Towards a Critical Technological Fluency: The Confluence of Speculative Design and Community Technology Programs

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ABSTRACT
In this paper we discuss the use of speculative design as an approach to developing technological fluency. We provide overviews of technological fluency and speculative design, trace their conceptual connections, and then outline the use of a speculative design approach to technology fluency programs, providing an example from a current project. We then conclude by discussing how a speculative design approach can extend the idea of technology fluency towards new directions: broadening common understandings of the practices of technology development and adding a dimension of criticality.

Keywords
Technological Fluency, Speculative Design, Robotics, Sensors

1. INTRODUCTION
Technological fluency is a necessary component in a participatory culture, in which the design, use and evaluation of technologies is an open process that goes beyond the purview of experts. [6] Many researchers, particularly in the learning sciences, have developed programs with the intention of fostering and nurturing technology fluency in formal and informal learning environments. From these programs, both scholarly findings as well as processes and toolkits for implementation have been produced. Prominent examples include Brigid Barron's work on equity and technological literacy in both formal and informal settings [3] and Mitchel Resnick's Computer Clubhouse program [13].

Design often plays a central role in technology fluency programs. Commonly, the design process employed follows a model of engineering design, in which functional requirements drive the design process with the objective of producing a viable solution to a given problem. Of course, this is not the only form of design: other forms of design exist, with distinct processes, objectives and outcomes. In this paper we advance a different design approach for the development of technological fluency programs: speculative design.

In contrast to engineering design, speculative design is driven by issues or curiosity rather than needs, and the objective is less the production of an operational system than the investigation and expression of potential futures. In addition, although both engineering design and speculative design require knowledge of technical content (i.e., how computers, sensors, networks work), speculative design brings the social and political content of the technology and context of design to the fore.

The differences between these two forms of design have consequences for how technology fluency programs are structured and for the outcomes of those programs. That is, the differences affect both design process and product. Moreover, they have consequence for describing the constitution and purpose of technology fluency. In particular, it is our contention that a speculative design approach broadens the common understandings of the practices of technology development and has the potential to add a critical dimension to the idea of technology fluency. In what follows we explore and support this contention. We first provide an overview of technological fluency and speculative design and trace their conceptual connections. We then outline the use of a speculative design approach to technology fluency programs, providing an example from a current project.

2. WEAVING TOGETHER TECHNOLOGICAL FLUENCY AND SPECULATIVE DESIGN
Far from opposing one another in concept, technological fluency and speculative design share qualities and intentions. These points of connection make it possible to consider the use of speculative design in the development of technological fluency programs. Although a thorough review of the two subjects is beyond the scope of this paper, a brief introduction to each provides the background necessary to understand their potential overlap.

2.1 Technological Fluency
Technological Fluency is a term used to describe a level of knowledge, capability to understand, use, and assess technology beyond its rote application. For example, from the perspective of developing technological fluency, it is not enough to know the procedure for finding an online resource using a search engine. To be characterized as fluent, one would need to have an understanding of how web pages and media files are indexed by search engines and how search engines perform queries so as to best structure the search parameters, how pages are ranked upon return, and too, the ability to discern and judge the appropriateness and veracity of the returned results. Technological fluency thus "requires a deeper, more essential

Digital Arts and Culture, December 12–15, 2009, Irvine, California, USA.

understanding and mastery of information technology for information processing, communication, and problem solving than does computer literacy as traditionally defined." [13]

The 1999 National Research Council report "Being Fluent with Information Technology" outlines 10 essential elements of technological fluency: Engage in sustained reasoning; Manage complexity; Test a solution; Manage problems in faulty solutions; Organize and navigate information structures and evaluate information; Collaborate; Communicate to other audiences; Expect the unexpected; Anticipate changing technology; Think about information technology abstractly [12]. A notable aspect of the report is the inclusion of social and societal aspects in the constitution of technological fluency. For example, in addition to the implicit social aspects of several of the 10 essential elements of technological fluency, among the 10 core technology concepts is included 'The societal impacts of information and information technology.'

2.2 Speculative Design

We use the phrase 'speculative design' to characterize an approach to design that emphasizes inquiry, experimentation and expression, over usability, usefulness or desirability. A particular characteristic of speculative design is that it tends to be future-oriented. This should not be mistaken as being futuristic in a fantasy-like sense, suggesting that it is 'unreal' and therefore dismissible. Rather, because it is not driven by market imperatives nor by engineering dictates of functionalism, speculative design has the opportunity to imagine and explore possibilities, without the necessity of delivering of actionable plans towards those possibilities. It is thus exploratory and suggestive of what *might* be.

Within the context of technology goods and services, speculative design can be defined as the deliberate configuration of technological systems to explore future-oriented scenarios, conditions or consequences of technology use. This endeavor is both investigative and performative. The speculative design process makes known and gives experiential access to the possible capabilities and limitations of a given technology. In doing so, issues that radiate from and intersect with these technologies are revealed and engaged with. The objects of speculative design thus include final production models and prototypes, but just as important are the artifacts and events produced throughout the design process, such as sketches, diagrams, models, brainstorms, and charrettes.

Of the various fields of design, architecture has perhaps the most developed history and tradition of speculative design. In the 1960s, collectives such as Archigram and Superstudio developed a practice of architecture that produced drawings, diagrams, collages and models of possible structures, buildings and cities. [14] While this practice rarely resulted in physical constructions, it impacted the discourse of architecture by testing the limits of the discipline and producing new cultural imaginaries of the built environment. Such speculative practices continue through today in architecture, from the work of star architects such as Rem Koolhaas [8] and Diller and Scofidio [2], to academics such as Bernard Tschumi [15], to hybrid art-architecture-design collectives and individuals such as Atelier Van Lieshout [1], and Andrea Zittel [11].

In the field of interaction design, which is generally charged with the design of technology goods and services, there are fewer examples of speculative design, due in large part to relative newness of the field. However, in the work of designers such as Tony Dunne and Fiona Raby [4], Natalie Jeremijenko [7], Bill Gaver [5], and those involved in the *Material Beliefs* project [10] we can witness a burgeoning culture and portfolio of design that adopts an explicitly critical and experimental stance, which extends into the domain of emerging technology products and services, ranging from information and communications technologies, to robotics, to biotechnology. A notable aspect of this work is that tends to engage with publics in ways that previous examples of speculative design did not. Many contemporary speculative design projects in the domain technology goods and services reach the public through direct experience and hands-on use. For example, the *Feral Robot Dogs* project by Natalie Jeremijenko explored the uses of low-cost robotics for the sensing of environmental toxins. [7] As one aspect of this project, Jeremijenko invited youth in a New York City neighborhood to work with her to deploy the robots in their neighborhood park (once a former industrial site and likely to have residual toxins in the soil). Such interactions and experiences suggest the potential of extending the range of engagement with and effect of speculative design beyond the common audience of other designers and critics.

With this brief introduction, similar qualities and intentions between speculative design and technology fluency should begin to be apparent. The orientation towards the future in speculative design intersects with the essential elements of technological fluency of expecting the unexpected and anticipating changing technology. The capacity for thinking about technology abstractly and knowing the limitations of technology required for fluency intersects with the experimental and critical aspects witnessed in much of the contemporary speculative interaction design. Finally, the attention paid to the potential consequences of technology design in speculative design speaks to the core concept of understanding the social impacts of information technology in technological fluency.

From these points of connection we can begin to consider the use of speculative design in the development of technology fluency programs. Moreover, the potential for direct experience and hands-on use found in speculative interaction design can be shifted towards being even more participatory by engaging publics in the activity of speculative design. That is, rather than speculative design being an endeavor taken on by designers alone, speculative design can be an endeavor taken on by a community, in a form of co-operative inquiry with designers and researchers.

3. DESIGNING A ROBOT-RADIO STATION

To outline the potential of a speculative design approach to developing technology fluency in the context of a community technology program, we present an example from a recent research project. In the subsequent discussion, we draw out the ways in which a speculative design approach broadens the common understandings of the practices of technology development and has the potential to add a critical dimension to the idea of technology fluency.

The example is drawn from the *Neighborhood Networks* project: a three-year research project that combines community arts,

participatory design, informal learning, and engineering to discover and articulate how communities use, or might use, robotics technology. To date, we have conducted three separate *Neighborhood Networks* programs. The third program, from which this example is taken, occurred over a period of nine-months, with two-hour meetings approximately three times a month, and regular (usually bi-monthly) meetings between researchers and some small group (6 – 8) of community members and stakeholders. A distinctive characteristic of the *Neighborhood Networks* project is the closeness between researchers and participants: researchers interacted weekly with participants over the span of the workshops, both as informal educators and as design partners.

The particular *Neighborhood Networks* program we will discuss in this paper was conducted Braddock, PA, a former steel neighborhood adjacent to the city of Pittsburgh. The situation of the neighborhood is important to contextualizing the program and making sense of the project undertaken by our participants. In the mid-twentieth century, Braddock was a flourishing community, with a bustling main street business district, and a population of over 30,000 working and middle-class residents. With the decline of the steel industry, the neighborhood was devastated. The population today is under 3,000 residents, many un-or-under-employed. On the main street business district, less than half of the storefronts are occupied, and those that are unoccupied are in disrepair, with broken windows and graffiti. In spite of this, among many Braddock residents, there remains a sense of pride in the neighborhood and a desire transform Braddock back into a strong community. One initiative within the neighborhood working towards this is 'Community 2.0', a program developed The Heritage Health Foundation to provide technology resources for capacity building within Braddock. Our work with Braddock residents was conducted through the 'Community 2.0' program, as a pilot project for both the host organization and residents.

Over the first several months of the program participants engaged in a series of activities that introduced them to the fundamentals of sensing and robotics technologies and allowed them to explore the use of these technologies in the context of their neighborhood. For example, in one activity — Sensor Walk— participants used hand-held sensors to measure light, sound, and air pollution around Braddock, and then created a map documenting the readings. Drawing from the Sensor Walk, in the College in Context activity, participants used stickers and images to produce a photo collage of how they would place sensors in a network around Braddock, to monitor a variety of environmental factors.

In the middle of the Sumer of 2008 (roughly 2 months into the program), the county announced that it would soon begin major renovation of the main bridge in Braddock. This bridge, known as the Braddock-Rankin bridge (Rankin being an adjoining borough) primarily served commuters from outlying boroughs and suburbs. The bridge provide a direct route of access from those locales into the city of Pittsburgh proper, darting them momentarily through Braddock on their way to the east-side of the city or onto a freeway leading into the urban core. At the first meeting after the announcement, participants in the program began discussing their concerns about the impending renovation, what they thought its effects might be, and how they might use the technologies they have been engaging with in relation to this upcoming event.

The potential effects of the bridge renovation were perceived by the participants as substantial and disruptive. Traffic across the bridge would be restricted, and it was assumed that many commuters would seek alternate routes, which would then take them off of the bridge and lead them through the neighborhood of Braddock. In addition to the frustration that would be caused by traffic, for both those waiting in their cars and the residents who were unaccustomed to such congestion, was the realization that such traffic would also have environmental effects: increasing fumes and smut in the air from the idling automobiles.

In line with a speculative design approach (and in contrast with an engineering design approach) we encouraged the participants not to try to 'fix the problems' of the bridge renovation, but rather, to consider how the assumed impact of the bridge renovation would create new conditions they could design for. With this framing, the speculative design challenge then came to be to imagine how the assumed consequences of traffic congestion in the neighborhood could become elements of a design, which would bring the issues of the neighborhood to the fore and express their pride in the neighborhood and desire for change. In the course of discussion and brainstorm activities, one participant suggested that the congestion would provide a captive audience to the neighborhood of Braddock: that these commuters who usually sped over the edge of neighborhood in hurried travel elsewhere, would now be spending time in the neighborhood. From this observation sprang the idea of a radio broadcast, targeted to those commuters, informing them of the rich history of Braddock, its current culture, and attempting to entire them to consider Braddock anew, perhaps even, to spend some *more* time in the neighborhood, outside of their cars. Working from this idea, the participants began to conceive what was referred to as a 'robot-radio station': a series of short format radio pieces, that would be broadcast over the radio to targeted locations around the neighborhood, with the content and pacing of the program structured by sensed data reflecting current traffic conditions.

Over the course of the next several months, the participants developed the concept for the 'robot-radio station' and planned for the system. This included series of design activities that challenged the participants to imagine and discover how they *might* use sensors together with radio broadcast technologies. The participants were directed to focus on how the sensors, broadcasting, and program content could weave together the neighborhood culture and the anticipated traffic patterns. For example, at one point a group of participants went out to measure what could be sensed, where, and within what bounds. They also researched the approximate range of various forms of radio broadcast. From this they developed a series of colored plastic overlays representing the sensor types and radio ranges, and placed them on maps of the neighborhood to explore possible relations between data, place and program content.

In the course of researching radio broadcasting, the participants also encountered the regulatory and market aspects of technology use. Specifically, the participants discovered the regulations that govern the use of airways for radio broadcasting and the market situation in which media companies own the majority of frequencies and those that are available are prohibitively expensive. This discovery prompted discussions of alternatives for radio broadcast, including briefly, the option of broadcasting without a license. As the project developed, connections were made with local low-power FM and community radio advocates, as well as with local producers of radio shows, providing

knowledge of radio programming and broadcast beyond what the group possessed or even could have likely learned on their own.

What the participants did, and did not, create, is also significant. An operational robot-radio station was not produced as part of the program. Rather, as is often the case in speculative design projects, what was created was a variety of artifacts including diagrams, models, and prototypes that expressed the idea of a robot-radio station, and demonstrated and documented key aspects of the idea. So, for example, early in the process participants created a scale model of the neighborhood, approximately 3' by 5', using craft materials. This scale model was used to document anticipated changes in traffic in the neighborhood due to the bridge construction, and to note the locations of sensors and broadcasts throughout the neighborhood. To structure the possible programming content, participants collaborated to produce a large diagram that marked out the days in hours, and correlated anticipated sensor readings and the program content with the time of day. Finally, participants recorded parts of radio programs, as examples of the actual content, such as reminiscing stories, historical facts, and announcement of upcoming events and promotions for local business and cultural resources, such as the library. These parts of program were not meant as final works, but rather served to illustrate the proposed character of the content.

4. EXTENDING THE IDEA OF TECHNOLOGICAL FLUENCY IN NEW DIRECTIONS

Throughout this project, which emphasized the exploration and consideration of what might be, multiple instances for developing technological fluency are apparent. Connections can be evidenced between the activities of speculative design and aspects of technological fluency as participants managed complexity, collaborated, discovered and came to understand the limits of information technology. Part of the appeal of speculative design however is not just how it matches with the elements and core concepts of technological fluency, but also how it extends the idea of technology fluency in new directions.

4.1 Broadening the common understandings of the practices of technology development

In addition to engaging many of the central aspects of technological fluency, the Robot-Radio Station project highlights how a speculative design approach can broaden the common understandings of the practices and issues of technology development. In the Robot-Radio Station project, more than specifying sensors, configuring networks or even producing radio content, participants engaged in varied experiences that contributed to their technological fluency, but were not explicitly technical endeavors. This included discussions of policy, legislations and regulation, and building teams to garner material, technical and social resources. In short, they exhibited an engagement with and a developing understanding of the social practices of technology development as a heterogeneous process involving multiple actors and skills [9].

This recognition of this heterogeneity is particularly important to recasting technology development as open and collective process. Often, even within technology fluency programs, technology development is cast as a technical endeavor in an overly reductive sense; in order to participate, one must develop the skills (or some resemblance of the skills) of an engineer or computer scientist. This is flawed in two respects. First, it leaves out those who do not want to develop such skills but nonetheless desire to have a voice in shaping technology development and use. Second, it does not accurately reflect the ways in which technology development and application occurs 'in the real world.' As the participants in the Robot-Radio Station project discovered, no technical knowledge would overcome the barriers to their desired radio broadcasting. What was needed was knowledge of, and capability to interpret regulations, navigate bureaucracy, and build networks of association with others in order to achieve a design goal. While such issues and activities are often not part of the engineering design driven programs, they form the core of speculative design programs, and in doing so, contribute new qualities to the constitution of technological fluency.

4.2 Towards a critical technological fluency

The experiences of the Robot-Radio Station project also begin to suggest how a speculative design approach might add a dimension of criticality to technological fluency. Such a critical stance can be witnessed in two forms. First, throughout the project, the technologies were not accepted as fixed and final constraints that had to be accommodated. Precisely because the final product of the project was not an operational radio station, but rather a series of exploratory artifacts, the participants had the opportunity to question, accept or reject a given technology. That is, they had the opportunity and develop the capacity to be critical of the technology, to analyze and judge it in regards to how the technology would or would not align with their desire to 'express' their neighborhood.

Second, the project suggest a move towards a critical technological fluency in the way that engaging in the project brought to the fore the social and political content the technology and context of design. This is most evident in the issues encountered in researching the opportunities for radio broadcasting. But there are also hints of this in the premise of the project: that the neighborhood was essentially unknown and ignored by those that traveled through it, and that a technological intervention might be designed to shift public knowledge of and beliefs about their neighborhood.

5. CONCLUSION

In this paper we advanced speculative design as an approach to the development of technology fluency programs. This proffering of speculative design is not meant to stand against programs that employ an engineering model, but rather as compliment to them. In some cases, a speculative design approach may serve as an alternative for individuals or groups who might not be predisposed to focus on technical content and process that is prevalent in other programs that intend to foster and nurture technology fluency. The potential outcome of engaging in a speculative design process then is a different kind, or supplementary mode, of technology fluency, which broadens the common understandings of the practices of technology development. Moreover, such an approach can add a critical perspective to technology fluency as it brings the social and political content of the technology and context of design to the fore. As we collectively pursue the development of a more participatory culture, technological fluency will be an increasingly

important quality to cultivate in individuals and groups. Speculative design provides yet another way to foster technological fluency, and moreover, a way to potentially provide technological fluency with a critical edge.

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