Envisioning Systemic Effects on Persons and Society Throughout Interactive System Design

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ABSTRACT
The design, development, and deployment of interactive systems can substantively impact individuals, society, and the natural environment, now and potentially well into the future. Yet, a scarcity of methods exists to support long-term, emergent, systemic thinking in interactive design practice. Toward addressing this gap, we propose four envisioning criteria – stakeholders, time, values, and pervasiveness – distilled from prior work in urban planning, design noir, and Value Sensitive Design. We characterize how the criteria can support systemic thinking, illustrate the integration of the envisioning criteria into established design practice (scenario-based design), and provide strategic activities to serve as generative envisioning tools. We conclude with suggestions for use and future work. Key contributions include: 1) four envisioning criteria to support systemic thinking, 2) value scenarios (extending scenario-based design), and 3) strategic activities for engaging the envisioning criteria in interactive system design practice.

Categories and Subject Descriptors
K 4.1 **[Computers and Society]**: Public Policy, K 4.2 **[Computers and Society]**: Social Issues

General Terms
Design, Human Factors

Keywords
Design methods, Value Sensitive Design, envisioning, value scenarios, design noir, urban planning, scenario-based design, ubiquitous computing, sustainability, values

1. INTRODUCTION
The design, development, and deployment of interactive systems can substantively impact individuals, society, and the natural environment, now and potentially well into the future. Consider how in many societies use of the camera has affected people's images of themselves, how they construct memories [30], and what it means to experience privacy in public spaces [20]. Even people's daily interactions with the telephone over the past century have altered their understandings of what it means to be "in touch" with another human being [15]. For these and other taken-for-granted technologies, long-term impacts have been widespread, emergent, and intricately linked to other changes in society.

As a pressing case in point facing the interaction design community, consider the growing tension between a desire for continuous technological innovation and development (ever newer, cooler technical "stuff") and environmental sustainability [5]. Daily, millions of functional laptops, cell phones, and other high tech, interactive devices are deemed obsolete. Toxins from their disposal flow into the planet's waste streams, often sent to countries lacking the infrastructure to handle massive amounts of contaminated material [24]. The current tension around environmental issues may be an unavoidable outcome of technical innovation. Alternatively, if early on designers, manufacturers, marketers, and technologists envision long-term effects, beyond initial purchase and use, perhaps durability and recyclability could be key features designed into contemporary interactive devices.

Norbert Wiener, founder of cybernetics, asserted that individuals developing interactive technologies have an ethical responsibility to take likely consequences, positive and negative, of their designs into account [40, p. 28]. We concur. Designers and technologists introduce technologies that have lasting consequences for persons and society, thus the implications of such technologies warrant serious investigation. Yet, a scarcity of methods exists to support long-term, emergent, systemic thinking in interactive design practice, technology development, and system deployment. While interaction design methods have increasingly engaged users and contexts-of-use, these methods typically have been either agnostic on the dimension of long-term systemic effects (e.g., design rationale) or focused on the short-term (immediate) context.[1] The work reported here offers some initial steps toward addressing this gap in an agile and consistent manner.

Our work is grounded in an interactional account of technological appropriation [16, 21]. From this viewpoint, the impact of an interactive technology on the world is not solely determined by the technology's design and the intended use. Rather, shaped by individuals and society at large, and by its form and content, a technology can be appropriated in numerous ways. Design methods that are sensitive to these interactions provide opportunities for reflection, iteration, and course-

[1] We acknowledge aspects of Participatory Design as an exception.

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correction in the design process. The consideration of technological appropriations, along with the new forms of social and cultural interactions that arise alongside them, should be part and parcel of ongoing technology development.

We begin this paper with an explicit recognition of the challenges of uncertainty and complexity for long-term envisioning, also acknowledging that systemic thinking is difficult. We then draw on the strengths of three design perspectives – the long-term, infrastructure-orientation of urban planning [39], the provocative stance of design noir [11, 12], and the values-oriented approach of Value Sensitive Design [16, 21] – to identify four envisioning criteria: stakeholders, time, values, and pervasiveness. We characterize how the criteria can support systemic thinking, illustrate the integration of the envisioning criteria into established design practice (scenario-based design), and provide strategic activities to serve as generative envisioning tools. We conclude with suggestions for use and future work. Key contributions include: 1) the four envisioning criteria to support systemic thinking, 2) value scenarios (extending scenario-based design), and 3) strategic activities for engaging the criteria in interactive system design practice.

2. CHALLENGES TO ENVISIONING

Envisioning long-term effects of interactive systems encounters three intertwined challenges: the complexity of socio-technical systems, the uncertainty of future outcomes, and the emergent quality of systemic interactions. We consider each aspect in turn.

2.1 Complexity

Complex systems can be characterized as having a) many parts and b) connections between the parts. For some complex systems the various parts are identifiable and to a reasonable degree of approximation the numerous connections are knowable. For this type of "known" complexity, with enough processing power it may be possible to make reliable predictions. However, it is well established that interactive design typically involves a different type of complexity because, in part, all factors are not known or a complete list of connections is unattainable [34, 40]. Rarely does a single actor, design team, or even a governmental agency, have access to a whole view of the system, and it is even more unlikely that they have control over all of the parts. Extending the amount of time the parts interact introduces even more complexity. Thus, tools for envisioning need to be flexible and nuanced enough to be able to represent and bring into focus some of this complexity.

2.2 Uncertainty

Consideration of the complexity involved in countless interactions across multiple social spheres raises the issue of uncertainty. In the act of envisioning, designers acknowledge that it is not possible to consider each potential outcome when a new technology enters a cultural and societal milieu, yet strive to use their human capabilities to contemplate future interactions in an effort to mitigate some harms and enhance some benefits. In the words of René Dubos man's responses to an imagined future are decidedly human behaviors. "The more human he is, the more intensely do his anticipations of the future affect the character of his responses to the forces of the present." [10, p. 7]. The envisioning criteria go some distance in the face of uncertainty, through providing tools with which designers can engage future possibilities.

2.3 Systemic Interactions

Systemic interactions refer to those developments which either happen at large scales or those that have large-scale effects that go beyond the initial locus of interaction. Such interactions are emergent; they often develop as small changes collectively shift larger patterns and affect the system or body as a whole.

To engage in systemic thinking in the face of complexity and uncertainty designers need: 1) generative tools that enable them to consider and enumerate possible futures, 2) mechanisms for deciding which of the possibilities they would like to support or mitigate, and 3) to be able to connect this work to activities in the present – to the design of artifacts, protocols, and infrastructure.

3. BRINGING THREE DESIGN PERSPECTIVES TO ENVISIONING

Throughout the evolution of this project we have been influenced by three design perspectives: urban planning, design noir, and Value Sensitive Design. Each design perspective offers unique insights in terms of systemic interaction. Below we provide a brief overview of each perspective and specify how we drew upon the work.

3.1 Urban Planning

At its essence urban planning entails envisioning the built environment. Urban planners, like interactive system designers, face uncertainty and complexity when considering systemic interaction over the long-term. Similar to reflections on interaction design [38] it has been noted that planning the built environment "… is neither an art nor a science in the strict sense of either of these terms, though, of course, sound judgment in town planning draws on both aesthetic and scientific understanding." [39, p. 167]. While developing the envisioning criteria we drew upon the tradition of successful urban planners to: 1) envision how their designs can support future interactions, 2) act in the present to address that future vision, and 3) include large scale infrastructure in their design schema. Consider the work of Frederick Law Olmstead who in 1858 partnered with Calvert Vaux to design Central Park in New York City. One hundred and fifty years ago Olmstead envisioned a future New York, a bustling metropolis in which natural vistas would be impossible to find. He held that it was the responsibility of landscape architects to satisfy deep human needs for slightly wild, pastoral landscapes and vistas [4]. Olmstead's firm demonstrated how consideration of future developments coupled with a principled stance can inform infrastructure decisions and positively effect future interactions. Curving pathways, inviting alcoves, open space, and the preservation of natural site features supported the Olmstead vision of a desirable future [14]. Visionary work of the Olmstead firm can be viewed across dozens of parks, academic campuses, government buildings, and planned communities across the United States and Canada including: Arnold Arboretum, MA; Capitol Grounds, DC; Johns Hopkins University, MD; Niagara Reservation, NY; Prospect Park, NY; and Yale University, CT.

3.2 Design Noir

Design noir uses semi-functional, provocative designs to engage and challenge consumers [11, 12]. The underlying claim is that

electronic products should recognize and support the full continuum of human needs and desires (e.g., a truly smart home would know when to lie). For the envisioning criteria we drew on design noir's consideration of human beings as fundamentally clever, creative, and adaptive (not just task-directed, goal-oriented users) which leads to: 1) unusual appropriations of a design, and 2) potential for dark uses of a design. By explicitly recognizing the variety of ways in which a technology can be appropriated, design noir stimulates the imagination to consider less desirable behaviors a product may inspire or support, possibilities that are often ignored in the push to market. We note that noir design ideas are often titillating and dark, such as the fictional Life Counter which uses acid from a deceased individual's stomach to provide battery power to an object that bears a plaque in her name. Although we do not preclude creating edgy, sinister prototypes during an envisioning activity, the envisioning criteria draw on the "beyond mainstream" lens of design noir, considering not only malicious use, but unintended constructive use as well.

3.3 Value Sensitive Design

Value Sensitive Design provides a principled approach to considering human values during the design, implementation and evaluation of interactive systems [21]. This approach has been used successfully in a diversity of projects – from the design of a code sharing repository [31] to the creation of an open source privacy addendum [23]. Consideration of values is not a simple undertaking. For the envisioning criteria we draw explicitly on Value Sensitive Design's attention to: 1) systemic interaction, 2) multiple stakeholders, and 3) value tensions. Value Sensitive Design has engaged the issue of systemic interaction and emergent values since its inception [19]. Further, an essential component of a Value Sensitive Design investigation includes identifying direct and indirect stakeholders, recognizing that interactive systems can influence the lives of users and non-users of the system [21]. This approach also focuses attention on tensions which develop when efforts to support one value impinges on other values [23]. That said, initiating a full-scale Value Sensitive Design investigation may appear overwhelming to a design team navigating the realities of limited time and finite resources. Thus, in part, the ideas described in this paper are aimed at providing a lightweight and flexible means for considering values during the design process.

4. DEVELOPING THE CRITERIA

This work grew out of a six-month reflective examination of Value Sensitive Design projects [38]. Over the past two decades, Value Sensitive Design projects have purposively investigated numerous *interactive technologies* (e.g., robots [27, 28], display technologies [26], code repositories [31]); *contexts of use* (e.g., work [18], public place [20]); *values* (e.g., autonomy [22], privacy [17], security [23]), and *age groups* (e.g., children [27], college students [20]). The review highlighted the multiple dimensions of interaction (e.g., interface, technical infrastructure, individual, societal), how various dimensions influence each other over time, and the difficulty of engaging value issues across the multiple dimensions within the day-to-day practice of design. This line of thought led to the following questions: 1) How might designers conceptualize systemic interaction? 2) How might long-term systemic thinking be supported in a rigorous but agile manner?

While engaged with the questions above three of the authors participated in a provocative UbiComp workshop titled ExUrban Noir which explored the sinister side of information system design [33]. Influenced by the workshop, our initial attempt to explicitly design for systemic interaction took a decidedly dark turn as we extended traditional scenario-based design to create misuses, abuses, and other ominous scenarios for a seemingly innocuous interactive system. We next drew out and explicated key criteria of the dark scenario work and developed *value scenarios* based on these criteria [32] (reported in Section 6). We engaged the concern of how to integrate the criteria with current design practice in a rigorous and agile way through conversations with design practitioners, initiating a case study with a software engineering team, and developed strategic envisioning activities to be used during the design process (reported in Section 7). Through cycles of iteration and refinement we evolved the criteria into their current, more robust form.

5. FOUR CRITERIA FOR ENVISIONING

We introduce a set of four criteria – stakeholders, time, values, and pervasiveness – intended to provide perspective and focus for considering the long-term systemic effects of current and future technologies. The time and pervasiveness criteria provide a future-oriented perspective. The stakeholders and values criteria focus on ethical considerations. Used in combination, we posit that the criteria go a good distance toward articulating what a value sensitive envisioning process might entail when considering functionality requirements, compatibility issues, and contexts of use in terms of systemic effects on persons and society.

5.1 Stakeholders

Drawing from Value Sensitive Design methodology, the *stakeholder* criteria [16] emphasizes the range of effects of a technology, both on those who are in direct contact with a technology (direct stakeholders), and on those whose who might not be direct users, but whose lives are nevertheless affected by various interactions around the technology (indirect stakeholders) (see Table 1 for examples). An exploration of stakeholder-related issues should consider the following:

Direct Stakeholders: Direct stakeholders refer to individuals who fill the roles that the design was created for and are in direct contact with a technology. Consider the design of a medical record system for use in hospital settings. Hospital personnel such as doctors, in-take receptionists as well as medical insurance representatives may directly access the system or its output. Thus, we consider individuals in these roles to be direct stakeholders. Direct stakeholders perform both expected, targeted roles such as a physician, and non-targeted roles such as those who use a technology with malicious intentions.[2] Continuing with the hospital interactive system example, the administrator of a fraudulent health care fund would represent a non-targeted role.

[2] As noted by an anonymous reviewer, Djajadiningrat and Gaver's work on extreme characters has some similarity to non-targeted malicious roles. One key difference is the emphasis on malicious roles rather than Djajadiningrat and Graver's emphasis on individual characters [9].

Table 1. Illustrative examples of interactive systems by stakeholder category and role

Name of System	Description	Direct Stakeholders		Indirect Stakeholders
		Targeted Roles	Non-Targeted Roles	Roles
CodeCOOP [31]	Knowledge sharing groupware system used to share code and software engineering know-how and build community in a large engineering corporation.	Content contributors, question askers, searchers, managers.	Disgruntled employees, individuals gaming system for professional benefit.	Corporate legal team, stock-holders.
Apache III [29]	Medical decision support system typically used to inform decisions around withdrawing life support.	Physicians, insurance reps., nurses.	Cost cutting administrators, hospital performance evaluators.	Patients, patient caretakers.
Project Demonstrate (Ken Goldberg, http://demonstrate.berkeley.edu)	Zoomable, web-based camera system in a public plaza. Used to capture real-time images of students in a public plaza for online display.	Individuals controlling camera, individuals viewing the images on the website.	Stalkers, predators, pranksters.	Students, professors, university staff, campus plaza visitors.

Indirect Stakeholders: In addition to those who directly interact with the system, there may be other individuals who are significantly affected by a health care system but never touch the system. We refer to these individuals as indirect stakeholders. In the hospital system described above, the patients themselves and their families who are dependent upon information in the system but can not access it directly would be indirect stakeholders.

We call attention to two characteristics of stakeholders: multiple roles and fluctuating boundaries. First, a single person may engage in multiple roles with respect to an interactive system. Continuing with the hospital records system, an individual may be in a direct stakeholder role as an intake receptionist and may be in an indirect stakeholder role as the mother of a patient. Second, stakeholder categories (e.g., direct, indirect) are not fixed but can change over time as the social environment changes. For example, individuals who previously did not interact directly with a system can later be given access, such as patients given access to personal medical records.

5.2 Time

It is easiest for designers to focus on the short-term, considering the implications of their designs on a 3, 9, or 18-month time scale. Yet most successfully deployed technologies remain in use in society far longer, on the order of 3, 5, or 10 plus years. Moreover, systemic interactions emerge over time. Thus, we are more likely to notice these interactions 5 years rather than 5 months out. Inspired by the long-term perspective of urban planning, the *time* criterion helps guide designers' to consider the longer term implications of their work – implications that will only emerge after the technology has moved through initial phases of novelty to later phases of appropriation and integration into society. Consider how norms and conventions are slowly emerging around cell phone etiquette. Signs discouraging cell phone use and signal blocking devices are becoming more prevalent as restauranteurs, theater managers, bus drivers, and others push back against incessant and pervasive use of a potentially disruptive technology. The time criterion also highlights interaction designs' potential environmental impact. As an example, Eli Blevis, concerned over long-term environmental effects of a continuous cycle of model upgrades suggests that Apple consider using "its fashion and design talents to make it chic to want to own and keep an heirloom quality iPod." [5, p. 509] In addition, the criterion of time can bring to light the cumulative waste a technology generates over its entire life cycle, looking beyond the footprint of its final disposal.

5.3 Values

Our use of the term values draws from the Value Sensitive Design literature, "what a person or group of people consider important in life" [21]. While a full discussion of the nuance and complexity of human values is beyond the scope of this paper, in brief our position is as follows. We posit a certain sort of commonalty shared by most people by virtue of their humanity. Such commonalty stems from the fact that as human beings we exist in human bodies with human minds that shape how we experience the world. This is not to diminish the importance of culture and context in human experience. Rather, how actions and related underlying values manifest in specific contexts will vary. For example, consider the desire to at times withdraw from other people - to be left alone. In the United States, a middle class teenage girl might retreat to her room, closing the door to indicate a desire for privacy from parents and curious younger siblings. In contrast, in an Inuit dwelling during the winter months, a teenage girl would likely lie in her sleeping place, turning her body to the wall to signal her desire to withdraw from the group [8]. Similar desires to be left alone; different social conventions, practices, and behaviors for achieving that end. In interaction design, we have found values of interest to include but not be limited to: autonomy, community, cooperation, democratization, environmental sustainability, fairness, human dignity, inclusivity and exclusivity, informed consent, justice, privacy, self efficacy, security, and trust (see [21] for a more comprehensive list). Following on the discussion of the stakeholders criterion, we have also found it crucial to bear in mind differences between designers' values and stakeholders' values. During the design process, interaction design teams typically focus on the positive changes that new technologies make possible. Such an emphasis on beneficial outcomes is understandable. However, designs do not always lead in that direction. Drawing again on Value Sensitive Design [21, 22] and aspects of design noir [11, 12], the *values* criterion can help designers take a more balanced view, envisioning both positive and potentially negative effects of a proposed technology.

5.4 Pervasiveness

As new interactive systems gain traction in society, their use becomes widespread. Yet, in the thick of design practice, attention to more immediate demands may cause designers to conceptualize the system in relative isolation, being used by a single person or small group of users. The *pervasive* criterion, influenced by Value Sensitive Design, helps to broaden designers' awareness of larger contexts of use, with an emphasis on systemic interactions that follow from the widespread adoption of an interactive technology. Interactive systems can become widespread in a variety of ways and contexts: with respect to geography (e.g., city navigation software use within most urban areas), culture (e.g., text messaging within the deaf community), and demographic (e.g., online social networking sites among teenagers), to name a few. Interactive systems can be used at one organizational level across multiple organizations (e.g., across universities nationwide, admissions personnel predominately use one commonly agreed upon software tool) or across levels within a single organization (e.g., within a single university, all faculty, students and staff use a single email system). Technologies also become entrenched in larger systems such that they remain around far longer than ever expected. For example, many corporations support machines and protocols decades old because the legacy technology plays various roles in innumerable daily operations and no practical way exists to replace them. We acknowledge that it is not possible, practical, or constructive to attempt to consider a design's influence on everyone, everywhere. However, considering pervasive use on a few critical dimensions (e.g., culture, geographic region, context of use) will go a good distance toward a broader understanding of the design's potential effect on persons and society.

5.5 Combining Criteria for Systemic Interaction

Any technology that becomes deeply ingrained and widely dispersed in a culture influences social practices, behaviors, and the ways in which people conceptualize the world. Wide-ranging implications of a technology can rarely be anticipated by considerations of technology use by an individual or a small group. It is only when one imagines the technology becoming pervasive, being used by many stakeholders, influencing values over an extended period of time that the possibility of broader change asserts itself. Thinking systemically challenges designers to explore the multi-dimensional interactions among technology use, psychology, society, culture, and the environment over a period of years.

Although the influence of a design noir perspective pushes one to consider the possible negative influences of a design, we are not suggesting that designers only consider the dark side. On the contrary; a systemic view allows us to envision particularly creative appropriations and positive broader effects of a technology as well. Taking the Internet as an example, local community organization is precisely the kind of startling, systemic effect of a design that the criteria help us to envision. During its early stages the Internet was typically used to support geographically distant researchers in sharing files and managing data. Over time, the emergence of a broader group of stakeholders has shifted expectations and design decisions. What we propose is that imagining such positive systemic effects could lead to changing aspects of the initial design. If the influence of the Internet on co-located, community members was considered when the Internet was first being developed, would its underlying architecture have been different? Would a different set of protocols and permission systems have been designed that are better suited for such uses? The time and pervasiveness criteria are future focused while the stakeholders and values criteria elicit ethical considerations. Thus, we posit that that there is a need to employ all four criteria to deeply engage in systemic thinking.

6. APPLYING THE CRITERIA TO AN ESTABLISHED DESIGN METHOD: VALUE SCENARIOS

We turn now to using the criteria in practice. In this section, we explore how the criteria can enhance traditional interaction design methods to better account for long-term systemic effects of interactive technologies. Our general approach here is to take methods that are already working well, and use the criteria to extend their use. In this way the envisioning criteria can be integrated into existing practice. For purposes of illustration, we work within the parameters of scenario-based design.

6.1 Value Scenario Foundations

Value scenarios integrate the envisioning criteria with Carroll and Rosson's powerful scenario-based design (SBD) approach [37]. Traditional SBD uses narrative descriptions of individuals interacting with a technology to stimulate and guide the design process. These engaging narratives are used to identify needs, anticipate usability problems, and facilitate communication among different groups involved in design and development. In SBD, scenarios act as central representations that focus the entire design process.

A review of SBD literature reveals that a majority of scenarios created using the traditional SBD methodology share two key characteristics. The scenarios typically focus on: 1) describing the functionality of a technology under development, and 2) the immediate use of the technology by its intended user-groups [e.g., 13]. While traditional SBD scenarios describe these aspects of a technology quite effectively, taken together the two characteristics tend to lead the scenarios in a direction which has a number of limitations. First, traditional SBD-type scenarios tend to portray the technology being utilized in the manner the designers intended. Moreover the uses are primarily depicted in a positive light. Second, the scenarios focus almost exclusively on the direct stakeholders—the groups that will be in direct contact with the technology. How the technology is likely to influence indirect stakeholders is rarely considered. Third, traditional scenarios tend to have a short-term outlook, on the order of days or months. They do not engage issues of long-term use of the technology and how such use would likely change over time. Finally, traditional SBD scenarios rarely consider effects a particular technology may have if it were to become pervasive in either a segment of society or in society at large.

An exception to this characterization of scenario-based design is Blythe and Wright's recent work on pastiche scenarios [6]. Pastiche scenarios leverage shared cultural knowledge of popular fictional characters to develop engaging 'felt-life' narratives. A number of examples presented by Blythe and White address the kind of value and long-term considerations that we are concerned with. However, the way in which

pastiche scenarios play out rests upon the fictional characters chosen to populate the stories. Thus, the range of consideration of the future that pastiche scenarios make possible can be idiosyncratic and dependent on the fictional work used to develop the scenario.

What do value scenarios look like? How do they compare to traditional SBD work? Below we offer two sets of examples from the Value Sensitive Design Research group's scenario work. The first example, SafetyNet, stems from our work with an open source, large-scale simulation system for urban planning [7]. The second example, Geminoid Jack, developed in response to a collaborative project with Advanced Telecommunications Research Institute's Intelligent Robotics and Communication Laboratory [1]. For each example, we first provide a traditional present-oriented scenario, then a more future-oriented value scenario, followed by a brief comparison of the two.

6.2 SafetyNet

SafetyNet is a hypothetical, commercial software platform which leverages publicly available demographic and criminal data, mapping technology, and satellite-tracking capabilities to create maps for display on various mobile technologies (e.g., cell phones, Blackberries, in-car navigational systems). These maps are used to alert urban travelers as they venture into potentially unpleasant or dangerous areas during their travels.

6.2.1 Traditional SBD Scenario [Present]

Sarah and her daughter Lireal recently moved to Los Angeles from Merced, California. Through a family friend Sarah found a full time job with decent pay and an apartment which accepts cats. The one worry she had left concerned 12-year-old Lireal walking home from school alone. Sarah even had a nightmare in which Lireal, absorbed in a cellphone conversation, wandered into a bad situation in a scary neighborhood.

After hearing about Sarah's nightmare a friend told her about SafetyNet and Sarah immediately purchased a subscription for Lireal's cellphone. SafetyNet has worked out marvelously. Sarah used the program to map out the safest route to and from Lireal's school. Now, no matter how distracted Lireal may be, the cellphone will emit a warning tone if Lireal gets too close to a neighborhood designated as questionable or dangerous. SafetyNet is constantly updated by crime reports from the police department, so if there is an incident on Lireal's route, SafetyNet automatically alerts Lireal to follow a new route. Sarah is less worried about Lireal and has stopped having nightmares.

6.2.2 Value Scenario [6 Years later]

Canbaro lives in a SafetyNet world, yet has never actually used the device. Her mother says SafetyNet keeps strangers out of the neighborhood. Yet, Canbaro has overheard her father complaining that since SafetyNet labels their neighborhood as poor and Somali, only poor Somalis move in. Neighbors joke that if a new car comes down the street, its SafetyNet must be busted. Canbaro's little brother is convinced that SafetyNet is a real net which encircles their neighborhood. Canbaro wonders whom the net is supposed to catch.

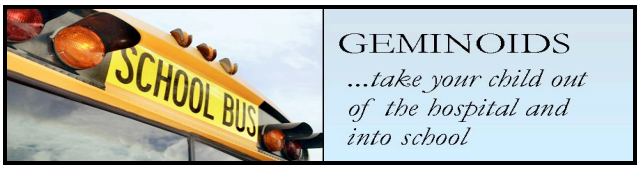
The 204th street gang has figured out the answer to Canbaro's question [2]. They regularly use SafetyNet to locate the home of the "catch" d'jour. For years homebuyers have been using SafetyNet to find decent neighborhoods filled with people like themselves. As a result, the city has become segregated into homogenous enclaves. This enables the gang to use SafetyNet as the ultimate profiling tool. Perhaps they are seeking to revenge themselves on a Chinese person or are looking for an Indian to harass. With SafetyNet demographic information is just a few clicks away. SafetyNet is the ultimate profiling tool.

6.2.3 SafetyNet Discussion

The initial SBD styled scenario is focused on direct stakeholders, Sarah and her daughter, doing typical activities that the technology was designed to support. The scenario portrays Sarah and Lireal using the technology in the present, in the way SafetyNet was intended to be used. Direct stakeholders have a positive experience with a proposed technology and benefit from its use. The scenario has little to say about the influence of wider appropriation of the technology throughout society.

The SafetyNet value scenario provides a vision of how the technology might influence the lives of both indirect (Canbaro) and direct stakeholders (home buyers and the street gang) as SafetyNet becomes pervasive. Canbaro has not used SafetyNet, but her neighborhood has clearly been influenced by others' use of the technology. Values such as diversity and de-segregation appear to have been left behind as the technology enables people to easily avoid commuting through or living in areas of the city they find uncomfortable. Systemic interactions over time have created a city which has become segregated to a level previously unimagined. The gangs' appropriation of the technology suggests nefarious activities that the "current" iteration of SafetyNet could easily support.

6.3 Geminoid Jack



The term geminoid has been coined by leading roboticist Hiroshi Ishiguro [1] to mean an android twin of a human "master". A current version of the geminoid is controlled via a motion capture system which tracks the master's movements and enables the remote controlled geminoid to mimic mouth and body movements while transmitting voice and audio signals.

6.3.1 Traditional SBD Scenario [Present]

Jack is beyond excited. Today, through his geminoid Jack-G, he can truly contribute to a class debate through his voice, his hand gestures, and his facial expressions [36]. Jack was born with severe combined immunodeficiency syndrome (SCIDS) and for 14 years he has been physically isolated in his sterile bedroom. His parents recently purchased Jack-G and after a training period, Jack-G has joined the class for the first time. By connecting to the geminoid's control system, Jack experiences real-time sights and sounds from the classroom. However, what is far more empowering is for Jack to actively participate in this environment. He can offer his own thoughts through Jack-G's voice and body language. Well, he could until a software glitch

caused a loud buzz over the headset blocking out all of the voices. Suddenly the buzz turned to silence. As Jack swivels Jack-G's head around he notices that Mrs. Cutter and the rest of the class are looking expectantly at Jack-G. Why is everyone staring at him? What is malfunctioning? What can he do to fix Jack-G when he is stuck at home? Could this be any more embarrassing?

6.3.2 Value Scenario [4 years later]

Jack is now a senior in high school and there are more geminoids in the school hallways, classrooms, and playing fields than humans. No longer used solely in specialized circumstances, geminoids have become massively popular for those who can afford them. Only poor kids and a few really ancient teachers attend school in "flesh mode" anymore. These geminoids are easy to distinguish because they are truly visions of humanoid perfection. No longer conceptualized as physically identical to their masters, geminoids are now created with blemish free skin, sculpted bodies, and fashionably styled hair.

Last month, after a strict regimen of cutting-edge meds, Jack was diagnosed SCIDS free. He could even go to school, but none of his healthy peers attend anymore. Moreover, his mother is against it. She says the world is changing and right now he is actually ahead of his peers because he is so adept at controlling Jack-G. If he stops using the controls on a daily basis, he may lose his advantage. As Jack looks in the mirror he suspects that she is also worried that his physical condition after years of sitting at Jack-G's controls instead of doing the exercises prescribed by his physical therapist. No sculpted perfect body here. Mom is probably right; most of his friends are spending entire days in their rooms, just like Jack. Even Jack's little brother, Joey, is getting pretty good with his geminoid. Actually Joey is becoming so used to engaging in geminoid play-dates from the comfort of his own room that he no longer likes to physically go to his best friend's house.

6.3.3 Geminoid Discussion

The traditional SBD styled geminoid scenario portrays Jack, a direct stakeholder, having a positive experience with a proposed technology. The scenario provides a glimpse of the technology being used in the present, as it was intended. Jack-G offers Jack a level of social interaction and engagement which otherwise would literally be beyond his reach. As a best-case scenario, it provides insight into the positive motivation for the technology, why it was designed. However, the technology has not become pervasive and only its main influence on a direct stakeholder is considered. The focus of the scenario is primarily on system functionality (e.g., what features need to be in place to avoid transmission overload).

In contrast, the value scenario takes a peek into Jack's future world, a society in which geminoids are ubiquitous. The pervasiveness of geminoids opens the imagination of the reader to a wide range of implications. The introduction of physically superior geminoids hints at appropriations that were not part of the original design motivation. The brief mention of indirect stakeholders (poor students and ancient teachers) those who do not directly own or operate a geminoid, also brings to mind issues of prejudice and inequity. Mention of physical atrophy alerts us to the effects of physical adaptation and stimulates consideration of the types of adaptations that are supported by the design.

At its most general level, Section 6 demonstrates how the set of envisioning criteria can be applied to an existing design method. Though we have not done so, we envisage a similar approach could work with other design methods such as personas, rapid prototyping, or task analyses.

7. STRATEGIC ACTIVITIES FOR ENVISIONING

Scenario-based design (and the value scenarios extension) represents one way to bring the envisioning criteria into design practice. Yet not all design practice and situations lend themselves to a scenario-based design method. Thus, in this section we report on a second technique to scaffold envisioning processes within professional design practice. We provide four sets of strategic envisioning activities – criterion specific questions or tasks. Each set of activities is based upon prior empirical work undertaken by the Value Sensitive Design research group. Table 2 presents stakeholder activities, Table 3 time, Table 4 values, and Table 5 pervasiveness. The activities are to be viewed as illustrative examples, not comprehensive lists. For a given project, depending on the current state of the design process (e.g., inception, elaboration, requirements, construction, or transition) different activities may prove more productive. We provide suggestions for use in Section 8.0.

Table 2. Stakeholder Activity Examples [20, 31]

STAKEHOLDER ACTIVITIES
1. **Identify Direct Stakeholders**. In what key roles will individuals interact directly with the system? Create a list (e.g., faculty member constructing an online quiz; teaching assistant maintaining a course web site; undergraduate student accessing course materials from a course web site).
2. **Identify Non-targeted Use**. Who might use the interactive system for nefarious or unplanned purposes? In what ways? Identify three possibilities (e.g., identity thieves, student collecting and selling or plagiarizing essays of fellow students).
3. **Identify Indirect Stakeholders**. What are five roles that will be affected by the interactive system but will not directly interact with it? Create a list (e.g., parents of students; university staff recruiting new students to campus).
4. **Consider Stakeholder Benefits and Harms**. For each role from above, what are the anticipated benefits of interacting with the system? What are the potential harms or downsides?

Table 3. Time Activity Examples [26, 27, 32]

TIME ACTIVITIES
Reflect on Future Trends. Imagine five years into the future. The design that you are working on has been widely adopted and is part of daily life for both direct and indirect stakeholders across society. Consider the implications for: • How people do their work… • How people make and maintain friendships and family relationships… • Physical health and wellbeing… • Those who cannot afford the technology… • Norms and social expectations…

Table 4. Values Activity Examples [7, 20, 31]

VALUES ACTIVITIES
1. **Choose Desired Values.** Create a list of three values the design should ideally support.
2. **Consider Values at Stake.** Create a list of five values that are implicated by the design under consideration. Possible values include (but are not limited to): autonomy, community, democratic, environmental sustainability, fairness human dignity, inclusivity, informed consent, justice, privacy, self efficacy, and trust.
3. **Elicit Stakeholder Views and Values.** In work with users (i.e., usability or user experience studies), include questions and probes about values. If possible, also include indirect stakeholders in user studies. Sample questions: ♦ *Evaluate the Importance of a Supporting a Particular Value with a Technology*. • Value = Privacy in Public Here are two ideas, please circle the idea that you agree with most: (1) It is OK to have a camera pointed at a fountain in a public plaza and display the live images in someone's office. There's really no problem. After all, the plaza is a public place. (2) It is troubling to think that when people walk by a fountain in a public plaza their image is being collected and displayed in someone's office. After all, people aren't expecting others inside the building to see them. ♦ *Evaluate How Well a Particular Value is Supported by a Technical Design.* • Value = Community From your perspective, how well does this technology meet your need for community? (1) very well, (2) moderately well, (3) not very well, or (4) just not relevant? Why?

Table 5. Pervasiveness Activity Examples [20, 32]

PERVASIVENESS ACTIVITIES
1. **Consider Masses of Direct Stakeholders.** Building from the earlier stakeholder activities, imagine a person in a given direct stakeholder role. Now imagine 10 such individuals interacting with the system. Then 100 individuals. Then 1000 individuals. What new interactions emerge from widespread use?
2. **Consider Masses of Indirect Stakeholders**. And to that scenario, next imagine 100 to 1000 individuals in an indirect stakeholder role, all interacting with the system. What systemic interactions emerge now?
3. **Identify Implications of Widespread Use**. Imagine the interactive system in use in a particular place (e.g., a department in a university). Then imagine the system in use in five such places (e.g., five university departments). Then 100 such places. How might interactions change as the use spreads?
4. **Consider Widespread Geographic Locations**. Imagine interactive system use across regional geographies (e.g., rural areas within a state).

7.1 A Preliminary Case Study of a Design Team's Experience with the Envisioning Criteria and Strategic Activities

As part of an effort to refine and validate the envisioning practice we recently initiated a reflective case study investigating use of the criteria. We are working with a university-based, software engineering team in the midst of designing a groupware product for campus-wide deployment. To date the team has received the envisioning criteria and four sets of strategic activities for incorporation into their design practice. During our initial interview the lead designer related the team's previous attempts to address envisioning related concerns such as privacy and malicious use stating "we probably have an intuitive red flag" around these issues. However, he described these past efforts as being sporadic and inconsistent across projects. In his words, the envisioning tools were "asking us to be more methodological about this". The interview also made salient several challenges to both the design team and to the tools we are proposing: 1) to push on design ideas without challenging morale, 2) to make tools concrete without being prescriptive, and 3) to find the right time to incorporate envisioning practices. Further work with a diversity of design teams would help us to address these challenges and develop a mechanism by which envisioning issues remain prominent throughout the design process.

8. SUGGESTIONS FOR USE

In this section we outline two contexts of design practice that could benefit from use of the envisioning criteria.

8.1 Professional Design Practice

As demonstrated by the ongoing case study, the envisioning criteria and associated strategic activities can be employed by professional designers. The criteria can guide the design process by identifying potential problem areas as well as depicting solutions [34]. The proposed activities provide one way for practitioners to work with the envisioning criteria. The activities also support the creative process by stimulating new ideas. Clearly, the amount of "thinking ahead" that occurs will be bounded by resource and time constraints and the type of application being designed.

The criteria and their associated activities can also support communication by facilitating elaboration and negotiation of value-sensitive solutions throughout the design lifecycle. From our experience value scenarios in particular offer strong support for the communicative functions termed: conscripting, framing, persuading, and recording [25]. By providing an evocative, engaging scenario of the future, team members are able to push against and negotiate their varied reactions to the envisioned future (conscription). The scenarios can also establish or reiterate a common ground, typology, or constraint field (framing). In terms of persuading, a design team may be locked in disagreement over the provision of a certain feature into a design. A value scenario which suggests a high social cost to this feature or an unexpected positive may persuade the team to drop, retain, or reconfigure the disputed feature. Once a value scenario is written, it is possible to incorporate design iterations into the narrative (recording).

Further, the value scenarios demonstrate how the criteria can extend scenario-based design. Similarly, we expect the criteria

can be incorporated with other design methods through a range of design representations (e.g. personas, task analyses, etc.).

8.2 Public Discourse, Funding, and Policy Decisions

Urban planning has a history of engaging the public in envisioning futures through scenarios, simulations, and so forth. Within interaction design there is a more modest history with this type of forward thinking. Some applications of Participatory Design (e.g., Futures Workshops) are attempts at encouraging engagement with individuals who will eventually use the designs. Yet we propose that more could be done to engage the larger public in the design of interactive technologies. For example, does the public want cameras pervasively present in all public places? Do parents and others want humanoid-robots acting as slaves for children? Or does the public prefer futures where there are digital technology-free zones, humanoid-robots are provided with civil rights, or information from public cameras is automatically destroyed after a certain amount of days? Technology visionaries as well as legislators can use the envisioning criteria coupled with other methods to bring long-term technology implications into the public discourse.

These criteria may also provide guidance for public policy and prioritizing funding of scientific research. For example, deletion of information is not high on the funding agenda; long-term storage of information is.

9. CONTRIBUTIONS & FUTURE WORK

Most importantly the work presented here provides initial steps for integrating long-term systemic envisioning into on-going design practice. More specific contributions include:

- Four key criteria for envisioning long-term systemic effects of interactive technical systems: stakeholders, time, values, and pervasiveness.
- "Proof-of-concept" that the envisioning criteria can be integrated successfully into established design methods. Offers a methodological extension of scenario-based design method through future-oriented value scenarios.
- Strategic activities – questions or tasks– which designers can use to assimilate the envisioning criteria into their design practice. The strategic activities are intended to be light-weight, tangible, and readily integrated with other design practices.

The four envisioning criteria were distilled from reflection on a particular body of work from Value Sensitive Design, urban planning and design noir. Considering the unique insights of other design perspectives might yield additional long-term envisioning criteria. Similarly, the strategic activities are a work-in-progress, not a completed product. Further case studies will go a good distance towards: 1) refining current criteria and activities, 2) identifying additional criteria, 3) developing a more extensive collection of strategic activities, and 4) identifying and addressing the professional, organizational, and cultural challenges of envisioning. In particular, activities that expose the long-term, multi-faceted environmental consequences of a design would be valuable. We also suspect that certain activities are more relevant at different stages in the design.

We recognize that there is a risk in introducing these criteria and strategic activities. Are we gratuitously adding to the morass of methods designers are expected to wade through and choose from? We contend that rather than introducing another standalone method, envisioning practices can be incorporated into established design methods that practitioners are already skilled in using. In order to be responsible designers, it is important to anticipate and support the long-term, systemic effects of new interactive systems. We suggest that addressing these effects requires a shift in design practice from a local, immediate focus to a broader process of envisioning that considers the long-term positive and negative influence of a technology in use. The envisioning criteria help designers work with larger scale social, ethical, and cultural developments rather than solely on task-oriented functionality.

While systemic thinking on any scale is difficult, we are inspired by the line of thought put forward by Hannah Arendt that although we can not know with any certainty the consequences of our actions, we attempt "nothing more than to think what we are doing" [3, p. 5]. The envisioning criteria and strategic activities are tools to think with.

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