In Section I, I trace out four paradox that need to be addressed in order for forms of such hybrid material-conceptual practice to be legitimately included within STS and the humanities and interpretive social sciences more generally. In Section II, I walk the reader through an exercise in critical making. I end with some thoughts on how to proceed.

## I. Rocks

Before you begin to read this article, please go outside and find a largish stone, though not so big that it cannot be easily lifted and carried indoors. Bring it in, and immerse it in a pail of water or under a running tap. Then place it before you on your desk – perhaps on a tray or plate so as not to spoil your desktop. Take a good look at it. If you like, you can look at it again from time to time as you read the article. At the end, I shall refer to what you may have observed. (Ingold, 2007: 1)

Tim Ingold kicks off his article ‘Materials Against Materiality’ with the above instructions, encouraging readers to engage materially while simultaneously engaging discursively with his article. Like Ingold, I encourage you, the reader of this chapter, to carry out his instructions now. Like him, I will return to your experiences later in this piece. I do want to point out how these instructions capture what I believe is key to critical making – the hybridity of material and discursively mediated experiences and how both can act as resources for individual and social transformation.

Taking this a step further, I understand critical making to encompass a recursive relation between two modes of engagement with the material world - making oriented towards self-reflection and discovery, and making oriented towards external impact and social benefit. This relation is the pivot point around which we can highlight modes of engagement that offer up novel ways forward. The work that needs to be done regarding critical making is therefore not so much developing new practices and forms of work, but in simply revealing and highlighting modes that are already present but undervalued or even deliberately hidden. We need to describe and cultivate what is common to critical making engagements - no matter the context or ultimate goal. Whether the focus is on material intervention, exhibition and display (as in the work of critical designers), or scholarly extension and critique (as in the work of the digital humanities), all these engagements share moments where the material and the conceptual are brought together in generative ways. These moments and the development of the skills, perspectives, and ‘habits of mind’ that help instantiate them are the ultimate goal of my work.

Making - understood in its simplistic sense as engagements intended to transform the material environment - can therefore be understood as critical in two different ways. These are of course analytic differences, but they serve as a useful starting point for a more detailed engagement with the theory and the practice of critical making.

## Making as Reflecting

First, we can consider making as critical when the processes and activities highlight the role of material resources in both processes of discernment and in communicating the results[[1]](#footnote-1). Here, critical making can be considered as sensuous engagements where the materials in play serve as a resource for reconceptualizing the acts of production and the subjectivity of the producer.

There is a long history in conceptualizing and activating the general concept of making as part of a process of reflection and learning. From constructivist forms of pedagogy such as those developed by Papert, to reflexivity in practice articulated by Dewey and later Schoen, to concepts of craft knowledge described by Harper, Sennett, and Crawford - all of these forms share an interest in how individuals develop the capacity to engage and reflect through material engagements. This is a well-studied phenomenon, particularly within the disciplines of Education and Cognitive Science, though often bounded, perhaps not surprisingly, by a realist ontology that focuses attention on a natural world. In other words, much of this work remains stoutly focused on how individuals parse a natural world and the laws that govern it.

The work of Papert serves as an influential example. Papert’s constructionism emphasizes the importance of material engagement in processes of intellectual development and the role materials play in three specific elements of learning. First, Papert incorporates the emotional dimension of learning, noting that the assimilation of new models of the world always involves endowing new understandings with a “positive, affectual tone” (Papert et al. 1998). Second, Papert emphasizes the use of transitional objects—gears, computers, other physical objects—as a way of connecting the sensorimotor “body knowledge” of a learner to more abstract understandings. Here, he emphasizes that these objects do not just serve to “illustrate” concepts but act as means for projecting oneself into an abstraction. Third, Papert, referencing Hawkins (1965) notes the importance of “messing about” with computers in order to overcome the “rigid style of work” typically associated with them. These three elements - affect, embodiment, and the overcoming of traditional instrumental perspectives - seem prescient given the ways these themes have more recently dominated social theory on technology. However, for the most part, constructionism has remained as part of a learning theory deeply embedded in science and technology education, maintaining the forms of realism related to both. Hints at how a more epistemically pluralist form of learning might be fostered are present in Papert’s work, and in particular in a chapter written by him and Sherry Turkle (Papert and Harel, 1991, Constructionism, ch. 9) but these remain under-explored.

**Paradox one - there remains a commitment to realist ontological claims often held within constructionist pedagogy that needs to be overcome in order for these forms to be embraced within disciplines (such as the interpretive humanities and social sciences) where such claims are held as suspect.**

Leaving aside the realist ontological claims, critical making in this form parallels the hermeneutic approach described by some (Habermas for one) as typical of literary critical theory (cite). Critical here is taken to be synonymous with reflexivity and the primary activities are those of reflection and interpretation. In this light, making is critical in so far as it allows us to interpret and understand the world. In a recent book, David Gauntlett - well-known for his pioneering work ‘Making is Connecting’ highlights precisely this focus on material production, noting that “Making things has always been a way for humans to think about things, critically and reflectively.” (Gauntlett, 2014: Making Media Studies). In the conclusion to this book, Gauntlett worries about separating critical making from everyday acts of making, concerned that “…the idea that the ‘critical’ and thoughtful version of making is something done by politically-aware professionals positioned – perhaps unintentionally – in contrast to other acts of making done by others, is unfortunate.” (126).

Gauntlett’s points are well-made - it is certainly not the case that reflexive making is only the domain of professional ‘critical makers’. The carpenter who makes a decision to use lumber from sustainable agricultural practices or the plumber who decides to use lead-free solder are both examples of everyday practices of reflexive making. From the 'tinkery business' of science (Norris, 1993) to the bricolage of Harper's 'jack-of-all-trades' (1992), detailed ethnographies of work have tended to highlight the ways material labour often involves coming to terms with local contingencies (Knorr, 1979), addressing the resistance of materials to our attempts to make use of them (Ingold,2007) while, at the same time, engaging in complex cognitive operations (Rose, 2004). In fact, some of the major outcomes of anthropologies of work have been to understand material practice as not merely the following of plans (Suchman, 1987) or as simple habitual non-cognitive action (Harper, 1987). Still, culturally, we continue to struggle with strong separations between intellectual work - often seen as happening beyond the sphere of the material world - and material labour - often depicted as a-conceptual and non-cognitive. Mike Rose, in his groundbreaking study of the intellectual aspects of manual labour writes:

It is as though in our cultural iconography we are given the muscled arm, sleeve rolled tight against biceps, but no thought bright behind the eye, no image that links hand and brain. (Rose, 2004: xiii)

So it seems more work must be done to reveal the ‘bright eyes’ as well as muscled arms of making. Insights regarding the reflexivity of making are found in both classic accounts of material work and reflexivity (e.g. Pirsig, 1974) as well as in newer articulations that focus on the value and importance of physical labour, particularly given the seemingly immaterial nature of so much modern work (e.g. Crawford, 2010). But despite the importance of such work in overcoming the simplistic platonic divides between body and mind that have troubled so much modern thought, the reconnections highlighted in these texts often seem retrospective and romantic. One reason for this may be the focus on the individual mind and singular body, with the value of reconnection being about reducing individual alienation and encouraging a kind of Maslowian self-actualization.

**Paradox Two – in our move to incorporate making as part of a critical repertoire we need to avoid the material romanticism and individualism that often colors this work.**

There is, therefore, work to be done in better understanding not just the intellectual nature of material work but also how such work connects up and engages with larger conceptualizations of society. We are not just interested in reflexive making per se but in how making can help us better understand the socio-technical nature of society. The pure focus on making and its cognitive nature needs to be extended to encompass theories of knowledge, of power, and, given the technical mediation of society, the role of technoscience itself as a dominant form.

I agree therefore with Gauntlett that “…all making…can be critical making; and critical making – or, as I would call it, making – is a ‘tool for thinking’ for everybody,” (127). But I do think that the key phrase in this text is ‘can be’. Yes, all making ‘can be’ critical making - but activating this possibility requires, first, overcoming the cultural tropes and disciplinary conventions that position making as merely an instrumental, habitual, hand but not brain, activity, and second, reconnecting making to the larger social structurings that work to determine social life. To review the two main points above, we need to overcome realist predicilictions often associated with constructionist modes and, as well, move beyond the individualistic and often romantic forms associated with making.

## Making as Intervening

We also understand making as critical when the intention is to transform or change the world. Here, critical making can be understood as material engagements intended to increase our understanding and ability to intervene productively in the larger socio-technical world. These forms of critical making are more directly attached to criticality in its Frankfurt School sense (Horkheimer, others) as focused on increasing the liberatory forces within modern society. If critical making in the first sense tends us towards engagements that focus on individuals and the material world, then critical making in the second sense focuses our attention outward, from the individual to the society, and asks us to think/make work that posits and performs socio-technical transformations.

I want to elide two types of activity that are often held separate; interventions from science and engineering aimed at instrumental ‘utility’ outcomes, and those from art and design directed towards expressive and social criticism. Engagements that use such names as ‘critical design’, ‘tactical media’, and ‘civic science’ link material practices and critical thinking in productive and insightful ways. Artist-designer-scientist-scholars such as Natalie Jerimijenko, Bill Gaver, Tony Dunne, Carl DiSalvo, Fiona Raby, Dara O’Rourke, Gwen Ottinger, Sara Wylie, Joanna Drucker, William Turkel, Phoebe Sengers, Helen Nissenbaum, Ian Bogost, Jonathan Sterne - to name just a few[[2]](#footnote-2) - use material work to expand the register of scholarship on issues such as the natural and digital environment, the role of industrial design and technologies, history, science, and more. Recently, Garnet Hertz, then an Artist-in-Residence and Research Science at UC Irvine now Associate Professor at Emily Carr University, solicited contributions on the topic of ‘critical making’ from a broad range of artists and academics, including some of the people named above. He compiled these into a series of handmade critical making booklets that cover a gamut of topics from childhood to making to manifestos. The resonance of the term can be taken to indicate great interest not just in social critique and not just in the maker movement more generally, but in the conjoined material-conceptual practices shared by many of the contributors.[[3]](#footnote-3)

I have been suspicious of critical making endeavours aimed at external show, and have written about this elsewhere. (medium piece) Here I only want to note the potential issues with too heavy a focus on the making of things for others but also the issues with too insular a focus on making for ones self. Moving beyond both issues requires direct attention to the epistemic commitments of the disciplines of technical work – including from engineering as well as design.

**Paradox three – how to work within, critique, and remain cognizant of the epistemic commitments of the science and engineering as well as art and design communities in which we engage in order to maintain the commitments of our own disciplinary affiliations?**

The different modes described above are of course analytic rather than real – most critical making activities partake of both kinds of activities, often shifting implicitly between personal reflection through making and forms of intervention through making. I believe both modes are valuable and that successful projects of either overt goal can benefit from clearer relations to the other. For example, work aimed at increasing the technical literacies of children by exposing them to coding or basic electronics (increasingly prevalent activities within public institutions such as libraries) might benefit from the kinds of social thinking that is necessary to contemplate intervention. Equally, interventionist goals can benefit from enhanced ‘thinking through’ the potentialities of the physical systems being engaged, a process where material reflection is paramount.

## Return to the rock

Return to Ingold - asks us to examine to rock, see how it has changed as it has dried etc:

Stoniness, then, is not in the stone’s ‘nature’, in its materiality. Nor is it merely in the

mind of the observer or practitioner. Rather, it emerges through the stone’s

involvement in its total surroundings – including you, the observer – and from

the manifold ways in which it is engaged in the currents of the lifeworld. The

properties of materials, in short, are not attributes but histories. (Ingold, Materials Against Materiality, Archaeological Dialogues 14 (1):1)

His point here is not so novel – basically deessentializing aspects of material object, demonstrating the environmental links etc. But what is novel is the means through which he asks us to experience and better understand this insight, utilizing hands-on material experience as a supplement to conceptual reflection. This is an important reminder, and for me, a model of critical making activity. But I reference this article for a different reason. I do wonder how many readers of Ingold’s article actually followed his instructions, finding a rock, putting it in water? Instead, how many people simply take the instructions as a kind of conceptual exercise, letting to textual description of another’s actions stand in for personal material experience? I have to come clean here myself – I probably read the article two or three times before feeling the needs to actualize the experience. This points to the fourth problem with critical making:

**Paradox four: How to address continuing deep belief, ‘habit’ of relying on discursive, linguistic description as ‘site’ for critical reflection (even within ourselves!)**

These four issues are both problems to be addressed but are also productive in the sense that our attempts to engage with them produce novel insights that may be productively deployed in STS and other fields. I want to make it clear here that I do not believe that individual scholars working alone can actually come to terms with these issues – addressing them will require ongoing, collaborative, and institution-changing work that is both fraught and potentially transformative within the humanities and social sciences more generally. To flesh out some of these issues more specifically (and taking our lead from Ingold’s rock) I turn next to a conceptual-material exercise.

1. It is misleading to distinguish critical thinking and critical making by saying that the latter involves material mediation while the former is entirely ‘mental.’ There is a diversity of work that notes the importance of material mediation in processes of cognition, including scholarship associated with Cultural Historical Activity Theory (Vygotsky, Leontiev, Engestrom, Nardi & Kaptelinin) and third-wave cognitive science of which Hutchins is a primary example (Cognition in the Wild, Hutchins, 1995) However, what differentiates critical making practices are their explicit attention to the role of the material world and the resources it provides for conceptualization and communication. [↑](#footnote-ref-1)
2. This list of names is not in any way exhaustive - but it is intended to represent the diversity of contexts and disciplines involved in material-conceptual practice. These include computer science, Design, STS, Law, History, Literature, Environmental Science, and Art. [↑](#footnote-ref-2)
3. do I need to add links here to scholars such as Mathew Fuller - media ecology, Lisa Gitelman, Parikka, Kittler? that do not do art of their own but do provide frameworks and methods for contextualizing, analysing, and relating it? think about this [↑](#footnote-ref-3)