Does speculative design contribute to public engagement of science and technology?

Tobie Kerridge, PhD student, Goldsmiths, University of London

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In the UK there is a considerable and growing body of scientists, funding councils, scientific societies and science communicators from various professional backgrounds who have taken on the task of engaging the public with science and technology (Burchell, 2007; Wynne, 2006). Recent policy commitments to fund these diverse projects have been linked to the 'problem' of perceptions of risk attached to outcomes of contemporary technologies including biotechnology and nanotechnology (Kearnes et al., 2006). In this paper I outline some ways in which design practices could contribute to these commitments to the public engagement of science and technology, by focusing on Material Beliefs, a project funded by the Engineering and Physical Sciences Research Council [1]. Additionally - and in the spirit of the conference theme of Multiple Ways - I would like to cross over to Science and Technology Studies for some assistance with a framework through which to stage a tentative and initial discussion of this contribution.

Some contexts for consideration

Before looking at Material Beliefs in more detail I provide some additional context for the discussion. I start by recovering some existing links between design and Science and Technology Studies (STS), largely through an exposition of a symposium on that theme in the journal Design Issues (Woodhouse & Patton, 2004). I then follow through these linkages with some entry points for design as engagement, with a description of the current state of public engagement of science in the UK as it has been articulated by STS scholarship. Finally I'll look to particular forms of design practice – notably critical design, and design for debate in particular - that are characteristic of how design was conceptualised in the Material Beliefs project.

In an introductory essay to the Design Issues symposium on relationships with STS, Woodhouse and Patton distinguish between "proximate designers" and "design by society" (Woodhouse & Patton, 2004). Recalling Victor Papanek (Papanek, 1984), Nigel Whiteley (Whiteley, 1993), and others, the concept of Design for Society provides a much broader and discursive network of actors than the "designers and clients" that comprise *proximate* practices. This extended network has implications for the ways in which design might then be discussed, including considerations of the institutions responsible for "setting parameters, procedures and directions within which proximate designers work". This patternation has "considerable influence on technological innovation" and serves to privilege particular accounts of technology by the exclusion of others (Woodhouse & Patton, 2004, p. 2). Of relevance to my discussion here of design

[1] EPSRC grant details of Material Beliefs are online at http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/E035051/1

as it contributes to public engagement, is the sense that "public concerns about design outcomes might appropriately be taken up in a public way" (Woodhouse & Patton, 2004, p. 3) so that:

> Rather than throwing responsibility on designers and clients alone, with government officials in the background as intermittent limit setters, how might design move into public debate, systematic inquiry, and institutional practices in unprecedented ways? (Woodhouse & Patton, 2004, p. 3)

In this way, an STS account of the networks where design has a hand provides an alternative to accounts of improved designs, or better products, by taking procedural focus away from the designer and the design to consider the relationships between materials, technologies, bureaucrats, institutions, users and other actors. This prepares the ground for reflection upon how publics become constituted in particular ways within these networks of humans and non-humans. Elsewhere these structures have been described as cyborgs and hybrids, and also as assemblages, within the context of public engagement (Irwin & Michael, 2003; Michael, 2002). What is the role of speculative design in the formation of these assemblages, and what accounts are achieved? Does this analysis provide the 'unprecedented' descriptions of the relationships between people and technology, anticipated by Woodhouse and Patton?

In the UK there is an ongoing effort to address *problems* in the relationship between science and the public, through public engagement programmes. Accounts of engagement activities vary widely across the actors involved, which include science communicators based at museums, scientific funding bodies and professional institutions, think-tanks involved in policy, scientists engaged in research and sociologists exploring relationships between science and society. Governmental accounts of public engagement often foreground the formation of citizenship around science and technology as a normative process. For example, this is evident in the language of a recent report that anticipates a role for public engagement in the formation of a public that is "excited by and valuing science" and "confident in the use of science" (DIUS, 2008, p. 5). There has been some criticism that these descriptions of engagement privilege a perception of a public who misunderstand science, or a public who inappropriately attribute risk to particular technologies. It follows that public engagement can address these deficits, and produce a literate and trusting public (Wynne, 1992). Rather than educating the public, engagement practices have elsewhere been reframed in terms of providing more robust dialogue that takes lay concerns into account, and which also enable dialogue to take place at earlier stages of scientific development. For example, a Nanotechnology lab provided access for a social scientist and public groups to "help imagine what the social dimensions might be, even though the eventual applications of the science aren't yet clear" (Wilsdon & Willis, 2004). There is a strategy here to provide access to laboratory spaces for non-scientists, so they can then witness science as a process rather than as a technological black box (Latour, 1987). Dialogue at these formative stages of scientific research provide opportunities for what has been described as an *upstream* debate about the outcomes and implications of science (Kearnes et al., 2006). These strategies offer some clear opportunities for speculative design practice, where it can help imagine how emergent research would become subject to social and cultural values.

So what design practices inform speculative design, as it might be performed as an innovative form of public engagement? Rather than pursuing models of usability, and optimisation, designing with technology can "provide opportunities to discover new pleasures, new forms of sociability, and new cultural forms" (Gaver & Dunne, 1999, p. 25). This perspective on design research leads to the development of playful prototypes with ambiguous functions, which aim to "shift current perceptions of technology functionally, aesthetically, culturally, and even politically" (Gaver & Dunne, 1999, p. 25). The ambition here is not to iterate or improve the design, but to use particular forms of user-centred design, and methods from social science, to consider the effect of the design as a trigger for reflections on everyday life. This context relates to concerns in the public engagement community for increasing the opportunities for upstream encounters with scientific research that encourage imaginative reflection from non-experts.

A second design trajectory informing Material Beliefs is critical design, which aims to "to ask questions, provoke debate, raise awareness, and explore alternatives" (Beaver et al., 2009, p. 64). Critical Design has been described as an exploration of the conventions of science fiction, art practice and the aesthetics of cinema. Here are sophisticated representations of identity, offering spaces for "complex individuals moving through an equally complex, technologically mediated, consumer landscape"[2]. These design provocations offer alternatives to accounts depicting a linear progression of scientific enquiry through to stable technological products. These linear models have been challenged in the field of Sociology of Scientific Knowledge[3] and later STS, particularly with Law's description of heterogeneous engineering (Law, 1987). Accounts of critical design articulate fresh routes through technoscientific landscapes, and make these reappraisals available to public groups through exhibitions and publications. There is an opportunity here also for some development of the implicit claims made for critical design and the associated project of design for debate[4]; who is involved in debate here, what kinds of debate take place and what are the effects?

In his discussion of John Dewey's *The Public and Its Problems*, Carl Disalvo contextualises critical design through its ability to construct the public by "increasing societal awareness, and motivating and enabling political action" (DiSalvo, 2009). Disalvo outlines *projection* as a way of describing how critical design might represent "a possible set of future consequences associated with a particular issue" so that the social or ethical implications of technologies can be considered. For Disalvo there is a prospect for more work to be done here, and he specifically points to the opportunities for working with other fields including STS to help answer the question '"Does the contribution of design to the construction of publics really matter?" and if so "When?" and "How?"' (DiSalvo, 2009, pp. 61-62). I hope to offer some tentative responses to this question, in the following discussion of Material Beliefs as it aims to extend these forms

[2] Design Interactions site, available at http://www.interaction.rca.ac.uk/information/department.html, accessed 16/6/09
[3] Steven Shapin offers an overview of SSK in Here and Everywhere (Shapin, 1995)
[4] Design for Debate is described in a postgraduate design brief at http://www.interaction.rca.ac.uk/briefs/designForDebate.html, accessed 16/6/09

of design through identifying and building relationships with public engagement of science and technology (PEST) through STS.

In this introductory section I have offered some context for framing a discussion of the contribution of speculative design for public engagement of science and technology. I have suggested that it might be fruitful to consider a much broader network of actors beyond the designer and the client, and shown how existing links to STS scholarship can help here. I then demonstrated that public engagement is an heterogeneous and complex field, and that recent descriptions of citizen participation that take place *upstream* when research is still being done in the lab is as good a place as any to locate a designerly association with this field. Finally I outlined some types of design research, including ethnographic Interaction design and critical design, which prepare the ground for a discussion of practice that I'm describing here are speculative design. With this context in mind, in the next section of the paper I would like to focus on a practice-based research project, as a way of linking these issues to empirical data.

Material Beliefs

Material Beliefs was a two-year interdisciplinary project funded by the Engineering and Physical Science Research Council[5]. This funding was linked to a call that aimed to refresh public attitudes to engineering in the UK. The allocation of resources to support the call are arguably linked to reports from science institutions about a crisis in the public perception of engineering [6]. While Material Beliefs did not concretely aim to rehabilitate attitudes toward UK engineering, the proposal articulated an ambition for speculative design to lead in the formation of experimental connections between science and engineering research taking place in UK academic labs with public groups, to provide opportunities for discussion about science and society[7]:

> There is a need to communicate and democratise recent innovation in UK engineering, and with this an opportunity to challenge and invigorate the public's perception of engineering. Unconventional collaboration methods used in PPE projects like Biojewellery and Robert Doubleday's sociological perspective on nanotechnology research are extended in this proposal, and employed to frame a creative and innovative process for representing the technical and sociocultural issues which attend engineering research, to a large and diverse audience.

The following sections offer some reflection on the development and delivery of Material Beliefs as is relates to some of the contextual issues described above. I draw upon data generated during the course of the project, structuring the data as four historical moments, which are indicative of how the project developed over time. I start with a description of building a relationship with a biotechnology research centre. I follow on with an account of providing access to this centre for the public, and then

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[5] EPSRC grant details of Material Beliefs are online at http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/E035051/1

[6] For an example see the Public Attitudes to Engineering and Engineers report, available online at http://www.etechb.co.uk/research/reports/public_attitudes.cfm

[7] Extract from the case for support document, accompanying the "Material Beliefs" proposal

provide an account of a speculative design project, which developed some of the issues raised with these public groups. In the final section I sketch some examples of public exhibitions that circulate the designs to larger public groups. Given the heterogeneity of the data available through the project, and my own involvement in the production of this data as a designer, I draw on a mixture of methods. For example, this includes participant observation of focus groups attended by project participants, field-notes written as part of the tutoring of postgraduate students, and discourse analysis of materials including emails, interviews and exhibition catalogues.

Accessing biotechnology laboratories

At proposal stage Material Beliefs expressed an ambition to access labs, and to make them permeable to non-specialists [8]. This approach was influenced by research that had articulated upstream interaction between science and social science (Doubleday, 2007). Additionally the proposal emphasised biomedical and cybernetic technologies as a technological focus, responding to increased institutional capacity for biotechnological research. Technologies and applications anticipated to emerge from these research areas have been described as "raising a range of novel challenges for society" that are "highly appropriate for new forms of citizen participation" (Burchell, 2007). Biotechnology centres were identified through online searches, and individual researchers were approached by designers contracted to Material Beliefs, to discuss their involvement in the project.

Material Beliefs provided resources for four interdisciplinary clusters that were each lead by a designer in some form of collaboration with scientists, researchers and technicians based in an academic research facility. The clusters operated in very different ways, and the various collaborative features have been documented elsewhere (Dawson, 2009). This paper will focus on the outcome of one cluster, based at the Institute of Biomedical Engineering (IBE) at Imperial College London.

The relationship with IBE was negotiated with Tony Cass, a director at the institute. In common with the other clusters, following initial contact by email, filmed interviews were used as an initial exploratory tool to draw out some description of facilities, roles and research. Topics were formed during the interview with Cass, which was lead by two designers. The footage was then presented as a series of clips online [9] . While these interviews are low quality 'sketches' rather than documentaries, using film to document and represent moments of design research has been characterised as enabling "dialogues between participants, researchers and designers" (Raijmakers, 2007).

[8] Extract from the case for support document, accompanying the Material Beliefs proposal
[9] The clips are available online at http://www.materialbeliefs.com/collaboration/tony-c.php


above: View of the Institute of Biomedical Engineering, still from an interview with Tony Cass

While there is scope to discuss these methods in more detail, I would like to focus on how these discussions with Cass provided an entry point for the formation of a network for public engagement. The interviews provide an initial description of the research from the researcher's perspective, which emphasises the eventual applications that come out of the research. For example Cass characterises the institute as participating in "areas of research including tissue engineering, medical robotics, bionics and nano-scale applications."[10]. He then describes advances in bionics as following on from "understanding how to make biology and electronics talk to one another" in order to develop "hybrid devices"[11] that will enable new applications which offer solutions to healthcare problems.

Cass provides a linear model of scientific innovation, where science research leads to a new technology that provides a benefit to a patient. This has been described as a *regime of economics and technoscientific promises* (Wynne et al., 2007), which is characterised by the "creation of a fiction to create resources" to "solve human problems". These promissory accounts of innovation provide a clear division of labour, between those that develop the technologies and those that use them (Wynne et al., 2007), and there is a sense that alternative regimes of innovation might support "new forms of interaction between scientists and other actors" (Wynne et al., 2007). I will turn now to two accounts of how this initial network at IBE could be extended to include other actors, and how this extension linked biomedical research to the social and cultural concerns of these others, and generated alternative stories of technology.

Providing access for others

Implicit in this term speculative design that I am using, is a sense that there is indeed some kind of speculation taking place. This begs the question, who is speculating - is the speculation performed in some way by a designer and then somehow embodied in the design, or does speculation take place out there, by the visitor to a design show or the

[10] Quote taken from clip http://www.materialbeliefs.com/collaboration/video/tony-c/5.mov
[11] Quote taken from clip http://www.materialbeliefs.com/collaboration/video/tony-c/28.mov

reader of a design journal (as these designs are not products to be used by users, but objects that are distributed and experienced in other ways)? In this section I will try to demonstrate that these questions can be reframed through an association with forms of public engagement. I'll provide two examples of how alternative accounts of technology can be invited from the public by providing access to the research that is taking place at IBE. The first is an event with a small interdisciplinary group, the second is a workshop with a larger group combining students from a design background with researchers from the institute.

Mind the Loop was a half-day workshop convened at IBE in March 2008. The aim of the day was to bring together individuals to discuss the artificial pancreas - a research project at IBE aimed at helping to control diabetes – and to draw out individual conceptions of the technology as it related to personal experiences and knowledge. There was no instrumental objective for the meeting; rather it was an attempt to make use of the project resources to build a network of discussants from different backgrounds with an interest in a common technology. This strategy was developed through a discussion between the GP and the designer about the relationships "between individuals, systems, devices and data"[12] that form around the artificial pancreas. This conversation followed feedback from a participant at an evening of debate at the Dana centre,[13] about her experiences of existing diabetes technology, which includes a sensor and pump for insulin delivery:

> I have to still be quite inventive about how I wear this, so that people don't know that I'm wearing it, so I have to have a little pocket sewn into my clothes and things… what processes are you using to get the designers in early enough, and particularly the patients, because we don't tend to get asked about which features we think are important... [14]

A group of five people, comprising the participant, NHS doctor and designer present at the Dana event, and additional a researcher from IBE developing the artificial pancreas and a filmmaker, were invited to attend the event. The session started with introductions and planning followed with a description of the artificial pancreas platform by the researcher, then some reflections from each participant, followed by some questions and answers, and finally some time for individual reflection about the process. The filmmaker followed the proceedings and captured most of the session so that a short film could be edited as a document of the process[15].

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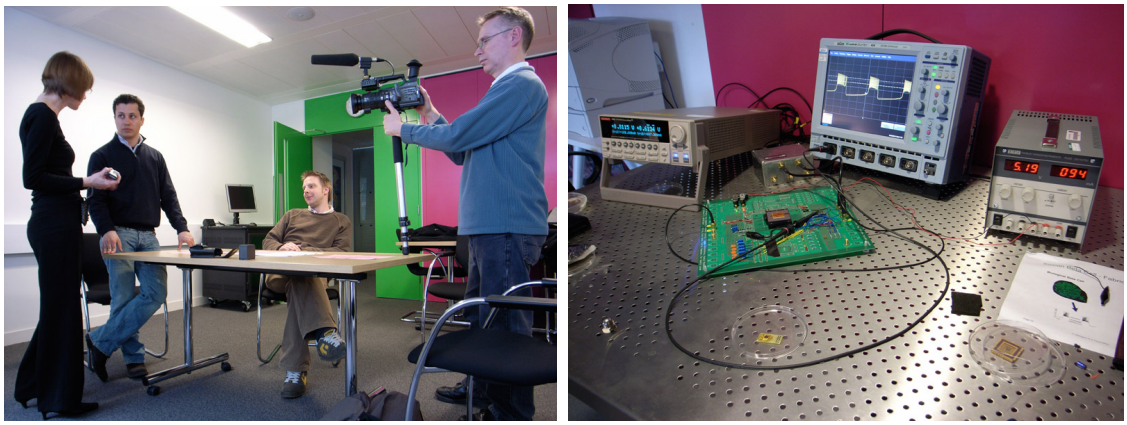
[12] Personal email between a researcher at IBE and the author
[13] See http://www.materialbeliefs.com/events/dana.php for documentation of the Techno Bodies; Hybrid Life? event
[14] Quote from a participant at Techno Bodies; Hybrid Life? event, see previous URL for film clip
[15] See http://www.materialbeliefs.com/events/loop.php for films and additional documentation



Above: Participants of *Mind the Loop* meeting, the test bench for the artificial pancreas

The engineer initially described that the ambition of the artificial pancreas is to provide control of blood sugar levels in a human body as a substitution for lost biological function:

> We've looked at the biology of the pancreas and questioned what happens when the pancreas sees glucose and releases insulin… We've taken that function of the beta cell and we've replicated it using electronic circuits, to provide an artificial pancreas for type 1 diabetics based on the actual biology of the pancreas[16]

A demonstration of the technology on a bench in an electronics lab showed how the microchip responds to changes in blood sugar (measured as a voltage level) by triggering the release of insulin in pulses that map closely to the biological pattern of control. Accounts of existing technology from the diabetic patient provide a different perspective:

> I realised I was using the word "Feel" about the pump... this is technology, and it's absolutely amazing, but when you have to live with it day in day out, you do actually have feelings about this technology because it makes a difference to how you feel, it affects your self-esteem how you wear it, so I realised that how I feel about the technology is actually really complicated…

The description of this technology is unstable, as it is subject to divergent values and expectations based on a particular orientation to the technology (making or using for example). STS accounts of these kinds of heterogeneous groups talk of 'epistemic communities' (Haas, 1992) and 'hybrid communities' (Callon, 2004; Callon & Rabeharisoa, 2003). Hybrid communities are at the same time collaborative and contrary, bringing together "expert know-how and lay experience" in the formulation of new and more robust medical devices. There is potential here for speculative design to link to these processes - and perhaps to an extent to stage environments that contribute to the formation of these heterogeneous communities – not because this type of design has an instrumental stake in the development of medical products, but for two other reasons. Firstly design can benefit from the complexity of the representations of

[16] Quote from a participant at Mind the Loop event, see previous URL for film clip

technology, and the presentation of experiences from different human actors. Secondly is can pull together groups who would otherwise not have occasion to articulate these different forms of knowledge, again, not to contribute to development of products, but in order to provide occasions for engagement between experts and publics.

As a second example of providing public access to the biomedical research environment at IBE, I now focus on a workshop for a group of postgraduate students from the Royal College of Art. The workshop formed the start of a four-week brief lead by Elio Caccavale and Kerridge titled Science and Society[17]. Rather than providing innovation for science and technology, an analytical or critical practice is encouraged in the students. As the head of department, Tony Dunne describes in an interview:

> Critical Design uses speculative design proposals to ask questions, provoke debate, raise awareness, and explore alternatives. Its opposite is affirmative design that reinforces the status quo. It rejects the idea that design can only exist in relation to industry and its narrow agenda, and it sets out to explore other ways design can contribute to society (Beaver et al., 2009, p. 64)

The aim of the workshop then is to develop this questioning role for design practice as it relates to emerging biotechnologies. A key issue here is to find a mechanism to encourage a robust relationship between the design students and technology. This was accomplished by working directly with researchers who were actively engaged in laboratory-based experimentation with the technologies that were objects of inspiration for the students. Theoretical discussions of intangible and distant processes (in this case biotechnology) are swapped out with more grounded, empirical experiences. This point is dealt with thoroughly by Wilkie and Ward in their paper about strategies for critical practice at undergraduate level, where the critical studies canon of "Baudrillard, Derrida and de Certeau" are challenged by empirical paradigms inspired by STS accounts of technology and society (Ward & Wilkie, 2008, p. 1). Rather than conducting desk-bound research, students are instead encouraged to get amongst the phenomena and practices that excite them; "to go out, open the black boxes and untangle the complexities and novelty they encounter and in doing so provide their own situated and partial descriptions and new design contexts" (Ward & Wilkie, 2008, p. 2).

I now focus on an example of student work coming out of the RCA workshop at IBE, and the relationship with a researcher that lead to the work, to ground this discussion. The workshop at IBE comprised of a general presentation of the Institute, a tour of facilities, two presentations from researchers about their research, an experiment to isolate DNA conducted in the wet lab, and a wrap-up session where the brief was set. One of the researchers from IBE who presented was Olive Murphy, who described an implantable blood-pressure monitor for Patients with chronic conditions, incorporating a passive radio system to transmit data to an external unit.

[17] Further documentation and a description of student projects is available online at http://www.materialbeliefs.com/events/rca-ibe.php

Above: Workshop for students at IBE, testing an implantable blood pressure monitor

Discussion between Murphy and the students can be characterised as focussing on issues arising from how biomedical data sent wirelessly from a human body, might be re-appropriated by services other than the remote healthcare. This discussion about data monitoring was developed in Nelly Ben Hayoun's project Cathy the Hacker. Hayoun designed props and made short films documenting "how you can hack your blood pressure implant" to provide fake, *healthy* data to an insurance company that is monitoring the fictional Cathy's lifestyle in order to make decisions on the premium she should pay on her health insurance[18]. Through an interview and follow up conversations with Murphy, Hayoun devised hacks which included attaching a sensor to an energetic pet cat, in order to generate a surrogate data set, while "The closing spin cycle of the washing machine also does a good job"[19]. The influence of Hayoun's access to technology, facilities and researcher upon the project are clear, but also of interest is the experience of these encounters upon Murphy, who commented about the experience during a focus group session[20]:

> I would have assumed, "Oh of course this is everybody's benefit" like you, you may not want one you know, people's civil liberties and everything and, and it was Nellie who first raised the issue of, well, what, what if your insurance company will make you have an implant or else won't cover your hospital expenses...

These encounters provided Hayoun with a technical context to interpret critically, while Murphy takes an active role within an alternative description of her own research. Something similar can be said about the Mind the Loop meeting, where different views and experiences of on the management of type 1 diabetes came together to make new types of knowledge. In this way, unfinished biomedical science becomes encountered by a particular form of public (students or patients), with a particular orientation towards

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[18] The project Cathy the Hacker is documented by Nelly Ben Hayoun online at http://www.nellyben.com/index.php?/project/biotech/ accessed on 7/8/09

[19] ibid.

[20] The focus group interview was conducted at the end of the Material Beliefs project by Emily Dawson, and included participants linked to activity at the Institute of Biomedical Engineering. A description of methods and a discussion of finding are available in a report available for download at http://www.materialbeliefs.com/pdfs/Summative-Evalution.

the science – that is, a set of motivations, agendas and impulses that provide momentum to the encounter. Callon and Rabehorisoa have talked about the "co-production of science and society" in the medical context of the French Muscular Dystrophy Association (AFM), where doctors, patients and patients families came together through a process of "research in the wild" so that different forms of knowledge become interleaved (Callon & Rabeharisoa, 2003). The object of the laboratory access in Material Beliefs is not medical knowledge, as was the case with the AFM research. Rather speculative design is a motivator or trigger for a coalescing of non-standard groups of people, experts and public, in order to discuss the ways in which technology inscribes forms of sociality. In terms of contemporary form of public engagement, much is said about the need for new forms of dialogue between experts and lay public that take place upstream, at earlier and formative moments in the life of technoscience. Of the engagement practices that have developed upstream models, it has been said that the ways in which the risks or implications of technologies are presented, or the questions with which the engagement is staged have been pre-framed by the *engager*, so that what we see is restricted to either an affirmation or dismissal of institutional concerns, rather than a more free ranging debate (Wynne, 2006). As Wynne describes, "there is no room left for constructive negotiation of possible alternatives, multiple trajectories, and different technologies" as the pre-framing of the engagement activity "imposes an unquestioned presumption that the publics concerns – which we are supposed to be investigating and learning to understand – are only instrumental concerns about impacts" (Wynne, 2006, p. 218). There is a opportunity here for design to identify emerging technology as a malleable and creative material, and to provide a framework around this material for encounters between experts and particular public groups that leads into the spontaneous identification and emergence of issues within which to then frame alternatives.

Developing speculative designs

I now focus on a different aspect of Material Beliefs, where issues and concerns about technoscience are pulled in to inform the design and development of prototypes. In common with the other interdisciplinary clusters that made up Material Beliefs, there was an ambition for the research at IBE to be transformed into more developed and resolved designs[21]. The aim of these designs was to in some way combine alternative applications that were being articulated through the discussions taking place between experts and interested publics, with research trajectories at IBE. Additionally the development of these prototypes was conceived as taking place through some form of collaboration between the designers and the researchers. In this section I will describe Vital Signs, a set of prototypes developing out of the discussions between publics and researchers at the IBE, and subsequently through a larger network of technologies,

[21] The original funding proposal focused on collaborations between designers and engineers; "The aim of this proposal is to pair experienced research engineers and designers through a residency program, leading to a series of public exhibitions and engagement events. These events will open up a reflective and critical space around the role of future technology, where the engineers' research can be represented to the public in a stimulating way"

materials, issues and institutions. I return to STS descriptions of assemblages, in order to characterise the ways in which these prototypes took shape as a mobilisation of different actors, with particular attention paid to Mike Michael's account of 'inventive problem making' (Michael, 2009). In this respect I provide some snapshots of the material and conceptual contexts that were combined and embodied in the design.

Vital Signs is technologically based on the Digital Plaster, a biomedical monitoring platform that sits alongside IBE research projects related to personalised healthcare. The Digital Plaster is a body-worn sensor that links to a distributed platform for body monitoring:

> Powered by thin, flexible batteries, and looking much like a plaster, the body-worn Sensium-enabled monitors can process and extract key features of the data and intelligently integrate it into an electronic medical record via a base station, using a power-optimised wireless operating and networking system (Toumazou, Christofer, 2008)

Wynne might describe the digital plaster as a *promissory technology*, and while the application is incomplete, it exists in a number of partial forms. For example there is a published account of a platform for ultra low power, wireless, biometric sensing (Toumazou, Chris & Lee, 2005) and a monitoring platform that includes a body sensor, though it is small and not yet miniaturised to the point of being plaster-like[22]. While the Digital Plaster is primarily discussed as a medical product, it is also linked to other markets:

> Monitoring 'health and wellness' has applications to sport, by monitoring physical states during periods of prolonged activity and stress. Constant monitoring builds a more complete picture of fitness and physiological change over time than conventional sampling techniques.[23]

There is a sense that this is a technology flexible enough to perform across different contexts of use, and for Vital Signs, the core technologies of the biometric sensor patch and the ability to send the data across the network were decoupled from medical and sports applications. In this way Vital Signs was initially conceived as a set of products for presenting a "complete picture" of physiological data, though the characteristics of that picture, and the motivation for picturing were at this stage open.

Existing products use mobile phone networks to transmit sensed data. For example the AlertMe system is a distributed suite of sensors that attach to products rather then people, so that the homeowner receives SMS messages when a door is opened, or when the central heating has come on[24]. Elsewhere there are a range of products for parents to monitor their children, various kinds of baby monitors, devices that attach to a child's shoe that is linked to the an alarm on a parent's keyfob. Technologies are arranged in

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[22] A description of The Sensium Life Pebble is available online at http://www.toumaz.com/public/page.php?page=sensium_pebble (accessed on 7/8/09)
[23] From the Personalised Healthcare research section of the IBE website available at http://www3.imperial.ac.uk/biomedeng/research/personalisedhealthcare (accessed on 8/8/09)
[24] AlertME is a modular and wirelessly linked "Intelligent Home Security" system, details about the product is available on line at http://www.alertme.com/

configurations that bring humans and non-humans together across distances, frequently through applications that aim to provide forms of control or reassurance. These more mundane examples of assemblages for control are at times disrupted and questioned through extreme versions that can make us feel uncomfortable. An example is Cotton wool Kids, a documentary produced for Cutting Edge, a series broadcast on UK Channel 4. Here an anxious parent meets an engineer in his office at Reading University, to hear about a tracking device that would be implanted in her daughter's body. The engineer describes:

> You could provide a sort of virtual fence, so when she goes outside a certain area, or if she goes into a certain place you don't want her to go to, then you could at home have this red light flashing (Neale, 2008)

The mother's desperation, the engineer's conviction in a technological solution and the silent presence of the daughter make for uncomfortable viewing, and perhaps our notions of what is reasonable or ethical in terms of how and why technologies are configured are raised. These questions remain settled or obscured in the encounters with more mundane technologies. In Michael's account of Technoscience and Everyday Life, these various social orderings of people and technology exist alongside one another:

> In all this, technoscience as a circulation necessarily ties together what have previously been seen as separate – the human and the nonhuman, the natural and the social; or rather it is constitutively productive of hybrids whose ontological and political status is ambiguous and multiple. (Michael, 2006)

A role of speculative design is to act within the networks it has established by bringing together and layering these ambiguous and multiple accounts within its objects. These objects then are about multiplying meanings, and providing additional complexity (Michael, 2009), rather than closing down around particular problems as stable products.

Vital Signs repositions the Digital Plaster as a platform for child monitoring. It develops some of the themes brought up in the students work after their visit to the IBE, which included the issues of surveillance and trust suggested in Hayoun's and other students work, and from discussions about data management during the Mind the Loop meeting. To a large extent Vital Signs develops the conversation between the mother and the engineer in Cotton Wool kids. Rather than an implanted transponder, sensors embedded in a skin worn patch measure biometric data, which is transmitted through a mobile phone network and becomes embodied in the behaviour of three devices, so that the child's heart rate, movement and breathing can be monitored in real time. Two sets of the prototypes were made, a blue and a pink set, for a boy and for a girl, and adopting other features of the design language used in the monitoring products described earlier.


Above: Still from Cotton Wool Kids Documentary, the Vital Signs prototype

Vital Signs are working prototypes; they are USB devices that incorporate an LED display, or motors for actuation. The devices use an embedded microcontroller[25] attached to a purpose built printed circuit board along with a wireless module so that data for the control of the devices can be transmitted over the air as well as via the USB signal. The process of designing and developing functional devices can be seen as a strategy for involving other people. For example the circuit boards were assembled at IBE and this lead to conversations with researchers about soldering small components, the cases were initially printed using a rapid prototyping tool also at IBE, programming code was discussed and shared with forum members at the Arduino website and the devices were put together with help from designers at the Interaction Research Studio. In this way the design process enlists a broader network of people, and so the design outcomes then embody a broader range of concerns and attitudes. This might be theorised as a broader, messier assemblage, and in practice it means that there are more opportunities for others to encounter and to become embroiled with the prototypes, which "spiral out in many conceptual directions, raising questions about a multitude of indistinct issues surrounding science and technology" (Michael, 2009, p. 10). It is to these opportunities I would like to turn for in the final section of this paper, which will explore how speculative designs were circulated to larger public groups.

Circulating speculative design

In the previous sections I have described how a biomedical lab can be accessed and an interdisciplinary group established, then how particular public groups can ask questions about research, and then how theses questions or issues become embodied in designs. In this final section, I'll provide some examples of engagement practices with public groups outside of the laboratory, focussing on exhibitions. Design is fairly accomplished when it comes to doing exhibitions, and arguably for design practices that *do not* lead to commercial products, the exhibition might be seen as the main arena

[25] Each device contains an Arduino Nano board, which is a popular platform for physical computing applications in art and design education. Arduino is an open source hardware and software environment see http://www.arduino.cc/

where design artefacts are encountered. The aim of this section is to consider some features of the public constituted through the events where Material Beliefs outcomes where exhibited.

One way of considering the make-up of the exhibition public is to think about how the event makes itself available to various groups. Material Beliefs was installed in four sections, where each section comprised of the outcomes from one of the clusters, so Vital Signs was exhibited with the three other projects; Neuroscope, Carnivorous Domestic Entertainment Robots and Bonsai Cells. The four Material Beliefs projects were included in a number of group exhibitions, including Nowhere/Now/Here at LABoral Centro de Arte y Creación in Gijón, Crossing Over at The Royal Institution of Great Britain in London and Touch Me Festival in Zagreb. Each show had a different curatorial ambition, "enquiry in contemporary design", "exchanges in art and biotechnologies", and "art at the intersection of science and technology"[26]. In this way, these events are composed of hierarchies of resources, from the issues and technologies of individual prototypes like Vital Signs (anxious parents and biometric monitoring), which sits within the broader aims of Material Beliefs (designers and engineers for public engagement), which is in turn subject to curatorial themes and ambitions. The exhibition can in turn be seen in the context of the institutional aims of the venue, and even the constitution or policy of the bodies that resource or fund the venue. To some extent the composition of those visiting the exhibition reflects these different hierarchies; someone might attend because they are a patron of the Royal Institution, or perhaps they are a colleague of the curator, or another might be subscribed to an internet mailing list about biomedical futures. The exhibition-going public is not a general public, but a self-selecting group, where individuals initially identify with a particular exhibition resource, and where they may be ambivalent to other resources.

Above: Visitors with Vital Signs prototypes at the Nowhere/Now/Here exhibition at LABoral, and a display for Material Beliefs at the Crossing over exhibition at the Royal Institution

How can we talk about exhibitions in terms of public engagement? Theorising about these events means turning away from a conception of the exhibition of science and

[26] Statements are taken from catalogue or brochures for each of the three exhibitions

technology as having an instrumentally educational role[27]. Instead of accounting for public engagement by providing visitor metrics, or evaluating learning outcomes, we can again turn to STS for an alternative framework. A recent example where STS agendas have been explicitly linked to an exhibition format is the curation of Making Things Public, installed at ZKM in Karlsruhe in 2005. In his introduction to an edited volume to accompany the exhibition, co-curator Bruno Latour writes:

> An exhibition cannot do much, but it can explore new possibilities with a much greater degree of freedom because it is so good at thought experiments, or rather *Gedankenaustellung*. One of those attempts is to design not one assembly but rather an assembly of assemblies, so that, much like a fair, visitors or readers can *compare* the different types of representation.(Latour, 2005)

For Latour there is an interplay between these representations, which leads to questions, including "What change does it make in the way people make up their mind to be attached to things?". Rather than fencing-in particular instances of technoscience – like the discoveries, innovations and applications of the science museum – an alternative aim for an exhibition then might be to uncover how "parliaments" (that is the mechanism for "making things public") might be "enlarged or connected or modified or redrawn". There is an opportunity for speculative design practices to make the most of public exhibitions as a way of providing resources for what Michael has described as "creative or inventive problem making" (Michael, 2009, p. 6).

Conclusions

In this paper I have provided a tentative account of the contribution of speculative design to public engagement of science. Science and Technology Studies were drawn upon as a theoretical methodology with which to consider empirical data from Material Beliefs, a design-lead public engagement project funded by the EPSRC. The paper opened by suggesting three contexts through which to consider contribution, an account of literature providing links between STS and design, a brief description of contemporary public engagement practice and related literature from STS, and examples of design approaches that informed speculative design as it was practised in Material Beliefs.

The paper then provided four historical snapshots from Material Beliefs through which to develop these contextual treatments of the question of contribution. They were accessing a biotechnology research centre, providing access to that environment for others, developing speculative designs and then circulating these designs beyond the lab to larger public groups. By initially building relationships with laboratories, speculative design provides a ground for discussions between researchers and non-experts about incomplete technologies, and these discussions arguably constitute "new forms of interaction" (Wynne et al., 2007) that support alternative accounts of those technologies. It was shown that by resourcing laboratory access for particular public groups, non-technical and emotive accounts of the technology were combined with

[27] For example the strategy of institutions like NMSI group, which includes the Science Museum in London, is to "to inspire and engage our audiences"(NMSI, 2007).

technical and operational knowledge. These framings were sustained by speculative design, in terms of providing a framework for a form of "research in the wild"(Callon & Rabeharisoa, 2003), which rather than building heterogeneous communities in order to generate novel medical or technical knowledge, would instead test and respond to contemporary forms of public engagement through the design of alternative technologies. It was then demonstrated that the questions arising from these laboratory encounters between researchers and the public could be interleaved with other conceptual resources, along with the technical and material resources of the lab, and embodied in design prototypes. Finally there was a brief discussion of how the circulation of these prototypes in public exhibitions made these issues available to others, and that although the prototypes were dispersed within a hierarchy of concerns and agendas, the exhibition encouraged "matters of concern" rather than "matters of fact" (Latour, 2005).

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