Design Technology's Lost Tribes

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Abstract

This article explores a knowledge transfer problem that significantly constrains technology design thinking. The problem is defined as follows: (1) experts in the field of developmental, counseling, clinical psychology and psychiatry remain outsiders to a majority of technical design teams, resulting in the loss of divergent thinking and the quarantine of a significant portion of psychological knowledge addressing transactional behavioral analysis and theories of mind; (2) this dynamic is bidirectional—while most psychology training programs and professionals avoid digital design as subject matter relevant to their fields, engineers reduce psychological expertise to a consulting function, not foundational knowledge for prototyping. The problem is explored as an epistemological divide, and a design methods problem.

Introduction

At first glance technology appears to be a ubiquitous utility with universal applicability to all professional practices. Yet there are areas of deep knowledge that have not been integrated into the design of software and engineering artifacts that would result in the cultivation of more divergent thinking, and a greater variety of tools which would make digital media more user friendly. What is missing from the fabrication of technology? In this paper it is proposed that too little technical manufacturing is based upon knowledge of human development and behaviors that support optimal growth. These circumstances have been fostered by the domination of robotics engineering in both commercial and academic settings which is focused on imbuing robots with human characteristics—a one way transfer of knowledge, or machine mimicry. This form of artificial intelligence is of limited use to artists, educators, clinicians, and many software designers who are interested in amplifying human creativity or design driven by enhancing human development and abilities. While these two approaches to software engineering and product development should be complimentary, robotics has captured a majority of funding from the private sector and defense industry and has inadvertently narrowed alternative areas of investigation that would integrate more diverse theories of mind, and, principles of human development into technology design in both the marketplace and in graduate institutions.

A literature search of "knowledge transfer and technical engineering design" in a database of 4,000 technical journals resulted in 407 academic articles which defined the issue quite expansively; a) an encoding problem for human to machine knowledge transfer, b) a significant knowledge drain in engineering communities that is going to result from retiring baby-boomers, c) best methods of expert knowledge storage and retrieval for reuse in successive production cycles, d) a discussion of project team communication dynamics and their impact on design processes, e) study of trans-disciplinary engineering communication characteristics and norms, f) using social media to facilitate knowledge transfer in complex engineering environments. The diversity of responses is evidence that technical engineering is beginning to integrate a broader view of knowledge and knowledge transfer than it had a short while ago. If this same query is restricted to the previous decade most search results address human machine knowledge transfer exclusively.

A broader approach to cultivating artificial intelligence and design methods will involve a fuller exploration of digital media by practitioners from the vast array of theoretical persuasions across psychology; we are waiting for this valuable input and experimentation to occur—hence the origin of the article title. The problem is defined as follows: (1) experts in the field of developmental, counseling, clinical psychology and psychiatry remain outsiders to a majority of technical design teams, resulting in the loss of divergent thinking and the quarantine of a significant portion of psychological knowledge addressing transactional behavioral analysis and theories of mind; (2) this dynamic is bidirectional—while most psychology training programs and professionals avoid digital design as subject matter relevant to their fields, engineers reduce psychological expertise to a consulting function, not foundational knowledge for prototyping

This essay will discuss: (a) the epistemological divide between disciplines and its characteristics, (b) what design theory has to add to this issue, (c) and how to cultivate the transfer of ephemeral and liminal cultural knowledge to engineering contexts.

The Epistemological Divide and Its Characteristics

What do developmental and clinical psychology have to offer technical design? Psychotherapists of all persuasions are designers of therapeutic environments although most do not think of themselves as design architects of emotional space. Very few clinicians would characterize their clinical practice as rote and formulaic, which confirms their specialized expertise. Each human being is a unique composite of possibilities, talents, and weaknesses never before seen, therefore clinicians are constantly modifying their methods and approaches to accommodate clients. In short, clinicians are well versed at iterative design, but because most have not been exposed to design thinking as subject matter, they eschew the label. This expertise is very valuable knowledge relevant to a myriad of transactional design problems in technical fields. It represents the height of skill in regard to interactive communication, and foundational knowledge of individuation in human development. Additionally, developmental psychologists maintain the reservoir of theory about cognitive and emotional development and research on human development. When practitioners and theoreticians of these domains engage with the idea of making what's ephemeral (i.e., their knowledge and skills as clinicians) concrete by manifesting aesthetic, feeling, and nurturing symbolic mediators in digital media—this will greatly expand the vocabulary of digital architecture for all.

Psychological knowledge is a highly sought after commodity; software engineers strive to create good user interfaces, teachers want to assist students in actualizing their intellectual potential, we are all pursuing harmonious work/family relationships--the list goes on. All of these activities require an intimate knowledge of human development and behavior as a basis for problem solving strategies So*, why has design reasoning remained out of reach for the practitioners of psychological knowledge when their skills are central to so many practical technical engineering endeavors? And why is it so difficult to place value on and operationalize what we do know about healthy human development in engineering contexts?* This is a profound disconnect in the marketplace. It could be explored in terms of production values, profit motives, and even politics, but going forward it's addressed as both a knowledge transfer problem and epistemological divide—a deep-seated preference for a way of thinking by technical engineers.

I've been pondering this form of bias for quite some time. While still a graduate student my advisor, Seymour Papert, challenged me to find out how engineers differed from artists from a clinical perspective to better understand what epistemological difference is. I set about this task by interviewing graduate students at MIT from two different departments; the arts (film/video) and engineering (architecture machine group). Here's what I learned: the two groups had very different life goals, verbalized different sources of motivation and satisfaction for academic studies and career choices, they also perceived their role in the world differently. The artists were interested in using their technical skills as a means to an end (i.e., the creation of a narrative that expressed their unique perspective on things). Additionally, they stated distinctly internal and self reflective sources of motivation for their choice of a career. The engineering students wanted to be technical architects because they like the idea of solving "hard" problems—problems that had clear and objective criteria applied to the evaluation of their efforts—success could be measured, and success or failure was an obvious outcome of their design approach. The engineering students' source of motivation for career choice was decidedly external; recognition and rewards by their community of practice, and the satisfaction of knowing that their software/device/engineering project contributed to progress in their chosen field.

In sum, the two groups had distinctive problem solving approaches, tactics, and strategies that fit their goals and personalities. Engineers, as a generalization, don't care to research an issue *ad nauseam*; the sooner they can narrow the scope of a problem and begin work on solutions, the happier they are. They are convergent thinkers. The main job of the engineer, generally, is to make something that works. The iterative nature of the engineering enterprise has as a goal to improve performance specifications. Artists, on the other hand, have a distinctly internal locus of control; they design and create from what they personally judge to be important subject matter, they are divergent thinkers who explore novelty, difference, and the culturally topical. The iterative nature of film making is less about improving upon the last film, and more about expanding one's range of subjects for study.

By contrast, clinicians and psychologists have a high tolerance for ambiguity, which allows them to hold several competing theories in mind, testing each one for efficacy in regard to its value for clients as practitioners. Converging upon one approach is not essential to their methods or practice. They are primarily divergent thinkers whose main job is to create an emotional holding environment conducive to psychological growth that is highly individualized. The iterative nature of psychotherapy is the subtext of human growth and development, and it is not pegged to expected outcomes. Clinicians thinking processes, therefore, have attributes of both artists and engineers as we have previously defined them.

Table 1.

Divergent vs. Convergent Thinking

Divergent Thinking	*Convergent Thinking*
Sustainable diversity; design based upon accommodating an infinite variety of individual differences in thinking, feeling, and acting in the world. Designing the new normal rejects a 'one size fits all' production model.	Selective diversity, enhance or replace faulty objects (mechanical devices, or thoughts and feelings), the creation of normative solutions, based upon averages and collapsing differences.

This comparison gives us additional terminology for our discussion of bias in knowledge transfer. It appears that technical engineering, as a community of practice, has a strong bias and preference for convergent thinking. This is not a personal attack on a particular cognitive style, rather we are concerned with how a predominant mode of thought or bias, in combination with monetary efficiency as overlord, have manifested in the institutional marketplace and in graduate training programs.

What Does Design Theory and the Design Literature Have to Say About this Issue?

The design literature on innovative design methods for technical engineering projects is quite robust (Zhu, F., Sun, X., Miller, J., & Deng, Z. 2014, Moreno, D. P. et al 2014,Wang, P., Luo, D., Li, L., & Cao, Y. 2013, Chang-Tzuoh, W. et al 2013, Eckert, C., Keller, R., & Clarkson, P. 2011, Sarkar, P., & Chakrabarti, A. 2011, Bargelis, A., Mankute, R., & Cikotiene, D. 2009). According to many experts, innovation requires a carefully planned mix of both divergent and convergent thinking. A strong preference for one mode or the other has predictable outcomes for production (see Table 2). Systems thinking has contributed sophisticated project management organization to product design, but product team aesthetic and artistic preferences along with integration of new knowledge exert powerful influences on success in the marketplace as well. An integrative approach and point of view about the evolution of design methods and manufacturing as a field of practice comes from Le Masson, Weil & Hatchuel (2010).[1] Le Masson and colleagues propose design theories and methods evolve to meet the creative challenges of historical circumstances, more specifically Hatchuel (in Le Masson et al 2011) noted:

> "..that recent design theories form a consistent body of knowledge that tends to increase the creativity of design. This result seems to confirm our belief that there are historical dynamics linking creativity issues and the development of new models of design reasoning" (p.218) [2]

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[1] Pascal Le Masson, Benoit Weil, Armand Hatchuel, *Strategic Management of Innovation and Design* (Cambridge/New York: Cambridge University Press, 2010).

[2] Pascal Le Masson, Armand Hatchuel, & Benoit, *"The Interplay between Creativity Issues and Design Theories: A New Perspective for Design Management?,"* *Creativity and Innovation Management* 20 (2011) 4: 217-218.

The authors also studied the interplay between creativity issues, design theories and design methods, and conclude that the tensions that drive innovation appear to be dynamic and persistent over time:

> "The dialectical interplay that links creativity and design theory is structured around the notion of 'fixation effect': creativity identifies fixation effects, which become the targets of new design theories; design theories invent models of thought to overcome them; and in turn, these design theories can also create new fixation effects that will then be addressed by creativity studies" (p.217) [2]

This analysis framework places the expert's individual professional development at the center of the design enterprise along with creativity as key drivers of design advances. The historical perspective is quite optimistic and even radical in its assumptions that progress is not overly subservient to monetary, political, and regulatory forces. Le Masson's views are being validated in practice by the increasing participation of first-time-builders and entrepreneurs coming into the marketplace using rapid prototyping methods from computer aided design systems (toolkits, 3D printing tools, open source CMS platforms, crowd sourcing research and beta-testing). These first-timers are injecting a level of ingenuity and imagination into hardware and software design manufacturing not seen in corporate behemoths.

Table 2.

Divergent vs. Convergent Thinking in Production

Overly Divergent Thinking	*Overly Convergent Thinking*
Lost time – Too much exploratory activity Lost focus –Too much prototyping takes away from focus on solutions Lost $$$ –Wasted time and focus results in a money drain	– Lost opportunities to integrate new knowledge – Lost opportunities to modify and innovate the production process –Potential loss of market-share to rivals

Human-centered design and human-factors engineering are now methods widely taught in graduate programs and should rightfully be advocating for the transfer of psychological knowledge into technical fields. However, it's important to note that these camps rarely concern themselves with the psychology of the individual, they are mainly focused upon anatomical, physiological, and perceptual motor factors in prototyping. In a recent paper for a

MIDI conference, Gilbert Cockton (2013) made the following observation about the lack of knowledge transfer between domains:

> [human-centered design's] weakness is that detailed design and implementation receives limited support from human-centered practices…….A more flexible, balanced and integrating paradigm is needed to combine the engineers' accountability with human-centered empathy and applied arts generosity (p.5).[3]

Cockton goes onto say that such activity has no current home—as in academic center—because academia tends to build centers around specific paradigms, or approaches. He calls for a "post-centric" design method that would not allow any one domain to dominate the design process.

Zahdi, Poldma, Baha & Haats (2012) have provided us with the most clear and concise course of action for how to organize design workshops with cross disciplinary participants to ensure equity, and to value discovery as highest aims. They proceeded from the premise that the design experience is essentially a knowledge building enterprise first, and a 'making exercise' as a secondary goal.

On another front, Oxman (2008), Oxman & Oxman (2014) addresses how digital media is challenging current architecture pedagogy at the university level by noting that digital media has broken down the lab experience and:

> "… [its] characterization of visual reasoning as a 'dialogue with the materials of the problem' and 'backtalk' from visual images, the digital and compound processes of formation, generation and performance of 'digital material' creates a completely novel view of design that may even justify the uniqueness of the term, digital design thinking." (p.116) [4]

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[3] Cockton Gilbert, "*Design isn't a shape and it hasn't got a center: Thinking BIG about excellences in post-centric interaction design*," Accessed 07/31/14, https://repin.pjwstk.edu.pl/xmlui/bitstream/handle/186319/145/MIDI_Cockton.pdf .

[4] Rivka Oxman, *"Digital architecture as a challenge for design pedagogy: Theory, knowledge, models and medium," Design Studies* 29 (2008) 2: 116.

Additionally, Le Masson et al (2011)[3] make the observation that much of future technical engineering design and manufacturing is going to take place from a new normal – that is, no firm object identity as a starting place (i.e.,cell phones and neutraceuticals). The authors also emphasize that expertise in any domain is the true currency of innovation for the future.

The importance of the previous observations is that they demonstrate architects/engineers openness to exploring the ephemeral, incorporating new elements of knowledge, and looking at the affordances and opportunities new production methods provide. In fact, advances in material design science is forcing discussion of this issue by its growing complexity; if the building materials themselves are 'alive' with nano-scale processes that can be more responsive to individual needs (biological, social, or aesthetic) then we have realized new pathways for making the ephemeral concrete. Just as animation and video have replaced the era of linear branching systems and binary toggling in visual displays of digital information, so too will narrowly defined concepts of mind as a basis for design come to an end.

Cultivating Ephemeral Knowledge Transfer in Technical Design

In answer to the question asked earlier….*why is it so difficult to operationalize and place value on what we do know about healthy human development in engineering contexts? …*the question appears less a matter of values and more about leadership and the availability of models that demonstrate how technical objects can be constructed using principles of human development. Those models have to be imagined and generated by the people with *that expert knowledge*. We can't expect the engineering community to think differently. Surprisingly, architects and engineers, rather than experts from the field of psychology, have voiced this dilemma most clearly and have been the most vocal advocates for integrating greater psychological knowledge into technical design. In terms of impacts, the biases or lack of integration of cross-disciplinary thinking is distorting the marketplace, resulting in products and services which serve industrial/corporate needs, not human needs.

The best example of how this integration can occur is in the learning sciences. Cognitive science has found its expression in educational technologies designed to reflect and engage conceptual change in thinking in childhood through adolescence. I'm not referring to the making of electronic books that simply mimic written texts—but to software and devices created using in depth knowledge of human development which informed new interfaces and new contexts for learning never seen before. When Seymour Papert and Marvin Minsky at MIT conceived of the programming language LOGO[5] for children in the 1960-70's it was a significant milestone for human interface design. Papert's application of cognitive theory and observations of children's classroom behaviors to the construction of LOGO and the floor Turtle[5] injected a new set of design parameters into discussions of educational software. This cross-disciplinary act forever changed the composition of design teams across the industry (Imholz & Sacther 2014) by making psychologists indispensable members of software design teams. This accomplishment calls attention to the fact that human to machine knowledge transfer as the highest aim of technical design falls far short of the goal of designing tools which amplify human creativity and intelligence.

Design theory, technical engineering methods, developmental, clinical psychology and psychiatry *are* intertwining at a snail's pace. Accelerating this integration in academia will likely result in a blaze of creative thinking and new design activities. If we are feeling the pinch of efficiency and instrumental reasoning as it has been applied to our daily lives and the devices and technical interfaces we interact with—we should remind ourselves we have the ability to change it. First, developing an awareness of the existence of design bias and its consequences needs to be articulated more clearly (is this article helping?). Seen as a design problem, the dilemma can be remedied by creating new processes for bringing together disparate disciplines in the engineering of objects. As a training problem, psychology disciplines can be introduced to design as subject matter in their education thereby affirming the clinician's identity as capable 'makers' and designers of therapeutic environments who have something important to contribute to the digital world.

In conclusion, we need to consider more carefully now design processes sustain or neglect the integration of ephemeral and psychological knowledge. As a starting place, we may need to develop a fresh vocabulary for discussing these issues with an interdisciplinary group of designers, theoreticians, psychologists, and engineers who can fashion these issues into research questions, design principles, and new design activities.

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