Beyond conversation: Palpating the hybrid materials

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Abstract: Based on an episode from a design case, it is argued that explorative interaction design with hybrid materials combining physical and digital properties is better conceptualized as palpating the hybrid materials, rather than having a conversation with them. This leads to a proposed design strategy for designers working with hybrid materials: to build prototypes and do material experiments in a way that foregrounds immediate sensate feedback and externalizes responses that are normally not perceivable.

Keywords: design of tangible interaction; hybrid design materials; design strategy.
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Introduction

Designers need to know their materials. This is a more or less undisputed statement in traditional design contexts (as well as in the traditional arts and crafts), and it is a strong historical reason for the way design educations have been organized with generous amounts of up-front material and workshop training. In the context of interaction design, however, it is not quite that simple.

First, there is currently considerable support for the position that interaction designers do not need to know materials in a traditional sense — as design is becoming increasingly immaterial and social, designers should rather serve as facilitators of sociomaterial change or instigators of sociomaterial interventions, the argument goes (for a prescient example, refer to Thackara 1988). This is a worthy topic in its own right, but not one that I will be addressing here.

This paper concerns the other part of the complication involving interaction design and materials: If we accept the notion that interaction designers need to know their materials, then what are the materials of interaction design? It was perhaps true twenty years ago that the primary material for interaction design was software, and to the limited extent that we do have interaction design theory addressing the question of designerly material knowledge, it tends to be focused on software (Tognazzini 1996; Víctor 2006; Winograd 1996; Özenc et al. 2010).

Today, with the Internet and the mobile Internet followed by the Internet of Things, it is undeniable that interaction design’s materials are increasingly hybrid materials, combining physical properties such as form, texture and weight with digital ones including behavior, responsivity, mediality and transience. So far, this development has mostly influenced the literature in terms of the users’ experience, ranging from seminal work on tangible interfaces (Ishii and Ullmer 1997) to what has recently been branded “the material turn in HCI” (Stolterman 2006) attracting ever-growing volumes of research. However, there are a few recent studies that consider specifically the design processes and the designerly knowledge of the hybrid materials (van den Hoven et al. 2007; Vallgårda and Sokoler 2010; Wiberg and Robles 2010; Wiberg 2014; Arnall 2014). This paper should be seen as a minor contribution to that emerging body of scholarship.

Speaking of relevant design theory, it is clear that most concepts and theoretical constructs we appropriate into interaction design draw on studies of more established design disciplines where the materials are predominantly physical. Shouldn’t that be an adequate complement to the software-centric concepts native to interaction design? In my opinion, the hybrid materials need to be explored in their own right (cf. Fisher et al. 2012 on “digital craft”), rather than being treated as a simple sum of physical plus digital. Prompted by Dearden (2006) and inspired by a more
A general question and a modification were formulated to seed the work: “How can I make a book that knows which page it is on? And can I do so in ways that refer to classical bookbinding craft?”

It should be noted here that the idea of a book that knows which page it is on is not completely new (Korabiewski and Litten 2010; Wegrzyn 2012). It is also not entirely without potential applicability: it is easy to imagine a photo album augmented with a dynamic soundscape, for instance, or a user manual for a digital product where the display on the product’s screen updates to follow the progression through the manual. Or a social reading application providing peripheral awareness of other readers focusing on the same part of the text as you.

The purpose of the Capable Books project, however, is not primarily to propose new product concepts but rather to gain insights into designerly knowledge and processes relevant for hybrid materials — and these insights should hopefully extend beyond the specific domain of augmented books, which then serves more or less merely as a case study. The core perspective of the project is a somewhat archaic one in an age of design thinking and grand-scale systemic conceptualizations of design — more than anything else, it is based on respect for craft skills, attention to detail, and curiosity as to the potentials of the design materials.

Context: Capable Books

The work forming the basis for this paper is an ongoing project called Capable Books. It is an individual, explorative effort within the field of interaction design; more specifically, it falls within the subfields of physical computing and tangible interaction.

Most work in interaction design aims at solving existing or potential problems for users, or arises from insights into particular use contexts. The Capable Books project, on the other hand, was conceived as an explorative inquiry into the nature and qualities of hybrid interaction design materials where the physical and the digital meet. Due to the fact that I am an interaction designer with a decent level of working craft knowledge in traditional bookbinding, the choice was made to combine software, programmable microprocessors and electronic sensing with the physical materials of hand-bound books.

recent analysis of the agency of interaction design materials (Tholander et al. 2012), this paper aims at showing how one particular appropriated design-theoretical concept — Schön’s (1987) notion of design as conversation — can be usefully refined for interaction design as palpating the hybrid materials.
The CB01 design story: Measuring resistance across top-edge “gilding”

— How can I make a book that knows which page it is on?
And can I do so in ways that refer to classical bookbinding craft?

The initial phase of the project was carried out in the spring of 2014, and involved listing a dozen ideas for augmenting the venerable construction of a book to measure which page (or, properly speaking, which spread) it is open to. Some of the deliberations are reported elsewhere (Löwgren 2014); it was decided to devote the first attempt — the experiment labeled CB01 — to the idea of measuring top-edge resistance. The data used to report this case study consists of dated notes, drawings and photographs captured throughout the design process, together with the artifact itself.

In classical bookbinding, it is not uncommon to see books with a gilded or marbled top edge. My idea was based on the rather obvious observation that the width of the left half of the top edge, between the front board and the current spread, varies. I also knew that the resistance of a conductor generally varies with its intersection area: a wider conductor has lower resistance. In principle, then, the resistance of the left part of the top edge should be inversely proportional to the current spread number.

The remainder of the paper introduces a particular design episode from Capable Books in some detail, then moves on to discuss the nature of the exchange between designer and material in that episode. The main point of the paper is established: that the dominant metaphor of design as a conversation with the materials can be usefully refined into palpating the hybrid materials. The implications of this proposal are discussed and finally it is assessed, albeit very briefly.
(All illustrations are by the author unless otherwise credited.)
I painted patches of different widths using BarePaint, a cheap conductive paint based on graphite, and verified that the resistance varied with the width of the patch. Next, I prepared a text block for CB01 using heavy-stock paper in order to get significant width differences from each page turn, sanded the top edge carefully and colored it with BarePaint. In order to get two measuring points, I stitched a conductive headband that would be in contact with the painted top edge, and placed the text block on a metal contact touching the top of the first page. Measuring the resistance using a multimeter while opening the text block to different spreads proved difficult, and I was not able to find a predictable relationship between current spread and measured resistance. I thought this was due to the physical manipulations involved and how different they were from how a book is normally handled.

The CB01 book was then case-bound in conventional style and a strip of aluminum foil was attached to the top of the first page to provide a measurement point opposite to the conductive headband. I connected the book to an Arduino board running code to measure the resistance between the foil strip and the headband. I also wrote a piece of Processing code to display the momentary and floating-average resistance being measured by the Arduino.

When testing CB01, I quickly concluded that the resistance measurement bore no predictable relationship to which spread the book was opened to. However, it was apparent from actually handling the book that the amount of pressure perpendicular to the pages had a direct effect on the measurement. This “failure” to get repeatable measurements was most likely due to a combination of poor contact with the foil strip and the relatively low conductivity of the graphite paint used, but that is beside the point. Instead, the point is this: **CB01 turned out to be a pressure-sensitive book**, rather than a book that “knows” which page it is on.

With hindsight, this result may seem rather predictable, but as evident in the project diary I did not anticipate it while building CB01. And when I realized that the book was pressure-sensitive, then of course all kinds of new application ideas presented themselves, from providing feedback on writing quality and offering subtle social cues when reading in public to controlling the speed of synthesized text-to-speech for reading learners.

To me as a traditionally bred interaction designer, this is a common trajectory when working in pure software for screen-based interfaces — you try to implement an innovative interaction mechanism, you play with it, you are surprised by its dynamic behavior, you see new directions for pursuing the work. It was reassuring to experience a similar sense of surprise-leading-to-ideation when working with a hybrid material. In the next section, I reflect on this experience and what we might be able to take away from it.
Reflection: What kind of exchange was there with the material?

When studying or teaching interaction design, the stock metaphor for understanding material exploration is the one of conversation. Donald Schön’s (1987) notion of reflection-in-action has been very influential: while sketching or crafting, the designer makes a little move—testing experiment in the moment. The designer then observes the outcomes of the little experiment. This is framed as a conversation with two turns: the designer proposes a what-if, the material talks back to the designer. It is important for the designer to “listen carefully” in order to “hear” what the material says, to help determine the further course of action.

The CB01 story contained roughly the following conversation, in Schönian terms:

*Designer:* Can I measure the resistance across the top edge to indicate how many pages?

*Material:* No, you can’t, because the measure I can give you depends on the pressure.

*Designer:* OK, so what you’re saying is that I have made a pressure-sensitive book? Interesting!

This conversational account is actually rather accurate, on some level, and captures the gist of the story well in retrospective. But here is the catch: the metaphor of conversation implies articulation removed from the actual first-hand experience. And interaction with hybrid materials is inherently physical. Thus, the conversation metaphor might work well for descriptive or analytical purposes, but it does not do much for our understanding of how to design in hybrid materials. In other words, it may not be very generative.

To illustrate this concretely, I didn’t anticipate the particular configuration of top edge paint and contacts to be pressure sensitive when I thought about it, nor when I drew sketches of it with a pencil on paper. When I had the text block on the table and tried to measure it with a multimeter, the results were inconclusive because I wasn’t handling an actual book in the way my hands are accustomed to. The insight emerged only when I had the CB01 book, with its customary physical book affordances together with the visualization of measured resistance: from “it doesn’t work as intended” to “it does something else” and then “it is pressure sensitive.”

It now seems that the metaphor of conversation actually hides something important, that may be relevant for our understanding of hybrid interaction design materials. Let us return to the details of the story: I have made the CB01 book and the software, and now I hook it up. I hold the book in my hands, flip it open, close it, open to another spread while looking at the
screen of the attached computer where the measurement is visualized. The resistance bar is not moving to proportional and predictable heights, as I was hoping for. I close the book and hold it. Now, the bar is not still but actually moving a little bit. This makes me curious; I wasn’t expecting that. Why is it moving? I think back to when I was testing the text block with the multimeter, and the difficulty in getting a stable connection between the first page and the metal contact. I had to apply … pressure! I start squeezing the closed book, and the bar goes up as I press harder. I put the book flat on the table and try applying different amounts of pressure to the top half. It is quite straightforward to learn to control the measurement bar by pressing on the book.

In this little phenomenographical account, it seems clear that the key is my ability to perceive the dynamic reaction through the bar on the computer screen and how it visualizes the resistance measurement in real time. This enables me to discover the nature of the connection between action and reaction, between physical manipulation and perceivable result.

This embodied, tightly-coupled exchange between me and CB01 is not very usefully rendered as a conversation. I would propose that it is better understood as a palpation.
Palpation is originally a medical term, meaning to examine a patient’s body with your hands in order to assess the texture of tissue, to locate anatomical landmarks, etc. In more general use, it means to feel with your hands in order to assess or determine something, and it has also been subject to transferred use in a variety of semantic domains.

Here is the reason why I find it to be an interesting metaphor for designing hybrid materials: When you palpate something and want to share your findings with someone else, you never simply say: “the lever feels like it is coming loose.” Sharing would always involve inviting the other person to feel the lever, possibly guiding their hand if necessary. In cases like these, the spoken words are indices of something originally non-verbal; understanding and insight requires first-hand sensation. To me, palpation appears to capture the embodied nature of hybrid interaction better than conversation does.

The practical implication of this, then, can be seen as a design strategy:

- If you want a hybrid material experiment to fuel your design process, and possibly open new directions of inquiry, then seek to make the experimental material palpable.
- Build your prototypes in ways that foreground the immediate sensate feedback, whether it is tactile, visual or other-modal.
- Take advantage of the malleability of the hybrid materials to externalize responses that are normally not perceivable.

Discussion: Is this a knowledge contribution, and how good is it?

Why should this idea of palpating the hybrid materials be seen as a research result, a knowledge contribution? The metaphor of conversation has proven its worth over thirty years in explaining design processes and communicating important insights; I also find that it works quite well in teaching thanks to a high recognition factor. However, my experience is that it works better in making sense of past design processes than in guiding the setup of new ones. To tell a student or a colleague that “you should design like you are in a conversation with the material” rarely prompts any substantial changes to working practices. In other words, I find the conversation metaphor to be not very generative.

The idea of making the experimental material palpable, on the other hand, might be more suggestive of concrete action. In the case of CB01, I expect that fellow designers reading this paper would at best get a received view of how a pressure-sensitive book feels and what it could be used for. On the other hand, touching the actual book and “palpating the experimental material” should convey a different kind of understanding and stimulate independent ideas on application areas as well as further inquiries.
Conversation and palpation are obviously metaphors, and as always the key evaluative question is what they do. As suggested above, I find that the conversation metaphor does an excellent job in retrospective sensemaking, perhaps even rationalization, of a past design process. Palpation, including not only haptic feedback but all manners of responsivity afforded by the hybrid materials, appears more generative in the context of planning and executing a new design process. The suggested design strategy above amounts to encouraging interaction designers to create “palpable experimental materials”; this is rather strongly generative position, with significant implications for established design practices such as prototyping.

When it comes to situating this work in the scholarly landscape, I find that the notion of palpation delimits a set of concrete examples in the literature that point to the significance of foregrounding immediate, sensate feedback when doing explorative interaction design. A well-known and much appreciated example is Victor’s (2012) approach to responsive programming environments, tracing its heritage all the way back to the key insights of Kay and colleagues at Xerox PARC (for a survey, see Barnes 2007) on interpreted versus compiled languages for explorative development. Moving on from software to more contemporary hybrid materials, Moussette (2012) makes a compelling argument for hardware sketching in a learning context. A further relevant example is found in Hobye’s (2014) work on Arduino-controlled physical installations to stimulate explorative interaction where it was deemed necessary to create an auxiliary design tool externalizing the dynamic properties of hybrid systems at runtime. Particularly noteworthy here is also Larsen’s (forthcoming) work on the aesthetics of tangible interaction, where “tangible” is approached as the duality of palpable and comprehensible.

For completeness, it should also be mentioned that the concept of palpability was used as the basis for international research efforts already ten years ago, when the Palpable Computing project (2008) was launched as a response to the then-hyped notion of the Invisible Computer. In that project, however, the concept did not develop beyond a rather fuzzy umbrella term for perceivability and apprehensibility in uses of ubiquitous computing.

Post scriptum: How to make a book that...

To return to the original question behind the Capable Books project: Based on what I have learnt so far, I would say that the “best” way to make a book that actually knows which spread it is on might be to use printed-electronics (Acreo 2014) light sensors on the pages. At the time of writing, this is work in progress.
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