

# The Hand, Across Twenty Years of Digital Craft

**Malcolm McCullough**  
Taubman College of Architecture  
and Urban Planning, University of  
Michigan  
[mmmc@umich.edu](mailto:mmmc@umich.edu)

## ABSTRACT

This paper probes the origin and trajectory of the notion of “digital craft” as perspective for current TEI thematic focus on the hand. As ever in craft practice, habits of the hand seek nameless orientation, playful discovery, and reflection in action. Specific to craft, these aspirations arise through mainly distal aspects of touch, through which the hand probes qualities of a medium, often without need for objects. Since twenty years of developments have advanced some but not all aspects of touch, some retrospect helps remind what has been unrealized. So for the benefit of more physiologically and technologically informed agendas in tangible interface research, this paper invites a longer view to the renewed relevance of craft, and the vital role of the hand.

## Author Keywords

Craft, practice, hand.

## ACM Classification Keywords

H.5.2. Information interfaces and presentation: Haptic I/O, User-centered design, Theory and methods; J.4 Arts and humanities: architecture; K.2 History of computing

## General Terms

Human Factors; Design.

## INTRODUCTION

“Little can surpass the hands in showing that we know more than we can say” [7, p3]. Tangibility research has gained stature lately, from the mainstream of gestural screen interfaces to the pioneering work of the the TEI community. For without touch, ever more saturation in technologies mainly of seeing and sending can feel somehow empty. Although gesture certainly helps, and even mere pointing feels different when at least directed at physical things, there is obviously much more to touch. For example continuous probing of texture establishes a rich sense of presence. This is especially so amid the kinds of mastery implied by craft, where the outcome of a process depends on a practiced flow of the hand. In craft the work seems worth something personally, communities of practice develop socially, and the medium itself invites expression, appreciation, and identity. Many such values also have gained stature lately; craft has reawakened in postindustrial life and work.

A twenty year retrospect fits well to this reawakening, and may now be worthwhile for the TEI community. For while research in newly possible implementations seldom occurs without some cultural context, it also seldom takes time out for retrospect. Adopting the hand as a TEI conference

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theme may warrant such a moment. Now the expression “digital craft” has been around for twenty years—enough to afford historic perspective. Beliefs in computer as medium (not just so many tools) and usage as practice (not just operations) have been widely held for about twenty years.

Some of this retrospect just provides general justification for current agendas in tangibility. For instance twenty years is about how long creative work generally took in rushing toward and then turning back from “cyberspace” (now a dated word) or other such goals in purely virtual artifacts. Today digital technology is no longer just something to sit at and point into. Today when aspiring designers self-describe as “post-digital,” this questionable epithet does contain a meaningful wish for a general tacity. This invites TEI research: seen better across twenty years than just two or three, great gains in the versatility of the technology have seldom been matched by gains in capacity for the latent versatility of the hand.

This paper emphasizes that more actionable insight from retrospect on digital craft. There it identifies five longterm trends: studio culture, play in rich media interfaces, digital fabrication, public art installations, and do-it-yourself sensate electronics. The paper interprets these for their respective contributions to touch, relative to preexisting notions of digital craft, and as if amid the novelty of these developments, or as if in the bias of any medium, something else might have been forgotten. This paper suggests that is a matter of haptics, and that however physiologists may understand the hand, artisans know something too.

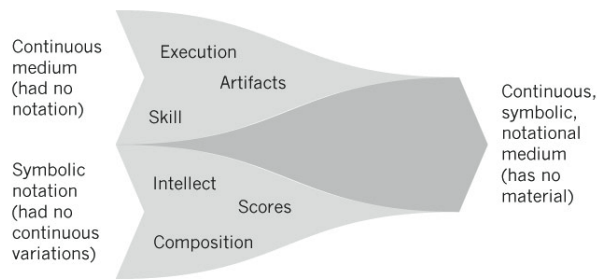
## DIGITAL CRAFT IN 1994

“Hands are underrated” was the opening sentence to *Abstracting Craft*, a book of scholarly design provocation written mostly in 1994, exactly twenty years ago [7, p1]. So to establish some retrospect here in 2014, consider the stance of that work.

At the time it seemed odd that design computing research still emphasized the modernist (and often positivist) goals of automation. The purpose of technology had been to reduce human participation, and now the legacy of this belief was now fitting less and less well with the emerging role of what was called “personal” computing. New hopes were now arising for technology to help people understand and not overcome the world, and to actualize not trivialize their personal agency in it. For by the early 90s the attitudes and abilities necessary for getting the most out of local configurations of digital technology were increasingly bottom-up, and rewarding more of skillful practice than specified operations. “Personal mastery of open-ended software can take computers places that deterministic software code cannot” [7, p21] Besides resulting from the impossibility of total top-down planning, this was largely a consequence of new capacities in human-computer interaction. Direct manipulation in graphical user interfaces made many formerly abstract subject matters into objects of playful design exploration. Given how that technology re-conceived so many operations as tools, it is unsurprising

how its practitioners began to understand what they were doing as craft. Although craft was a notion that modern life had almost completely abandoned, or at least reduced into a minor countercultural folkway like astrology, this new work was sufficiently removed from the usual lowbrow or leftist connotations to give the word new life.

In retrospect, it seems clear that what began to change was the experience of computing as a *medium*, and not just as a set of proceduralized tools and tasks. Thus the key argument for abstract craft was twofold. In general, a medium surrounds the work of tools, affords expression, gives a bias to that, and so builds a genre. “We say that a medium has a feel, and we sense that quality only in action” [7, p194]. More specifically, a digital medium now with sufficiently “dense continuous notation” made it so that between any two states of a manipulated object—for instance the hue, curvature, or differential scale envelope of a lofted form—there would be another [7, p235]. Whereas formerly materials that afforded coaxing and discovery lacked a reproducible notation, and notations where creativity worked on the score and not the artifact lacked realtime manipulation, now these combined (Figure 1).



**Figure 1. Dense continuous notation, amid direct manipulation, as newly possible in the 1990s.**

“Ways of the Hand” a famous text by jazz pianist David Sudnow here led into an exposition of play, among the first of such in the design design media literature anyway. Playful discovery explains the connection of hand, tool, and medium. To Sudnow, jazz occurs in “handfuls”; the hand “takes hold” of the music. In what is still one of the best expressions a key idea, play involves “coping with the topography of the terrain by the hand as a negotiative organ” [11]. Moreover, this is a matter of disciplined craft. About play in craft, the psychologist Jerome Bruner, who was well known among HCI pioneers, had remarked: “The production of creative surprise demands the masterful control of a medium. It is not the act of spontaneous seizure. . . How curious that surprise grows in the soil of grinding work” [2].

To attribute as much to the play of rich digital media was still a stretch, albeit one that held and grew. Even amid the euphoria of its arrival, the GUI seemed temporary. “The two-dimensional mouse, point-and-click form of direct manipulation has prevailed for a strangely prolonged period

of time. Although there is every indication that human computer interaction research is evolving toward more satisfactory haptic engagement, there is also evidence that this might take a while.” [7, p25] Until then, and so until today, there were substantive objections to the notion of digital craft.

Some of those were temporary too. For example the legacy and monoculture of computers as “business machines” slowly wore off. But in 1994, for an HCI discipline that was still quite young, mastery in creative work was hardly the emphasis. Mechanical usability for office tasks by nonspecialists was challenge enough For indeed usability was so primitive that most people never touched computers, and many looked down on those who did. To an industrial legacy, anyone properly trained in operating a machine would be as productive as another. Aspirations still seemed absurd here. Besides, the tools changed too frequently for much appreciation or mastery to develop. Although eventually the early flux of programs gave way to a steadier feature creep in a few major applications (bloat that within a decade would drive an exodus from the desktop), at least the core toolsets settled into something stable enough for practice. Yet there wasn’t must comfort in trust, not like with a favorite old table saw. Silicon Valley’s core belief that you can never have enough tools, or that old tools are bad tools, does not sit well with more timeless notions of craft.

Meanwhile the main objection proved more permanent: then as now, you could not actually touch the work. Because that lament was usually voiced just so simply as that, here it does need some qualification. For of course even in many traditional crafts, glassblowing for instance, nobody laid hands on the material they were working. Conversely, in digital crafts, although at first the wondrous union of densely malleable medium with realtime notation came at the cost of physical output, that limitation steadily waned with advances in prototyping and fabrication. So to qualify this objection, retrospect suggests the lament was, and still is, mainly one of haptics. However separately they have done so, notions of digital craft and tangible interface have each come a long way in twenty years; yet the experience of haptics in everyday form-giving digital work has not. The process of discovery amid dense continuous notation gained enough hand-eye coordination in the 1990s, but still wants for hand-mind coordination in the 2010s. By way of five intervening developments, consider how.

### A TWENTY YEAR TRAJECTORY

A much longer history of craft, one that went back so far as Morris or Diderot, might well take interest in these latest twenty years. It could identify the 1990s as the origin of digital craft, the 2000s for a remarkable rise and diversification of its media, and the 2010s for its becoming more tangible. Although a broad history might have to see the gestural smartphone interface as the most significant arrival of touch into the technological mainstream, one more specific to craft would have more emphasis on the settings of practice and the objects of work, and less on telecommunications. One particular case in that history

could note the growing crossover between interaction design, now no longer just a usability science, and architecture, a more venerable studio-based discipline, and how this crossover has given rise to new research and degree programs in tangible interaction. Both fields give form; both rely on propositions and not indicated solutions; both study and serve organizations and places; both produce results that many people have to live with. To TEI, with its basis in interaction design, architecture brings insights not only into studio practice but also for public installations and other such situated technologies, especially through advances in digital fabrication, and with these a frequent, even normative, identification with craft. So within this crossover, consider five longterm trends (Table 1) for the changing role of the hand.

1) Begin from *studio culture*. Here interaction design reinterprets architecture's venerable model, and with it the importance of premise and not just product. Because design is what you choose to work on and not how you solve a preexisting problem, it benefits from a setting conducive to propositions. As activity theory so often explains, embodied contexts of practices really matter. Studios combine community of practice, open-ended tools, conversational props, and interpretive venues. The notion of craft fits this better than one of art, research, or industry does, even if studio craft somewhat involves elements of each of those. Over last twenty years, much about studio culture has been transformed by technology. In the 90s it was sometimes a "paperless" studio; by the 2000s sitting at a computer all day was normal work (although increasingly distracted by entertainments); and into the 2010s, studio culture increasingly complements software-based representations with tangibly prototyped realities. Distinct from the library or the lab, the studio is not just for making—often making by hand, almost always making with personal knowledge and commitment—but also about it.

2) *Playful explorations in rich software media*, as explained above, first became good enough for a notion of digital craft in the 90s. (In the 80s, Apple had claimed "the first interface good enough to criticize.") Over the last twenty years, computers came to be for much more besides work. More media allowed more manipulations at more rates and scales. And while alas so many distractions and disembodiments accumulated, a more fundamental and positive aspect of play likewise grew. As a state of mind that comes and goes, play is not necessarily a game, but more an attitude about free exploration within a given structure [9]. As understood through craft, play means a more productive, engaging exploration of use and beauty together, now amid the states and affordances of a sufficiently rich medium. This might be so simple as twiddling a few sliders, or so complex as tacit agility in redesigning an organizational strategy. To the hand, physical structures come first in affording play, but conceptual and operational structures also count. Much as one plays a musical instrument, one could ideally play a good digital technology. Much as a child's play reconfigures things without regard to declared affordances,

so other acts of embodied cognition play namelessly. And where for vision this play is foveal (the eye keeps shifting about), for touch it is haptic (the hand learns through moving, not just pointing). Even a child knows this, and may know it best.

3) *Digital fabrication* improves tangible speculations. To architects and product designers, this has often been fastest gaining digital design trajectory of the last twenty years. In particular this has validated "research through making." For example, at the author's university, one leading such program declares: "Historically, research and creative practice have been constructed as 'opposites'... indicative of age-old anxieties within the architecture field to understand its nature as an 'applied art'" [8]. There is artistry in design for assembly, modeling in toolpaths, discovery in the material configurations of tangible prototypes, or combining explorations of fabrication process with explorations of material. Increasingly, this complements concerns for knowledge representation as the mainstream of digital design research in architecture. Quite often these researchers self-describe in terms of craft. And yet the costly gear seems a step back from ownership by the artisan, which the personal computer had provided as a first basis for digital craft. And whether or not the emphasis on robotics is a step forward in workmanship, it puts the hand in a more secondary role, more for interpretation than in execution, and instead emphasizes the presence of the material configuration.

4) The latest provocations for alternative interface occur as *public interactive art*. Participatory, often ambient, sometimes spectacular, usually somehow ineffable, these are propositions indeed. In particular, this fast-growing and diverse genre departs from the tyranny of all that is iconic, clickable, corporate, transmitted, and tracked. (For alas one major change over the last twenty years is that Silicon Valley has lost its barefoot maverick innocence.) As in food, so in technology, today countercultural stance is slow and local. As in most good interaction design, the participatory quality of public interactive art makes content something you do, not something you are given. However it is through physical presence, not the hand per se, by which you participate, and the sensory integration is less about haptic orientation than the integration of presence, motion, sound, and light, (at least light usually liberated from propriety screens, and usually layered into valued venues.) There are fewer works based on massively multiuser touch, however.

5) Instead where an ever larger public brings touch into their experience of digital technology is in *do-it-yourself maker culture*. Here the trajectory is more recent, mostly the last ten years not twenty, and steeper, with civic events and amenities arising, and casual talk of a revolution. The crossover of architecture and interaction design has its entries here; Arduino courses are very hot at the moment; imperatives of smart green building portend significant applications, etc. Something about the bricolage of assembling integrative prototypes from stocks of modules and open source components certainly has aspects of craft.

Much about DIY maker culture seeks a richer physical experience, and in particular the playful design process gets at the exploratory, nameless aspects of touch. For the hand, the process allows grasping, stacking, and a variety of physical inputs and outputs. And yet it seems very little like the reflective flow of probing the contours of a continuous medium, that has been so important to other notions of craft.

	Tangible medium	Practice of craft	Role of the hand
Studio culture	tangible setting, full of tools and props	community, dedicated work, media conventions	anything, but certainly something
Playful use of rich software	not so much	aspiration, reflection, agile media choices	rich guidance, poor probing
Digital fabrication	detailed, often full scale output	configuring process variations	embodied gear and results
Public interactive art	uncanny interface novelties	integrative design and installation	presence more important
DIY electronic making	physical component assemblies	selecting, tinkering, calibrating	grasping and connecting

Table 1. Five longterm trends in tangible creative work.

**THE PROBING HAND RECONSIDERED**

Although the passage of twenty years has not brought advances in haptic interface commensurate with these other design technological trajectories, it has brought longevity to the notion of craft, respectability to the cognitive science of embodiment, and new insights on the active role of the hand. With the leading work on the latter as a keynote for this conference, and some anticipation of that in the recognition of digital craft twenty years ago, this seems a good time for the TEI community, fond as it is of newly possible implementations, to take stock of this most fundamental human characteristic. For as Frank Wilson has so visibly explained, the hand connects to the mind, indeed speaks to the mind, in ways undervalued by recent cultural norms of technology, work practices, and especially learning. As Wilson explains to a refreshingly broad spectrum of researchers, the hand and the brain really grew

up together. Today across a “convergence of neurologic, linguistic, developmental, and anthropological perspectives in our search for an understanding of the role of the hand in human life...” (i.e. to many researchers who increasingly share in a reevaluation of the hand), the time seems right to consider and develop “our own unseen, dormant, *knowing, praxic*, inventive hand and put it to our own personal and expressive use—to make it speak, and ourselves more articulate.” [12, p.209] So for an agenda to take away from retrospect on twenty years of digital craft, in its trajectories so different from those hopefully imagined for haptics in 1994, consider (and perhaps seek ways to develop) what Wilson calls “the articulate hand.”

Of course many normative conceptions of haptics have held up well: Gibson’s early observation that active contact leads to external environmental attention (whereas passive perception leads into self) remains vital, for example to debates whether affordances may be tacit or whether too much ontology could get in the way. Decades of cognitive science research into tactility have established many principles that seem pertinent to the question of craft. For example in a plenary “tutorial” on normative knowledge of haptics, Lederman and Klatzky assert “Haptic perception of surface and object properties is tightly bound to to the nature of contact” [6]. For examples of properties: proximal or distal, skin or kinesthetics, point pressure or lateral texture, holding objects or following contours, instantaneous or over time. From these, one could generalize craft as: distal; kinesthetic; holding tools but more vitally sweeping contours of a medium; flow rates also important (Figure 2).

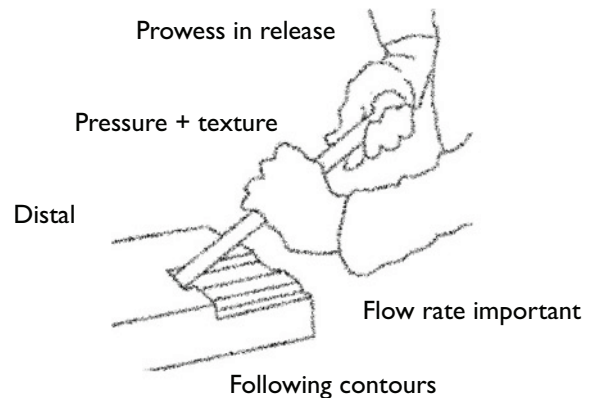


Figure 2. Generalized haptic qualities of idealized craft.

By contrast, the twenty year trends surveyed in this paper often seem: too discrete, as in selecting and connecting components; weakly conducted, as the hand apprehends but does not shape the work; and seldom so topographical to allow creative discovery by taking hold, to put it in Sudnow’s words. Neither the best of desktop design software, nor robotic fabrication, nor consumer electronics,

nor of course tapping on smartphone apps yet affords enough skillful haptic probing to imagine, as Wilson would emphasize, how “the hand speaks to the mind” amid other more venerable media.

Now while some of that may seem obvious here in TEI, other aspects might not. For example, imagine, as the crafts historian and curator Glenn Adamson does, that “there is no craft without motion” [1] Note, as influential HCI researcher Paul Dourish has done, that embodied cognition is often “pre-ontological”, i.e. without mental object representations [3]. Or as haptics philosopher Matthew Fulkerson has explained, the hand can proceed without identifiable objects or spatial mental models [4]. Although touch occurs amid what Wilson calls a “hand-thought-language nexus” [12, p3], it integrates tangible features in to perceptions well before, and into topographies quite different from, representations in vision, language, or deliberative intent. Recognizing this vitality of the hand sometimes comes less easily to computer scientists, in their bias toward knowledge representations, or indeed to anyone for whom the hand has been subdued in favor of superabundantly visual media, where alas so many haptically insufficient conduits, and indeed many processes not guided by the hand at all, are casually called “tools.” In this regard, Fulkerson’s treatment of distal touch seems a very good complement to Wilson’s for consideration of digital craft. For within the distal aspects of touch emphasized by craft, the flow of work nevertheless involves presence. Craft arises through richly mediated connections to tangible qualities that may not require or achieve object or spatial representations, and that nevertheless reward skillful practice [4]. Researchers forget that such practice is an end in itself. In craft, what you are really working on is yourself. Wilson on organized haptics research: “In ignoring the extent to which people can invest themselves in their work, psychological formalisms seem to me to have demonstrated a colossal lack of learning and foresight” [12, p297].

To close on a vivid example of use, consider the kitchen knife, as interpreted by the sociologist Richard Sennett in perhaps the most widely read work of this kind, *The Craftsman*. To Sennett, this case illustrates an aspect of distal touch that is prized by masters but difficult for clinical haptics research: “prowess in release.” In the kitchen, as for the piano, and often in sport, a “principle of minimal force” expresses self control and minimizes error, physical strain, and material backlash. “As as the knife falls into the food, the chef’s hand instantly relieves further pressure” [10].

The cut of the knife illustrates a grand thought by which Wilson closed his celebrated “We humans are what we are not because of our rationality but because of our capacity to harness our irrationality.” [12, p 311]

May this retrospect on digital craft help that calling.

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