transgresses and redefines that boundary” (1998: 48); it “deforms limits into new paths in order to reach—or better yet, to produce—an alternative destination” (1998: 69). The aim of *technē*, she asserts, is to “transform the ‘what is’ into ‘what is possible’” (Atwill 1998: 70). Indeed, the *Weaving Codes / Coding Weaves* project attempts to redefine the relation between weave and code, transforming understanding of both the past and the future of these two practices, by dislodging the dominant utilitarian histories that connect computer and the loom, and instead placing emphasis on the potentially resistant and subversive forms of live thinking and knowing cultivated therein.

Word Count: 8355 excluding abstract, biography and references.

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Figs. 1 a – 1 c. Documentation of workshop by Dave Griffiths, Ellen Harlizius-Klück, and Alex McLean at the Centre for Participatory IT, Aarhus University, 2014. Photography: Emma Cocker.

Figs. 2 a – 2 c. Documentation of residency at the Museum für Abgüsse Klassischer Bildwerke (Museum for Plaster Casts of Classical Sculptures) Munich, 2015.

Figs. 3 a – 3 c. Documentation of residency at FoAM Kernow, Cornwall, 2015.

Photography: Emma Cocker.

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Fig. 4 a. Plaster cast of Penelope (foreground) alongside Artemis (Plaster cast of The Diana of Versailles, a Roman copy a Greek sculpture by Leochares), at the Museum für Abgüsse Klassischer Bildwerke (Museum for Plaster Casts of Classical Sculptures), 2015. Photography: Emma Cocker.

Fig. 4 b. Plaster cast of Penelope (background) alongside a reconstruction of a Penelope loom within the frame of Ellen Harlizius-Klück's exhibition, *Textile Matrix*, at the Museum für Abgüsse Klassischer Bildwerke (Museum for Plaster Casts of Classical Sculptures), 2015. Photography: Ellen Harlizius-Klück.