Chapter 13
The Methodological Pivot

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Abstract This essay formalizes a mode of inquiry called 'transdiscursive material practice' based on the communication theory of Niklas Luhmann. Technologies are understood to be in the environment of discourse, and thus amenable to an indeterminate number of disciplinary investigations, which are articulated within the operational closure of communication systems. This mode of inquiry begins with material practices which are refracted through any number of discursive lenses that are brought to bear on the prototype through the process of the methodological pivot.

13.1 Sketching Transdiscursive Material Practice

Today the place of making in inquiry is becoming increasingly prominent, not only through the expansion of doctoral programs in art and design, but also in the growing trends of developing makerspaces as part of a general innovation network connecting makers to educational institutions and startup accelerators and incubators. New interdisciplinary programs, whether mobilizing existing or producing new knowledge, are integrating the skillsets of art, design, engineering and computation toward new kinds of research in the academy, or products for the marketplace. Increasingly, there is a need for a first principles approach that can orient making and inquiry across any possible disciplinary and technical configuration, as existing models such as reflective practice, design thinking or art-based research do not fully capture the epistemological and discursive dimensions of developing a robust R&D program around making. New developments in understanding interdisciplinary collaboration, such as proposed by the concepts of 'trading zones' and 'interactional expertise' do not explicitly foreground making as a component of exchange amongst experts, beyond noting that artifacts can function as 'boundary objects' between disciplines (Gorman 2010). In making, however, the artifact is not at the boundary

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M. Filimowicz, V. Tzankova (eds.), *New Directions in Third Wave Human-Computer Interaction: Volume 2 - Methodologies*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-319-73374-6_13

but rather at the center of inquiry. It constellates its own multi-disciplinary character through the relevant methodological pivots.

This chapter will sketch a new variant of what might otherwise go under the headings of inter-, multi- or trans-disciplinary research and production, what will be called *transdiscursive material practice*. This mode of inquiry builds on Niklas Luhmann's concept of autopoietic communication systems, in which systems produce distinctions through operations of self- and other- reference in an environment to which they are structurally coupled. To remain a sketch, I will limit the discussion to a short summation of Luhmann's ideas.

In Luhmann's theory, technology is in the environment of communication. Distinctions, also understood as observations, are always produced by the autopoietic systems which produce forms of self/other reference, and which exist in various environments. For Luhmann there are three autopoietic systems that are the focus of his extensive oeuvre: social, psychic and biological. His 'supertheory' as he called it – by which he means a theory which includes itself in its own observations – proposed this triadic model as a solution and alternative to the traditional modern mind/body dichotomy. For Luhmann, only communication communicates, i.e. minds or bodies do not communicate. E.g. if a mind wishes to communicate, it would be through the structural coupling of language or gesture or some other form of meaning, since the operational closure of minds is demonstrated by the fact that we are not telepathic. Similarly, the body's processes are not open to either directives spoken in language or thoughts aimed at it, but has its own operational closure. If one becomes ill, positive thoughts directed at the illness tend to have little effect; rather medicine intervenes at the level of the body's own autopoietic and operationally closed processes. Mind, body and communication are systems that take each other as their local environment. The environment itself makes no distinctions, and it falls to the particular observing system to produce meaning through both its own operational closure and structural coupling to an environment.

> Observing systems...have *no contact with the environment* at the operational level. All observation of the environment must be carried out in the system as an internal activity with the aid of the system's own distinctions for which there is *no correspondence* in the environment. Otherwise, it would make no sense at all to speak of observing the *environment*. All observation of the environment presupposes the distinction between self-reference and other-reference, which can be made only in the system (where else?). (Luhmann 2012: 49)

> Communication systems do not know that communications contact nothing else but communications. Systems therefore operate under the illusion of having contact with the environment– at least so long as they only observe *what* they observe and not *how* they observe. (50)

> Technology...operates orthogonally to the operational closure of autopoietic systems. This is likely to explain why societal evolution takes recourse to technology in order to secure couplings between the societal system and its environment. (318)

> [C]ommunication has to presuppose technology and be able to rely on technology in all *present* operations (322)

Society is understood as an ecology of functionally differentiated communication systems, such as mass media, law, the economy, the political sphere, education,

art and science (or academic inquiry generally). In society, each of these communication systems is operationally closed with respect to the others, despite some relations between them of dependence, perturbation or structural coupling since they take each other as their environment in the ecology of society. While academic communication is functionally specialized and distinguished from other social communication systems, within academic discourse there is no operational closure between the disciplines, since in his terminology all academic knowledge is based on the same orienting code (to be discussed shortly). Communication systems, which are autopoietic (i.e. self-producing) are only operationally closed relative to each other when they change codes, programs and media. Such differences are not evident between different academic disciplines, since all of the academic disciplines are part of the same general communication system, and thus there are no operational boundaries between them. In everyday social contexts, academic disciplines might appear to have a kind of 'faux operational closure' between them that ultimately does not stand up to either analytic scrutiny or practical inquiry.

All academic disciplines are susceptible to cross-pollinations between them since by default there is no difference in the guiding codes, which are always binary. Examples of codes in Luhmann are:

- Law: legal/illegal
- Economy: possession/non-possession
- Politics: conservative/progressive
- Science: true/false
- Mass Media: information/non-information

In addition to codes, communication systems have media – such as money, ballots or television– and programs "to implement the code" (Mattheis 2012). In mass media, for example, the main programs Luhmann distinguishes are news, advertising and entertainment. Academic disciplines would be analogous to different programs which all share the same code – true/false, arguments about what Dewey (2013) would call 'warranted assertions' (one might say alternately – warranted or unwarranted assertions)– and the same media (e.g. academic journals and conferences). Operational closure exists between autopoietic systems such as law, economy, politics, science or mass media, which together comprise the ecology of society. But within such a system, however, there is no closure, and thus, within the system of science (or inquiry), all academic disciplines are in principle operationally open to all others, since they are only different programs using the same codes and media.

I argue that *transdiscursivity* emerges from this general empirical situation of all academic disciplines differing only in their programs for implementing the same general code in the same media. Further, all technologies are outside of, or in the environment of, all discourses. A discourse in the context of HCI research is a communication system for making distinctions about technology as the environment for human systems, whether psychological, physiological or social. In the context of making-oriented research, one way this is manifest is that there is no limited set of discourses that can be brought to bear on any technology, and in fact technology is open to discursive observations from any if not all disciplinary positions.

This general state of transdiscursivity is herein joined to material practice as a mode of inquiry. Material practice, following the main line of Western thought on techne and labour– from Aristotle through Hegel and Marx which is synthesized in Lukács' social ontology (1980)– is the entraining of causal chains to teleological positing, i.e. human goals. Material practice, as techne-labour, can be broken down into various components, such as the positing of the goal, investigation of the means, consideration of alternatives, contingency of past decisions, material constraints, social needs, posited vs. actual causality, being and reflection, material production and so on.

In material practice, causal chains are entrained or harnessed by teleological goal and means positing acts in order to bring something new into reality that would not otherwise come about through mere causality alone. No new material novelties can come into existence without being thoroughly founded in causal chains, but causality alone will never turn iron deposits in the earth into into a metallic instrument, for example. In the history of Western thought, the primary intellectual background for material practice begins with the Greek concept of techne and is developed further by the Hegel-Marx-Engels concept of labour, in which teleology becomes separated from its classical rootedness in all natural processes and becomes a specific feature of human historical development. In other words, natural events in more recent thought are not understood to have goals or ends as originally proposed in Greek philosophy, but human behaviour unavoidably does, and Lukács develops this theme throughout his social ontology.

Having here sketched the concept of material practice in order to establish its general import, we can pose the question: Why is it that the technological artifact can have any number of discourses 'thrown' at it, as it were? What makes it at the same time escape any particular discipline, and yet invite so many to it?

An answer to this question can be found in Luhmann's 'supertheory.' Technology is in the environment of communication, as something to be distinguished by discourse. While by necessity only a finite set of methodological pivots can be accomplished by a single researcher, there is no final and limited set of discursive possibilities. Pivots of this kind are possible because methodologies are practices of distinction and observation. Technology is in the environment of such communication, and thus is not in any meaningful way contained or constrained within it.

Luhmann's theory itself is an example of porosity across disciplinary domains. He was nominally a sociologist, doing "social theory," but in his development of a supertheory aimed to sublate philosophy in the same way that Hegel tried to sublate religion– i.e. integrate and surpass it– and so placed himself in an intellectual lineage with Kant, Hegel and Husserl. He borrowed heavily from two applied fields– the phenomenology of biology (the concept of autopoiesis of Maturana and Varela) and second order cybernetics (the systems theory which includes the observation of observation). George Spencer Brown's calculus of form and distinction was also integrated to understand cognition as the production of distinctions in general. In the realm of sociology– his nominal profession– he took from Talcott Parsons the concept of functional differentiation of social systems– but did not really follow the discipline's founders, such as Weber and Durkheim, in his conception of sociology.

The artifact, in the mode of transdiscursive material practice, stands outside of any particular discursive lens, being in the environment of discourse. The prototype is not there because one has previously gathered together many disciplines and then forged an artifact out of it, as can sometimes be implied in discourses of interdisciplinarity. I.e. first there is nothing, then the disciplines come together, and then there is something, with each discipline is understood as a distinct, coherent, and unified entity. Perhaps something like this happens in the case of such massively complex technical systems as the Large Hadron Collider, and other examples well conceptualized by Galison's notion of 'trading zones' (1997) and Collins and Evans' 'interactional expertise' (2002) applicable to complex experimental design in the physical sciences, where the artifact is specifically designed to answer research questions and advance disciplinary frontiers.

However, in a making process such as prototyping, it will often be the case that one has a sudden insight or intuition and just proceeds to build something more in the mode of Deweyan practical inquiry, and perhaps accompanied by Schönian reflective practice. The artifact is at the center, not the boundary, of inquiry. Once built, the artifact, which is the result of a process of teleological positing that gathers up the causal chains, occupies a part of the local environment and can then be the subject of multiple research trajectories, each one of which produces forms of observation and distinction. The unity and coherence of this process is what is meant by the notion of transdiscursive material practice.

13.2 Critique of Reflective Practice

Transdiscursive material practice is distinct from the notion of 'reflective practice' common in art and design research discourses. Reflective practice entails refinement in the ability to articulate and understand one's professional practice, which is often obscured by an individual's intuitive or 'tacit knowledge' (Polanyi 1966). It is typically confined to the sphere of a particular professional activity– such as architecture, nursing, or psychotherapy– and does not aspire to a wider range of discursive application, conceptual abstraction, or epistemic engagement, but has as its goal both better practice of the professional activity, and a more conscious, communicative and reflective explication of that activity.

The concept of reflective practice received its founding elaboration by Donald Schön (2008). Schön's aim was to establish a general "epistemology of practice" (Loc 60 & 63) to define and legitimate the often tacit knowledge and expertise of professional practitioners. However, what this epistemology actually looks like– e.g. as a stable set of principles or methods, in the manner of other widely used epistemologies– is not synthesized by Schön. One likely explanation for this lack of synthesis is Schön's unclear use of the term "research" in this canonical work, *The Reflective Practitioner.* One might wish to argue that professional reflection rises to the status of research when there are pathways established that allow one to traverse back and forth between general concepts and particular contexts. However, the dif-

ficulty encountered in this text is that while Schön tries to affirm or posit practitioners as researchers, all of his case studies show reflective thinking occurring only within particular professional contexts, without that thinking being worked up into a level of generality– by the practitioners themselves– that would satisfy the kind of meanings one would normally associate with the term "research," e.g. as expressed in publications of peer reviewed journals, which is a normative standard in the use of the term.

Schön's concept of research becomes a kind of desired status symbol to attach to the thinking of professional practitioners, and perhaps because of this only Schön himself, as a researcher, comes into possession of something like an episteme of practice, whereas the practitioners themselves, whose thinking he would seem to want to validate and affirm, do not quite become researchers into practice as Schön's epistemology would attempt to argue.

Schön's writing on research and epistemology is under-developed on several levels. For instance he writes, "universities...are institutions committed, for the most part, to a particular epistemology, a view of knowledge that fosters selective inattention to practical competence and professional artistry" (Loc 49) However it is too much a stretch to claim that universities affirm only one kind of epistemology, given the wide spectrum of disciplines and methodologies that constitute the contemporary university. Schön often appears to advocate that professionals should have different notions of rigor from the academy, which on more careful reflection cannot be the case – e.g. architects rely on the same physics as academic engineers, just as doctors do not have an alternative vision of science just because they are not teaching in medical schools.

Schön depicts universities as fostering only a single epistemology, which is defined in the negative as 'other than professional' (!) which mixes tautology and reduction with a counter professional or anti-establishment sentiment. Schön doesn't define what he means by "epistemology" other than to say that universities do it one way, and practitioners do it another way, and what isn't mentioned in this construct of defining something by what it is not are all the professional programs that have long since made their way into the academy anyway, e.g. business, law, medicine, architecture etc.

But Schön also finds fault in professionals, who are often inarticulate with regards to the ways in which they know things:

> It is as though the practitioner says to his academic colleague, 'While I do not accept your view of knowledge, I cannot describe my own.' Sometimes, indeed, the practitioner appears to say, 'My kind of knowledge is indescribable,' or even, 'I will not attempt to describe it lest I paralyze myself.' These attitudes have contributed to a widening rift between the universities and the professions, research and practice, thought and action. (Loc 53)

Thus there is a fundamental social rivalry set up, between the prestige of the academy and the social status of practitioners, and between the theoretical and the practical that at times seems to result in either ambiguous conceptual binaries or a straightforward competition for social legitimacy and esteem.

Schön does however assemble a formidable set of descriptions, elements and propositions that could perhaps form a coherent epistemology of practice, but if we wish to have one we will have to assemble it ourselves out of all the tantalizing and promising components that emerge from his case studies – like Nigel Cross (2011), his concepts emerge out of case studies of specific practices. Unlike Cross, Schön doesn't attempt formal modeling of his emergent concepts but perhaps this is an intended part of his discursive strategy, to not academicize the episteme of professional practice, but rather let it hover close to its empirical case context.

Should we wish to construct the epistemology of practice that Schön does not synthesize out of his many "vignettes of practice" (Loc 64) as he calls them, we would have to gather together the following elements, which exist only as brief textual elements, into a coherent scheme:

- It would move beyond "knowing-in-practice, most of which is tacit" (Loc 66).
- Professional knowledge would be discovered through "protocols of actual performance" (Loc 67).
- What one is looking for, and hoping to inspire, is "reflection-in-action" (Loc. 888 and elsewhere).
- Scientific application fails when it encounters "messy," ambiguous, and uncertain reality, or in dealing with conflicting goals and values (Loc 529–550).
- Problem setting is more important than problem solving. "Problem setting is a process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them" (Loc 656).
- The process of a successful solution emerges from Naming and Framing, or the gathering together of the main elements of the problem (naming) and becoming aware that one's solution is based on the ways in which one frames what one has pooled together in the naming phase.
- Theories are clean, reality is a mess: "In the varied topography of professional practice, there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and there is a swampy lowland where situations are confusing 'messes' incapable of technical solution" (Loc 678).
- Abandoning Comte-esque "Technical Rationality" does not imply abandoning what is sometimes called "instrumental reason" in the humanities: "instrumental problems are not given but must be constructed from messy problematic situations" (Loc 760).
- We have to accept "experience, trial and error, intuition, and muddling through" (Loc 691).
- An epistemology of practice makes implicit processes explicit.
- We have to account for and acknowledge the importance of knowing-doing, or doing-knowing (the interactive feedback loops between thinking while enacting in situated contexts).
- Research is equivalent to reflection. "When someone reflects-in-action, he becomes a researcher in the practice context (Loc 1095).
- The reflection of the practitioner often results from the "back-talk" of the overall situation. Reflection is in essence "a conversation with the situation" (Loc 1408).

- The reflective practitioner attends to a "web of moves" and cycles across the global implications of local moves which change the global situation and create new possibilities and constraints for the allowed local moves (Loc 1401, 1475, 1498, 1513, 1517 and others).
- Schön's concept of material practice is found in his notion of the back-talk of the material: "In the designer's conversation with the materials of his design, he can never make a move which has only the effects intended for it. His materials are continually talking back to him, causing him to apprehend unanticipated problems and potentials" (Loc 1492).
- Reflection-in-action can often involve metaphoric processes, a "seeing-as" in which analogies are traced across dimensions of the situation.
- Research of practitioners is "triggered by features of the practice situation, undertaken on the spot, and immediately linked to action" (Loc 4567).
- There are four kinds of reflective research: ""Reflective research," as I shall call it, may be of four types, each of which already exists at least in embryo. Frame analysis, the study of the ways in which practitioners frame problems and roles, can help practitioners to become aware of and criticize their tacit frames. Description and analysis of images, category schemes, cases, precedents, and exemplars can help to build the repertoires which practitioners bring to unique situations. A most important kind of research has to do with the methods of inquiry and the overarching theories of phenomena, from which practitioners may develop on-the-spot variations. And practitioners can benefit from research on the process of reflection-in-action itself" (Loc 4572).
- Practitioners do repertoire building out of their situations, establishing a background of possible action patterns that can be used to frame new situations. This repertoire is matched against and is in dialogue with the abstract theoretical models of the profession.

As should be apparent, Schön's theory doesn't seem to gel into the kind of conceptual form or model that one might typically desire of a set of concepts that claim to be a new epistemology. Rather, the writing style seems closest to a phenomenological analysis of professional practice, in its eschewing of formal abstract models for reflection-in-action, and preferring to stay thematically close to the vignettes of practice that Schön assembles. Schön's epistemology of practice is never presented directly in an all-at-once frame or formalized into a set of principles, but rather is a loose set of emergent themes closely tied to particular contexts. He ultimately seems to present a kind of phenomenology of professional knowing in action, rather than an epistemology that elevates professional reflection to the (somewhat coveted) status of research.

This critique of Schön's 'epistemology' of practice highlights it's insufficiency with respect to its own claims and aspirations to become research. It is not clear how professional knowledge, if it were to name itself 'research,' would differ in either media or code from the other established disciplines, at which point it would be understood as yet another program of general inquiry. Reflective practice articulates a valuable core of experience but ultimately needs to be accompanied by methods

elsewhere in use by other disciplines in order to realizes its own goals that it has set for itself to be a form of research.

There is a particular importance for reflection on practice underscored not by Schön but rather by Dewey, namely that experience is the main safeguard against forms of dogmatic orthodoxy:

> What is the reason for using the term [experience] at all in philosophy? The history of philosophy supplies, I think, the answer. No matter how subjective a turn was given to the word by Hume and Kant, we have only to go to an earlier period to see that the appeal to experience in philosophy was coincident with the emancipation of science from occult essences and causes, and with the substitution of methods of observation, controlled by experimentation and employing mathematical considerations, for methods of mere dialectic definition and classification. (Loc 36336)

What today we distinguish as 'art' versus 'design' has its origin in exactly such a 'dialectic definition and classification,' namely that of the Encyclopedists of the eighteenth Century who gave us the distinction of the fine (or 'final') arts relative to the useful arts. They were in turn preceded by the Scholastics who, in the medieval era, had divided the liberal from the mechanical arts. Behind both these dialectical classification schemas was the ancient Greek distinction of means versus ends. Today, every 'art and design' institution, or institutions in which there are 'art' units in one faculty division, and 'design' units in another, reflect in their organization exactly these non-experienced-based but rather conceptually and dialectically derived classification schemes.

The actual experience of prototyping yields no necessity for these categories, which are found not in practical experience but in ancient dialectical tropes, based on "divorcing means from ends" (Dewey's Moral Philosophy 2005). What becomes evident in prototyping with computational media is that there are no practical or meaningful boundaries between art, design, engineering, cognition, computing, workplace, a research project or aesthetic presentation within the artifact 'itself'– rather, these distinctions appear later as discursive and contextual additions that are useful only for scoping practical programs of research or creation.

13.3 The Methodological Pivot

The foregoing theoretical summary will now be grounded in a particular artifact to illustrate how the methodological pivot unfolds and why it is needed. Pixelphonics (PS) is a prototype system for the colocation of audio sources with their associated visual objects in screen-based media, a technology first described in *Apparatus, Method and System for Co-locating Visual Images and Associated Sound* (U.S. Provisional Patent No. 62/482725, 2017). The prototype produces a new form of multichannel audiovisual display in which the associated sound emanates from the specific screen areas of the moving image, allowing for colocated audio and visuals. The technology adds a new perceptual and experiential layer to the technology of synchronized sound, which has existed now for over a century, by adding its

spatial complement, so that sound can now be in place with its image, in addition to being in time with it. In contrast to surround sound arrays, which envelop listeners in an ambient sound field, Pixelphonics draws attention to areas of screen-based imagery, so that sounds are attached to their visual sources within the display just as they are in natural perception.

The application and user contexts for this new format of multimodal representation cut across many domains, briefly outlined below. The areas that have been identified for transdiscursive research have been organized below under the following headings: Home, Workplace, Industry, Education and Public Exhibition.

(1) Home

- Home Gaming
- Home Video
- Multi-stream video interface
- General Sonic Display

(2) Workplace

- Communications, Command and Control
- Work-based Telepresence
- Process Control
- Remote air traffic control

(3) Industry

- Pro Audio Hardware
- Audio and Video Editing Software

(4) Education

- Simulation-based Training

(5) Public Exhibition

- Large Scale Immersive Environments and Interactive Displays
- Art and Performance
- Virtual Arcades and Escape Rooms

Transdiscursive material practice proceeds by way of the methodological pivot, which builds upon established ideas of conducting interdisciplinary or multi-methodological research. What is perhaps new in this idea of the pivot, as applied to research, is a kind of agnosticism or multi-perspectivalism with regards truth paradigms, disciplinary boundaries, ensembles of methods, epistemes and theories of validity. As will be discussed below, the pivot differs in many respects from the similar concept of bricolage research. Moreover, the pivot is not quite equivalent to research ‘eclecticism’ as there is a clear anchor or ground that centers and focuses the inquiry, namely the prototype, which is a built thing, present nearby, concrete, and a catalyst for refracting any form of inquiry that may seem appropriate in the process of, and reflection on, its making.

Table 13.1 Investigation layers

Investigation Layers	Concerns
Physical	Acoustic & materials performance
Psychophysics	Perceptual organization
Cognition	Higher level cognitive processes
Cultural practices	Music, art, games, films
Social practices	Workplace environments

The term 'pivot' here is appropriated from the discourse on startups, economic disruption and technological innovation, its status in the popular lexicon captured well by a *New Yorker* cartoon caption of a man and a woman sitting at a cafe table: "I'm not leaving you. I'm pivoting to another man" (Art.com). The methodological pivot is an apt figure for the general method of transdiscursive material practice, since the technology, being outside of discourse, is available to any discourse and its related methods. The assemblage of methods are motivated by the requirements of developing a new technology of mediation which colocates sounds with the associated moving image. The selected discursive and methodological moves are summarized below (Table 13.1):

All of these layers can be integrated in order to fully investigate and develop a new representational format of multimodal display in which sound is colocated to visual sources in the video media, ranging from engineering considerations to human cognitive capacities to sociocultural forms and practices, all directed at a single prototype built in a 'cottage industry' manner in a basement studio. As might be clear from these tables, the total sum research potential exceeds what would typically be found in a single book-length volume, both in terms of potential length (word count and pages) but also strain at all genre boundaries as to what could constitute even an edited volume, since the audience diversity and disciplinary variation could literally make such a compendium unmarketable. Alternately, perhaps new genres of writing are called for, in which the artifact, as the phenomena at the center of discursive variation, constellates its disciplines and audiences irrespective of traditional academic conceptions. Parallel to this, transdiscursive inquiry through material practice would generally entail that the maker-researcher develop what Collins et al. (2010) call "interactional and contributory expertises" in other disciplines by publishing in the respective journals of other fields or collaboration with researchers in different disciplines.

> The difference between explicit, interactional, and contributory expertise can be summed up by reworking the distinction between "talking the talk" and "walking the walk." If "talking the talk" corresponds to primary source knowledge (knowing what has been said), and "walking the walk" corresponds to contributory expertise (actually being able to perform the task), then interactional expertise corresponds to "walking the talk"– that is, being able to use the language in novel settings in much the same way as a contributory expert might. (loc 832)

The methodological pivot is a strategy for developing new kinds of expertise, interactional and contributory, in the development of new computational media and design artifacts.

While the notion of a pivot is used in many contexts – for example, in foreign policy, the United States might be said to pivot toward Asia in contrast to its traditional focus on Europe and Russia, similar to the way a basketball player may pivot on the competitive court, who in turn pivots like a kind of mechanical connection– its use has been popularized by Eric Ries's *The Lean Startup* (2011) – and the considerable media content developed around the best selling book. Ries refashions concepts around 'lean manufacturing' developed in Japan by researchers such as Taiicho Ohno and Shigeo Shingo who pioneered new methods for working with small batches in large scale production lines. A pivot, as a research methodology, undergoes some transformations and analogies. The prototype, for example, is a material analog of the small batch since it offers the benefits of learning quickly while not consuming vast resources. There is the interplay of human intuition and imagination and rigorous research methods, and a rejection of persevering in a single method when there are clear indications that other methods may bring fresh perspectives. The concept also promotes a 'plucky entrepreneurial' spirit which is always useful for motivation in a making context. The prototype developed here can serve the purposes of useful artifact– with potential commercial potential– or artistic exhibition, and can work either as the setting for lab-like experimentation or creative expression. There is no need to foreclose commercial application when developing new technologies of multimodal display – designs exploring practical application may well have artistic outcomes and vice versa.

This fluidity between artistic and commercial activities is exemplified in this interview excerpt with Dimitri Nieuwenhuizen (Filimowicz and Tzankova 2017):

> You know the way it works here, there's LUST, which is formally a company, and there's also LUSTlab, and those are two entities and they're actually in two separate buildings, but pretty close to each other. And the purpose of the lab is that we need to do these ongoing continuous experiments. Trying both new theories, new methodologies, also new technologies that come out. We're not just trying to play with these things but conduct experiments with them. And usually that work ends up as autonomous installations which end up in museums all over the world, and we can put all our skills into that, all our thoughts, etc. And then, of course, as you can imagine, that delivers a lot of knowledge, and a lot of ideas, so that we actively try to look for interesting institutes or companies or whatever, that we can use these ideas and technologies for. And by doing so, we often manage to find the clients that we want to work for, so then the teams that form themselves when starting such projects, it's a very organic process. (302)

This distinction between LUST and LUSTlab, and the output of research as either museum exhibitions or client companies, is indicative of a pivot-rich material practice and research environment, in which "new theories, new methodologies" are applied in "continuous experiments" that produce "new technologies." In this context, the idea of "persevering" in a single research methodology (to borrow Ries's term) makes no practical or intellectual sense, or rather, one perseveres only so long as is required. Nieuwenhuizen gives a description of the extent to which one does in fact persevere in the process he describes:

> You know, if you do such an extensive research, and you dive so deep into the topic that there's nothing you can mix anymore, that you know so much about it, and parallel to that you start experimenting, you start making things, you start visualizing things, then at a certain moment those two things cross. And when they cross then you know you're on the right track and you've created something that you couldn't have thought of before. So you need this process. (309)

Thus the methodological pivot, as presented here, does not exactly do without methodological perseverance– or to use a more common word, 'rigor'– but that persevering rigor is far from an end in itself, and is taken up within a more overarching process of making which relativizes not just research methods, but implicitly all of the epistemic 'baggage' that comes with them (positivism, constructivism, activism, etc.). It could perhaps be argued that this idea of pivoting is encapsulated within what Creswell (2007) calls the 'pragmatic' paradigm: "consequences of actions, problem centered, pluralistic, real-world practice oriented"(23). Some have argued that the pragmatic (Feilizer 2010) and realist (Hall 2013) epistemes allow for the coherent complementarity of quantitative and qualitative methods, and these paradigms also happen to inhere in the position of grounding transdiscursive inquiry in a material practice. However, the artifact at the center of prototyping does not always need to be at the center of theoretical reflection, but rather can act as a general theoretical spur which prompts transdiscursive inquiry in lines of development that may not immediately serve real-world application and problems. This is because the process of making itself can also be at the center of reflection, and it is an easy shift from thinking about the physical prototype to consider the human making of it.

The methodological pivot, then, is a kind of 'meta-methodology' which uses the process of making a particular artifact as the 'pivot point' to frame inquiry as a discursive ensemble that the maker brings to bear in a manner akin to bricolage research but different from it as well, since bricolage inquiry has a particular association with qualitative research in the humanities and humanities-inflected social science, and nothing restricts the prototype to remaining strictly within a qualitative domain of inquiry.

While there is some conceptual similarity between the methodological pivot and what is more widely known as bricolage research, the latter term is not quite adequate for application in material practice as defined here. As mentioned already, with bricolage there is a particular connection to qualitative humanist discourses that the pivot moves well beyond in its 'catholicity' of inquiry. Here I will rely on Rogers (2012) historical survey of bricolage research to distinguish it from the pivot.

> Bricolage research...can be considered a critical, multi-perspectival, multi-theoretical and multi-methodological approach to inquiry. However, the theories that underlie bricolage make it far more complex than a simple eclectic approach. (1)

The notion of bricolage research takes its initial spur from Levi-Strauss's *The Savage Mind*, in which the anthropologist made a contrasting distinction between a method of meaning-making that makes "use [of] the tools and materials 'at-hand'" versus "the work of engineers, who follow set procedures and have a list of specific

tools to carry out their work." With respect to the notion of the methodological pivot, the bricolage research concept becomes immediately limited in this at-hand vs. engineering binary construct, since engineering method can actually be one of the pivots. In fact, in the PS prototype there is a custom-made hardware component, a 32-channel audio amplifier which was built by two electrical engineers. The methods of engineering are not beyond the scope of what can be pivoted to.

It is primarily in the area of multiplicity of approaches that the pivot overlaps with bricolage research. As Kellner argues, "the more perspectives one can bring to their analysis and critique, the better grasp of the phenomena one will have and the better one will be at developing alternative readings and oppositional practices." (cited in Rogers: 2). Again, however, the pivot differs from this conception. The methodological pivot is not only about producing "readings," but in the context of making, is about producing functioning artifacts. Bricolage research, as qualitative humanities methodology, is primarily oriented to texts and readings, or phenomena read as texts. Also, many of the authors associated with bricolage research (Kellner, Kincheloe, McLaren, Steinberg, Berry and Watt) impart strongly political and anti-empirical strains to bricolage research that are not essential and even contrary to the methodological pivot.

First, it will be clear that prototyping a new design for multimodal display is not the most politically contested field of inquiry and not a particularly ideal site for activism or what Creswell (2007) calls the transformative paradigm. Secondly, and far more importantly, the anti-positivist strain in bricolage research, or what some of its theorists call "the monological" is actually unwelcome and counterproductive. In Creswell's model, bricolage researchers in the main adhere to what he calls the constructivist paradigm, or in some cases mix the constructivist with the transformative, such as McLaren and Kincheloe who "[extend] bricolage to activist levels" (Rogers 2012: 13) since simply "developing an awareness of power and embracing subjugated knowledges might not be enough for bricolage to be considered a political research praxis."

The anti-empirical strain, however, is most problematic for material practice, since artifacts are capable of assembling causal orders that crucially pose challenges to imagined theories.

> The epistemological basis of positivism suggests that knowledge of the world is obtainable only through the objective scientific examination of empirical facts. Positivism proceeds on an assumption that scientific research will lead to the development of an understanding of world, and human interaction in "concrete and universal terms" (8)

Berry argued that "positivistic and other traditional research designs tend to work with the singular, linear, step-by-step structure."

> These strict positivist methods, like those of a metaphorical meaning-making "engineer" in Levi-Strauss's *Savage Mind* (1966), uncover "truths" about the social universe that exist independently of humans. (8)

The methodological pivot can embrace these positivist, strict, linear, 'monological' and 'formal' methods, and can accept– in some cases or with some kinds of phenomena– the empirical position that states of affairs in the world can be what

they are independent of what we know about them or how we model them. Material practice embroils one in causal chains, properties of materials, functions of mechanisms, real things, entropy and so on that are the discursive stuff of technoscience. The pivot is not saturated by any single truth paradigm or episteme, and can as happily embrace the social constructivist dimension when needed– for example, when it comes to aesthetic matters– and 'switch gears' to consider our 'hardwired' cognitive capacities if multisensory processes subsequently come under consideration.

While bricolage research can claim to assemble a wide array of methodologies– Rogers names "discourse analysis, deconstruction, Foucauldian genealogy"(4) and "ethnography, content analysis, historiography, cultural studies analysis, rhetorical analysis, semiotics, and critical hermeneutics" (10) as examples, from a prototyping perspective this is a small corner of the overall methods that are indeed 'at hand' in the original sense of bricolage as appropriated by Levi-Strauss. However, what this 'at-hand' means today is not clear, since it could be said that the internet makes nigh everything at hand! This at-hand quality is not an essential feature of the methodological pivot, since one can always go out of one's way to seek out that which is not at-hand, whether that means learning a new skill, hiring an external firm, or finding collaborators.

Nonetheless, there are some fruitful convergences with bricolage research to note, such as the connection Denzin and Lincoln make to "emergent design" (cited in Rogers: 5):

> The solution (bricolage) which is the result of the bricoleur's method is based on an [emergent] construction...that changes and takes new forms as the bricoleur adds different tools, methods, and techniques of representation and interpretation to the puzzle." (5)

Material practice, however, arrays not just representations and interpretations, but also causal chains, an appreciation and understanding of which requires empirical epistemic commitments, which in general are eschewed by bricolage research. Presumably, a transdiscursive material practice would never become a discipline in its own right, unless the technology developed for some reason evolves into a major field.

The prototype reveals what Ihde (2012) might call its "multistability" as it is investigated through a series of discourse variations which run the prototype through the wringer of multiple epistemologies, methods and their discursive frameworks, in order to capture as fully as possible the potentialities of the system, whether those potentials are in realms of meaning, experience, or function.

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