(Re)collecting Craft: Reviving Materials, Techniques, and Pedagogies of Craft for Computational Makers

AMY CHEATLE, Cornell University, USA
STEVEN J JACKSON, Cornell University, USA

This paper examines craft's foundational relations to materials, techniques, and collaborative modes of teaching and learning, and these can be called upon to strengthen and extend computational craft as practiced in fields like CSCW and HCI. Drawing from literature in HCI, craft studies and Science and Technology Studies (STS), we explore craft's modern formation at the dawn of the Industrial Revolution across three formative sites: Scandinavian Slöyd, British Arts and Crafts, and Japanese Mingei. From this review we identify three key (and still evolving) features: craft's accountabilities to natural materials and local ecologies; craft's holistic ways of making with 'head, heart, and hand'; and craft's distinctly collaborative and embodied styles of teaching and learning. We then show how these lessons can be applied to contemporary practices and pedagogies of computational making. We argue that doing so can help to rebalance computation's ecological ties and relations, recenter its practice on a sensorially rich and 'whole-self' concept of making, and support more collaborative modes of teaching and learning that are inclusive, relational, and heterogeneous.

CCS Concepts: • **human-centered computing → Human computer interaction (HCI) • HCI theory → concepts and models**

Additional Key Words and Phrases: craft and computation; craft studies; collaboration; history;

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1 INTRODUCTION

Within CSCW and HCI, a small but growing community has investigated the fruitful and complex intersections between "craft" and "computation". Generative work in this area reflects on and sometimes pushes against dominant modes of computing and data work, often invoking craft to counter computational tendencies and ideologies towards obsolescence, abstraction, and ubiquitousness, while working towards more material, embodied and richly collaborative forms of work. This research has often sought to surface neglected and craft-like dimensions of computing itself. It has also generated new craft-based lessons and insights (including speculative and alternative ones) that might change, reimagine, or even revive elements of computational practice.

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Getting "hold" of craft – a malleable, complex, and even contradictory concept remains a difficult endeavor [1]. Accountings of craft vary widely and show a range of disparate connections built around a loose assemblage of "largely disconnected… activities, programs, and pedagogies" [83]. Craft has historically been associated with the use of and unique qualities assigned to natural materials [91]; techniques of handwork [94]; collaborations in small-scale workshops [19]; and the careful handing down and continuation of skills over time [44]. As the cases below will suggest, like many other forms and activities (mis)positioned as 'traditional' [87], craft also has a long, complicated and by no means straightforward relationship to industrial modernity.

Computation is no less complicated. It is simultaneously pervasive, ubiquitous, or in the palm of our hand at once. While its history is rich with stories of small-scale manufacture, experimentation and ingenuity [42] these can be lost in larger narratives that emphasize its more abstracted nature, rooted in mathematical calculations and information theory [68]. Computational artifacts anonymously produced in mass – like tablets, laptops, and other personal devices hide composite inner workings which in turn facilitate a kind of 'forgetfulness' (what Wakkary [111] describes as 'anti-biography') that obscures the fundamentally earth-bound nature of computational materials and the work, both artful and destructive, by which these are processed and assembled. These inclinations towards abstraction and disembodiment are reflected in computational conceptions of the human itself and cognitive and sensory hierarchies – mind over body, eyes over hands [76] – that limit who might participate in and what might count as computing work. Like craft, computation carries its own propensities, many (but not all) of which surround speed, temporality, and durability [49] expressed in designs for forced obsoletion [15] or increasingly shorter and more disruptive cycles of innovation [27].

Given these histories, there are two central dangers that can arise when computational practitioners seek to engage and learn from fields of craft. One of these is the danger of 'computationalizing' craft, leaning into a rationalized and deconstructed sense of craft that strips away its distinct power, intent, and relational nature. A second is the danger of freezing and exoticizing craft, locking it into an ahistorical notion of 'tradition' that denies the dynamism and suppleness of craft practices (including their ability to grow and change in response to the changing conditions of the world). With these in mind, we draw from scholarship in HCI and craft studies to explore the lines and processes, tensions, and overlaps by which craft and computation have met. Following recent arguments for the utility of a "historicist sensibility" in CSCW [97] we suggest how lessons drawn from much earlier (and very *un*computational) fields of craft can nevertheless show up patterns and commitments that can help inform the understanding and practice of computing and collaborative work today. Drawing on the examples of Otto Salomon at Nääs and Scandinavian Slöyd (orig circa 1865), William Morris at Merton Abbey and British Arts and Crafts (orig circa 1870), and Soetsu Yanagi at Onta and Japanese Mingei (orig circa 1920), we draw three core lessons.

First, we argue that craft's accountabilities to local *materials and ecologies*, can be used to reimagine how computation might deepen its own relations and responsibilities to natural and material worlds. Second, we show how the *techniques* of craft – and the figure of the *embodied craftsperson* (as mindful, affective, and embodied) can act as an alternative or extension to computing's dominant discourse and emphasis on *thinking* – or an often reduced or disembodied notion of cognition. Finally, we explore *teaching and learning* in craft, and show how its situated, intergenerational, and practice-based character can provide a broader conception of HCI education and collaborative work. We conclude each provocation with imaginings and caveats for a more balanced and informed arena of computation as both a large-scale enterprise and as a more intimate, creative, and collective endeavor.

2 CONVERSATIONS IN CRAFT AND COMPUTATION

2.1 From Computation to Craft

Computation has explicitly drawn on craft in important ways. A first area of convergence explores material and hybridity, [83] where time-honored media such as ceramics [89], wood [70] [[77] [9] [107], and textiles **Error! Reference source not found.** [25] enjoin with more computational materials – including sensors, electronic components, and code and data streams – to formulate novel, hybrid material composites. Composites as hybrids have a "strange" existence, in-between the "material and the immaterial". They bring data and algorithms together with other material's "tensile properties, optical properties, electrical properties, thermal properties and insulation, acoustic properties, deformations, deterioration, appearance, and so forth" and are animated by (and require) voltage, for their liveliness [106]. Composites can spark new communication or sensory channels [9] [68]. Hybrid-lace for example entangles earth-grown fibers with electrical connections [36] to create a wearable 'second skin' capable of transmitting visual, haptic, auditory, olfactory [2] [[23] [112] or other biomedical signals through the weave. Natural materials bring their own properties and propensities that can "soften" or even conceal computational powers and processes. Wood for example, can improve the integration or 'disappearance' of hybrid objects into everyday household life and rhythms,[1] and contribute to a temporal 'slowing' of technology that contests wider patterns of acceleration, unreflectiveness, and disposal [70]. Our long experiences repairing and restoring natural materials also creates space for sustainable computing [35] and material and ethical approaches to data work [53] [65].

Other work in HCI operates at the level of practice, tools, and techniques, and explores changing modes of production. This includes investigation into "push-to-print" technologies that augment or replace handwork such as drawing, carving, shaping, spinning, weaving, forging, and forming [14]. Computer numerical control (CNC), computer-aided design and manufacturing (CAD/CAM), 3D printing and rapid prototyping reduce risk, tedium, and the time spent on laborious, repetitive tasks and provide new opportunities for design, reproduction, and creativity [18]. These techniques also reduce (or erase altogether) important and embodied connections to tools and material that support affective, adaptive, and intellectual modes of engagement, crucial feedback loops between body and material that have long been central to craft [103]. To reduce this gap, Van der Veen [107] conceptualizes machines that enhance (rather than overwrite) craft-like propensities such as resistance and ambiguity. Devendorf and Rosner **Error! Reference source not found.** reimagine CNC machines that are directed by the movements and forces of the wind rather than by predetermined code that limits chance and accident.

Finally, a third area of focus centers on craft-inspired collectives and pedagogies, exploring the myriad ways that craft and computation can bring people (and other living beings) together [21] [81]] [85] [[88]. Rosner and Ryoki [88] strengthen and enhance interpersonal relations by extending craft circles into *hybrid* craft circles. In small social groups, they weave digital audio messages into handmade knits often made for gifting to loved ones. Ratto [85] guides small groups of learners through the collaborative imaginings and constructions of novel, networked artifacts designed to push back against dominant infrastructure. And Devendorf et al [21] extend collaborative making to include non-human species, relying on the hard work of hungry moths who subsist on the very cotton and woolen materials that are used by human makers.

In terms of teaching and learning, explicit efforts in pedagogy call on and develop craft-like ideologies such as self-reliance, collaboration, and skills development. This work often draws on

[1] Though in potentially intrusive ways that can hide, disguise, or add ambiguity to their in-home functionality [75]

a constructionist pedagogy, where learning is contextual and based on pre-existing knowledge, skill, and cognitive models that help learners make sense of the world [71]. Alternative spaces such as FabLabs, Makerspaces, and distributed online communities provide learning spaces for human interaction and the transmission of knowledge forged through making. Gershenfeld [28] envisions these as revolutionary" DIY settings that align small-scale fabrication and rapid prototyping with personal and transformative learning. These spaces attract and unite all skill levels, from the beginner to the creative and accomplished expert amateur [73]. Blikstein and Krannich [11] highlight makerspaces as locations where a fluency in computation can develop as a kind of practical know-how crucial for all citizens. Through undirected and unpredictable messing about with tools and materials - including computational ones - learners can develop familiarity, comfort, and new lines of creative questioning [85]. Bean and Rosner [7] extend these concepts into digital spaces, arguing that teaching and learning need not occur in the same physical location. Digital apprentices can be widely distributed and yet, via internet technologies, still connected and engaged in the same workshop in order to collect, archive, and even disperse heritage craft technique. This approach can also influence more formal academic settings of computational teaching, suggesting alternatives to rote and individually centered techniques by which large-scale introductory programming is often taught [116]. Vihavainen [109] proposes a method of learning-by-doing that introduces students to a cognitive apprenticeship that situates learners alongside of master programmers. Proximity to practice-based, real-world encounters encourages learners to experience the spirit or culture of the discipline in more open-ended or improvisational ways [38].

2.2 From Craft to Computation

Parallel and in some ways inverse discussions have been raised by craft scholars and practitioners exploring the perils and possibilities of computation's entry into worlds of craft. Here a fundamental tension arises between the kinds of materialities central to both fields. Craft's primary materials sourced from and tied to the natural world are already "alive" in their own way. Wood, argues Baudrillard, has its own "being". It "draws its substance from the earth, it lives and breathes and 'labours'. It has its own odour, it ages, it even has parasites" [6]. These materials can surprise, resist (even at the risk of romanticizing, enchant) the craftsperson. Through their handling they invoke ways of thinking *through* their "...essential physical sensuousness" [40] via a richly phenomenological experience with the world.

When held against materials like wood, clay, or wool, computational materials can (though not always) seem less sensuous, curiously distant and abstracted, and unrooted from time and place. As hardware, they await electricity to come alive. As software or information flows, they seem "immaterial", untouchable, and phantom. Shaping this class of digital material might require high levels of know-how in abstract computational or engineering thinking. Exploring or "messing about" (as potters are wont to do with clay, or carpenters with wood) seems unlikely or untenable without complex ensembles of tools and utilities. Digital craftspeople argue that code is not as immaterial as some might think. Harrod [32] reduces distinctions and contradictions between longstanding craft and new digital materials. Code, like clay, also "pushes back" against the digital artisans who shape it, and varieties of software (like varieties of wood) can lend themselves to particular pursuits and outcomes. Software may exhibit certain qualities, or atmospheres, that reveal recognizable and distinct visual patterns and material sensations that a trained eye can identify. Gershenfeld [28] shows that digital objects reveal their own unique kind of fluidity and flexibility, a flow of variation which can be infinitely enlarged, stretched, shrunk, deepened, or flattened. One can learn the “feel” of digital materials and develop new forms of intimacy with them - even if they are, by nature, more visual, conceptual, abstracted, and largely disconnected from the body [54].

Craftspeople like Bruce Metcalf [55] and Richard Sennet [94] find the “unreachable” character of these materials to run counter to craft’s reverence for the ‘hand’ and ‘human touch,’ a stand-in describing a kind of intimate and embodied knowing, a tacit knowledge [33] [71] [68] [4] [81] that once displaced, can leave us off-balance. The Bauhaus weaver Anni Albers [32] explains; “*we touch things to assure ourselves of reality.* We touch the things we form. Our tactile experiences are elemental. If we reduce their range, as we do when we reduce the necessity to form things ourselves, we grow lopsided”.

Elsewhere, attention has shifted away from the tacit knowledge of the individual and onto a knowledge shared by and transmitted within a group or collective. Von Busch [17] calls this collaborative way of knowing and cooperative style of work the “bodyhood” of craft; an endeavor with its own unique relations and commitments that includes the training of young practitioners. Galley [26] describes similar social relations as central to the “spirit” of apprenticeship, discussed by Lave [45] as non-linear pathways and peripheral practice (cleaning, organizing, and getting the “feel” for materials) that lead up to more central tasks of production and making. Lancy notes the infrequency of “actual teaching” by master craftspeople, reporting the core of apprentice pedagogy as “...careful observation, imitation, trial and error, and practice for improvement of skill and speed” [44]. Learning craft is described as an imparted knowledge, only “acquired by contact with one who is perpetually practicing it” [69].

As shown above, the intersections between craft and computation are complex (whether real or imagined) and not always so easy to parse (nor do they need to be). But the exercise is a useful one. Craft and computation each come to us with their own unique social worlds [8] - ethos, animating stories, and practices - that if we let them, can help drive and direct both individual and collective forms of work. CSCW has rightly turned towards and engaged with craft on multiple levels and in powerful ways. For the most part, the histories and originating principles of craft have remained underexplored and underutilized. This absence guided our questions; how might HCI build on its existing work while invoking craft in new ways? What other associations, relations, and interdependencies arise from the points of contact we have discussed above? And, what artful connections remain unexplored and uncollected when the roots of craft remain unearthed?

3 CRAFT HISTORIES

To help answer the above questions we bring forward three historical and defining moments in craft. We focus on the work of Otto Salomon at Nääs and the development of Scandanavian Slöyd (orig. circa 1865), William Morris at the Merton Abbey and the British Arts and Crafts (orig. circa 1870), and Soetsu Yanagi at Onta and Japanese Mingei (orig. circa 1920). We show a deeper set of (inter)relationships, kinships, and accountabilities to natural materials and local ecologies, craft’s originating emphasis on a balanced approach to making using the “head, heart, and hand” in unison, and collaborative and collective practices of work that include an integrated process of teaching, learning, and training. We then show how each can inform HCI craft in particular, and computer supported collaborative work in general.

3.1 Otto Salomon at Nääs, and Scandinavian Slöyd (orig circa 1865)

The roots of Educational Slöyd lay in Finland circa 1865 with the teachings of Uno Cygnaeus, who answered the charge of creating the first, purely Finnish, system of education [24]. Cygnaeus's reformist pedagogy centered on handwork, and was grounded in the ways of domestic living and agrarian lifestyles. Students were taught to make use of the nearby woodlands to carve and piece together wooden utilitarian objects - keeping their small hands (and minds) occupied during long, dark winter months, a scene described by historian Charles Bennett; *"The father and sons, with a few simple tools, would work in wood, making ax helves, hammer handles, rakes, pins for yokes...benches, tables, forks and spoons...Thus it was that instruction in skill, art, and patriotism was given, and discipline maintained in the home"* [10]. The development of Educational Slöyd within the schools was meant to bolster Finnish traditions waning in the face of industrialization "*...not for training vocational skills"* of children, but for *"waking up and developing children´s individual abilities with versatile handicrafts and emphasizing both industrial and religious moral basis"* [10].

Following the work of Cygnaeus, Swedish Educator Otto Salomon embraced Slöyd in the classroom as a means for replacing oral recitation and student's "thoughtless" copying of learning exercises. He too drew upon time-honored material practices rooted in the local environs, a learning-by-doing situated in place [115]. Nothing, argued Solomon, "*...was so well adapted as wood for the purpose of formative education*" [93] for Sweden's smallest citizens. Slöyd was a unique pedagogy of making, one whose "*...sole use is development of the mental, moral, and physical forces of the child*". The making begot the maker in a kind of reciprocal relationship; "*We cannot*" he continued *"... train in habits of respect and love of labour, of attention, order, and the like, without at the same time giving a knowledge of, and a dexterity in, the use of tools; but this is accidental rather than essential*" [93]. Salomon drafted the aims of Slöyd:

The formative aims:

1. To instill a taste for, and a love of, labour in general.
2. To inspire respect for rough, honest, bodily labour.
3. To develop independence and self-reliance.
4. To train in habits of order, exactness, cleanliness, and neatness.
5. To train the eye and sense of form. To give a general dexterity of hand, and to develop touch.
6. To accustom to attention, industry, perseverance, and patience.
7. To promote the development of the physical powers.

The utilitarian aims:

8. To directly give dexterity in the use of tools.
9. To execute exact work [93].

For 2 hours a day 6 days a week, the school classroom became the workshop for both boys and girls aged 11 and up. The walls of the shop were arranged with Slöyd models and 2D drawings, examples to help guide student's work. Each student was responsible for their own tools and cleaning up after themselves. Assignments began simply with the construction of a Kindergarten pointer and progressed in a pedagogical order, growing in complexity to include hinged cabinets, tables, and hooped baskets. The models required exercises to be mastered by students (see fig. 1-2) so as to "*secure the constant and proportionate development of mind and body...such that each should prepare for the next; not only physically but mentally* [93]. "*It is obvious*", argued Salomon;

1. That the first exercise is the easiest of all the exercises.

2. That between the first and second exercises no easier series of operations can be arranged.
3. That any given exercise is, generally speaking, harder than the preceding, and easier than the succeeding ones.
4. The exercises, then, form the foundation for the models, and not the models for the exercises. The models are but expressions of the principles, and in themselves are not Slöyd; and we shall do well if we can abstract the models in thought and regard the series merely as a list of exercises [93].

Salomon advocated for full sensory training and teaching proper tool handling. This would enable students to "*...acquire the knowledge as to the degree of order, accuracy, neatness, and exactness required of them"*. Such learning was foundational and in opposition to classroom learning; "*...the pupil derives great advantage from the constant use of his faculties of observation and perception through both sight and touch. This he cannot do so well when he sits a passive and patient listener to the dogmatic instruction of the teacher. In the former case every sense is quickened, and the pupil seems alert at every point. In the latter, one faculty – perhaps more – is being employed but the teacher cannot be sure of even one"* [93]. This gave way to adopting techniques of the body in special relation to tools, materials, and somatic expressions like motion or exertion. Salomon explained how a student, "*...observes how the teacher handles the wood and manipulates the tool, and notices the position of the body, or any part of it, in relation both to the tool and the model itself. He estimates at the same time, as far as he can, the amount of force required to execute a certain movement or perform a definite amount of work, and so on*" [93]. He considered woodwork a kind of gymnastics and trained his teachers to pay particular attention to the alignment of head, chest, and feet to tools and workbench, as well as the best ways to overcome resistance during woodwork. He emphasized this point reminding that children consist, "*not of soul alone but of body*" [93].

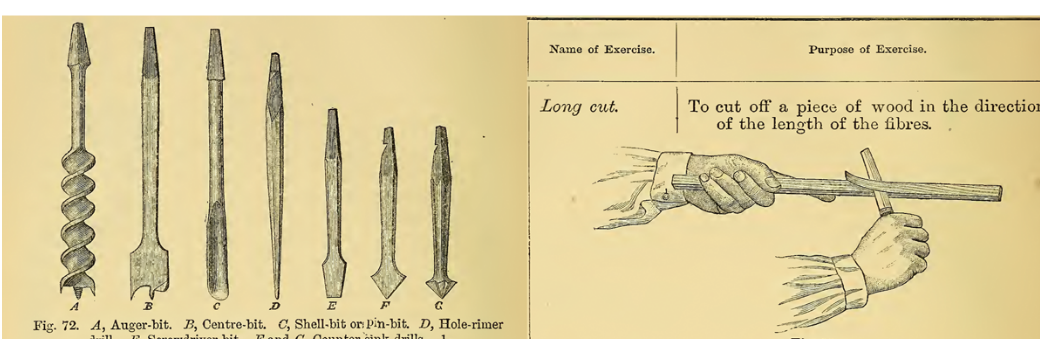
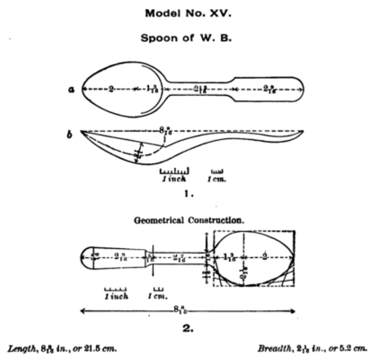


Fig. 1 Illustrations of tools and exercises [10]

Training the whole child nurtured their interdependence. "*It is of great importance that the teacher abstain from rendering actual assistance on the work itself. Better even that children spoil the objects they are making, than that the teacher do part of the work*" [93]. After the initial training, help provided along the way was minimal, as "*one or two helpful suggestions"* rather than *"too minute instructions,*" as it was "*...very important that children should think and judge for themselves and not the teacher for them*" [93]. Students chose their own approach to making and they alone decided when a work was finished. Soloman believed such a process avoided thoughtless, manual labor, as every Slöyd student *"...must work and think about his work- a Slöyder cannot be an Automaton*" [93].



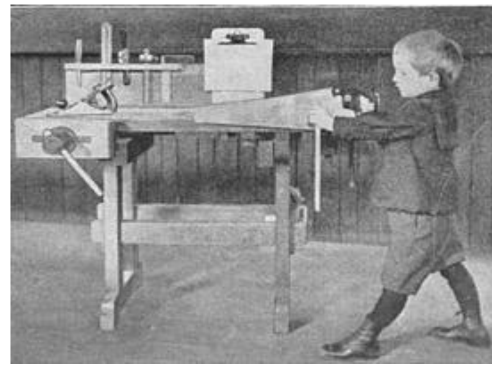


Fig. 2. working from drawings Fig.3 Proper sawing position [10]

While the crafting of Slöyd objects was meant to develop children into ideal citizens, the Slöyd aesthetic was rooted in utility. "*If a beautiful object serve no useful purpose, it is, from an aesthetic point of view, incorrect. Beauty in Slöyd must be subordinated to serviceableness*" [93]. Ornamentation was seen to invite dishonesty while decreasing utility; "*If a ladle be elaborately carved in the handle or on the bowl, and its utility thereby diminished, it is more difficult both to use and to keep clean...From an educational point of view it is very bad for the children to carve such objects as they have not accurately made themselves; for it discourages respect for rough work, and instils into the children a desire to decorate objects rather than to make them. This is a very bad fault... if an object be badly made, to encourage children to try to hide its defects by carving is to put a premium on dishonesty. It is morally bad and dangerous; it teaches children to conceal and throw dust in the eyes of others*" [93].

Over time the theory and practice of Educational Slöyd made its way around the world, influencing a line of pedagogy ranging from American pragmatist John Dewey [115] to more contemporary educators - even computational ones [33]. Yet it is through reviewing Slöyd (however briefly and partially) through its foundational texts that an origin of craft and its crucial relations begins to take shape. One key relation seen above is the significant and formative role played by natural materials used in the workshop, and how wood from the local forests shaped not only household objects but moral, cultural, and national identities alike. During an era of early automation and urbanization, Slöyd tied identity to woodcraft. Another important element seen above is Slöyd's relation to the whole child; and the importance of developing their "*mental, moral, and physical forces*" at once. Here learning was tied not only to the child's intellect, but to their body and their wellbeing. It was through the handling of tools, the sensing of oneself and environment, and the movement of the body in the workshop that a child "*woke up*" from the rote memorization of facts taught in the classroom. "*Automatons*" they were reminded, were not welcome.

Finally, students were acknowledged to be capable and independent learners in charge of their own making and development. A process of continuous learning and betterment was modeled through a kind of scaffolded practice, where learning was always on-going and open-ended, and resulted in objects meaningful to their own world. Learners crafted real-world objects, made through real-world work.

3.2 William Morris, Merton Abbey, and the British Arts and Crafts (orig. circa 1870)

Our second case draws on the British Arts and Crafts movement explored through the work of craftsperson William Morris [1834-1896] and his collaborators at the Merton Abbey workshops. Together they revived and reanimated multiple "lost" craft techniques, one of which was dyeing with plant-derived materials, [50] a process that had been replaced with industrially derived aniline dyes made from tar-coal. Morris aligned his practice and workshop as an economic and aesthetic alternative to modern industrialization, juxtaposing his work in opposition to newly manufactured materials and processes, alienated labor, and fragmented, often deskilled, work [79]. Around him new forms of consumerism and industrial production led to "*sham materials and sham techniques*" as well as an art disconnected from the everyday, that "*no longer had any root*" [50]. As Morris was coming of age as a craftsperson, commodities were rapidly becoming the cult objects of progress, "*a religion born in the 19th century*" [13]. Advocating for labor he warned the craftspeople of his era, "*...don't let yourselves be made machines or it is all up with you as artists. Though I don't much love the iron and brass machines, the flesh and blood ones are more terrible and hopeless...* [63]. Morris' craftwork was also political work, at times inseparable from his own unique formula of Socialism [105]. As such, craft (read below as art) was not a "pure" esoteric pursuit undertaken by a solely inspired genius, but a relational and material practice, situated and grounded. "*It is not possible"* says Morris, *"to dissociate art from morality, politics, and religion...talk of inspiration is sheer nonsense...there is no such thing; it is a mere matter of craftsmanship*" [80].

He let his sentiment be known through both lectures and written work and more pragmatically, by the ways in which he operated his firm at the Merton Abbey – a large workshop and dye house on the Wandle River just outside of London. He relied on the local flora and fauna for dye ingredients, and his materials were treated as "honestly" as possible. He explained, "*I have tried to produce goods which should be genuine as far as their mere substances are concerned, and should have on that account the primary beauty in them which belong to naturally treated natural substances: have tried for instance to make woollen substances as woollen as possible, cotton as cottonny as possible and so on: (all this quite apart from) have used only the dyes which are natural & simple, because they produce beauty almost without the intervention of art* [39].

At the shop it was observed that, *"[N]othing is manufactured ... except by hand. No machine-power is used, either steam or electric, but implements of the simplest construction, the most primitive in kind, the old tools, the old handicrafts of four or five centuries ago*" [105]. For all his reverence for the past, Morris attempted to dampen down any romance with it. "*Do not misunderstand me...I am not a mere praiser of past times. I know that in those days of which I speak life was often rough & evil enough, beset by violence, superstition, ignorance, slavery; yet I cannot help thinking that sorely as poor folk needed a solace, they did not altogether lack one, and that solace was pleasure in their work"* [60].

Merton employed Morris and his wife and daughter, but also "*...some sixty or seventy workmen and a little band of women*" [114] where "*various process...are carried out by male and female operatives of all ages from 14 or 15 upward, and of different degrees of skill*" [46]. The community at Merton aligned with his broad vision for intergenerational learning-by-doing, a scene described by Morris in his fictional book, "*News from Nowhere*"

> *'School?' he said; 'yes, what do you mean by that word? I don't see how it can have anything to do with children...'*

> *'I was using the word in the sense of a system of education...a system of teaching young people' 'Why not old people also?' said he with a twinkle in his eye. 'But,' he went on, 'I can assure you our children learn, whether they go through a "system of teaching" or not...They all of them know how to cook; the bigger lads can mow; many can thatch and do odd jobs at carpentering; or they know how to keep shop. I can tell you they know plenty of things....you see, children are given mostly to imitating their elders and when they see most people about them engaged in genuinely interesting work, like house-building and street-paving, and gardening...that is what they want to be doing' [64].*

For several years, Morris and his team at Merton endeavored to resurrect a shade of Indigo, a rich, blue hue once ubiquitously produced from the native woad plant. Indigo had been part of the everyday in Britain and was associated to the Indigo-dyed uniforms of the working classes. Despite this it had gone nearly "extinct" as commercial dyers switched to new shades of aniline blue [95] or the equally problematic importation of Indigo dye cakes. Morris described the loss;

> *"...from the earliest times of the ancient civilisations till within about forty years ago there had been no essential change... Then came one of the most wonderful and most useless of the inventions of modern Chemistry, that of the dyes made from coal-tar, producing a series of hideous colours, crude, livid - and cheap, - which every person of taste loathes, but which nevertheless we can by no means get rid of until we are able to struggle successfully against the doom of cheap and nasty which has overtaken us...Of these dyes it must be enough to say that their discovery, while conferring the greatest honour on the abstract science of chemistry, and while doing great service to capitalists in their hunt for profits, has terribly injured the art of dyeing, and for the general public has nearly destroyed it as an art. Henceforth there is an absolute divorce between the commercial process and the art of dyeing. Anyone wanting to produce dyed textiles with any artistic quality in them, must entirely forego the modern and commercial methods in favour of those which are at least as old as Pliny, who speaks of them as being old in his time" [61].*

During his Indigo revival, he likely learned to "read" the vats with his body, allowing senses to guide decision-making and technique. It was said that his "*hands and arms up to the elbow remained permanently blue*" [20]. And ancient texts from his library provided some tacit clues; one passage read, "*It is known she has too much lime by the quick smell; on the contrary, a want is known by the sweetish smell, and by the scum being of a pale blue... part of the grounds are taken out, which is replaced by new woad ... the quantity cannot be prescribed on this occasion, for it depends upon the work the Dyer has to do"* [30]. At the same time, historians find that Morris, "*...was not an antiquarian bent on using the older great natural dyes; he revived them in the context of the chemistry of dyeing current in his time*" [20]. He experimented growing his own dye plants at Merton, where "*[S]crupulous neatness and order reigned everywhere ... pleasant smells as of dried herbs exhaled from clean vegetable dyes, blent with wholesome odors of grass and flowers and sunny summer warmth that freely circulated through open doors and windows... Here, besides ordinary edible roots and plants, flourish others which were not considered susceptible of cultivation in England until Mr. Morris introduced them in order to extract particular juices for his dyes. One of the clear, brilliant yellows frequently employed in his fabrics is procured from the bushes of his garden* [46].

In addition to woad, plants resulting in reds (madder), yellows (Persian berry), and browns (walnut juice) soaked in the vat [30]. Substances such as urine (or fermented urine), animal fats, limes, salts, and ash stew were also included [47]. Dye brews were heated then cooled, tested and adjusted to achieve uniformity and consistency, before each final recipe was recorded and preserved in Merton's dye book.

The effort took the workshop three years of trial and learning, imagination, memory, fortitude, and energy. Morris described his practice, *"…a man at work, making something which he feels will exist because he is working at it and wills it, is exercising the energies of his mind and soul as well as of his body. Memory and imagination help him as he works. Not only his own thoughts, but the thoughts of the men of past ages guide his hands; and, as a part of the human race, he creates…All other work but this is worthless* [62].

Shortly after Morris's death his head embroidress remarked on his success, of Indigo and other hues, "*There was a peculiar beauty in his dyeing, that no one else in modern times has ever attained to. He actually did create new colors; then, his amethysts and golds and greens were different from anything I have ever seen*" [86].


Fig. 4. Woad plant [2], Fig. 5. Indigo dye in "Strawberry Thief" fabric[3]

The above vignette describes craft at the Merton Abbey as a moral, political, and ecological practice. Craft was purposely and willfully juxtaposed against and in reaction to the "sham" that were industrial modes of production and the accompanying brutal working conditions and ecological damage caused by factories, mills, and competing dyeworks. Morris aligned his workshop with patterns and protocols of productivity, but also with the joy, pleasure, and solace found in certain forms of work. For Morris, craft meant creating the world you desired to live in, forging a series of relations to people (and other living beings) and place. At the Abbey local - but also distant - dye plants were nurtured, each bringing their own unique qualities and hues to the vats. He encouraged the special characteristics and qualities of each material, calling for wool to be as "woolen" as possible, and cotton always "cottony". Such "honesty" could only be found in natural materials rendered true to form. In terms of his technique, Morris called upon the knowledge and skill of the craftsperson in the fullest sense. His practice enjoined the intellect, the imagination, and the affect, as well as skills of the body; with attention paid particularly to sensorial knowledge (ie the smells and sights of the vats). At the same time, these ways of knowing joined with more studied and scientific knowledge of contemporary chemistry, in a way that models craft as an interdisciplinary practice that occupies a kind of liminal space between past and future; one that looks in both directions at once. Finally, at the workshop, people of all

[2] JB Hurry. 1973.The woad plant and its dye. Clifton [N.J.]: A. M. Kelley

[3] Strawberry Thief, c 1936. Designed by William Morris (British, 1834–1896). Plain weave cotton, discharge printed; overall: 88.3 x 99.1 cm (34 3/4 x 39 in.). The Cleveland Museum of Art. Available at: https://archive.org/details/clevelandart-1937.696-strawberry-thief

ages learned alongside each other, and in at least one instance, through problem-solving activities that sought to revive a fading knowledge. For Morris himself, this meant studying texts alongside of his tactile explorations. For apprentices, this meant problem-based and experiential learning, where knowledge and know-how develop through work.

3.3 Soetsu Yanagi at Onta and Japanese Mingei (orig. circa 1920)

In early 1920s Japan, urban dweller and art scholar Soetsu Yanagi (1899-1961) wandered the countryside hoping to find examples of "pure" Japanese craft to inform his developing theory of Mingei (*min*, meaning "the masses" and *gei*, meaning "craft"). As he entered the small town of Sarayama in Onta, a mountainous region in the south of Japan, he came upon a village of farmers who used the off-season to make wares using clay taken from the surrounding mountainside. Little had changed since the founding of the village 300 years prior, when descendants of the same ten families had first formed the community. Yanagi framed this community as Mingei, and one of *'innocence'* and *'naturalness'*, where "*the natural environment, raw materials, and production, these three are inseparable*" [119].

A pot was born of clay gathered from the mountainside. Fathers and first-born sons extracted large rocks (two to three tons per year) and delivered them to the village kara-usu, massive, timber clay crushers operating via fulcrum, the river current, and gravity. These giant hammers rhythmically crushed rock into finer and finer particulates, creating a soundscape of the cascading river flow and the wooden hammers creaking downward until the struck rock [66]. The rate of crushing stayed tied to the seasonality of the rivers, with the process slowing with the dry periods and increasing during the wet spring - conditions that also regulated the scale of production by controlling how much clay was available to shape. Powdered rock was laboriously purified by women in the families who worked to remove unwanted particles. Father and son practiced a hybrid form of wheel throwing and coil building necessary to give shape to the tough clay. Wheels were powered by the speed and motion of potter's legs and feet. Women, who were not permitted to shape the clay (as it was believed they did not have the physical strength) waited for the next step of dipping the formed and partially-dried pots into slip (wet clay also taken from the mountain), before men decorated the surface using traditional technique[98]. Finished pieces were left to dry under the sun for weeks before women stamped the wares using the town's communal logo. When enough pots had been produced by each family, they were loaded into the town's shared kiln where the 36-55-hour firing was expertly maintained by the eyes of the potters who gauged the temperature by sight [59]. Firebrick, straw, clay, and wood ash was carefully saved from each firing to be used in the production of glazes for the next round of pots.

According to Yanagi, pots from Onta were utilitarian, "*...faithful friends willing to help out when needed*" [118]. Mingei embodied a '*nonmindedness*' and '*timeless*' technique that utilized a tightly-knit, highly-organized, and mutually-supportive mode of production that put the wellness of the community over that of the individual [68]. But the mountain itself was the "mother" of the craft. Says Yanagi, "*When a certain locality is rich in a certain raw material, that material gives rise to a certain craftware. It is these resources, the gift of nature, that are the veritable mother of craftwork.*" Yanagi's colleague the potter Shoji Hamada also spoke of craft's relation with nature – both external and internal to the craftsperson; "*the clay, the glazes, the wood, the condition of the kiln, the temperature, wind, humidity – all of these play a role in producing a piece of pottery...a young potter must use his hands, his head, and his heart, but his heart is the most important*" [78]. The mind (or mindlessness) of the maker was also rooted in nature; "*Nature must be freely at work in* *the mind when anything is well made...astonishing is the effect that 'nomindedness' has upon it. ... all things become simplified, natural and without contrivance...Try to add or contrive, and life vanishes. Lovely things are almost always simply made*" [117]. Simple, and anonymous; Yanagi suggested there would be no individual genius – it was only in a 'communal ' society, where "*people cooperated with one another that beauty would be born. Cooperation bound not only one man to another, but man to nature*" [58].

As the theory of Mingei became socialized and shared among a cultural and political elite and an urban demand for Onta pots brought new forms of capital to the village, the lofty ideals of Yanagi and Hamada became a pragmatic standard of making and a rule-bound system that in Yanagi's words, sought to *'nurture and protect'* the village from the external pressures of modernization. The potters he argued, "*have a natural power absent in modern factories. Time means little to them, and this timelessness releases this natural power*" [118]. Hamada and Yanagi recommended the adoption of four general rules which were later taken up by governmental powers intervening in the day-to-day management of the village:

1. The number of pottery households within the community is fixed.
2. Potters produce clay themselves from raw materials.
3. Pots are made on kick wheels and fired in traditional kilns which use wood for fuel.
4. Electric kilns, wheels, and clay processing mills are not used.
5. Work is done collectively, not by individual artists [31].

As time passed and slight changes were adopted by the community (the use of kiln shelves to facilitate the firing of more and smaller pieces and bulldozers to extract rock) Mingei experts following Yanagi and Hamada's path grew concerned that Onta pottery was becoming "polluted" [57]. As a result, folk-craft museum personnel (who "advised" the village on proper Mingei techniques) along with the Hita city Ministry of Commerce and Tourist Association, and the Association of Cultural Property and Preservation (referred to by some locals as the "shadowy" world of craft [101]) worked to slow or stop altogether any large changes to technique. A series of national designations were put into place to preserve and maintain the existing process, marking Onta pottery and the town itself an "Important Intangible Cultural Property" in need of preservation. Echoing Yanagi, the Agency for Cultural Affairs' citation mentions a number of preservation points that must not change, including rules surrounding clay preparation, continued use of non-electric kickwheels, certain styles of acceptable decoration and glazing techniques, the mandating of communal firing in traditional kilns, and stabilizing the role of women as clay purifiers. Later, the village was identified as one of Japan's 100 soundscapes to preserve, further cementing the long-term use of water-powered kara-usu in the community [43]. Nearly 100 years after Yanagi's visit, many practices at Onta have remained unchanged.

For potters of Onta, proximity to the mountain meant interactions with its bright yellow stone, the nearby rivers, and the other supporting materials that enabled glazing and firing. Natural materials dictated form and the wares of the region and were manipulated and shaped according to gender and familial roles - with men assigned extraction and form-giving tasks (as well as decorative and firing roles) and women assigned to purifying and preparing materials.

Yanagi sought to develop a "whole self" theory of craft while drawing on a distinct notion of 'nomindedness' as a state in which nature flows freely through one's process. Potters and their families were highly-skilled (and undoubtedly thoughtful) technicians, as seen in the scraping of the mountain and the purification of its substrate, the centering of thick clay with hands, arms, and torso trained to interact just right with the spinning wheel, or the means to evaluate the kiln's temperature by sight. Making Ontaware meant social relations and interdependencies on several levels. Families worked in communal networks of mutual aid, harvesting clay and running the kilns as a community. They formed consensus on practices while drawing heavily on intergenerational technique and elder knowledge. In addition, being recognized as a form of Mingei craft meant that larger bureaucratic controls and management strategies were applied to the community. Political power attempted to freeze ways of making by holding it in a timeless place where materials, methods, even gender roles were rendered unchangeable. These were preserved in a unique "Japanese-ness," caused by constraints and restrictions (entangled within designations and honors) that left potters in a temporal double-bind; caught between a society that ardently looks to them to preserve the past while they also must try to live - and make sense of – a larger culture and ecosystem that continues onward in flux. Says one potter in 2019, "*Our community didn't adopt this profession because we like it. We were born here so we have no other choice*" [98].

Fig. 9 – 14 The process at Onta, photos courtesy of Maigo Mika[56]

4 DISCUSSION

What can the histories of craft bring to computation and computational makers? As schools of craft emerging under early industrial modernity, the three sites discussed above show patterns of craft that include complex, relational, and evolving processes, practices and commitments. How do these compare with the kinds of practices that help to define and give shape to contemporary computing in its own ongoing unfolding – and how might a world of computing and collaborative work organized along these alternate lines look and operate differently? How might those already engaged in craft-like computational practices help to fill the space between the two? Below we offer three core insights and speculations: craft's accountabilities to materials rooted in their own ecologies and unique temporalities and can help reorient certain computational approaches to materiality. Craft techniques that engage the "whole" person can help to further balance computation's general focus on cognition. Finally, the collaborative, situated, and relational nature of craft pedagogies can motivate alternative approaches to teaching and learning in computational (and other) settings.

4.1 Craft's kinships with materials are situated, honest, and transformative

Craft's distinct relations to the material world – in particular to materials originating from specific and local environments and communities – feature prominently in each of the cases above. Nature and local ecology were framed as a kind of genesis to craft, providing substance, inspiration, and a way of relating to the world. Rather than exploit these materials as 'dead matter' or raw resources to be extracted, manipulated, and consumed, craftspeople were bound within an accountable and enduring relation with 'things'. Wood kept Slöyders rooted to an agrarian lifestyle and had the added power of transforming the mental, moral, and physical forces of the child - as well as the power to help forge a larger national identity. Morris's dye plants were nurtured and supported as long inhabitants of his region and were called upon to maintain a fading practice – and a hue of historical significance deeply connected to the everyday. Mingei in Onta involved acts of protection, conservation, and cultivation, a careful and sustainable extraction of rock transformed via the currents of the river, the force of a community at work, and heat and flame of the kiln. Cooperative work included collaborations with others but also, "*bound man to nature".*

Whether working with wood, woad, or bright yellow clay, craftspeople were attuned to the natural qualities and properties of their materials in ways that allowed their distinct characters to remain visible. "Life vanished" when one tried to add or contrive while forming materials. Decorating became a kind of "dishonesty", obscuring the "truth" of materials and the articulations of skill that went into their shaping. Natural qualities were revered and retained (and often featured prominently) in the finished object where the aliveness, persona, and histories of material were carried through to the final form.

Based on the empirics above, moving computational practice in general towards a more craft-like relation with materials would honor materials by surfacing them - allowing them to be true to their distinct patterns, tendencies, and propensities and honest in their functionality. Refocusing our sights on the "materiality" of our materials in a craft-like way would hold us accountable to not only their agencies, properties, and qualities, but their movements over time and the complex histories, both social and ecological, that have accompanied them (and their handling). For example, instead of "smart" materials overwriting or "updating" the past, a more craft-like computation would acknowledge material histories through design and engineering, linking them to the present, the past, and a future that continues to unfold. For computational designers this would mean learning the social histories of the materials they interact with and their roles in sociopolitical histories in order to knowingly continue or alter them. Contemporary computational craft that was aware of the stories of power (and oppression) embedded in their material might even try to repair these past imbalances by reanimating small centers of skilled craftwork production within towns that once supported artisanship and tradework, (reimagining the production of e-textiles as a regional practice informed by its past histories, partially contested ones that adopted machines and automation but not always willingly). Or they might work towards projects that seek to remedy, reclaim, or reimagine technologies that supported acts of destruction (much like the way weaver Jovencio de la Paz [74] transformed a super computer used as an early war machine into one capable of self-directing the design of woven tapestries that reinforce feelings of warmth, beauty, and nurturement).

In turn, relational kinships and accountabilities might involve and contribute to a fundamental reorientation of current senses of time in the computing industries. This would encourage an industry accustomed to acceleration to slow down, which might coincide with planning and crafting artifacts and devices meant to last, an anti-designed obsolescence. This kind of holding-steady could coincide stronger standards, methods, protocols, and policies. It might also ground a very different sense of computational 'place.' This includes the connection to extractive landscapes from lithium mining in the Atacama Desert to artisanal Coltan ore mining in central Africa. It also includes material and place-based connections sometimes rendered invisible under metaphors of the cloud: for example, when mothballed coal-fired power plants are restarted to power bitcoin mining operations in upstate New York, warming local lakes and exacerbating greenhouse gas emissions [51]. Some computational communities [110] have already begun operating under the monikers of "collapse computing", "vernacular computing" or "perma-computing". In this work questions of *what do we really need*, and *how can we solve local problems with local resources*, come to the surface. In terms of data and algorithmic practices, groups such as the *Low Carbon Research Group* running out of Trent University [72], transition their own data collections away from cloud-based storage, adopting hyper-local backyard servers running from solar power collected from their own garden.

Immaterial data flows [67] and algorithms approached in a more craft-like manner would be designed and rendered as visible, honest, and traceable, part of a system of collection and usage held accountable to its primary utility; i.e. user data collected, stored, and shared would be visible, felt, or otherwise experienced as tangible and present and importantly, would not be shared or sold as secondary income streams unbeknownst to users.

4.2 Craft engages the head, heart, and hand in equal measure

Our cases above each illustrate ways of making that hold together a rich and dynamic concept of personhood, a 'whole self' approach, where mindfulness and thinking (or in the case of Mingei, unthinking) join affect, and workings of the body (including learned sensory and embodied skill) in equal measure. This kind of 'togetherness' of self, of the 'head, heart, and hands' working in unison, was reinforced in each scenario above. Morris for example, illustrates how degrees of sophisticated knowledges - the chemistry and botany of dye making - joined embodied skill at the vats – a practice driven by his affective sense of responsibility focused on social, ecological, and political spheres of work, production, and consumption.

Cognitive work and thinking things through was part of design and planning, but also occurred spontaneously during the moments of making as a kind of problem-solving or experimental behavior. In the case of Mingei one was asked not to take this too far, to not *over*think, to trust the practice. There was perhaps no primary problem to solve in Onta - no process to optimize outside of the rhythmic repetitions of production. Morris may have warned the village of Onta not to allow their thinking to be outsourced – to hold onto their power and position as craftspeople who maintained their agency and the creative expression of their practice. The heart of craft varied from site to site, but enabled an energy from which to move work forward - respect for labor, for hard work, for self-reliance or for community and mutual support, for perseverance, and for doing a job well. Work was built upon an ethical frame. The concept of handwork was extended into bodywork in each site. Young woodworkers were disciplined in body positions and tool handling, ceramicists sensed and engaged in the movements and resistance of clay. In these unique ways the unity of head, heart, and hand formed the tripartite approach to crafting artifacts. Applying this approach to HCI craft could extend the already important work being done in this space by enhancing techniques that keep the whole-person in the loop of production, if not at its core. Or, production teams might extend membership and responsibilities to form interdisciplinary and multi-actor partnerships. This would mean not only designers and engineers collaborating, but historians, artists, environmentalists, scientists, lovers, and ethicists.

More tangibly, a robotic arm could be designed to assist or augment, not replace, a human counterpart. This would support human engagement and learning through material interactions and touch, in ways that keep the "feel" at the heart of handwork. These configurations could enable new kinds of open-ended human-robot collaborations such as those envisioned and tested by Pat Treusch and team [104] who engineered a pair of robotic arms to support (rather than replace) the person engaged in the process of knitting. Such a move can help sustain the pleasure of work, described by knitter Susan Lydon; "*What I found in this...world of knitting is endless; it runs broader and deeper than anyone might imagine. It is infinite and seemingly inexhaustible in its capacity to inspire, excite, and provoke creative insight*" [34]. Embodied engagement in computation might also extend into other more accessible ways of working with computer interfaces, or even code itself. Programming and notation could and in fact more recently does [3] move away from the keyboard and screen, towards pencil on paper (maybe one day brush on canvas?) opening spaces for drawing (rather than typing) code. This could reconstitute such practices as "*...more humane...accessible...and dynamic*" [108] while simultaneously encouraging new ways to think through the body.

Engaging with or developing further the heart of computation might encourage practitioners to reflect on and connect their work to larger motivations, to ethical frameworks and community care, and the desire for good work done well. This heart could be a generative kind of perseverance or personal investment that sees work through during challenges, failures, or difficulties. Perhaps most provocatively, it could extend empathy-centric design [52] by growing into a kind of 'love language' enacted through building a better world through "*...care, commitment, trust, responsibility, respect, and knowledge*" [34].

4.4 Craft pedagogy is a collaborative, situated, and relational practice

A final point surrounds craft taken not only as a solo endeavor but as part of a larger and much older collective, where the practices of teaching and learning become central to craft's continuation and stability over time. Importantly, the craft sites above each manifested their own unique temporalities and rhythms, flows of intergenerational knowledge, and both explicit and implicit ethical apparatus' that helped to inscribe activities and engagements (as well as artifacts). Despite adaptations and alterations that occurred along the way, there was an endurance built into these sites that kept craft lively, (rather than "traditional" - presuming we subscribe to a notion of "tradition"), close at hand, and durable.

Crafts were taught from one person to the next (including across generations and in unbroken chains of knowledge) using a process that was proven yet flexible enough to adapt when needed. Sites were both formal – as in the more scholastic setting of Slöyd (ie: school workshops using pre-determined lessons) and informal - places where daily life or labor, work, and learning were entangled as one complex practice. Within Slöyd, classroom-like organization joined workshop-like endeavors, blending two seemingly distinct systems in order to honor and maintain histories of social and cultural practice. Teaching and learning in Onta and at the Merton Abbey occurred during the day-to-day unfolding of work, where learners grew skillful while progressing along a spectrum of intergenerational, socialized, and unstructured learning and development. Morris' teacherly vision and practice varied greatly from formal schooling. Apprentices and pupils saw first-hand how their work and labor fit into larger social, ecological, even political contexts, and values and ethics were a part of the identity of the vocations they were trained into. Learning/work meant that implications of practice were not distant from the day-to-day but inseparable from it.

A craft-like computational teaching could draw from sustainability education, where learning is action-oriented and happens both in and out of the classroom, where connections are made to the everyday lives and needs of students [96] where ethical responsibilities, like skillsets, are developed over time, [99] and where the 'self' is explored as interrelated to local ecologies [113]. The pedagogues call for a "*…deeper understanding of the interdependencies within human communities – and between humans and natural systems*" [12] is reflected in our sites above. More pragmatically, for today's students, restorations, remediations, and a (re)balancing of human relations with local ecosystems could be the starting point for design. As touched on earlier, computational teaching might also strive for equilibrium – the rationalized, abstracted, and algorithmic side of computation (and computational thinking) would be balanced with skillful training in building and making, sensory and somatic practice, and the improvisational sense and developed creativity that comes from working "honestly" with the materials, contexts, and the "frictions" of the world. Such a move might open the field to a wider range of learners and practitioners [38], or build new relations that are critical for sustainability in a fracturing world. Importantly, through practice, affect and value systems would be accounted for and enriched in teachers and learners alike, transmitted both implicitly and explicitly. While it is possible to separate the head, heart, and hand as an intellectual exercise, educators remind us that we never do actually "*…make, act or know without the cooperation of each of these domains*" [5].

Craft has takeaways for teaching and learning in the humanities and adjacent creative fields as well, where generative artificial intelligence applications raise questions of authenticity, and the automation of student work may at times limit the practice and effort required for learning and the development of expertise. Applying a craft approach to ai in the classroom might reimagine the learning space as one where pleasure and work are entangled, and where learners can forge deeper relations with the people, materials, and social worlds around them. In such a space instructors might enrich the use of AI with an emphasis on the use and development of certain "human" propensities in workmanship (a metaphorical sense of the "human hand") such as imperfection, variation, and evidence of work [84].

5. CONCLUSION

Of course, the stories and speculations above are incomplete and taken in their best light. Craft histories have been associated with things and practices that we would *not* want computing to borrow or recreate in modified form. Craft has sometimes been associated with gender norms which portray women as purifiers and men as form-givers, and has periodically exhibited discomfortingly close relations with nationalism [100] [41] and forms of discipline that can lead to new techniques of control and conformity. Craft can enforce patterns of privilege and exclusion (for example, the organization of Mingei through familial and kinship networks) that may run against inclusionary or democratizing values we might seek to promote. Craft (like computing) may also be prone to fetishize its objects in ways that can, if we're not careful, exaggerate their distance from other kinds of objects. Craft could also rely on a tendency to obscure or tell narrow stories about the conditions of its practice and production, performing a theatrics of distinction that calls out its separation from, rather than continuities with, the wider object worlds around it. At its worst, craft can lose its originating power and become simply nostalgic and quaint, supporting elite modes of production and consumption accessible to only a certain demographic (seen in the exclusionary prices charged by Morris and Co.) that leave worlds of mass and ordinary practice untouched: a self-congratulatory 'museum gift shop' response that leaves the predations of global technological practice and capital unchallenged. These practices also come against the risk of 'craftwashing', marketing tactics and techniques employed by big brands as platitudes, "*false oppositions to mass production and consumer culture*" [16].

But as a means of recentering and reimagining computation, even speculatively, craft – and specific craft histories, like those shared above – has important virtues and advantages. It can help us to reimagine a relationship with earthly materials that inspire more socially and ecologically sound practices, open us to futures where technological decisions are made in larger, more inclusive collectives, and where systems of power and information are not hidden in invisible networks. Finally, it can shift systems of teaching and learning in ways that transform individuals and collectives through the development and articulation of values and ethical positioning.

Finally, craft's relational nature makes desires to "freeze" it in time and place impossible, as small changes "here" will have larger and unseen consequences "there" (as when a new road into Sarayama led to increases in the speed of production) The metaphor of freezing, however, may help computational communities resist or reclaim narratives to "overwrite" the world anew with upgrades and updates, challenging ethos that center on "disruptions," or the "*move fast and break things*" [27] mentality. Craft and computation together can help develop a conception of time and temporality that might continue to root and sustain work through uncertain futures. As the critic Clement Greenberg [29] found many years ago, successful creative endeavors looking to break with the "*customs and conventions of the past*" will always, "*…inevitably [be] caught up in the continuities of its own making…*". Computation, like craft, "*…is continuity – and unthinkable without it*".

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