The Neighborhood Networks Project: A Case Study of Critical Engagement and Creative Expression Through Participatory Design

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ABSTRACT
In this paper we examine the Neighborhood Networks project: a community-based participatory design project. The goal of the Neighborhood Networks project is to facilitate and investigate the use of participatory design to prompt critical engagements between people, technology, and the urban environment, and to enable the production of creative expressions of local issues by residents, using robotics and sensing technologies. We describe the activities and outcomes of the first workshop, and discuss how participants used the technology in a rhetorical sense, that is, to discover, invent, and deliver arguments about how we could or should live in the world.

Keywords
Participatory design, participatory sensing, robotics, robots sensing, urban computing, rhetoric

INTRODUCTION
In her seminal paper, "P for Political," Beck poses the question: "What constitutes political action through computing?" [2] Certainly, the expansive history and range of contemporary projects in participatory design provides a rich and varied set of answers to that question. To those answers we would like to propose two others: prompting critical engagements with technology and enabling people to use technology to produce creative expressions of issues of concern.

By *critical engagements* we mean experiences that bring about the reflective analysis and interpretation of issues, building from traditions in informal learning [3,23] and the arts [17,19,20,28]. In particular, we are interested in facilitating encounters with technology that reveal and/or call into question common assumptions and beliefs about technology and the urban environment, and the possible relations between those subjects. The goal of these critical engagements is to provide people with experiential knowledge so that they can make informed and insightful suppositions and judgments concerning the capabilities, limitations, and applications of technology.

By *creative expressions of issues* we mean imaginative and resourceful representations of problems, or possible interventions into the conditions of a problem, which are convincing and aesthetically absorbing. Regarding the use of technology, our interest is how people apply and manipulate the capabilities and affordances of a given technology while infusing the artifacts or systems they produce with their own voice and style. Our goal is not to teach people to be engineers, but rather to help bring people to a point of technological fluency where they are comfortable with and capable of utilizing the products of engineering beyond familiar uses.

Taken together, critical engagements with technology and creative expressions of issues through technology begin to form a public rhetoric: they constitute the activity of discovering, inventing, and delivering arguments about how we could or should live in the world. The artifacts or systems conceived or created become rhetorical by their persuasive intentions and capabilities, and how they inform and/or provoke a response from or dialogue with others.

Design can be, and often is, portrayed as a form of argument—that is rhetoric. [4,7] Positioning design as rhetoric does not claim some essential or deterministic quality of technological artifacts or systems. Nor does it suggest that design is fundamentally duplicitous, as contemporary pejorative notions of rhetoric might imply. Rather, positioning design as rhetoric calls attention to the ways in which the built environment reflects and attempts to influence values and behavior and the capacity of people to design artifacts or systems that promote or thwart certain perspectives and agendas. In this light, design, inclusive of both the process of making artifacts and the artifacts made, can be considered a discursive activity and participatory design can be cast as using design to enable people to take part in public discourse in new or more effective ways. This becomes a kind of political action through computing as people use technology to communicate and solicit support for their perspectives, with the hope of initiating change.

We developed the Neighborhood Networks project to facilitate and investigate this particular kind of political action through computing. The project includes the production and evaluation of multiple public participatory design workshops that provide opportunities for neighborhood residents to engage in the open exploration and application of emerging technologies in the context of neighborhood activism. As part of this effort, we are also developing affordable technology platforms suited to these public programs, an example of which is the Canary: a low-cost, simple-to-use platform for constructing environmentally reactive works of art and design. To ensure that the technologies themselves do not determine the workshops' agendas, we work to develop strong ties to neighborhood residents, organizations, and issues and to develop a rich understanding of the social, material, and political conditions of the neighborhoods in which these workshops are held.

In the Neighborhood Networks project we are particularly interested in the use of robotics technology in urban community contexts. We take a broad view of robots as physically persistent technical systems that are embodied (i.e., that exhibit a high-degree of coupling with the environment through sensing and actuation). This embodied quality of robotics produces immediate and direct representations of the environment – as the machines react to external stimuli – making robotics an opportune technology to use in exploring the relationships between technology and the environment. Although there is an established body of research concerning communities and ICT [see 11,16 and 18 for overviews] and emerging research concerning participatory sensing [8,10,13], there is limited research on robotics in community contexts. What research does exist is usually within the context of educational programs for children. [e.g., 14,26] In contrast, an explicit goal of this project has been to focus on multi-generational activities, working from the belief that adults are central to any effort towards sustained community action.

In this paper we describe the structure and activities of the Neighborhood Networks Summer 2007 program in detail and then discuss the experiences and outcomes of the worskhops as evidenced through conversations amongst participants and the artifacts designed in the workshops. In the discussion we call attention to the ways in which the participatory design process fostered critical engagements with technology and enabled residents to creatively express local concerns and suggest possible technological interventions.

PROJECT DESCRIPTION

The Neighborhood Networks project began in 2007 and is planned to extend over the course of three years. The project consists of multiple community workshops in selected neighborhoods in Pittsburgh. In this paper we are reporting on the first community workshop, which took place in the Lawrenceville neighborhood of Pittsburgh, PA in the summer of 2007.

The Lawrenceville neighborhood is a typical former working-class neighborhood in Pittsburgh. The housing is dense, the streets are narrow and residents still regularly meet to chat on front porches and in the alleys. Part of the reason we chose to work in Lawrenceville is because the residents are particularly active in civic projects: the neighborhood boasts three community organizations and four block watch groups.

In the Lawrenceville workshop, seven meetings were held over an eight-week period, with one week off for the 4th of July holiday. Meetings occurred in the evenings, once a week, for 2 hours. The meetings were held at a multi-use community center, which was chosen because of its standing in the community as a place for people to gather and host neighborhood activities. For example, during the day the center provides meals to elders, health and well-being classes, and counseling services, and in the evening the center is often used for Boy Scouts meetings and the convening of various neighborhood groups, such as the block watch.

Neighborhood residents were informed of the workshops through flyers posted around the neighborhood and in the center, notices in a neighborhood print bulletin, via the email lists of community organizations, and through word-of-mouth. These notices described the program as a chance to "use technology to make art about your neighborhood" and were designed to appeal to a broad audience. Two weeks after the first flyers and notices were distributed, the Lawrenceville summer 2007 program began, with approximately 20 residents participating in the first evening's activities. Of the first 20 participants, 14 continued through to the final workshop. Participants varied in age and gender, including four middle-school aged children (3 boys, 1 girl), eight adults aged 35 to 55 (5 women, 3 men) and two adults over 55 (1 woman and 1 man). The participants were all middle-class. None of them claimed to have technical expertise and approximately one-fourth (4) characterized themselves as artists.

Throughout the workshops, the research team (consisting of three senior researchers and two students) took field notes and photo-documentation. The field notes were structured using a standard split-page form [15] along with a set of questions to support documentation and reflection. No direct interviews were conducted, however, conversations and statements were recorded in field notes. After the workshops, the field notes were collected, reviewed by one of the senior researchers, and hand-coded for themes.

In what follows we describe the Lawrenceville Neighborhood Networks summer 2007 workshop, separated into four phases. The activities of each phase were developed to build towards our project goals. Thus as a whole process, these four phases lead participants through reflective inquiry into the limitations, capabilities, and potential uses of sensing and robotic technologies in their neighborhood and enable them to discover and invent novel and compelling applications of the technology toward locally relevant issues.

Phase 1: Initial Engagements

The first phase of the workshop was designed to familiarize participants with the basic capabilities and limitations of sensing and robotics technology platforms and to ground the use of the technology within their neighborhood. Because of the novel of character of the technology and the desire to provide a solid foundation for their future design work, we chose to span Phase 1 over the first two meetings.

Scavenger Hunt with Commercial Sensors

In the first meeting, our objective was to provide a broad introduction to the concept and activity of technologically-mediated environmental sensing. For this reason, we opted to use professional sound-level and air-quality sensor platforms, rather than the sensing/actuation device we had developed (the Canary: described in the following section).

We began the first session with a sensor scavenger hunt; an activity designed to excite participants and to encourage exploration of both the technology and the neighborhood. As an activity, the sensor scavenger hunt builds upon prior work in participatory design that investigates the use of playful approaches and games to motivate participation, stimulate creative and critical thinking, and overcome hesitancy to using unfamiliar technology. [5,6]

For the sensor scavenger hunt participants, in small groups of 3-7, were given a packet of materials, including: an environmental sensing platform (either measuring CO/CO2 or sound levels), a map of the area, a Polaroid camera, a pack of film; a pen, and a printed slip of paper outlining the tasks of the scavenger hunt. The scavenger-hunt tasks were developed around the idea of "taking a reading". For example, three of the tasks were: "Find a place with the highest value for a given sensor" and "Go someplace you have never gone before and take a sensor reading" and "Find the least agreeable place and take a sensor reading." Upon taking a sensor reading, participants were to take a Polaroid photograph of the place and then write the sensor readings and a brief description on the Polaroid. Participants also marked the location on the provided map.

After approximately 1.5 hours, participants returned to the community center to share their experiences and documentation. This activity of sharing took place around two large maps of the area (30 by 40 inches, or ~1m square). As participants taped each Polaroid onto the large maps, they described that place, the readings they had taken there, and their reasons for choosing that particular place and their understanding of the readings.

Exploring the Neighborhood with the Canary

In the second session, participants were introduced to the Canary as the platform they would use to design and prototype their robot and were given the opportunity to explore and experiment with its sensing and actuation capabilities. The objective was to familiarize participants with the specific features of the Canary and to probe the possible application of the Canary in the neighborhood.

The Canary is a relatively inexpensive, handheld platform that we designed and built for use in Neighborhood Networks. As compared with the desktop computer, there are few robotics prototyping tools that are simple and robust enough to support participatory design in a community setting. Most of the tools that do exist are either designed for other designers and engineers or for use with youth. [e.g.,14,22,26] Although commercial sensing equipment is robust, it is not engaging or accessible, nor it is affordable for extended use. The Canary is an attempt to expand the range of technologies available to participatory design endeavors, specifically to include robotics by combining adequate sensing capabilities and simple kinetic actuation with an accessible form factor.

The housing for the Canary is constructed as a simple box made from folded corrugated plastic. (Image 1) The design enables participants to easily open the box and examine the sensor board inside—to look at, even to touch, the actual sensors and experiment with them directly. When people do open the Canary, they see six sensors mounted on the main circuit board: air quality, light, sound, humidity, pressure and temperature. Closing the box, they can see that readings from these six sensors are continually displayed on a built-in LCD screen, which also tracks the highs and lows for each reading. Plugs within The Canary enable servo-motors to be connected into the device, which immediately animate the motors based on sensor readings.

Image 1. The Canary robotics prototyping platform

To take advantage of the residual excitement from the sensor scavenger hunt in the first session, we kept the introduction to The Canary brief. Participants were provided with a 10-minute hands-on overview and the asked to use The Canary to explore both the inside of the community center and the immediate surroundings for 30 minutes. Once the participants returned, we discussed their experiences, encouraging them to reflect on the differences and similarities between The Canary and the professional sensors used the week before.

From Exploration to Expression

Apart from its physical form, the uniqueness of The Canary stems from the way that it combines servomotor outputs with environmental sensors and signal processing in a single package. The Canary, as well as the artifacts constructed using The Canary, can be considered robotic because it enables the production of physically embodied entities that respond to the environment. Moreover, the manner in which The Canary "expresses" environmental stimuli is user-configurable. Users can select one of several different sets of "expressions," resulting in a different mapping of inputs to outputs. This selection mechanism uses two pushbuttons, much like the ordinary cellular telephone menu interface. Users can then connect up to 4 servo-motors to The Canary. These motors automatically move in response to environmental stimuli, facilitating the prototyping of reactive devices without any programming or engineering knowledge.

To illustrate these capabilities to participants, we developed a simple single-axis, single-motor mechanism that mimicked a large set of butterfly wings. By connecting the butterfly wings to different servo ports, we could demonstrate a variety of stimuli (e.g., clapping near the microphone, or breathing on the humidity sensor). After demonstrating the actuation capabilities of the Canary, we encouraged participants to spend 30 minutes experimenting with craft materials such as feathers, pipe cleaners, and cardboard to produce objects or sculptures of their own design that used The Canary to produce movement in response to sensed data.

Understanding the Canary

From our observations of participants' behavior and our shadowing of conversations, we concluded that participants seemed able and comfortable in operating The Canary. As an example, by the end of the evening, participants were able to navigate the device menus using the two pushbuttons and readily and repeatedly opened the housing to touch the board and interact with the sensors.

Participants were observed to manipulate the sensor input directly; for example, covering The Canary (to lower the light-level reading) or alternating between whispering and yelling into the microphone. Participants also seemed have a general understanding that the sensor input was mapped to the motor output. However, the ambiguity of how the input was mapped to output frustrated participants. Specifically, they were confused by the range of motions across the different sensors and wanted to know "the formula" for how the different sensors produced different ranges and kinds of motion. A shortcoming on our part was not providing sufficient support materials to explain the relationship between the input and output.

We concluded the evening with a ten-minute brainstorm concerning how participants might use The Canary to create an object of some sort that would address an issue in the neighborhood. The kind of object and the issue was left completely open to their discretion. We encouraged participants to think of this as an exploratory project: it could be a sculpture or an imagined product—the emphasis should be on their creativity and expressiveness. As they left, participants were challenged for the next session to bring-in materials, toys, appliances, etc., that they thought they could, or would like to, integrate into their project in based off of their working knowledge of the Canary.

Phase 2: Concept Development and Design

The second phase of the workshop concentrated on the discovery and invention of possible uses of robotic technology (via The Canary) in the context of the Lawrenceville neighborhood and its issues. We wanted to capture the excitement of the 'blue sky' ideas and avoid the self-doubt, hesitation and second-guessing that can undermine expression when ideas are examined too closely or for too long, so we compressed the concept development and design activities of phase 2 into a single meeting.

The objective of the phase 2 was twofold: for participants to imagine what might be possible using The Canary and to facilitate the documentation and specification of their designs, with at least enough definition to enable them to begin prototyping the following week. To achieve these objectives we developed two activities: the first involved participants bringing in materials from home to use as starting points for their project, and the second was robot storyboarding.

Activity 1: Reflecting on Objects from Home

As mentioned, in the week prior we had asked participants to collect and bring in materials to use in their robot projects. We believed this task would challenge them to make connections between the novel technology of The Canary and their familiar material environment. The suggestion was met with enthusiasm. Participants arrived with handfuls, bags and even a suitcase full of "stuff" including model cars, motorized toys, various arts and craft supplies, and unused computer peripherals.

We asked participants to share what they had brought from home and to discuss how they envisioned using these materials towards their robots. We also encouraged other participants to provide feedback through this process. From their presentations, it appears asking participants to bring in objects from home did encourage participants to think about and engage in the project outside of the prescribed workshop time. Most of the objects appeared to have been selected with care and consideration. The descriptions of their possible use in conjunction with The Canary revealed an emergent understanding of the technology and its affordances. For example, one participant brought in a board game called *Loopin' Louie*: a game from the early 1990s that includes a motorized airplane on a swivel. He envisioned using The Canary as means to control it differently, as he stated: "*Well, we could remove this motor* (pointing to the motor controlling the place) *and put the other motor on there and have it fly back and forth like it does now but hooked up to The Canary thing to show what kind of day it is, if the air quality is good or not."* Elucidating how it could be used in conjunction with the Canary to visualize environmental factors, the participant's description reveals a developing understanding of the technology, and, perhaps most interestingly, a developing ability to understand and articulate how he might apply or manipulate it towards his own ends.

Activity 2: Robot Storyboarding with Text and Drawings

After the group sharing of objects from home and discussion of their possible uses, participants began storyboarding. Through this activity, they attempted to make their ideas more concrete and explicit by producing sketches and written descriptions of their robot, in terms of both construction and purpose. The storyboarding format takes its cue from practices in filmmaking that have also be adapted to communicate scenarios. A key quality of storyboards is that they do the work of both an elicitation and documentation device.

To support the storyboarding of robots we developed a set of custom storyboarding sheets, with plenty of space to write on, that asked the participants specific questions organized around four themes:

- **Actions:** What actions will people, things or the environment do that affect the robot?
- **Sensing:** What does your robot sense from those actions and using what sensors?
- **Output:** How does your robot reaction to those actions and express what it senses?
- **Communication:** What do you want to communicate through your robot? How should people feel or respond to your robot?

Getting participants to make use of the storyboards required more explanation and encouragement than we had anticipated. More than half expressed strong resistance to drawing complete designs. But nearly all participants (with one exception) did at least roughly sketch some set of basic mechanisms or sensors they intended to use. As a method of design and documentation, writing was more actively pursued than drawing. All participants wrote at least a few (2 or more) sentences in response to each of the questions.

Phase 3: Iterative Design and Production

Phase 3 of the project focused on the iterative design and production of the final prototype for presentation. This stage spanned three weeks. During this time the workshop took on an "open-studio" format, in which participants would arrive at the community center and work on developing their prototypes. This work took a diversity of forms, with some participants forming small groups of two or three and others working individually. In addition to building the prototype robots, during Phase 3 all participants were given poster boards. Participants were instructed to use the poster boards for documenting their robot design and production, and as a place to provide an overview of the purpose and functioning of their robot.

During this time, we, as researchers, began to take more active roles in scaffolding the work of the participants. We would causally walk around the room, stopping at tables and asking participants to describe what they were doing, or asking if they wanted any feedback or direct assistance. Participants were at first hesitant to ask for either. However, as time passed, and as participants ran into mechanical or conceptual difficulties, they began to call upon us.

To discourage the development of dependencies, we privately agreed on one specific guideline: we would not work with any single group for more than 15 consecutive minutes. We took responsibility for observing each other, and if one researcher observed another working with a group for more than 15 minutes, he or she would call the other researcher away. Then, after some time, another researcher would make himself or herself available to the group. As a side effect, this "mix-it-up" practice meant that by the end of the second production session, participants were well aware of each researcher's strengths and weaknesses. When asking for help, participants would direct their request toward the researcher they perceived as having the most expertise for that question. So, for example, mechanical questions were most often directed towards a member of the team who was an undergraduate in industrial design, while sensing questions were directed towards other the researchers with engineering backgrounds, and questions concerning "the big picture" were directed towards the senior researchers.

We believe this tendency to target specific researchers with specific questions suggests an increase in the fluency of participants towards the technology and also towards problem solving. The ability of participants to identify *what kind of problem* they were encountering and *who* (or *what kind person*) would be the most effective to assist them in addressing the problem signals a meaningful, if implicit, understanding of the problem space.

Stage Four: Final Presentation

The final workshop was organized as a public event, modeled loosely after a science fair, at which participants presented their designs. On the evening of the event participants arrived early to set up their projects on tables arranged around the perimeter of the room and displayed both their robot prototypes and their documentation posters. Each participant, or group of collaborating participants, were given a table to use.

The use of the poster boards proved to be important, as several (3) of the teams were unable to finish their prototypes to a level of completeness they were satisfied with. The poster boards were employed by these groups as an effective means to extend and complete the communication of their ideas through another format. For the visitors, the poster boards served to distinguish among people and projects by establishing spatial distinctions and created a visual order to the room layout.

At the public event, there was no formal introduction or overview to the workshop provided from the researchers. As attendees arrived they milled about, walking among the displays and chatting with the participants, who presented their projects and discussed their process and motivations. Other than providing the poster boards for the documentation and encouraging their use, we had provided little guidance to participants regarding how to structure their presentations.

The public event was well attended. In addition to the 12 attending participants, approximately an addition 25 people from the community attended. These included family members, neighbors, two representatives from two different community organizations and a city planner from City of Pittsburgh Department of City Planning. While participants said they enjoyed the opportunity to share with their neighbors, they were most excited by the presence of, and the opportunity to interact with, the city planner and the representatives from community organizations.

EVIDENCE OF CRITICAL ENGAGEMENTS AND COMPELLING EXPRESSIONS

As stated in the introduction, the goal of the Neighborhood Networks project is to prompt critical engagements with technology and enable people to use technology to produce creative expressions of issues of concern. These are closely intertwined objectives and endeavors: critical engagements bring about awareness of issues and insights into convincing and absorbing ways of expressing those issues. Evidence of such engagements and expressions, and of their interrelation, were found in the conversations that emerged throughout the workshops and the artifacts participants created. In what follows, we describe and analyze these conversations and artifacts, with an eye towards how they come to form a kind of public rhetoric. Because the amount and range of discussion within the Summer 2007 workshop was extensive and broad, we have focused our description and analysis on three activities and a single prototype, loosely following a critical incident methodology [9].

Scavenger Hunt Activity: Shared Experiences of Productive Questioning

The scavenger hunt activity prompted a rich set of critical engagements between the technology, the neighborhood and other participants through experiences that were both exciting and problematic. They were exciting in that participants collaboratively worked together to understand and make use of an unfamiliar technology that they perceived as usually "being for experts" and problematic in that the sensors were at times ambiguous in their readings or even contradictory to the expectations of the participants. Through these experiences, the participants engaged in reflective analysis and interpretation of the sensing technology and its relation to their local environment.

For example, many groups used the sensing technology to explore obvious sites of pollution or natural rot, such as sewers, portable toilets, commercial waste bins, exhaust vents, etc. However, most of these sites did not emit stimuli detectable by the given sensors, resulting in readings that were not different from casual readings taken on the street corner: the readings for sound, light, VOCs or CO taken in a garden might not be all that different from those taken next to an industrial waste bin. In other cases, the differences in sensor readings were counter to what might have been expected: the readings of VOCs might be higher in playground next to a tire swing then from a sewer (as the rubber tire swing off-gasses organic chemicals). Participants immediately perceived and noted such differences and would "talk through" the way the sensors were functioning and "talk through" the environment, attempting to conjointly make sense of these two factors.

The ways in which participants collaborated in the use and of the sensors were also significant experiences that shaped their processes of analyzing and interpreting the sensor technology. As they took sensor readings, and particularly if the readings were confusing or a surprise, participants would ask each other questions such as whether or not they needed to adjust the sensor and if so, how to do so. This was true of both the commercial equipment and of the Canary. To operate the sensing platform the participants would stand shoulder-to-shoulder, often with multiple people holding the object at the same time while the others circled around the device examining it. The photo documentation was also undertaken collaboratively. Across multiple groups we witnessed a process in which one or two people would hold the sensor platform in place, while another person posed next to object being sensed, often pointing at it, while the remaining other participants would stand back and together frame and take the picture. In this way the act of taking a sensor measurement was transformed from a solitary action into a collaborative group activity.

The activities involved in "getting the sensor to work" can be further contextualized within the common experience of exploring, navigating and investigating the city together with the technology. In addition to collaboratively operating the sensor platforms, we observed participants frequently discussing, debating and negotiating where to go and what to measure once there. Identifying the most agreeable or disagreeable place was not a neutral task, and resulted in conversations among group members about what was agreeable or disagreeable and also what was sense-able and not sense-able.

These small group experiences occurred again when the groups returned to the community center to produce a collective documentation of the scavenger hunt. As each group returned, prior to affixing their Polaroids to the two wall-mounted maps, they would lay their images out on a table and discuss them. As others would come by to see the photographs, they would engage in discussions of particular places (e.g. "*We went to the park too.*" or "*You went to the Firebird Lounge? — What a great idea!*"), often coupled with commentary or questions concerning the capabilities and limitations of the sensors (e.g. "*I couldn't get any measurements there, could you?*" or "*What kinds of stuff did you find there?*") Of particular interest and value in stimulating discussion and reflection were occasions in which multiple groups documented the same place, but recorded different measurements or interpretations of those measurements.

By the end of the scavenger hunt participants felt capable of using the technology and enticed by its potential applications. They also were able to begin to question —in an experientially informed manner—the accuracy and appropriateness of sensing in the urban environment. While participants appeared to enjoy the social activity of sensing, they were also initially suspect of the sensing technology due to the ambiguity in sensor readings and the mismatch between perceptions of a place and its measurable qualities. The things observed, encountered, and experienced through the scavenger hunt were later drawn upon by participants in order to spark conversation among themselves concerning neighborhood issues and the potential applications of technology toward those issues.

The Storyboarding Activity and The Robot Camera Prototype: Engaging the City through Dialogue and Concepts

Through storyboarding and the presentation of the storyboards, participants further called into question the existing and possible relationships between technology and the environment, particularly in regards to how specific instances of a technology or specific technological interventions might or might not "fit" and "work" within the city and to what effect. The storyboarding was also the starting point for enabling the use of technology to produce creative expressions of issues of concern and documenting those expressions. The concepts produced amount to the kinds of imaginative and resource representations of local problems and possible interventions into those problems problem that constitute the creative expressions of issues that the program was designed to elicit. Additionally, the process of sharing the storyboards begins to hint at the rhetorical nature of the endeavor by challenging participants to persuasively articulate their ideas to others.

Traffic was the issue that emerged as paramount in the Summer 2007 workshops. Nearly three-quarters of the concepts in some way attempted to address problems in speeding and loud traffic on neighborhood streets. In addition to the fact that speeding traffic was a visible problem on the neighborhood streets, we believe the commonality and prominence of the issue was influenced by to the ability of the sound sensor to provide immediate and direct mapping and responses between stimuli and motion.

As a salient example of how participants produced imaginative and resourceful interventions into the problem of traffic, one participant named Mary conceived of and designed a device simply called *The Robot Camera*, which would monitor the sound levels of passing cars, and when a certain sound level was exceeded, a robotic mechanism would take a photograph using a digital camera. The photograph would then be "sent to the city" to report on the car. In addition to visually recording the noise incident with a photograph, it was also suggested that an audio recording could be made that would document the actual sound.

The Robot Camera generated significant discussion among participants during the presentation of the storyboards and initial concepts. This discussion is striking because it so clearly illustrates the ways that participating in the participatory design activities can generate sophisticated reflections on the relations between technology and the urban environment. Through the storyboards, discussion, and prototype concepts participants materially and dialogically surfaced and traced multiple themes regarding technology and the city, including legal issues, questions concerning technical feasibility, and questions of efficacy.

Upon first presentation, numerous participants stated there might be "issues" with such a device, particularly surrounding the legality of capturing pictures of people purportedly breaking the law. But in the course of the conversation several participants noted that there is an existing system in the city that captures people running red lights and offered such as system as a point of comparison, rallying the existing technology/system to the defense of the proposed system. This prompted a discussion of "the city" as a specific entity, evidently distinct from the individual or groups in the neighborhood in terms of what is it legally and technically capable of doing, exemplified in the following exchange between two participants.

A: *Well the city does it.*[referring to taking pictures of people breaking the law, specifically running red lights].

B: *But that's the city and they can do things like that. Its different that just us doing it, and I bet even for them its tough.*

A: *Well they* [the drivers] *are breaking the law. And if people are speeding, gunning their engines and all that, or breaking windows or writing all over* [referring to spray painting], *they are breaking the law too.*

B: *Yeah, but I still don't know if we can take their picture and then send it around like that to the police or whoever or projecting it on the street.*

Participants also discussed the technical feasibility of *The Robot Camera*. These discussion illustrate the developing understanding of the capabilities and limitation of the technology and the capacity for invention and resourcefulness in its application. The first set of feasibility questions concerned The Canary itself and ways to add addition functionality within the limited capabilities of The Canary. Mary was concerned that the microphone might not be capable of distinguishing moderate, but nonetheless annoying, sounds. As another issue, participants wondered if it would be possible to record the time. After discussing that The Canary did not, and could not record time, a participant proposed an alternative: you could have 2 cameras, one that took a picture of the event, another that took a picture of a clock.

The issue of how to communicate this information to the city was also raised. Mary realized it might be difficult to automatically email this picture to the appropriate person at the city. She, and others, assumed such a thing might be possible, but they were unsure of how to do it. As Mary noted, "*The Canary connects to the computer and if the camera is also connected to the computer and the computer is on the Internet you should be able to do it.*" As the discussion continued along a suggestion was made that perhaps the photograph could be sent in separately either as a digital photograph or even as a Polaroid (building on the use of the Polaroids from the scavenger hunt) put in the mail system. When asked if she would be capable and willing to mail the photograph, she said, "*Yes, I could do something like that, I could totally do something like that. It could do the sensing and the recording and I could send it on to the city*."

Storyboarding and the presentation of storyboards thus emerged as an crucial element of the participants design process and of process of bringing the critical engagements to bear on the production of creative expressions. The storyboarding enabled the participants to make their ideas more concrete, and in the process, raised questions that caused them to reexamine their understanding of the technology and imagination of how the technology might operate within the content of their neighborhood. In a sense, through the storyboarding process they were able to experiment with the invention and discovery of arguments for the specific uses of technology, with each other as the first audience for such arguments.

Final Presentation: The Public Communication of Local Issues and Desires

It was through the final presentation event that participants were able to communicate their perspectives to others in manners that were convincing and inform and/or provoke a responses from others, that is, it was at the event that the process and artifacts of critical engagement and creative expression come together to constitute a kind of public rhetoric. While during the prior weeks, the participants had been the audience for each other, at the final event, the audience for their arguments about issues in the neighborhood was expanded to include other residents as well as members of neighborhood organizations and a city planner. During the evening's busiest moment, there were over 30 people in attendance. More than simply viewing the work of the participants, the attendees were engaged in significant conversations with the participants. These conversations were about the technology, the process of making the prototypes, but most of all, they were conversations around the ideas and motivations behind the prototypes, that is, they were conversations about the lived experience of the Lawrenceville neighborhood, concerns in the neighborhood, desires for change, and possibilities for intervention. (Images 3 and 4)

The ideas of the participants were not expressed through the prototype objects alone: the robot did not alone constituted an argument, but rather, the prototype objects worked as part of an argument embodied and expressed through multiple materials. As previously noted, many of the prototypes were only partially functional. This was actually a benefit, as it challenged participants to

Image 2. Mary explaining and demonstrating The Robot Camera to event attendees.

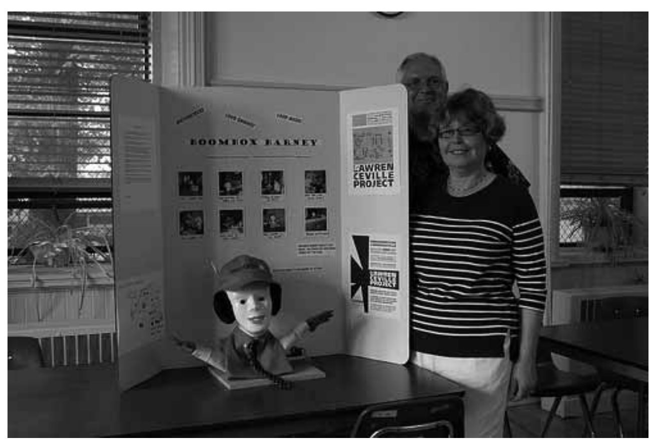

Image 3. Participants in front of their robot and accompanying presentation board with scenario.

develop multiple ways of expressing their intentions. To accomplish this, most of the participants had constructed stories to communicate their ideas and used the poster boards or forms of documentation as support for these stories. In many ways, these stories functioned similarly to scenarios common to a user-centered design process. [12] But there was an important difference as these scenarios were grounded in the authentic experience of participants calling attention to and leveraging the lived social and material particularities of the neighborhood. Thus the robot prototypes, support documentation, and story-telling and conversation operated together as a rhetorical structure and format.

In the process of demonstrating their prototypes, participants would communicate why they created what they had, how it would work, and often what they would do differently or what would need to be added to it to make it work. From our observations of the conversations, it was these explanations, more that the details of prototypes themselves, that garnered the most follow-on questions from the city planner and community leaders (e.g,. "*Why would you want to do that?"* or "*Why would you only want to run this at night?*") These questions and the responses from the participants formed a casual dialogue exchange in which the issues and desires of the participants were elucidated.

Both the participants, the planner, and community leaders commented to the research staff on the importance of the event and the significance of the exchange that took place between the constituencies. Most directly, the planner and community leaders were surprised by the level of commitment in the participants. As once community leader said "*I can't believe you got all these people to spend all this time, week after week this summer, doing this*." The phrase "doing this" reflected the mixed feelings of this the community leader towards the program, and more generally, towards art-type programs. Previously, this community leader had expressed hesitations concerning the role of the arts in community efforts. But while attending the final presentation he acknowledged the potential effectiveness of the arts as a way to mobilize residents. The participants too were motivated by the event, particularly by the attendance and attention of those of the community leaders and the city planner, whom they considered as people of authority and influence in the neighborhood.

CONCLUSION

Historically, one of the objectives of participatory design has been to enable people to take part in the design and development of technological artifacts and systems. But as Beck and others have stated, participation, as we have commonly thought of it, is "not enough": we must consider how we can extend the participatory design project to new political forms and objectives [2]. As stated in the introduction, the goal of the Neighborhood Networks project was to facilitate and examine the use of participatory design to produce such critical engagements with technology and opportunities for people to use technology to produce creative expressions of issues of concern, as kind of political action through computing. Throughout the Neighborhood Networks workshops, as evidenced in conversations, activities, and artifacts, participants developed informed analyses and interpretations of sensing technologies, and created imaginative and resourceful interventions into local concerns.

In addition, the Neighborhood Networks project begins to describe a kind of participatory design practice that builds upon the rhetorical character of design to constitute a public rhetoric. In the context of a public rhetoric, the aim of participatory design then is to enable participants to increase the visibility and volume of their voices and capture the imagination and attention of others in support of their agendas. In the case of the Summer 2007 Neighborhood Networks projects, the arguments created were made up of prototype robots, documentation, and as the narratives participants constructed to convey the idea of their robot: how it would "work" and "fit" within the neighborhood.

Framing participatory design as an endeavor concerned with enabling the discovery, inventions, and delivering of arguments has consequences for considering the how we, as university researchers, might enable and promote these endeavors. It requires ongoing investigation into how technology functions within the construction and delivery of arguments, as a tool for discovery, and as a rhetorical device that supports certain kinds of argumentation and possessing certain persuasive qualities. [for example, see 4] These qualities are not only a characteristics of the materiality of the technology (i.e., its affordances) they are also reflective of the standing of technology in contemporary culture.

As the Neighborhood Networks project progresses, we hope to be able to provide clarity and depth to the process of using participatory design to prompt critical engagements with technology and enable people to use technology to produce creative expressions of issues of concern. We also hope to better describe how, and to what effect, technology, and specifically robotics and sensing, can contribute to facilitating public discourse in new or more effective ways. Taken together, we believe these ideas and objectives form an exiting new mode of political action through computing, but clearly too, a mode of political action that through computing requiring more research to fully articulate.

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