Interactive Technologies for the Public Sphere
Toward a Theory of Critical Creative Technology

by

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Executive Summary

Digital media cultural practices continue to address the social, cultural and aesthetic contexts of the global information economy, perhaps better called ecology, by inventing new methods and genres that encourage interactive engagement, collaboration, exploration and learning. The theoretical framework for *creative critical technology* evolved from the confluence of the arts, human computer interaction, and critical theories of technology. Molding this nascent theoretical framework from these seemingly disparate disciplines was a reflexive process where the influence of each component on each other spiraled into the theory and practice as illustrated through the *Constructed Narratives* project. Research that evolves from an arts perspective encourages experimental processes of making as a method for defining research principles. The traditional reductionist approach to research requires that all confounding variables are eliminated or silenced using methods of statistics. However, that noise in the data, those confounding variables provide the rich context, media, and processes by which creative practices thrive. As research in the arts gains recognition for its contributions of new knowledge, the traditional reductive practice in search of general principles will be respectfully joined by methodologies for defining *living* principles that celebrate and build from the confounding variables, the data noise. The movement to develop research methodologies from the noisy edges of human interaction have been explored in the research and practices of ludic design and ambiguity (Gaver, 2003); affective gap (Sengers et al., 2005b; 2006); embodied interaction (Dourish, 2001); the felt life (McCarthy & Wright, 2004); and reflective HCI (Dourish, et al., 2004).

The theory of *critical creative technology* examines the relationships between critical theories of technology, society and aesthetics, information technologies and contemporary

practices in interaction design and creative digital media. The theory of *critical creative technology* is aligned with theories and practices in social navigation (Dourish, 1999) and community-based interactive systems (Stathis, 1999) in the development of smart appliances and network systems that support people in engaging in social activities, promoting communication and enhancing the potential for learning in a community-based environment. The theory of *critical creative technology* amends these community-based and collaborative design theories by emphasizing methods to facilitate face-to-face dialogical interaction when the exchange of ideas, observations, dreams, concerns, and celebrations may be silenced by societal norms about how to engage others in public spaces.

The *Constructed Narratives* project is an experiment in the design of a *critical creative technology* that emphasizes the collaborative construction of new knowledge about one's lived world through computer-supported collaborative play (CSCP). To construct is to creatively invent one's world by engaging in creative decision-making, problem solving and acts of negotiation. The metaphor of construction is used to demonstrate how a simple artifact – a building block – can provide an interactive platform to support discourse between collaborating participants. The technical goal for this project was the development of a software and hardware platform for the design of critical creative technology applications that can process a dynamic flow of logistical and profile data from multiple users to be used in applications that facilitate dialogue between people in a real-time playful interactive experience.

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Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

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My registration with the Center for Advanced Inquiry in Integrative Arts began in 1999, which was the beginning of my theoretical research for this dissertation. The Constructed Narratives project began the summer of 2002 with a team of student research assistants from Carnegie Mellon University.

The results of this research have been published and presented in many venues including Inter-Society for Electronic Arts, ACM CHI, Multimedia, and Creativity and Cognition, and INTERACT. A list of presentations and publications follows.

Presentation and Conferences Attended:

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Shneiderman, B. Fischer,G., Czerwinski,M. Resnick, M. and Myers, B. (with contributions from Jennings, P.,et. al) (2006) "Creativity Support Tools: Report from a U.S. National Science Foundation Sponsored Workshop," in *International Journal of Human-Computer Interaction*, 20(2), 61-77, Lawrence Erlbaum Associates, Inc.

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Co-chair, *About Face: Interface – Creative Engagement in New Media Arts and Human Computer Interaction*, ACM CHI 2006 Worshop Montreal, Canada. (collaborators Elisa Giaccardi, Center for Lifelong Learning and Design, University of Colorado and Magda Wesolkowska, Faculty of the Built Environment, University of Montreal)

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Syracuse University (2002). *Art Media Program Visiting Artist Lecture*, Syracuse, New York.

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Sony Wonder Technology Lab (2002). *Race in Digital Space* panel, N.Y., New York.

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Chapter 1: The Liberal Ironist as Progenitor of the Theory of Critical Creative Technology

"Technology at present is covert philosophy; the point is to make it openly philosophical." (Agre, 1997)

1.1 Introduction

As a digital artist and technologist (technoartist) with creative foundations in street photography, I have always been intrigued by the implications of an individual's interpretations and understanding of people, objects and events through the use of gestures, spatial positioning, verbal expressions including tonality and pacing of speech. My interest in the intersubjective experiences of people in public spaces was rekindled while traveling around the world and being forced to feel unapologetically aware of the sense of "otherness" imposed upon me and that I imposed on others. These experiences drew my attention to and increased my awareness of the opportunities for dialogue and learning that were silenced by the tensions and unspoken curiosities of those I encountered in public spaces.

It must be prefaced, that it is a mere coincidence that these contact-less encounters only occurred in other countries and cultures. I have made similar observations in the United States, the country that I reside. However, throughout my travels, tense street encounters were often neutralized by the camaraderie of a group of international colleagues who each in their unique methods and practices were working toward inventing a better world. Countless hours of watching people watch people in public spaces – from city plazas to international airports led to my formation of the theory of critical creative technology. The goal is to understand the methods by which people construct meaning to understand and explain their actions and the actions of other people and objects in the situations in which they occur. Sometimes referred to as discourse wranglers, or tangible social interfaces (TSI), in this text, critical creative technologies are designed to facilitate dialogical exchange by providing a common-ground for people to share stories, gather new

information facilitate dialogical exchange about participant's ideas, assumptions, beliefs and dreams, revealing their dissonances and more importantly, the harmonious counter-points in their shared experiences.

1.2 The Stance of the Liberal Ironist

> *"After the Egyptian and Indian, the Greek and Roman, the Teuton and Mongolian, the Negro is a sort of seventh son, born with a veil, and gifted with second-sight in this American world,—a world which yields him no true self-consciousness, but only lets him see himself through the revelation of the other world. It is a peculiar sensation, this double-consciousness, this sense of always looking at one's self through the eyes of others, of measuring one's soul by the tape of a world that looks on in amused contempt and pity. One ever feels his two-ness,—an American, a Negro; two souls, two thoughts, two unreconciled strivings; two warring ideals in one dark body, whose dogged strength alone keeps it from being torn asunder." (DuBois, 1903, chapter 1 "Of Our Spiritual Strivings")*

> *"All human beings carry with them a set of words that they employ to justify their actions, their beliefs, and their lives. These are the words in which we formulate praise of our friends and contempt for our enemies, our long-term projects, our deepest self doubts and our highest hopes. They are the words in which we tell, sometimes prospectively and sometimes retrospectively, the story of our lives. I shall call these words a person's 'final vocabulary'"*
> *(Rorty, 1989, p. 73)*

These final vocabularies and passing theories are used to decipher the meaning, implications and intentions of another person. They are final in the sense that the owner of the vocabulary is limited by its scope. According to Rorty, there are three types of reactions that occur when the individual is asked to process information that challenges the limits of their final vocabulary. The first is to recede into passivity. The second is to strike out in violence. The third is the stance of the liberal ironist, who maintains the flexibility to reposition her descriptions of her motivating beliefs and ideologies.

The liberal ironist is the modern intellectual who lives in a society that relishes freedom of opinion and expression. She is defined by three traits: (1) she has radical and continuing doubts about her own final vocabulary because she is impressed by other vocabularies taken as final by the people and/or the mass media she has encountered; (2) she realizes that arguments phrased in her present vocabulary can neither support nor dissolve her doubts; and (3) insofar as she philosophizes about her situation, she does not think that her

vocabulary is closer to reality than others – nor is it connected to a power not herself. The liberal ironist "spends her time worrying about the possibility that she has been initiated into the wrong tribe, taught to play the wrong language game." (Rorty, 1989) The liberal ironist holds suspect definitive claims to truth by any final vocabulary. Rather, she culls, from a broad continuum of beliefs, ideals, processes, and rule structures, a landscape of philosophical, cultural, and technical concepts that are sometimes described in abstract descriptive terms such as: "weltanschauung," "perspective," "dialectic," "conceptual framework," historical epoch,;" "language game," "différance," "heteroglossia," and "irony." (Rorty, 1989; Rittel, 1984; Wittgenstein, 1958; Derrida, 1978; Bakhtin, 1981a) The liberal ironist molds these abstract concepts and essentialist ideals from metaphysics, critical theory and liberal democracy into systems that enable her to recognize, understand and challenge the properties from which intersubjective experiences are made. It is this portrait of the endless inquirer, the liberal ironist, which has driven my research-in-practice on critical creative technology.

1.3 First Person Methodology: Experience Seeding Research

First person methodology refers to the recognition of the personal lived experience. The method is used to integrate subjective influences on the ways that we perceive, and make meaning in our world as a foundation on which to base scientific inquiry. First person methodology in the form of introspection, phenomenology or meditation does not supercede the traditional third person empirical methods of observation from the system of inquiry. First person methodology can provide an "open link" to third person empirical research methods via a second-person methodology. The second-person is one who understands the experience and can validate the first-person account of the phenomenon based upon their experiences. (Varela & Shear, 1999)

The following story about my personal experience encountering and negotiating difference in the city streets of Riga and Karosta, Latvia is a cultivating seed for my inquiry into the design of collaborative applications for bridging people, cultures and ideas in public spaces. Based upon this encounter and others that may have been less harsh, yet leaving an everlasting impression, I researched contemporary critical thoughts on communicative actions, public sphere, theories of technology and creative digital practices in support of the theory and practice of critical creative technology.

In the April 2001, I traveled to Riga, Latvia to co-lead a management-training workshop, hosted by the Network Interface for Cultural Exchange (N.I.C.E.) The workshop, based on my report for the Rockefeller Foundation titled, *New Media Arts | New Funding Strategies*, was focused on sustainable funding strategies .(Jennings, 2000)

Fig. 1: N.I.C.E. workshop attendees collaborating on an development exercise about non-profit sustainability.

1.3.1 Encounters in Latvia, 2001

The N.I.C.E. network, a consortium of new media arts centers located in Northern Europe and the Baltic, was formed to address the impact of emerging information technologies on the region. The workshop included new media arts organization representatives from Latvia, Estonia, Minsk, Czech Republic, Poland, Finland, Norway, Sweden, Denmark and Russia. The overall mission for the network, as stated in their literature is to "bridge the traditional gap between "high" and popular culture, and the divisions between various youth, sub-cultures and minority cultures by celebrating the activities of these groups that often remain invisible from the cultural policy makers and wider public." (N.I.C.E., 2005; R.A.M., 2005)

What was it like to be an African-American woman visiting a former Soviet Union eastern block country as an ambassador of highly sought after and simultaneously critiqued methods for non-profit organization self-sustainability that was based upon American entrepreneurial ideals? I was an outsider to this event at least twice removed. I was the only person from the United States who was not an expatriate and the only African-American and one of two attendees with roots in the African Diaspora. The collegiality and openness of the participants of the N.I.C.E. network created a buffer to the hostilities I encountered on the streets. Within the action-oriented efforts of N.I.C.E., doors that have been bolted shut among their own cultures were being pried open. Their activities create an opportunity for exchange with other cultures within and bordering the Baltic region – a type of regional effort I would love to see organized in the United States. Additional information about the activities of the consortium can be found in chapter five.

Fig. 2: Museum of Occupation, Riga, Latvia.

One late afternoon, following the end of the day's discussions, I went walking alone through Riga. In the center of the town I came upon a most somber and foreboding structure. The architect, Gunârs Lûsis-Grînbergs, designed the building such that its presence incorporated the vocabulary of domination – for here before me was Latvia's Museum of Occupation. (Museum of Occupation, 2006) It seemed to be both hiding in fear behind and warding off strangers with its two huge cast iron doors. The building was a personification of the pervasive repressive ambiance of the past Latvian history that has left its xenophobic residue in its contemporary era of liberation.

In the 20th century alone, the former Soviet Union occupied Latvia over several politically brutal periods with a brief interlude by the Third Reich. After the fall of the Soviet Union

and Latvia's sovereignty in 1991, Russian citizens of Latvia lost their position of political and economic power to fall to minority status as second-class citizens. This new meaning of the word "minority" as being of Russian decent, challenged my American-centric understanding of a term that is used both to describe the quantitative relationship between ethnic groups or a given society and as a weapon for oppression to denote persons of color.

Regardless of this culturally specific definition of minority, racism toward people who looked ethnically different was prevalent. Worldwide media, film, television and radio, is not absent of images of African-Americans from the worldwide distribution of American television shows, movies, music, and sports-entertainment franchises. The majority of these images serve to perpetuate stereotypes of the African-American either as poor, criminal, a super-human athlete or an elite performer. Even when mediated images are not outwardly negative, they are often loaded with culturally specific signifiers whose meanings are lost and morphed into new international interpretations of African-American culture leading to the extremes of cultural imitation to profound cultural hybrids. I quickly realized that the majority of people I encountered had never seen an unmediated African-American woman. This is not only a problem of access to alternative media forums in foreign countries. For often when telling this story, I reflect on the fact it is a mere coincidence that the setting is in Latvia as opposed to Italy, Brazil or the United States.[1]

My participation in the N.I.C.E. workshop and the experience of walking around the cities of that strange and new land has left me with a lasting impression of those I encountered, even in the cases when the essence of the experience was beyond articulation. The polemic nature of my experience of walking in the streets of Latvia was filled with many anthropological moments for cultural observation. To one extreme, I encountered people

[1] Scholarly research on the impact of African American culture on international social and cultural ideas and practices have been written in *The Black Public Sphere*, scholarly work by Bell Hooks, Cornell West, and others. (Hooks & West, 1991; Black Public Sphere Collective, 1995)

who appropriated and re-articulated cultural, social and political tropes from the African Diaspora as a means to create a framework for a liberal underground Latvian cultural community. In the other extreme, I encountered people in the streets who blatantly demonstrated their ignorance, hatred and fear toward what they thought my presence represented. The Latvian streets were a hostile territory to navigate. Cold stares from people in the street whose gaze were so incredibly locked onto me caused their bodies to turn in rhythm with my gait. The intensity of the gaze was one that can only be indicative of a non-empathetic stance to the "otherness" of another being. Racial epithets were freely thrown through the air in a trajectory aimed to pierce my eardrums. I don't speak Latvian or Russian; however, certain derogatory English terms are not hard to cull out from the utterances of a "foreign" tongue. These epithets were most likely learned from the media created in or imitated from that produced in the United States.

My story begins near the end of my week long visit to Latvia on a bus tour to a poor Russian community called Karosta that borders the city of Liepajas, a former Soviet military port city, to visit a newly opened media arts cultural center "The Center for Information and Culture 'K@2'". The center was established by Kristine Briede and Carl Biorsmark, two filmmakers from Sweden who began making a documentary film on the port city and stayed to form the center in 2000. The center represented "best practices" in bridging the "digital divide" by using independent media culture initiatives to address urgent social issues such as, minority cultures, region development and other social changes in the Baltic region.[2]

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[2] *(from RIXC center website Riga, Latvia http://rixc.lv and the Wikipedia http://en.wikipedia.org/wiki/Karosta)*

Karosta, north of Liepaja in western Latvia on the Baltic sea, was constructed as a naval base for the Russian Tsar, and later served as a base for the Soviet Navy. It has most recently come under NATO occupancy. The base, Port of Alexander III, was of tactical importance due to its central location in the Baltic sea and the fact that it does not ice over in winter. Built on the bare coast it consists of a large man-made harbor including a large breakwater and inland submarine warren. The army headquarters include Tzar-era mansions used by admirals, a palace for the Tzar (reportedly only used once), an impressive Russian Orthodox cathedral, as well as underground bunkers and abandoned storehouses. Soviet-era buildings include many rows of block housing. At its height Karosta was home to over 20,000 people.

Fig. 3: Young men on tour to Karosta, Latvia who engaged in conversation about United States cultural politics.

Fig. 4: Tenement housing in Karosta.

Fig. 5: Russian Orthodox Church in, Karosta, Latvia.

Fig. 6: Conduct sign posted at the gate of the Russian Orthodox Church, Karosta, Latvia.

During the bus ride from Riga to Karosta I engaged in conversation with two young men – fellow liberal ironist - who were active members of the Latvian digital media counter-culture. One sported a head full of dreadlocks covered by a, red, black, green and gold knit cap. The other young man, sporting a buzz cut and "Amish-like" beard had a thoughtful yet pensive demeanor, was a student of philosophy. They asked me questions about American racism, 1960's civil rights movement and hippie counter-cultures. They were also fascinated by the prospect that I could give them a first hand experience of encountering a Native American – their symbol of the American underclass. As our conversation progressed, I wondered how they learned about American culture and why they were so intent on borrowing from American counter-culture to define their own Latvian counter-culture.

As the shiny red double-decker bus entered the port city of Karosta, the cacophonous conversations about politics, culture, and digital media fell to a pin-drop quiet. Optimistic chatter dissipated to dismay. Visually, we knew that we

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The Port of Alexander III was a completely autonomous settlement with its' own infrastructure, electrical power plant and water supply. After the Soviet occupation of Latvia, Karosta became a military base housing some 25,000 and was closed to civilians by a fortress wall built around the city. After Latvian independence the Soviet army left in 1994, leaving behind some 6000 people (mostly Russians relatives of the army, staff or military pensioners). Those who stayed salvaged what was left behind, stripping the buildings of their floors, windows, wiring and even bricks; selling them for scrap. The town appeared to be a landscape of ruins. Many houses were completely destroyed from the original vandalism, and the town is plagued by mass unemployment, street crime and drug problems. Today some 7500 people live in Karosta. Less than 25 percent of them are Latvian citizens and most are Russian speaking. The stateless citizens of Karosta are not considered Latvian or Russian and carry a Latvian issued "alien passport."

were driving through war, not of the past, but of the present. This neglected community – rusted residue of an industrial past sitting on the shore of the Baltic Sea, was not unlike regions of the place I call home – Pittsburgh, Pennsylvania. Signs of life, in the blackened windows of the cement tenement apartment buildings, were hinted at by laundry thrown over structurally unsafe terraces. The abject poverty of this community and lack of civic infrastructure flanked by the hope of the new media arts center reminded me of a visit I made to Flint, Michigan in January 2000 to visit several newly formed community-based technology centers, funded in part by the United States Department of Education, located in an African American and Hispanic communities. (Penuel, et al., 2001)

The despair in this Karosta community seemed more violent. The social/cultural infrastructure of the community was supported by three bars, a meticulously maintained Russian Orthodox Church guarded by a noble cast iron fence, and the new media arts center. After our morning sessions in the Karosta Center for Information and Culture that was spent discussing the value of net-culture and critiquing "American techno-imperialism" by socialist media theorists from the wealthy and technologically sophisticated Scandinavian countries, we broke for lunch. Individually, and in small groups we ventured out into the streets of Karosta. The Russian Orthodox Church, a shining pearl in this oil-slick sea of crumbling infrastructure and dire poverty, was a "safe" magnet for many of us. Bravely, with my invisible shield to deflect hostile gazes and racial epithets, I walked toward the church. Mounted at the gate entrance was a large sign in English, German, Latvian and Russian, that read, "Please do not enter the cathedral's territory with evil thoughts and words, with lit cigarette, intoxicated in beach or other indecorous clothing. Please keep out dogs and other pets." I spoke with a Norwegian colleague from the workshop, at the gate, who proclaimed that the visit changed his perspective on life. I nodded with a wordless empathetic acknowledgement and walked through the gate entrance to admire the classic Russian Orthodox architecture - as any good tourist should.

I decided to walk around the circumference of the building to admire and take photographs. Two young boys who were approximately thirteen years old were walking toward me on the other side of the cast iron fence. Both carried large bundles as they cajoled each other in a boyish manner. Their gaze and laughter transformed from youthful horseplay into a targeted sharp dagger once they spotted me. By this time in my trip, I had grown a tough skin to deflect this and all too frequent response. I tried to ignore them.

In crystal clear English, at the top of their young lungs the boys shouted, "Hey you black man.... I hate you black man!" One may wonder what made them assume that English could be the language to wage this verbal war. I ignored the "man" part of their proclamation. My hair was cut short. It is only logical that their manner of addressing me would be based on stereotypes of gendered appearance if they were not exposed to the countless hair styles of women from the African Diaspora. I was left in shock by their other bold, blatant and hateful words. My blood boiled deep inside even though I tried to ignore them. After all, I thought that I had as much right to be in their community as they would in mine, should they ever have the opportunity to venture beyond the boundaries of their concrete jungle. Perhaps this is a sentiment of the "ugly American" bred on a western sense of entitlement. Besides, there was a fence separating us! I continued to walk around the circumference of the church... the only symbol of peace in that wretched community.

I met the boys again on the other side of the building. Whereupon their racism articulated in our only common language, rang out again. By this time, I had experienced enough stressful encounters in the streets that if a fence did not separate us, I may possibly have strangled them. But I'm not the violent type. Rather, I stopped, looked at them and asked, "Do you speak English?" To their dismay... this strange yet familiar other person from another world was addressing them. They had no choice but to enthusiastically answer,

"YES...!?" "Have you ever met anyone African-American before?" Then I realized that in their limited knowledge of the world beyond their community and exposure to regurgitated syndicated American mass media, they did not know the term African-American. I rephrased the question, "have you ever met anyone Black before?" Their response was, "no?" "What's your name?" They both excitedly told me their names. I must admit that in the chaos of the moment compounded by the "fight or flight" adrenalin flowing through my body, their names did not register. "Well," I said, "whenever you meet someone new, you should be nice to them. Don't be rude. It isn't nice."

I really wanted to curse them out, but I realized that this probably wasn't the best tactic given the limitations of the depth of our shared language. However, they probably would have understood the affect spewing forth from my lips. The boys smiled an uncomfortable smile – the type a person displays after being reprimanded. As they continued on their way, their cajoling was transformed to nervous laughter.

1.3.2 The Meeting of Double-Consciousnesses

Double-consciousness, a situation of living a double life that is informed both by the subject's own sense of being in the world and the expectations and belief structures of others, need not only be a condition of the African-American. The condition can be rightfully assigned to persons who are denied the opportunity to experience a sense of self that is not manipulated by the actions, expectations, and beliefs of others who make-up the dominant culture. For instance, the young Russian boys in the Latvia story struggled with double-consciousness that I can only empathetically imagine based on my understanding of the second-class citizenship of Russians in Latvia. One sense of their being led them to believe that they owned the public space of our encounter and were entitled to express their naïve racism. Another sense of their being was filled with an overwhelming curiosity and desire for making a connection with another person they categorized as stranger and other.

Intentions were suspect for all of us. We were forced into a situation that required a rapid analysis and negotiation with our visual and cultural perceptions held in our minds that prompted us to defensively adopt strategies for interaction.

I shared this experience with a few workshop colleagues who gave cautiously empathetic responses. My experience was foreign to their experience of the world and the final vocabularies they employed to understand and resolve social conflicts.

1.4 Toward a Theory of Critical Creative Technology

> *"A good society should enlarge the personal freedom of its members while enabling them to participate effectively in a widening range of public activities. At the highest level, public life involves choices about what it means to be human. Today these choices are increasingly mediated by technical decisions. What human beings are and will become is decided in the shape of our tools no less then in the action of statement and political movements. The design of technology is thus an ontological decision fraught with political consequences. The exclusion of the vast majority from participation in this decision is the underlying cause of many of our problems." (Feenberg, 1991, p. 5)*

The theory of *critical creative technology* is informed by a social cartography[3] that examines the interlinking relationships between critical theories of technology, society and aesthetics, information technologies and contemporary practices in interaction design and creative digital media. Applications for social engagement that are informed by the theory of *critical creative technology* mine public spaces to uncover dissonances and, more importantly, reveal harmonious counterpoints between the multitudinous lifeworlds [*lebenswelt*] (Husserl, 1929) that transform a public space into a place for intersubjective experiences and opportunities. The theory of *critical creative technology* is aligned with theories and practices in social navigation and community-based interactive systems[4] in the

[3] Critical social cartography, a social research method, incorporates the creation of maps to illustrate interconnecting relationships that exist in the social milieu to support the "opening of dialogue among diverse social players, including those individuals and cultural clusters who want their 'mini-narratives' included in the social discourse." In essence, the social cartographer's map represents her "perceptions of the social world... locating in it multiple and diverse intellectual communities, leaving to the reader not a truth, but a portrait – art representing the possibilities portrayed by being open to the world's multiple cultural truths." (Paulston, 1995)

[4] Community-based Interactive Systems (CIS) interactions are based on digital appliances with software agent capabilities that can support people in performing their social activities, promote communication and enhance the potential for learning in a community-based environment. Such capabilities allow the device to act intelligently in support of one of more users, further facilitating the interoperability between devices

development of "smart" appliances and network systems that support people in engaging in social activities, promoting communication and enhancing the potential for learning in a community-based environment. The theory of *critical creative technology* amends these community-based and collaborative design theories by emphasizing methods to augment and enhance face-to-face dialogical contact when the exchange of ideas, observations, dreams, concerns, and celebrations may be silenced by societal norms about how to engage of others in public spaces.

The social cartography for *critical creative technology* is founded on the overlapping, sometimes complementary and other times conflicting, philosophies and practices in the theories of: (a) embodied interaction – the development of tools and systems that support richer intersubjective experiences that "support an engaged interaction that highlights, celebrates and augments the social, cultural and historical importance of how people construct meaning." (Dourish, 2001); (b) constructivism – the idea that an individual's social, cultural and historical situation, or "social matrix," impacts the individual's ability to learn and live in the culture in which he/she resides (Penuel & Wertsch, 1995; Spivey, 1997); (c) communicative action and the bourgeois public sphere – an analysis of the normative rules used to validate speech acts between a speaker and hearer to arrive at a rational consensus about a given topic and the historical and cultural implications on the development of a theory of the public sphere (Habermas 1989; 2001); and (d) critical theories of technology – an examination of instrumental and substantive theories of technology as a means to inform a dialectics of technology based on four principles, concretization, vocation, aesthetics and collegiality. (Feenberg, 1991) Each of these

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through a network. Key to this concept is that technology is not an end in itself. Technology is a way of serving, empowering and assisting people in their role as a member of a local community. Technologies that support a CIS approach are multi-disciplinary in nature including human-computer interaction, information management using multi-agent systems, and distributive network computing. (Stathis, 1999)

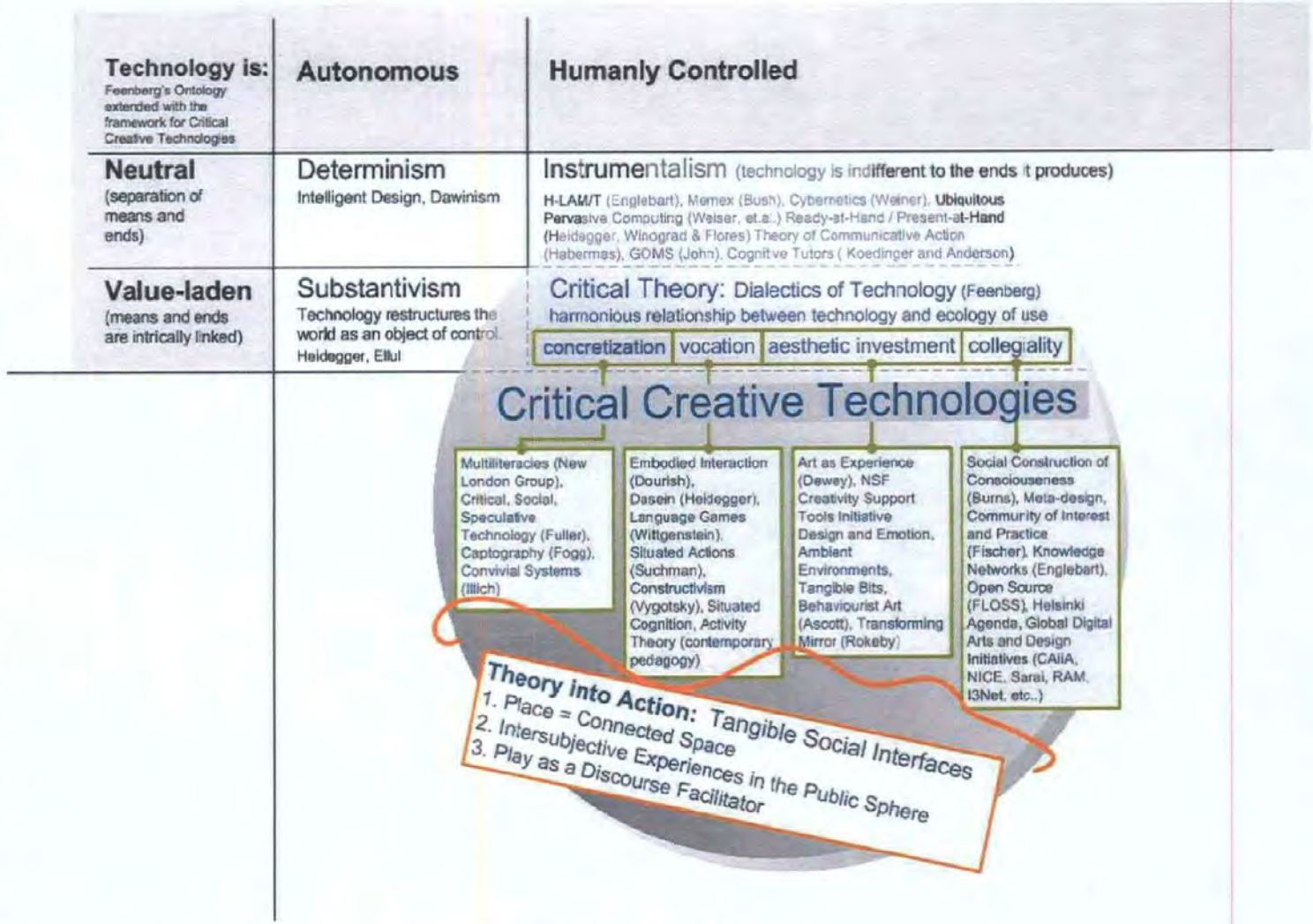

Fig. 7: Critical social cartography that informs the theory of critical creative technology.

theories, along with satellite theories examined in this text, emphasize the impact that systems, technologies and tools have in facilitating or hampering intersubjective experiences, quality of discourse, social interaction, and learning. This critical social cartography informs the design of technology-based projects, in the spirit of critical creative technologies, as forms of research-in-practice that incorporates practices from the

digital media arts, interaction design, critical theory, human computer interaction and engineering.

1.5 The Constructed Narratives Project

Constructed Narratives is a construction kit of blocks that, when connected, form an open topology network. This *tangible social interface* is designed to uniquely respond to each builder based upon his/her profile and interactions, with the blocks, as they collaboratively build abstract structures with other builders at the game table. Construction patterns and keywords from each builder's profile, completed prior to game play, are used to seed a word search using the Wordnet API (WordNet, 2006). The results of the word search are overlaid onto a three-dimensional virtual replication of the physically-built structure displayed on a screen that the players can view as they are constructing their narrative. Each action performed by a builder is recorded and cycled back into the environment, creating a persistent memory that is bounded by a reflection of the physical construction and layered with text that is themed around each builder's self-defined concepts of self-identity, origins, home, work and play environments, and beliefs and value systems based on unique profiles for each builder.

> *Nur dann erfüllt ja Spiel den Zweck, den es hat; wenn der Spielende im Spielen aufgeht. Alles Spielen ist ein Gespieltwerden. Das Spiel ist es, was den Spieler in seinen Bann scwägt, was ihn ins Spiel verstrickt, im Spiel halt. Der Spielende erfahrt das Spiel als eine ihn übertreffende Wirklichkeit.*
>
> *(Play fulfills its purpose only when the player is wholly involved in play. All playing is being played. The play's the thing that captures the player, enraptures him and holds him in play. The player experiences play as a reality that surpasses him.) (Gadamer, 1990)*

As stated in the executive summary, the *Constructed Narratives* project is an experiment in the design of a *critical creative technology* that emphasizes the collaborative construction of new knowledge about one's lived world through computer-supported collaborative play (CSCP). To construct is to creatively invent one's world by engaging in creative decision-making, problem solving and acts of negotiation. The metaphor of construction is used to demonstrate how a simple artifact – a building block – can provide an interactive platform

to support discourse between collaborating participants. The technical goal for this project was the development of a software and hardware platform for the design of critical creative technology applications that can process a dynamic flow of logistical and profile data from multiple users to be used in applications that facilitate dialogue between people in a real-time playful interactive experience.

A critical element for learning, as identified by the United States National Research Council Committee on Developments in the Science of Learning, is the ability for an individual "to engage in the mental work of making inferences" as a means to perceive relationships between information from a heterogeneous group of sources. From these inferences comes solutions of problems, answers to inquiries, and completion of tasks. (Bransford & Brown, 2000) By enhancing the potential for discovery, collaboration and learning in a shared environment through collective reflection, creative problem solving and the exploration of alternative methods of building that foster a deeper understanding of the context of the shared environment, participants are given the opportunity to deconstruct the context of that environment and challenge the "passing theories" (Rorty, 1989) that they use to justify their observations of and making of meaning in public spaces as they co-build a social architecture. (Jennings & Giaccardi, 2005) The builders' actions of arranging and rearranging the physical blocks artifacts supports a process of empowerment where the builder negotiates structural solutions simultaneously with her collaborator and the topic of discussion as revealed through the lexical layer in the virtual replication of the built structure. The builders are co-constructing a world in which they have ultimate design authority. This is a world in which they are the very material from which that richly contextualized intersubjective world is made.

1.6 Chapter Summaries

Chapter 1 The Liberal Ironist and First Person Methodology: seeds for developing socially resonating technologies

Rorty's persona of the liberal ironist is presented as the spirit by which this text and research has been approached. The concept of first person methodology as a viable place from which to cultivate scientific research is described. The description of Shear and Varela's first person methodology technique is followed by a travel experience by the author which helped to instigate the development of the theory of critical creative technology. Insight to the critical social cartography that informs the theory as well as an introduction to the Constructed Narratives project is given.

Chapter 2 Intersubjectivity and Theories of Communicative Action

Thompson's theory of enactive cognition and the role of empathy set the foundation from which the first person methodology story articulated in chapter one opens a space for inquiry into the role of empathy, intentionality and intersubjectivity in supporting discourse. Habermas's models of the theories of society, in particular his fourth model for communicative theories founded on intersubjective experiences sets the stage for the development of his theory of universal pragmatics and ideal speech acts. Alternative theories of communication and society that fit the specifications of the fourth model, which Habermas does not address, are also explored including Wittgenstein's "language games," Bakhtin's "speech genres," and Vygotsky's "constructivism. The chapter concludes with a metaphor for visualizing the polemic theoretical positions on the nature of discourse from Habermas's validity claims to Rorty's liberal ironist stance based on Davidson's concept of "passing theories."

Chapter 3 The Construction of the Public Sphere

Models and theories of the public sphere are examined in this chapter. Dewey's concept of the public sphere as the locus of political decisions is followed by Broeckmann's argument

about engaging the public domain. Habermas's infamous theory on the bourgeois public sphere is addressed along with comments from several of his critics. Alternatives to the bourgeois public sphere are explored including Mouffe's agonistic democracy and Negt and Kluge's proletarian public sphere. The chapter ends with Habermas's reprieve to his critics and an enlightened view to the nature and potentialities of the public sphere as a place to influence policy in a "siege-like manner".

Chapter 4 Critical Theories of Technology

Feenberg's analysis of the two main camps of critical theories of technology, instrumental and substantive, is examined. The chapter further elaborates on the theories with historical examples from well known visionaries and technologist. Instrumental theory is illustrated with an analysis of Vannevar Bush's "As We May Think" article, Englebart's HLAM/T theory, Weiner's cybernetics, and Weiser's ubiquitous computing framework. The substantive theoretical platform is supported with Heidegger and Habermas's concerns, or lack of concern, on the impact of technology on society. The chapter concludes with an overview of Feenberg's position on the critical theory of technology his elaborations on the bias and neutrality factors of technology leading to discussion and elaboration in the following chapter on his *dialectics of technology*.

Chapter 5 Dialectics of Technology and Contemporary Practices in Creative Digital Media

Feenberg's *dialectics of technology* and its four core components; concretization; vocation; aesthetics; and collegiality, are explored, dissected and augmented with examples from contemporary digital media, interaction design, human computer interaction and pedagogical practices. Among the theories and practices brought forth in support of his theory is the New London Groups theory of multiliteracies, Fuller's critical software concepts, Fogg's persuasive computing, Dourish's embodied interaction, Ascott's behaviorist art; Rokeby's transforming mirror; Fischer's metadesign, and digital divide

community empowerment efforts. The chapter concludes by connecting concerns of Feenberg's dialectics of technology to my theory on critical creative technologies.

Chapter 6 Principles for the Design of Critical Creative Technology Applications

The three main principles in the design of applications in the spirit of critical creative technologies are described. Principle 1: Place as Connected Space is supported by theories that differentiate the terms space and place as one that defines logistics and the other which defines contextual attributes. Research methods, such as Hillier's space syntax, designed to analyze and assign attributes of quality to the quantified data are examined in comparison to Deleuze and Guattari's rhizome as a metaphor for place. Principle 2: Empathetic Intersubjective Experience takes its lead from the discussion on Thompson in chapter 2 to further elaborate on situational requirements for an empathetic experience. Principle 3: Discourse and Play seeks to define a notion of "deep play," by examining the important western historical and philosophical platforms in which play was relegated as an important element of society or treated as an unnecessary distraction to rational discourse. The principles lead to the main goals involved in developing applications for critical creative technology in the form of tangible social interfaces. The chapter ends with an overview and scenarios of the Constructed Narratives project, an brief description about the project's technical development.

Chapter 7 Constructed Narratives Block Design

The design of the Constructed Narratives block is discussed in detail. In particular, the development of the generative design methodology based on Stiny's shape grammars theory in architectural design is discussed. The influence of Froebel's kindergarten gifts on Stiny and the development of the Constructed Narratives block is also discussed. The design methodology and process are described and illustrated. The materials in this

chapter set the stage for discussion in the following chapter about the development of the software architecture.

Chapter 8 Constructed Narratives Software Development

The development of the Constructed Narratives software architecture is discussed in detail. The overall component architecture is presented with information about each component, its task, and the approach taken for its development. The methodology of integrating theories from visual semiotics as a framework for the development of the Semantic Engine is discussed and described in detail.

Chapter 9 Constructed Narratives Hardware Development

The development of the Constructed Narratives hardware architecture to support an open-topology network of blocks is discussed in detail. In particular the approach to hardware solutions, electrical connection solutions, and proprietary circuit boards are discussed. The two-bit sensor which manages incoming messages from ten block faces is described and images of the circuit boards and selected schematics are presented.

Chapter 10 Methods to Support Interdisciplinary Research Teams

Issues in managing an interdisciplinary research team are addressed in this chapter. The selection process for student research assistants at Carnegie Mellon University is described. The procedures put into place to celebrate the "symmetry of ignorance" inherent in the team as we tackled many wicked technical and design problems are described. The results of an informal questionnaire about the interdisciplinary team process are presented. The questions and answers, although a small pool, indicate the success of the process put into place as well as inherent differences in the approach to problem solving by practitioners in different disciplines.

Chapter 11 Public Presentations and Future Plans

Opportunities to present a demonstration prototype of the Constructed Narratives project are discussed. During an exhibition opportunity at the Kiasma Museum for Contemporary Art in Helsinki, Finland, I was able to observe people, who where not members of my lab, interact with the blocks. Based upon this experience I was able to validate some issues that I already knew had to be addressed and learn about a few more. This was also an unprecedented opportunity to gain feedback from an international community of peers, which on the whole was overwhelmingly positive. The chapter ends with four new scenarios that take their lead from the scenario about Constructed Narratives in chapter six. In particular, these scenarios present a platform of continued projects in the area of critical creative technology as a means to facilitate discourse and knowledge about one's immediate surroundings.

Appendix A Narrative, Interactivity, Storytelling and Intelligence

Narrative as it relates to contemporary practices in creative digital media is addressed. Starting from Laurel's attempt of a revisionist application of the poetics to computer-mediated applications, I explore the ideas from Ascott's 1967 behaviorist art, Rokeby's 1996 transforming mirrors and Schank's positioning of communication as the act of intelligent storytelling.

Appendix B Construction Toys and Electronic Construction Kits

This appendix is a colorful overview of the construction toys and electronic construction kits literature search that informed the design of the Constructed Narratives project. In particular, the electronic construction kits are divided into four categories: historical electronic construction kits; sensorial interfaces; information navigation; and shape analysis systems.

Appendix C Semantic Engine Documents

This appendix contains additional tables in support of the description of the Semantic Engine in Chapter eight.

Appendix D Public Dissemination of Research

This appendix contains a list of opportunities for the public presentation and paper publication about the Constructed Narratives project.

Appendix E Early Design Prototypes

This appendix contains a description of an early Constructed Narratives block design that was contemplated before the Constructed Narratives shape grammar methodology was developed.

Appendix F Software Application Programming Interfaces (API)s

This appendix contains selected sections of the Constructed Narratives software API.

Chapter 2 Intersubjective Theories of Communication

2.1 Introduction

My recollections of discomfort, anger, and the defensive positioning I was forced to take during my travels in Latvia may overwhelm some readers and leave them in a state of awe, embarrassment, empathy, and/or doubt about the details of the encounter. Some will feel uncomfortable, recognizing their own reflection among any of the characters in the story. Discomfort will arise for others from a sense of frustration in being part of such a divisive world. Some readers will challenge the protagonist's story, stating in their mind that it really could not have been that bad, "she must be exaggerating." Others will classify the story as a "race" story, one that does not have direct impact on their lives and thus can be dismissed or not taken seriously. Regardless how this story may be received by others, an intersubjective and empathetic bond between the storyteller (speaker) and hearer is required for reaction.

2.2 The Theory of Enactive Cognition and Intersubjectivity

Intersubjectivity is the dynamic interrelationship of self and other that negotiates the thin boundary between self-identity and collective consciousness. The concept of intersubjectivity helps to understand how individuals interact, interpret, and produce mutual understanding of a shared world experience. (Thompson, 2001) I argue that to reach an intersubjective state requires much more than "simply" achieving mutual agreement, Habermas's model of intersubjectivity. The concept of intersubjectivity must be broadened to include attributes of embodiment, empathy and "self-other co-determination" as theorized by Evan Thompson's theory of intersubjectivity, consciousness and empathy.

Thompson's theory of intersubjectivity, consciousness and empathy is founded on five key presuppositions: (1) individual human consciousness is formed in the dynamic interrelation

of self and other; (2) the concrete encounter of self and other involves empathy, which is a unique and irreducible form of intentionality; (3) empathy is the precondition of a science of consciousness; (4) human empathy is developed; and (5) real progress in the understanding of intersubjectivity requires the integration of methods grounded in practices of: cognitive science; philosophies of the mind; continental European phenomenology; and the psychology of contemplative or meditative experience. Thompson articulates a similar goal to that of other social-philosophical theories which is to develop a theory about the essence of intersubjective experiences. Thompson's theory is based on a core dyad of ideas. The first, empathy, is the precondition (the condition of possibility) for the science of consciousness, stems from philosophies of phenomenology that is structured on the perceptual awareness that make human experience. The second component states that empathy is an evolved, biological capacity of human species (and probably other mammalian species) based on research in cognitive science.

Thompson's theory of enactive cognitive science or embodied cognition, an alternative view of cognitive science challenges the classical view that the world outside of the mind is represented by symbols. Rather for Thompson, the relationship between empathy and consciousness becomes the central focus and is based on the premise that the human mind is situated throughout the body. Its functioning relies upon connections that reach beyond the biological body into the realm of interpersonal social world of the self and others.

Components of enactive cognition include: (1) embodiment; (2) emergence; and (3) self-other determination. These three components combined with empathy are prerequisites for supporting an intersubjective experience.

Thompson's definition of *embodiment* complements Dourish's in that the mind is located in "the whole organism embedded in its environment." (Thompson, 2001) One could easily

trace similarities between enactive cognition and Dourish's *embodied interaction*. Whereas Dourish focuses on the social and the tangible, Thompson's view is physiologically located. He seeks to understand how sensory perception is molded by empathetic and intersubjective experiences. For example, visual perception of space is the result of interactions from multiple body locations (e.g. eyes, head, arms, perception of self, etc..). Each partakes in spatial mapping to manage physical movement. (Dourish's human computer interaction theory of embodied interaction is addressed in chapter 4.)

Emergence is the development of the global activity patterns that are built from local activity patterns and the rules structures that create them. The causal relationship between local and global is reciprocal.

The third component of enactive cognitions, *self-other co-determination*, emphasizes the importance of affect and emotion as fundamental elements of the mind, particularly in understanding the self as an interpretation of the other and vice versa.

2.3 Brentano's Theory of Intentionality

Brentano introduced the concept of intentionality, an important element in all subjectivist theories of communication, to explain the implications of human desires on their actions. Brentano's theory of intentionality set the stage for subsequent theories of intentionality including Dennett's theory of intentional stance. Brentano's theory is based on three premises; (1) Mental phenomena are the exclusive object of inner perception. Perceptions are a result of the cognitive processing a person applies to his or her observations that are triggered by stimuli applied to the body. (2) Inner mental perceptions always appear as a unity. If a mental perception contains elements of multiple senses (e.g. sight, sound, smell) then mental perception is a sum of all elements rather than unique sequential instances. (3) Inner mental perceptions are always intentionally directed towards an object. In other

words, intentional objects are objects of the mental state which *inexist* in mental acts without a corresponding physical world entity, resulting in intentional inexistences. Brentano emphasized that people can interact with a mental object, or intentional inexistence through presentation, judgments – the acceptance or rejection of things and states of affairs in the world – and the "phenomenon of love and hate," by using propositional statements of desire and acts of will. (Brentano, 1874)

Brentano's theory of intentionality has been criticized for its inability to account for the intentionality of entities that do not have mental processes (e.g. physical objects – computer, lightening strikes, or non-existing objects, such as a fictional character in a play that possesses beliefs and desires).

2.4 Dennett's Intentional Stance

Daniel Dennett, philosopher of science of the mind and artificial intelligence, described a series of intentional strategies that can be used by a subject to predict the behavioral intentions of another agent, be it a physical object, person, or thing. (Dennett, 1997) Dennett's theory of intentionally identifies four strategies that are used to attribute properties of rationality to an object, person or thing: (1) magic stance; (2) physical stance; (3) design stance; and (4) intentional stance. The *magic stance* places the prediction of behavior on superstition and supernatural belief systems. The *physical stance* requires a deep knowledge of physics and other empirical sciences to understand the physical nature of the agent. The *design stance* accepts the impossibility of knowing all the "physical constitution" of the agent. However, a subject can predict the intentional behavior of an agent if she understands the intended functionality of the agent. For instance, if I know that pushing a key on the keyboard will make a letter print on my screen, I understand the intention of the design and can correctly predict the behavior. Unless, too many crumbs have fallen between my key pads and the keystroke is resisted with an impotent response!

The *intentional stance* is adopted when a design stance is not possible. The process is based upon the assumptions that: subject is interacting with a rational agent; the agent's beliefs are definable and can give the subject an understanding of the agent's place and purpose in the world; and that the agent will act accordingly to further its goals. The caveat to the intentional stance is that the subject can only attribute beliefs and desires to the agent that are immediately available. Past histories that may attribute to the current behavior are not available to help discern false beliefs from actual reality. Dennett notes that verbal behavior further complicates how intentionality is attributed to an agent, particularly when the verbal behavior is fallacious and adds further complexity and distortion to understanding that agent's intentionality. Leading a subject to "believe that some particular, actually formulated, spelled and punctuated sentence [formed in one's mind] *is true* and that in other occasions we should come *to want such a sentence to come true*...". (Dennet, 1997, p. 64) Discourse, as a method to break the potential impasse created by fallacy-laden language and assumptions, is not factored into Dennett's intentional strategies. However, dialogue helped to challenge the pre-judged intentional stance, or stand-off, between myself and the boys in Karosta – if only for a few minutes. The *intersubjective communicative stance* is the mutual understanding of another's intentions based on a complementary interpretation of a shared experience. In chapters four and five I address issues on the use of information technologies to facilitate the *intersubjective communicative stance*.[1]

2.5 Towards the Theory of Universal Pragmatics: Habermas's analysis of theories of communication

Habermas seeks to develop an intersubjectivist theory of communication, which challenges both objectivist and subjectivist ontological theories that study the nature of being, as a

[1] Also see Appendix A, "Narrative, Storytelling, Interactivity and Intelligence," for an overview of Roger Schank's thesis on storytelling as the major vehicle for communication between subjects.

method for understanding the process by which western societies make meaning about relational entities in the world. (Habermas, 2001) His theory of universal pragmatics focuses on qualities of intersubjective discourse that enable subjects, the speaker and hearer, to attain mutual understanding and consensus about objects, persons or states of affairs. In order to achieve mutual understanding, the speaker's intentions must be clarified through symbolic expressions, components of a system of signs or language, which are relevant to both the speaker and hearer. Habermas's emphasis is on verbal linguistic expressions. He supports this position by claiming that "whatever can be meant, can be said." He believes that non-verbal expressions can be rendered, even if only approximately, in words whereas not all words can be rendered non-verbally.

Habermas's theory of universal pragmatics and the public sphere, discussed in the following chapter, are foundational theories containing first principles about communication and society that have been augmented, amended, contested, and defended by many instances of western critical theory discourse. Many of his critics, several which will be addressed in this text, have called into question his: (1) ranking of linguistic expressions over other modes of communication; (2) leaning toward consensus politics mediated through ideal speech acts as a viable form of discourse; (3) modeling of the public sphere on a romanticized notion of the 18th and 19th century bourgeois cultural practices; and (4) limited reference to the role of aesthetics in discourse. (Mouffe, 1999; Langsdorf, 2002; Fraser, 1992; Negt and Kluge, 1972)

2.5.1 Polemic Relationships in Habermas's Meta-theoretical Framework

Habermas's two volume treatise on the *Theory of Communicative Action* followed with his text *Pragmatics of Social Interaction* serves as a guide to understand the relationships between post-Kantian psychological and philosophical generative theories of communication leading to his meta-theoretical framework for the theory of communicative

action. The meta-theoretical framework is segmented by three polemic relationships: (1) behavior versus action; (2) observation versus understanding; and (3) conventionalism versus essentialism.

2.5.1.1 Behavior versus Action

Behaviors can be recognized without having to rely upon a pre-understanding of the meaning of the social lifeworld in which that behavior is observed. Behavior versus action distinguishes between the interpretations of observable events and their attributes of being privative or intentional. The privative behavior is a primitive behavior enacted upon as a direct response to a certain stimulus or need (e.g. on a hot summer day, one drinks plenty of water to restore fluid balance to the body). Intentional behaviors, or actions, are the results of norms and rules created in and understood in an intersubjective social situation.

2.5.1.2 Observation versus Understanding

"I see a fly bouncing off the window," is Habermas's example of an observation of behavior. In contrast, "I see John returning from work," is his example of understanding meaning. Recognizing, observing and interpreting an action require familiarity with the norm-driven intentionality of the actor. (Habermas, 2001) A person can master a norm and yet be incapable of articulating the specific norm or rule that governs their actions.

2.5.1.3 Conventionalism versus Essentialism

Mastering a norm implies that a person is capable of implicitly following the rules or conventions governed by the norms and understanding the degree to which a given behavior deviates from the norm. Validation of a social norm is marked by "intersubjective recognition" and consensual agreement. Conventionalism and essentialism are methods used to measure the meaning of a symbolic expression. Conventionalism, most relevant to the theory of communicative action and universal pragmatics, indicates

that the meaning of an utterance or action "can only be tested by reference to the knowledge of the subject who produced the expression." Whereas essentialism assumes some foundational theory of truth upon which knowledge is formed. Conventionalism assumes an implicit knowledge of the judging subject that is based on a preconceived rationalization and categorization of one's actions and behaviors. (Habermas, 2001)

2.5.2 Habermas's Analysis of Theories of Society

Habermas's theory of communicative action was developed as an alternative to objectivist and subjectivist ontological theories to understand properties of intersubjective communicative relationships. (Figure 8) Objectivist theories emphasize the role of external natural processes, empirical observation and nomological rules about social interactions and behavior patterns (e.g. behaviorism, classical learning theory, etc...) and individual and intersubjective perspectives are not considered. Subjectivist theories place the self at the center of interpretation as the sole source for constituting meaning in the world. The subjectivist approach "conceives of society as a meaningfully structured system of life [*Lebenszusammenhang*], and as a system of symbolic expressions and structures that is continuously produced according to underlying abstract rules." (Habermas, 2001) Strongly influenced by the Descarte's notion of *cogito ergo sum* (I think therefore I am), subjectivist theories are monological and support solipsistic models of the relationship of individuals to the world.

	OBJECTIVIST Subjective Meaning is not Admissible	**SUBJECTIVIST** Subjective Meaning is Admissible	
	Behavior	**Purposeful - Rational Strategic Action**	**Communicative Action**
ATOMISTIC	Behaviorist Psychology	Rational choice theories (e.g. pure economics)	"interpretive" sociology (e.g. ethnomethodology)
HOLISTIC	Biological Systems Theory	Social Cybernetics (e.g. organizational sociology)	Structuralist and functionalist systems theories; symbolic interactionism

Fig. 8: Habermas's table on approaches to social theory. (Habermas, 2001, p. 15)

2.5.2.1 Meta-Theoretical Decisions that Define Theories of Society

Habermas identifies three meta-theoretical decisions that separate the intersubjectivist from objectivist and subjectivist theories of communication.

2.5.2.1.1 Decision 1: Understanding the core questions addressed in subjectivist theories.

a. Who is the subject of this generative process, or is there a subject?

b. How is the mode of this generative process to be conceptualized, as cognitive activity (Kant and Hegel), as linguistic expression (Humboldt), as labor (Marx), as artistic creation (Schelling, Nietzsche), or as instinct (Freud)?

c. Are the underlying systems of rules according to which social structures are constructed invariant? Do these abstract rule systems develop historically? Is there an inner logic of their development that can be reconstructed? (Habermas, 2001)

2.5.2.1.2 Decision 2: Understanding the difference between purposive-rational action and communicative action, two categories of intentional action.

Purposive - rational action can be strategic or instrumental. Instrumental actions are based on technical rules and empirical knowledge that can be verified through formative and summative method of evaluation. Communicative action, "is governed by binding norms that define reciprocal expectations about behavior and that must be understood and acknowledged or recognized by at least two acting subjects" (Habermas, 2001)

2.5.2.1.3 Decision 3: Understanding the difference between atomistic and holistic constitutive components in social theories.

Atomistic theories that examine social structures (e.g. institutions, value systems, and traditions) reduce actions and behaviors to the individual, the core element of the atomistic social world. The structure of social norms is greater than the subjectivity of the individual in holistic theories, which are often designed to solve problems of society that are larger than the individual.

2.5.2.2 Habermas's Models of Theories of Society

Habermas's framework is comprised of four models that outline properties of generative theories of society to understand attributes of objectivist and subjectivists theories and situate his intersubjectivist theory of communicative action in the canon of contemporary social-philosophical discourse. (Figure 9) The models are categorized by: (a) the admissibility of the historical development of constitutive factors; (b) the type of theory (e.g. constitutive, system or communicative); and (c) atomistic or holistic forms of agency.

Historical development of constitutive factors	**Model 1: Constitutive Theories**		**Model 2 and 3: Systems Theories**	**Model 4: Communicative Theories**
	atomistic	**holistic**	**holistic**	**holistic**
Not Admissible	Neo-Kantianism (Rickert, Adler); Phenomenology (Husserl, Schutz)	Romantic social theories (O.Spann)	Structualism (Levi-Strauss, de Saussure)	Symbolic Interactionism (G.H. Mead); theory of language games (Wittgenstein, Winch)
Admissible	Marxist phenomenology (Marcuse, Satre, Kosik)	Dialectical social theory (Lukacs, Adorno)	Systems Theory of societal development (Parsons, Luhmann, Weiner)	?

Fig. 9: Habermas's generative theories of society table. (Habermas, 2001, p. 19)

2.5.2.2.1 Model 1: Rational Knowing Subject and Phenomenological Subjectivity

Philosophical models that fall under the rubric of constitutive theories, model 1, are based on Kant's concepts of the rational knowing subject and Husserl's phenomenological subjective conditions. Habermas notes that Husserl's theory of phenomenology is more appropriate than Kant's transcendental philosophy for transforming constitutive theory into a theory of society.[2] Husserl challenged this concept noting that scientific theory is a construct of the community of scientists – it is a situated practice that is influenced by its lifeworld [*Lebenswelt*] the everyday lived world of experiences that enable us to perform actions related to other objects and living entities. (Husserl, 1936; Habermas, 2001)

[2] Kant's transcendentalism holds that a plurality of egos remains subordinate to a singular transcendental consciousness that is validated by theoretical propositions of contemporary physics.

Husserl's perspective on phenomenology is captured by the following paradox: "How can I, as a transcendental ego constituting the entirety of my experience, constitute another ego and nevertheless experience what is constituted in me as another ego?" (Habermas, 2001) Or, how can I know what is you if all I can know is what is directly imposed on me? Phenomenology contributes to the development of constitutive theories of society an assumed multiplicity of transcendental egos that occupy and influence the lifeworld. It disregards any hierarchical cognitive ranking of individual egos, natural sciences or non-human entities (e.g. nature, or super-natural). The individual ego constitutes the other as an attribute of its world. Therefore, the other is a reflection of the one perceiving and not a separate entity. The only means by which we can come to recognize each other's worlds is through an objective world that is presented to all individual egos as the same world of common natural objects.[3]

2.5.2.2.2 Models 2 and 3: Rule-driven Generative Subjectivist Theories

Historical development of constitutive factors	Model 1: Constitutive Theories		Model 2 and 3: Systems Theories	Model 4: Communicative Theories
	atomistic	holistic	holistic	holistic
Not Admissible			Structualism (Levi-Strauss, de Saussure)	
Admissible			Systems Theory of societal development (Parsons, Luhmann, Weiner)	

Fig. 10: Models two and three from Habermas's generative theories of society table. (Habermas, 2001, p. 19)

Models two and three of generative subjectivist theories view the transaction of information in society as a systemic structure in which abstract rules can be derived to explain various interactive dynamics (e.g. de Saussure structuralism, Levi-Strauss, structural anthropology, Weiner, cybernetics, Luhmann social systems). Common to systems theories is the replacement of the intersubjective subject with a system of rules for

[3] Phenomenology has been heavily referenced in contemporary research practice domains including: the interactive arts; interaction design; human computer interaction; and sciences of the mind. (Dourish, 2001) However, it is interesting that Habermas categorizes phenomenology as atomistic and ego-centric rather than holistic or intersubjective in nature.

understanding the underlying mechanisms of language, communication, and other social mechanisms.

For example, Weiner's theory of cybernetics notes similarities between the homeostatic functions of human and machines. Cybernetics supports the replacement of humans with machines for mission-critical functions and situations (e.g. flying military aircraft). (Weiner, 1954) Katherine Hayles remarked that, "This type of study has the effect of eroding liberal humanist ideas of subjectivity. That is to say, if we humans are simply parts of systems – our skins not boundaries but permeable membranes, our actions measured as behavior rather than by introspection – the autonomous, sufficient "self" begins to seem an illusion." (Hayles, 2003) Further discussion about cybernetics and critical theories of technology can be found in chapter four.

2.5.2.2.3 Model 4: Communicative Theories Based on Intersubjective Experiences

Communicative theories focus on interpersonal communicative and intentional actions as a means to observe and develop rules for social behavior that are based on common intersubjective experiences. The individual ego is recognized as a "transcendentally sociated subject," which shares common objectifying constructions of the world. (Habermas, 2001) The common intersubjective experience opens the individual's perspective such that another being is recognized as an observable sociated subject and not an alter ego or reflection of the self. G.H. Mead's role-taking theory, an example of a communicative theory that takes into account personality structures, forms of intersubjectivity, expressions, speech and interaction, assumes that anticipated and reciprocated behavioral expectations, based on the understanding of the intentions of observed behaviors, can be generalized.

An example of generative theories that align with Habermas's fourth model of generative theories of communication is Wittgenstein's "language games". (Figure 11) Wittgenstein's theory of language games placed emphasis on the symbolic structure of rules abided by the rule follower (speaker) and the rule observer (hearer) as the instance "when an expectation and its fulfillment make contact." Language is a game analogous to the vast domain of games of strategy, competition, and discovery from chess to simple abstractions invented in a child's collaborative play. The game facilitates interaction. To follow through with the analogy, language then is a form of interaction. (Wittgenstein, 1958, 445, p.131)

Historical development of constitutive factors	**Model 1: Constitutive Theories**		**Model 2 and 3: Systems Theories**	**Model 4: Communicative Theories**
	atomistic	**holistic**	**holistic**	**holistic**
Not Admissible				Symbolic Interactionism (G.H. Mead); theory of language games (Wittgenstein, Winch)
Admissible				?

Fig. 11: Model four from Habermas's generative theories of society table. (Habermas, 2001, p. 19)

Wittgenstein observes the pragmatic attributes of language game rules that support communicative acts between subjects. "There are... countless different kinds of use of what we call 'symbols,' 'words,' 'sentences'... New types of language, new language games, as we may say, come into existence, and others become obsolete and get forgotten." (Wittgenstein, 1958, 23, p.11) The system of language games can be expressed but not reduced to a structural model. "To think one is obeying a rule is not to obey a rule. Hence it is not possible to obey a rule 'privately': otherwise thinking one was obeying a rule would be the same thing as obeying it." (Wittgenstein, 1958, 202, p. 81) Habermas presents the example of subject "A" the rule follower and subject "B" the rule observer as

proof to Wittgenstein's theorem. Subject "B" must be aware of the rule being followed and be able to recognize any deviations from that rule, in order to verify that subject "A" is indeed following the rule. This form of reciprocal critique is required for subjects to be able to act and critically evaluate intersubjective rule-governed behavior in the public arena. In particular, he emphasizes the role of the status of the rules and the competence of the players. The rules determine the permitted signs and operations. A player may understand the rules and master a technique, but is not required to be able to describe the rules. And competence in rule understanding is a generative process. As indicated in the example of subjects "A" and "B," participation in a language game is a process of consensus. Although Wittgenstein uses the descriptor language, and Habermas places further emphasis on the mode of interaction emanating from speech acts, the grammar of language games may be embodied in non-lingual acts of communication including utterances, face and body gestures, etc... Participants in a language game share common understanding of the rules. When one encounters an unknown language game, as in the protagonist walking through the village in Latvia, she equates her observation of the interaction of others on a rule based on her pre-understanding of her own lifeworld. Her hypothesis for understanding the action of others can only be tested by her agreement to step out of her role as observer and into the role of participant in the communicative act.

2.5.2.3 Habermas's Niche: Holistic Communicative Theories

The empty lower right corner of Habermas's table of *Generative Theories of Society* calls for a holistic communicative theory with admissible historical development of constitutive factors. He surmises that this quadrant of the table is empty because theories with these attributes have not been "adequately developed." He may have assumed that the theory of universal pragmatics may eventually fill this gap, although this desire is not clearly articulated in his writing. It is surprising that constructivism is not included in that empty lower right hand table cell. Constructivism, which will be addressed in chapter 4, is a

socio-historical account for intersubjective understanding of one's world. The theory posits that "humans, either as individuals or as collectives are portrayed as constructive agents," and their "meanings and knowledge are portrayed as constructed products created by seeing patterns, making connections and comparisons and inferring sequence and cause." Constructivism, being both atomistic and holistic, allows admissible historical development of constitutive factors as is evident in Vygotsky's research. (Spivey, 1996)

2.5.2.4 Alternative Holistic Communicative Theories: Bakhtin

> *"The word in language is half someone else's. It becomes 'one's own' only when the speaker populates it with his own intention, his own accent, when he appropriates the word, adopting it to his own semantic and expressive intention. Prior to this moment of appropriation, the word does not exist in a neutral and impersonal language (it is not, after all, out of a dictionary that the speaker gets his words!), but rather it exists in other people's mouths, in other people's concrete contexts, serving other people's intentions: it is from there that one must take the work, and make it one's own" (Bakhtin, 1981a, pp. 293-294)*

Bakhtin's *utterance* is an exchange of contact, confrontation and dialogue between a speaker (or writer), and hearer (or reader) founded on geographically-situated cultural realities among discursive languages (e.g. English, French, German, Swahili, etc...). (Bakhtin, 1981a) Whereas Searle's speech act is denoted by a binary relationship between *Mp (please see section 2.5.3.1 for an introduction to this binary relationship)*, the communicative and the proposition, the *utterance* is made by the union of three elements: (a) its theme which is the referentially semantic element; (b) its attitude which is an expressive element; and (c) its "addressivity" in response to utterances from others. (Holquist, 1990) "My non-alibi in being," is Bakhtin's ethical imperative to value the "I" as a unique actor within a complex ecology of multiple "I's." The "I" or individual maintains a unique position that is both immediate and potential. It is the individual's responsibility to realize her fullest potential in union with other individuals to create a phenomenon that is greater than the individual. (Bakhtin, 1993, p. 40 – 41, 53-54) The "I" is transformed to a dialogic "we" through *polyphony*, *heteroglossia* and *hybridization*. *Polyphony* is a repositioning of ideas and truth with multiple consciousnesses and

possibilities. *Heteroglossia* is the complex intersection of languages and world views that are constantly viewed and adjusted in relationship to each other. *Heteroglossia* results in the splicing of *utterances* into a language of *hybridization* which implies that meaning lies not in the text, but in the juncture point between the speaker and hearer. This "dialogized *heteroglossia*" is a process that celebrates the negotiation of identities and perspectives as a means to collectively determine cultural values and norms. "Every utterance participates in the 'unitary language' (in its centripetal forces and tendencies) and at the same time partakes of social and historical heteroglossia (the centrifugal, stratifying forces)." (Bakhtin, 1981b, p. 272)

Bakhtin's concepts about dialogue complement and expand the pragmatic tendency of theories generated from Searle's speech acts to consider the situation in which communicative action occurs. Bakhtin's concept of dialogue, based on the linguistic relationship between the speaker and hearer, recognized the role of ambiguity, abstraction, juxtaposition and negotiation of difference in the dialogical experience. His concept of ventriloquation, in which the speaker of a social language integrates the words of another into her thought process and utterances, results in "hybrid construction" which is "an utterance that belongs, by its grammatical and compositional markers, to a single speaker, but that actually contains mixed within it two utterances, two speech manners, two styles, two 'languages', two semantic and axiological belief systems." (Bakhtin, 1981a, p. 304 – 305) Once again, I will reference Schank's theory on Storytelling and Intelligence model where communication is merely the telling of a story in attempt to connect, relate, augment or argue the story that was delivered by another being. (See Appendix A for further elaboration on Schank's theory.)

Bakhtin's theories on dialogue and the utterance are suitable candidates for Habermas's empty cell in his table of communicative theories by means of the richness afforded by

juxtaposition and negotiation of intersubjective experiences, rather than the rigidity of linguistic theories based on structural analysis (e.g. Structuralism, psychoanalysis, Marxism.) (Figure 11) Three global concepts that reappear in Bakhtin's work are *prosaics*, *unfinalizability* and *dialogue*. *Prosaics* is a world view that holds suspect explanatory theories based on grand prophecies. It urges us to appreciate the small everyday life events as important components that define our existence in the world. *Unfinalizability* celebrates the indeterminate in the world and life of the individual where the present, combined with the future, holds the answers to our questions about our intersubjective world. In the spirit of the liberal ironist, the individual is able to change her course in life by challenging her final vocabulary. *Dialogue* is comprised of utterances that are shaped by a multitude of real and imaginary hearers.

Habermas and Bakhtin agree that intersubjectivity requires a shared experience of the world. Habermas's *universal pragmatics* attempts to define a meta-theory or set of normative laws for analyzing the speech act. Bakhtin's theory of *translinguistics* also recognizes the role of normative rules as an important construct of communication. However, Bakhtin's normative rules include: such attributes as perspective, conceptual horizon, and intention; world views of the speaker and hearer; and the historical, cultural and social context of the communicative exchange in which the utterance takes place. (Wertsch, 1991) These normative rules are packaged in what Bakhtin called *speech genres* which are generalized patterns of utterances that can be observed and categorized through the study of the "social languages" that are supported by social institutions. These patterns "correspond to typical situations of speech communication, typical themes, and consequently, also to particular contacts between the meanings of words and actual concrete reality under certain typical circumstances." (Bakhtin, 1986) Just as it is impossible to speak without using a national language, it is impossible to speak without using speech genres, (e.g. military commands, salutations, everyday conversations about

common subjects, table conversations, intimate conversations, and narration of everyday events) which are "relatively stable typical forms of construction of the whole." (Bakhtin, 1986, p. 78) Once again, Bakhtin's (critical theory) socio-cultural notion of speech genres is a parallel concept to Schank's (cognitive psychology) *scripts* and Goffman's (social psychology) *frames*. (Schank.1990; Goffman, 1974)

2.5.3 Universal Pragmatics: a Rubric for Competency in Rational Discourse

Communication requires that the speaker and hearer are focused on the desire to understand and be understood by each other. They must understand each other's intentions. And the subject of communication must be mutually experienced. To achieve this goal, according to Habermas, the speaker and the listener must be engaged in the exchange of rational speech acts. (Habermas, 2001) Habermas distinguishes between two forms of intentionality one which places the subject in a referential relation with the object of inquiry. The other is attitudinal where the subject "places herself in a cognitive relationship with the object," and is positioned to make a validity claim to truth or sincerity. (Habermas, 2001) Habermas's goal is to define universal conditions by which mutual understanding can be achieved through consensus defined as compromise, negotiation and agreement for productive means of society. (Rawls, 1971) It is this notion of a desired state of consensus that many critics of Habermas base their counter-arguments to universal pragmatics and Habermas's theory of the bourgeois public sphere discussed in chapter 3. (Mouffe, 1999)

Set on expanding Wittgenstein's theory of "language games," Habermas's universal pragmatics addresses both the cognitive and communicative use of language as the foundation for intersubjective linguistic competence. The first goal is to develop a theory for the structure of intersubjectivity and the second goal is to demonstrate that the concept of "language games" impacts the world with implications far beyond a cognitive exercise.

"Language games" focuses on the constitution of meaning and not the representational functions of the knowledge constituting those entities of topic – objects, events, things, people, utterances – such as historical references and societal norms. Habermas's critique of Wittgenstein's theory fails to recognize the dualistic structure of speech acts – that is, the level of intersubjectivity between the speaker and hearer and the level of objects or states of affairs about which they speak.

Universal pragmatics is concerned, in particular, with linguistic competence in formal communication rather than the details of a specific speech situation where principles of rationality, reason and action are embedded in formal structures of speech. Linguistic competence is founded on the speaker's ability to spontaneously generate an "unlimited sum" of syntactic, semantic and phonemic expressions and to be capable of judging the grammatical correctness of those linguistic expressions. (Habermas, 2001)

Habermas's goal, with his theory, is the rational reconstruction of the rules structures that explain the relationship between all relevant syntactic, semantic and phonemic expressions. Habermas recognizes that grammatical rules are influenced by various empirical conditions in which the subjects maintain great influence on the transmission and reception of spoken utterances. Universal pragmatics differs from Chomsky's *universal grammar* in that universal pragmatics is not a linguistic theory "concerned primarily with an ideal speaker-listener, in a completely homogenous speech community, who knows his language perfectly and is unaffected by such grammatically-irrelevant conditions as memory, limitations, distractions, shifts of attention and interests, and errors (random or characteristic) in applying his knowledge of the language in actual performance." (Chomsky, 1965) Chomsky's theory assumes that the competent speaker has a complete mastery of linguistic rules yet performative aspects of speech are disregarded. Although linguistic competence is driven by the empirical pragmatics of explicit grammatical rules

and implicit contextual appropriateness there are plenty of opportunities for deviation from the norm.

2.5.3.1 The Speech Act: from Searle and Grice to Habermas

> *"Every speech act raises certain claims to validity that are open to being challenged and defended with reason." (Habermas, 2001, p. xiv)*

Habermas's universal pragmatics is based on the concept of the speech-act, an intersubjective communicative act. Habermas's notion of the speech-act is based on Searle and Grice's theories for understanding structures of communication for the purpose of developing intelligent machines. The speech act is an elementary unit of speech formed from linguistic rules and institutional meaning. It is composed of the performative clause, used to establish an intersubjective relationship between the speaker and hearer, and the dependent clause, the communication about the topics of discussion.

Searle's speech act theory is based on a paired combination of spoken utterances denoted as *Mp* – where *M* stands for the elocutionary attributes (communicative) of the utterance and *p* indicates the propositional content (cognitive). (Habermas, 2001) Searle's four rules: (a) preparatory; (b) prepositional content; (c) sincerity; and (d) essential, were co-opted into H. Paul Grice's conceptual model for the speech act called the *cooperative principle*. Grice's speech act rules included *quantity, quality, relation and manner*. The *cooperative principle* is a rather terse set of rules that emphasize concise and efficient communication that urge the speaker to make, "conversational contribution[s] such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged." For instance, the *quantity* rule is set to limit the amount of information provided by the speaker to the optimum minimum. The maxim states that the speaker should make his contribution as informative as is required for the current purpose of the exchange while not contributing more information than is required. The *quality* maxim aligns with Searle's *truth* rule urging the speaker to not say what he

believes is false or that he lacks "adequate evidence." Grice's *relation* maxim instructs the speaker to be relevant. His *manner* maxim describes the method for delivering the speech act with perspicuous tactics (e.g. avoid obscurity of expression, avoid ambiguity, be brief, and be orderly.) (Grice, 1975) Needless to say, conversing with Grice was sure to be short, quick, concise, and lacking in contextual expansion through the use of challenging, tangential, and rhetorical expressions. In other words, dull!!

Claims to Validity	Speech Acts	Pragmatic Universals
Intelligibility – Habermas *Preparatory Rule – Searle* *Quantity – Grice*	**Communicatives** Used to make explicit the nature of an utterance	To say, to express oneself, to speak, to talk, to question, to answer, to reply to retort, to agree, to contradict, to object, to admit, to mention, to render, to quote. . . .
Truth – Habermas *Propositional Content Rule – Searle* *Quality – Grice*	**Constatives** Used to express the meaning of a cognitive use of sentences and references to the objective world	To assert, to describe, to report, to inform, to narrate, to illustrate, to note, to show to explain, to predict… To affirm, to contend, to deny, to contest, to doubt.
Sincerity – Habermas *Sincerity Rule – Searle* *Relation – Grice*	**Representatives (Expressives)** Used to express the pragmatic meaning of the speaker's self-representation to an audience, explicating the speaker's intentions, attitudes, and experiences	To know, to think, to believe, to hope, to fear, to love, to hate, to like, to wish, to want, to decide….
Normative Rightness – Habermas *Essential Rule – Searle* *Manner – Grice*	**Regulatives** To express the normative meaning of the interpersonal relations that are established.	To order, to demand, to request, to require, to remind, to forbid, to allow, to suggest, to refuse, to oppose, to commit oneself, to promise, to agree upon, to answer for, to confirm, to endorse, to vouch for to renounce, to apologize, to forgive, to propose, to decline, to recommend, to accept, to advise, to warn, to encourage….

Table 1: Comparison of the speech act components in the theories of Searle, Grice, and Habermas derived from Habermas's Lecture IV "Universal Pragmatics". (Habermas, 2001; Grice, 1975; Searle, 1969)

Universal pragmatics transforms Searle's four speech act rules: preparatory; prepositional content; sincerity; and essential into the four claims of validity; *intelligibility, truth, sincerity and normative rightness*. Intelligibility is denoted by communicatives, truth by constatives, sincerity by representatives and expressives and normative rightness by

regulatives as illustrated in table 1.[4] (Searle, 1969; Habermas, 2001) Together, these four claims are the foundation for rational expression that can "in the best of all possible worlds" (Bernstein, 1956) support the utterance of *ideal speech acts*. In the *ideal speech act*: the speaker makes the claim that she is intelligible using expressions that can be understood by the hearer; she speaks the truth by formulating propositions that represent experiences or facts; her utterance is appropriate for the situation at hand and conforms to *recognized* norms of accepted self-image; and she speaks sincerely. The "ideal speech act" is further complicated by an agreed upon goal of mutual understanding rather than a strategic means to a self-appointed end.

2.5.3.2 Three Dichotomies in Communication

Successful communication requires that three fundamental dichotomies are understood and mastered: (1) reality and appearance; (2) essence and accident; and (3) is and ought. Differentiating between reality and appearance [*Sein und Schein*] is achieved with the use of constatives that help to filter the private world of beliefs and a public world of intersubjectively recognized concepts. Essence and accident [*Wesen und Erscheinung*] is identified with the use of representatives such as "to think," "to believe," "to hope," and "to fear." Is and ought [*sein und sollen*] is determined by the use of regulatives that emphasize cultural norms that can be intentionally obeyed or violated. (Habermas, 2001)

2.6 Communicative Action and Discourse: Expressions and Arguments

Habermas defines two forms of communication: 1. *communicative action* that comprises expressions in the form of sentences, expressions and actions with their sole purpose to

[4] Habermas's analysis of pragmatic universals used in speech-acts attempts to reveal the constitutive role such universals play in the cognitive and communicative attributes of language. He defines five universal classes of words and grammatical forms for general speech structures that are required to formulate conditions by which speech situations can occur. (1) Personal pronouns; (2) Vocative and honorative words and phrases are used for initiation of speech establish the identity of the conversation participants. (3) Deictic expressions include demonstratives, articles, numerals; quantifiers form the spatiotemporal and factual parameters of conversation. (4) Performative verbs, which can be interrogative and imperative points to the internal relation of the speaker to her speech-acts and between the speaker and hearer. (5) Non-performative intentional verbs and modal adverbs emphasizes the intentions and experiences of the speaker. (Habermas, 2001, p. 77)

exchange information; and 2. *Discourse* which is the process of validating through reestablishment or replacement, a communicative agreement that has been challenged. To engage in discourse requires the suspension of "constraints on actions" to support a collective search for truth that separates questions of experiential knowledge from ontological belief structures. Judgment or claims to validity, about objects of discussion must be suspended: facts become "states of affairs" and norms become "suggestions." Once these situations are satisfied, a reflexive process of argumentation can lead to a "discursively produced, justified agreement." (Habermas, 2001) Hermeneutic, or interpretive, discourse is enlisted when arguing about the interpretation of expressions. Theoretic and empirical discourse is used when verifying empirical assertions and explanations. Pragmatic discourse is engaged when arguing the validity of standards and norms.

In a holistic communicative theory of society it is assumed that the intersubjective other is capable of accounting for her actions through articulation of speech, expressions or action. She abides by the norms that she follows and her beliefs are legitimately justified. Normative validity presupposes that all subjects, in an intersubjective situation, maintain an intuitive knowledge or pre-judgment that serves as the generative mechanism for discourse. Intuitive knowledge is engaged when a subject encounters another subject as a being and not an object or opponent to be manipulated.

2.6.1 Validity Claims and Ideal Speech Acts

> *"as long as experience does not teach us otherwise, we have in fact no plausible cause to doubt a truth claim, even though we know that doubts, when they arise, cannot be resolved by experience, but only by arguments." (Habermas, 2001, p. 88)*

Validity claims are based on the subjective experiences of corroborators of intersubjective experiences. Validation of a truth claim must satisfy two conditions. As stated above, it must be grounded in experience and not conflict with any dissonant experience and it must

be able to hold its ground to all counter arguments. In return, truth claim assertions can be challenged, compromised or resolved through argument and discourse. This is what Habermas refers to as the universal-pragmatic meaning of truth, which is determined by reaching a rational consensus using current and historically relevant discursive processes of interpretations, assertions, explanations and justifications. Linguistic techniques used for discourse and consensus building include: converting critical interpretations into contextual observations; connecting singular assertions with theoretical statements; justifying explanations with reference to natural laws and norms; and justifying singular actions from generalized and justified actions.

The question remains: how can we "nonetheless assume in every conversation that we can reach a mutual understanding?" (Habermas, 2001, p. 96) Habermas holds that the "consensus theory of truth" is superior to all other theories of truth. Consensus requires the ability to differentiate between the "truth of propositions, the veracity of utterances, and the legitimacy of actions." (Habermas, 2001, p. 96) Irony resides in the fact that to know that one is judging competently can only be based on consensus of participant experience and is thus a cyclical argument with no a priori theory of truth. Habermas argues that we approach mutual consensual understanding because of our desire to presuppose an ideal speech situation. "The ideal speech situation admits only speakers who as actors have the same opportunities to use representatives (expressions that represent to an audience the speaker's intentions, attitudes, and experiences). For only a harmonious reciprocity as to the scope of utterances, which are always individual, and the complementary oscillation between proximity and distance ensure that subjects are transparent to themselves and others in what they actually do and believe, and if necessary, can translate their nonverbal expressions into linguistic utterances." (Habermas, 2001, p. 99)

The ideal speech situation requires that at least two participants reach a common understanding or discursively arrive to agreement about disputed validity claims. The qualifying components of an ideal speech situation require that all participants in a dialogue have equal opportunity to speak by initiating, responding, asking questions and giving answers using all four categories of claims to validity (communicatives, constatives, representatives and regulatives.) The ideal speech situation is only ideal when it is not influenced by external distorting forces and not constrained by faults in communication, such as deception or lack of efficacious opportunities for all participants to perform speech acts. This latter point, Habermas refers to as the "assumption of symmetry." (Habermas, 2001, p. 99) In other words, everyone must have an opportunity to voice their opinions, ideas, desires, hopes and fears. Since mutual understanding assumes a rational consensus and a true consensus can be distinguished from a false one only by reference to the ideal speech situation, then the idealization of the speech situation must involve anticipation or a pre-judgment that enables the participants to engage in argument. Habermas concludes that the freeing of discourse from "coercive structures of action and interaction" as required by ideal speech situations is attainable only in light of pure communicative action. (Habermas, 2001, p. 98)

2.7 The Mechanics of Universal Pragmatics and Violations to Validity Claims

Pragmatics of cognitive language requires a supposition about the existence of the object, which is structured by language, cognition and action, and a presupposition about the truth of the original proposition about the object of the speech-act. The first supposition ensures that the speaker and hearer can both identify the object of discussion. Justification of the second supposition is attained if both the speaker and hearer verify that the proposition is true and corresponds to an existing state of affairs. How then are these propositions formed and suppositions validated?

There are four categories of abstraction that determine communicative competence as indicated in table 2. Social linguistic abstraction involves contextually appropriate utterances that align with social-cultural norms. Universal pragmatic abstractions consist of situated utterances that are not context driven. They form basic speech units. Linguistic abstraction consists of strings of symbols that determine syntactic grammatical structures. The logical abstraction is used to form and transform the truth-value of propositions and is expressed using assertive propositions.

Object Domain	**Competence**	**Theory**
Utterances in social contexts	Pragmatic	Sociolinguistic
Non-context specific utterances	Communicative	Universal Pragmatics
Linguistic expressions	Grammatical	Linguistic
Propositions	Logical	Formal Logic

Table. 2: Comparison of linguistic abstractions, competencies and the theoretical domains in which they reside. (Habermas, 2001, p. 74 – 75)

Habermas's condition for normalcy of linguistic communication is rooted in the concept of mutual understanding and reciprocal recognition. The act of mutual understanding assumes that the speaker is committed to abiding by and striving to fulfill the universal claims to validity, as stated earlier, that include: 1) to use intelligible expressions; 2) to make something understood; 3) to be understood; and 4) to reach mutual understanding with another. In reality, we rarely achieve this idealistic notion of communication. Rather, our communicative acts traverse a slippery terrain bordered by a lack of understanding [*Unverständnis*] and misunderstanding [*Missverständnis*] that is undercut by "involuntary" insincerity, passive and active disagreement and pre-judgment. Violation of communicative acts occurs when the validity basis of linguistic communication is manipulated without a break in communication or acknowledgement that the discourse has become strategic rather than communicative. In his lecture, "*Reflections on Communicative Pathology*," Habermas describes types of violations that provoke

systematic distortions of communication for three of the four validity claims (intelligibility, sincerity, and normative rightness). As described below, violations to truth either do not systematically distort communication processes or fall under the category of sincerity.

Violations to intelligibility occur when: the speaker lacks the skills to express herself in a language she does not know; the speaker's assertions violate the norms of intelligibility of a given community in a specialized sphere (e.g. critical theory lecture given to a group of engineers); the speaker finds herself in an embarrassing situation and tries to sustain a misunderstanding to avoid further embarrassing reactions; and a speaker expresses herself unintelligently in her native tongue without intention.

Violations to the claim of sincerity occur when: a speaker acts strategically by suppressing information; a speaker falsifies her feelings to fulfill the expectations of another; a speaker falsifies her feelings and has suppressed this reality to herself as well as the other party.

Violations of normative rightness are divided into two categories. Formalized norms occur when standardized behavior can be violated. For example, when a speaker behaves inappropriately by ignoring social norms such as inappropriate rules of social distance or a speaker is incompetent and behaves inappropriately to the norms of a formal situation (e.g. reception, party, meeting, etc...). Neither case is one where linguistic communication has been distorted. Although, it could be argued that several rules of non-verbal communication have been compromised. Habermas focuses on cases where the fulfillment of norms by specific behavior is placed into question. Such violations occur when the speaker uses forced utterances that are out of place and lead others to regard the communication as flawed, or when a speaker's normative belief structure contradicts her own image of self, which can also be observed by others, leading to repressed distortions

that "continue to smolder under the cover of apparently consensual action." (Habermas, 2001, p. 153)

Habermas claims that most *violations to truth* are not systematic distortions of communication. Being unintentionally mistaken or making unintentional mistakes is not a subset of actions that can be made accountable. Rather, this situation sets an opportunity for learning. Strategic lies, on the other hand, used to distort a conflict, fall into the category of violations of sincerity.

Habermas explores a relationship between the empirical research on dysfunctional families and violations of validity claims between non-familial subjects as comparative theories on the violations of social norms that compromise attempts for attaining mutual understanding and consensus through discourse.[5] Strategies for creating *pseudo-consensus* involve creating a consensus that serves to conceal a lack of consensus about the speakers' intentions or speaking in deceptive inconsistencies that deceive both the speaker and other

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[5] Habermas points out that these violations may be culturally normalized and looks at empirical research on the dysfunctional family as a model to understand the factors involved in compromised communicative expressions. Although these studies do not produce a single theory of familial interaction, findings in the body of research have shown that there is an inverse relationship to the family's ability to negotiate issues of boundaries, openness, myths and the forces outside of the family and its relationship to internal conflict and systematically distorted communication. (Habermas, 2001, p. 161)

"The conflicts at issue here tend to be smoldering, partially concealed ones that cannot be publicly played out because the psychodynamic preconditions do not exist for reaching an understanding metacommunicatively and dealing with these conflicts discursively." Such discursive methods include joking, irony, and forms of ritualizing and neutralizing conflicts are lacking in the communicative actions of dysfunctional families and are replaced by pseudo-mutuality, schism, skew and separatedness and other counter-concepts to role-reciprocity, complementarity of expectation and mutual understanding. (Habermas, 2001, p. 162)

Studies by Lidz and Wynne's have shown that resolution of social distances (Proximity/distance), as defined by gender and age, causes alienation or a coerced solidarity that is maintained by force which leads to relationships of pseudo-mutuality. (Mishler and Waxler, 1968) Allowance for self-representation in the family is important for family members to be able to recognize sameness and difference.

Hess and Handel showed that pathological families controlled its self-image to the degree that either over-powering stereotypes overshadow the development of the individual or permitted such a loose structure that the collective structure of the family is threatened by lack of consensus. A habitualized dominance relationship that negates the desires of marginalized family members promotes a power relationship where the activities of one family member are determined by the agenda of another family member. This activity/passivity relationship sets a stage for exploitation.

And finally, the "rubber fence" syndrome focuses on the lack of clear boundaries kept by the dysfunctional family. The dysfunctional family has difficulty negotiating such boundaries leading to isolation from contacts with other "normal" families. This isolation leaves them vulnerable to external social and ideological influences. (Ackerman and Behrens, 1956)

intersubjective participants about the true intentions of her utterances. In other words, the speaker is deceiving both herself and others while believing that her utterances are sincere. Pseudo-consensus, a product of dysfunctional communication patterns, can be generated using several techniques including: breaking off one's utterances; ignoring the utterances of another or forcing a topic change; refusal to answer (silence); answering to someone other than the person asking the question; commenting, in the third person, on the person expecting an answer; giving a curatorial answer where subject C answers instead of B to a question or remark by A; and to give an answer in which the content has nothing to do with what has been said. Psuedo-consensus can also be corroborated with techniques of shifting topics to a peripheral element in the discussion and strategies of obfuscation or "idle communication." (Kaufmann, Familie, Kommunikation, Psychose, 106ff, 84ff)

2.8 Conclusion: "Tug-of-War" – the Communication Game

> *"The living utterance, having taken meaning and shape at a particular historical moment in a socially specific environment, cannot fail to brush up against thousands of living dialogic threads, woven by socio-ideological consciousness around the given object of an utterance; it cannot fail to become an active participant in social dialogue" (Bakhtin, 1981b, p. 276)*

Our world is far from ideal and communicative breakdowns are pervasive. Discourse, which requires the suspension and/or challenge of one's final vocabulary or ontological belief structures, is a generating tool that supports intersubjective experiences that present an opportunity for discovery, exploration, argument, negotiation and change. Ideal speech situations, if possible, are few and far between. They can only exist when intersubjective relationships are recognized and complementary. In the world in which we live this utopia is but a dream. Most conflicts are based on a collision between interests and agendas of the individuals or groups involved. Resolution comes in the form of negotiations and compromises that are mediated through discourse that can only be filled when a stance of impartiality and the subjects are able to transcend their individual preferences. (Habermas, 1992, p. 449)

We can think of communication as a bandana tied around the middle of a tug-of-war rope. On one side we have the universal pragmatics team, led by Habermas, counter-balanced on the other side by the liberal ironist team, led by Bakhtin. The attributes of the speech act are represented by the ever foreshortening and lengthening sides of the rope. As the rope is pulled, the bandana draws closer to the universal pragmatics team. This produces a gradual shift to a process of claims to validity, consensus and negotiation. As the bandana approaches the liberal ironist team, the speech act shifts and is characterized by heteroglossic final vocabularies. This analogy begs the question of where the ideal speech act truly resides in this continuum of communicative actions and discourse.

In chapter one I introduced the motivating seed to this thesis by means of a personal story about traveling in Latvia in 2001. The key issue revealed through reflection on the clash between the protagonist (me) and the antagonist (the young boys) – or perhaps the roles are reversed – was the method of resolution taken to dampen the impending crisis. Rather than striking back with fiery tongue or fist, the protagonist chose to engage the antagonists through recognition, conversation, and thought provoking questions. For merely a minute or two, both worlds were forced to stop spinning in their collision paths, as though momentarily suspended – like the character, Neo, in the film "The Matrix" just before extrapolating the path of bullets aimed at his body. Okay, perhaps our moment of pause was not as fantastic, but it was far more meaningful. According to Rorty's hypothesis, the subjects in the Latvia story had not reached the limits of their final vocabularies. They were neither silent, nor violent and engaged, ever so briefly, in the preliminary stages of discourse. This momentary pause allowed an empathetic glimpse into the humanity of the other.

> *"For us ironists, nothing can serve as a criticism of a final vocabulary save another such vocabulary; there is no answer to a redescription save a re-re-redescription. Since there is nothing beyond vocabularies which serves as a criterion of choice between them, criticism is a matter of looking on this picture and on that, not of comparing both pictures with the original. Nothing can serve as a criticism of a person save another person, or of a culture save an alternative culture – for persons and*

cultures are, for us, incarnated vocabularies. So our doubts about our own characters or our own culture can be resolved or assuaged only by enlarging our acquaintance." (Rorty, 1989, p. 80)

I will conclude this chapter with another first person experience of encountering the gaze of others. The experience concluded with an intersubjective and discursive communicative exchange with my travel companion.

The year was 1998, my first visit to Linz, Austria and the Ars Electronica festival. Once again, I felt a discomfort when walking in the streets of the city. I did not fear for my physical well-being, but I was incredibly stressed by the piercing Austrian gaze. One afternoon, I and a colleague, who happened to be white, male and Jewish, from the United States shared a stroll to one of the festival events. I made a comment about my discomfort with the intensity of the Austrian gaze – one that could have burned a hole through me if I were made of paper. Whereupon, my walking companion empathetically challenged the intensity of this negative experience. I asked him to simply observe.

"Neither in gender nor in race nor in class nor in secularities is it possible to treat different particulars as having merely paratactic or serial difference. Differences in such realms already come coded as the difference between the unmarked and the marked, the universalizable and the particular. Their own internal logic is such that the two sides of any of these differences cannot be treated as symmetrical – they are, for example, in the rhetoric of liberal toleration or "debate" – without simply re-securing an asymmetrical privilege. The bourgeois public sphere has been structured from the outset by a logic of abstraction that provides a privilege for unmarked identities: the male, the white, the middle class, the normal." (Warner, 1992, p. 383)

The first person we passed on the sidewalk was oblivious to both of us. Upon being ignored by our first subject of our quick ethnographic observations, my colleague remarked that the gaze I felt could not possibly be as bad as I made it out to be. He discredited my experience as is typical of someone representing a majority cultural point-of-view to another from the minority point-of-view. My colleague did not want to appear callous, so he softened his initial response with an empathetic gesture. He stated that Austria made him uncomfortable because of his Jewish heritage. I responded by requesting that we keep observing. After approximately three blocks of walking in silence,

my colleague changed his intentional stance and acknowledged my observation of the intensity of the gaze directed toward me.

What is the significance of this story? It is not unusual, that empathy abounds around us as we observe the experiences of others, particularly when they are in a heightened emotional state (happy, sad, frightened, and elated) or in a situation of interactive engagement that may be visually positive or negative. But often, in the society that I am a member of, we keep our empathetic awareness silent, if not hidden. However, during our ten-minute walk through the streets of Linz, two subjects, the speaker and hearer allowed themselves to experience, typically unspoken, attributes of each other's lifeworld.

In the following chapter will examine theories of the public sphere and its appropriateness as an arena for the development of computer mediated interactive experiences that facilitate discourse among its occupants.

Chapter 3 The Construction of the Public Sphere

3.1 Two Models of the Public Sphere

"Individual human beings may lose their identity in a mob or in a political convention or in a joint-stock corporation or at the polls. But this does not mean that some mysterious collective agency is making decisions... " (Dewey, 1927)

3.1.1 Public Sphere as a Nation State

Dewey defines the private sphere to be actions and consequences of social transactions that directly affect the person(s) who are engaged in those transactions. This includes social transactions that benefit the welfare of a particular community or an individual.

The public sphere, according to Dewey, is a political state managed by the work of elected or appointed individuals who serve as representatives of collective societal interests. Those representatives are empowered to oversee the welfare of a society of individuals and groups by the powers invested in them. The public sphere is characterized by "routine, impulsive, and other unreflected acts" of individuals that have direct consequences on those other than the initial interlocutors. (Dewey, 1927) The representative takes on the role of "guardian of custom, as legislators, as executives, judges, etc..."

3.1.2 The Public Domain as a Locus for Intersubjective Engagement

Dewey defines the public sphere as a mechanism in the development of the political nation state. Broeckmann creates a model of the public sphere that is founded on and yet diverges from Habermas's concept of the *bourgeois public sphere*. Before diving into Habermas's theory of the *bourgeois public sphere*, I want to introduce Broeckmann's notion of engagement in the public sphere or public domain, as a concept that has greatly influenced the design principles for *Critical Creative Technologies* described in chapter five.

3.1.2.1 Engagement in the Public Domain

Broeckmann's public domain manifesto was written in a critical essay about Raphael Lozano-Hemmer's seminal public art work, *Vectorial Elevations*. This interactive light project was experienced by spectators in an urban geographical location and manipulated by a global participative audience via the Internet. (Lozano-Hemmer, 2000) Broeckmann defines the public sphere as heterogeneous, hybrid, fragmented – a composite of multiple layers that is open and closed, physical and mediated. The public sphere includes, but is not limited to: urban social space; market place; theaters; libraries; cafes; sports arenas; and schools. They are places where "ideas and practical concerns of society can be voiced and discussed freely in an open dialogue." (Habermas, 1962)

These places are governed by signs, symbols and social norms that guide people about how to appropriately interact, communicate and co-exist with others. The interconnected global attributes of the public sphere must be taken into consideration since the public sphere is largely mediated with networked information technologies. No longer can the public sphere be based on singular nationalistic scope of beliefs, politics and actions. Whereas interactive engagement with the global public sphere presents an intractability problem, the city, a microcosm of the world, can serve as a location for a public interface that can be designed to mediate intersubjective experiences and facilitate discourse.

3.1.2.2 Properties of the Public Domain

The public domain includes three properties:

1. Visibility: the physical placement in a public space such that the individual can both survey and be surveyed.
2. Presence: the ability to leave a trace of oneself to inform others of one's current or previous occupation of the space.
3. Action: a political agency, which aims to transform a material and symbolic situation by means of argument and performative acts.

Inventing methods to attain visibility is often a goal of subjugated groups and countercultures. However, the irony that becoming visible opens the possibility of also

being surveyed and potentially controlled creates a paradoxical dilemma between wanting to be seen and be private. Therefore, actions of visibility by countercultural groups are typically clandestinely performed (e.g. poster wheat pasting, graffiti tags, pirate radio and false identities on the internet.)

Fig. 12a

Fig. 12b

Fig. 13

Fig. 12: Raphael Lozano-Hemmer's Vectorial Elevation in (a) Mexico City 1999-2000 and(b)Lyon, France, 2003.
Fig. 13: Brucker-Cohen and Moriwaki's Scrapyard Challenge Workshop in Newcastle, Australia 2003.

The attribute and desire for visibility can be fleeting. The attributes of presence and action require a political agency that calls for reclamation of the public domain. Broeckmann urges practitioners engaged in creative uses of information technologies to transform the public domain, from a commercially-mediated and possibly "dangerous" space, to a site for "constructive conflict," resolution and the development of "democratic forms of agency for the new intersections of virtual and physical public environments." (Broeckmann, 2000, p. 169) Lozano-Hemmer's *Vectorial Elevation* and the Brucker-Cohen and Moriwaki's *Scrapyard Challenge Workshops*, are examples of a new genre of community-based art and creative design initiatives that place the control and creativity with technology into the hands of the public. (Lozano-Hemmer, 2000; Brucker-Cohen & Moriwaki, 2006) In both of these projects "constructive conflicts" are resolved by empowering people with the tools to transform technology for aesthetic wonderment and critical inquiry.

3.2 Habermas's Motivating Questions: Why the Public Sphere?

Habermas reflects on the influence of his formative experiences as a German youth at the end of the Second World War, with a cleft palette, on his lifelong philosophical queries in his 2004 Kyoto lecture. (Habermas, 2004) Habermas became interested in the political public sphere and the interactive qualities of the socio-political world as a member of the "*Gnade der spaten Geburt*" generation – old enough to witness the fundamental changes of the end of the Third Reich yet too young to have participated in Nazi activities.

In particular, he wondered:

- How forms of social integration become manifest in the structures of public spaces?
- How integration in a particular society corresponds to the degree of its complexity?
- How public spaces betray the pathological traits of society?
- How is it that a complex society, where people no longer have face-to-face communication, is held together through civic solidarity, public opinion and will? (Habermas, 2004)

Although Habermas barely references Dewey in the *Structural Transformation of the Public Sphere,* Habermas's theory on the development of the public sphere is aligned with Dewey's concern that the "critical state of a democracy can be measured by taking the pulse of the life of its political public sphere." (Hohendahl, 1992, p. 99, Dewey, 1927)

3.3 The Bourgeois Public Sphere

> *"... A portion of the public sphere comes into being in every conversation in which private individuals assemble to form a public body. They then behave neither like business or professional people transacting private affairs, nor like members of a constitutional order subject to the legal constraints of a state bureaucracy. Citizens behave as a public body when they confer in an unrestricted fashion – that is, with the guarantee of assembly and association and the freedom to express and publish their opinions – about matters of general interest. (Habermas, Lennox & Lennox, 1974)*

Habermas's framework for the public sphere was based on his idealist understanding of changing social and political structures in the 18th and 19th centuries. He labeled this social and cultural phenomenon the *bourgeois public sphere*. This was an era, not unlike his own formative years, when social, cultural and political institutions were quickly evolving from monarchies (or in his case totalitarian regimes) to laissez-faire economic states. From the

literary salons, held in private residences that developed in the late 18th and early 19th centuries, discussions of literary and political issues migrated into the public sphere. These public discussions influenced and transformed cultural practices in societies and political actions of states.

The public sphere became a mediator between society and the state where public opinion could be espoused by the appropriate private individuals (always male property owners) in a society that was once ruled by "arcane policies of monarchies and which since that time has made possible the democratic control of state activities." (Habermas, Lennox & Lennox, 1974 p. 50) This was a social realm where private property owning individuals could engage in "rational critical debate... and the practical concerns of society can be voiced and discussed freely in an open dialogue." (Habermas, 1962) Habermas credits the arts and literature as the locus for cultural and political discourse leading to the development of the contemporary democratic public sphere. Irony lies in the fact that other than the genesis of the bourgeois public sphere from literary circles, Habermas's theories tend to avoid aesthetic, emotional and embodied gestures of language or body as viable components of communication in the analysis of rational discourse. Despite the fact that the arts have historically provided an important platform for the articulation of private and public issues, they are viewed to be "nicht wahrheitsfähig" (not truth or false.) They are relegated to be non-essential to the formation of political policies. (Hohendahl, 1992, p. 108)

> *"... often enough today the process of making public simply serves the arcane policies of special interests; in the form of "publicity" it wins public prestige for people of affairs, thus making them worthy of acclamation in a climate of non-public opinion." (Habermas, Lennox and Lennox, 1974, p. 55)*

The bourgeois public sphere marked its decline into a welfare state of partisan interests as private interests gained coverage in mass media. The exclusive bourgeois public sphere expanded to incorporate pressing issues (e.g. education, culture and social needs) that were

relevant to those not included in the exclusive ranks of the bourgeois public sphere. These were issues that separated the "haves" and the "have nots" of society. Thus, "refeudalization" of the public sphere, Habermas's term for the social welfare state, was born. As an effect of the "refeudalization" process, methods of negotiation and compromise were developed that avoid discourse in the larger public sphere. This was a symptom of the convergence of private and public concerns of special interest. (Habermas, Lennox and Lennox, 1974; Negt and Kluge, 1972)

3.4 Weaknesses in the Theory of the Bourgeois Public Sphere

> *"The most important destiny of Habermas's first book may prove to be this: not to stand as an authoritative statement but to be an immensely fruitful generator of new research, analysis, and theory." (Calhoun, 1992, p.41)*

The *Structural Transformation of the Public Sphere*, originally presented at the University of Marburg as a post-doctoral thesis, was a call to the public to re-engage the public sphere in contemporary German culture. The work was rejected by the University of Frankfurt after criticism by social theorists Max Horkheimer and Theodor Adorno (the later whom Habermas worked with as a research assistant at the Institute for Social Research in Frankfurt). The work was eventually published in German in 1962. It was Habermas's call to re-engage the public sphere that prompted many cultural theorists to employ and critique Habermas's theories as a platform for new ideas on the essence of the contemporary public sphere. Craig Calhoun identifies six weaknesses, of underdevelopment or omitted details, evident in the *Structural Transformation of the Public Sphere* that include: historical and intellectual influences; identity politics, religion and science; social movements; power relationships; and derivative models of the public sphere in which many subsequent theorists have critiqued Habermas's original premises.

3.4.1 Historical and Intellectual Influences

> *"Habermas's account of the twentieth century does not include the sort of intellectual history, the attempt to take leading thinkers seriously and recover the truth from their ideologically distorted writings, that is characteristic of his approach to the seventeenth (medieval histories), eighteenth (Locke and Kant) and nineteenth centuries (Marx and Mill). Conversely, his treatment of the earlier period doesn't look at "penny dreadfuls," lurid crime and scandal sheets, and other less than altogether rational-critical branches of the press or at the demagoguery of traveling orators, and glances only in passing at the relationship of crowds to political discourse." (Calhoun, 1992, p. 33)*

Habermas relies upon limited historical and philosophical perspectives for the foundation of his theory. The bourgeois public sphere, much like the universal pragmatics, serves as a pre-theoretical foundation to describe the diachronic or linguistic changes over time. Habermas credits 18th and 19th century bourgeois culture for the formation of the public sphere. His model, however, is an ahistorical and idealized account of the Enlightenment period.

Hohendahl notes that ahistorical models have two functions. The first is to provide a paradigm for analyzing historical change and the other to create a normative platform for the critique of politics. (Hohendahl & Silberman, 1979) McCarthy, a long-time scholar and critic of Habermas, believes that Habermas's treatment of historical fact is scant and incomplete. It is a philosophical theory that is not grounded on an in-depth analysis of the specific identified time-period. Therefore, it can be viewed as a generator of general questions concerning the essence of a societal phenomenon, but cannot be taken as declaring any definitive truths. (Hohendahl, 1992; McCarthy, 1992)

3.4.2 Identity Politics

> *"The feminist critique thus shows not just that Habermas failed to pay enough attention to the gendered nature of the public sphere, nor even that he sees the solution to this problem only in gender neutrality rather than in thematizing the issue of gender. It also points up that the public/private dichotomy itself imposes a neutralizing logic on differential identity by establishing qualification for publicness as a matter of abstraction from private identity." (Calhoun, 1992, p. 35)*

Habermas privileges the formation of consensus building based on an ideal process of rational-pragmatism without recognizing the impact of cultural and national differences (e.g. gender, ethnicity, sexuality, age, sub-cultures, etc...) on how frameworks for understanding and acting in the world are constructed. The rich fabric of difference, both harmonious and contentious, is a crucial component to communication methods used to contend, negotiate, and resolve issues of common-ground. (Warner, 1992; Eley, 1992; Benhabib, 1992; Fraser, 1992)

History is used to understand a philosophical and political phenomenon and yet the discourse is limited by the very nature of whom or what is excluded. This is particularly pointed out by Benhabib's observations about the exclusion of women in the bourgeois public sphere. (Hohendahl, 1992; Benhabib, 1992) Benhabib presents a model of the public sphere where it is not a realm of the cultural and political elite; rather it is a creation of democratic procedures that are influenced by norms of society and collective political decisions. Boundaries are permeable in Benhabib's model. These indeterminate boundaries enable change through negotiation. The nature of having such flexible borders brings to the foreground questions about the nature of the "good life" as defined by social and family issues, and in essence supports the intersection of the public and private by directly involving institutions that are predominantly led by women such as the home and education. (Benhabib, 1992)

3.4.3 Religion and Science

Religion and science are neglected discourses in the Habermas's theory of the bourgeois public sphere. Habermas aligned himself with a position that emphasized cultural enlightenment over ideological belief in the omnipotent power of a non-human entity as the driving influential force of culture, society, and the world. As can be seen in the burgeoning culture wars concerning "intelligent design" and the proliferation of worldwide

sectarian violence founded on religious sects, religion continues to have profound influence on discourse in the public sphere. Basic ethnographic explorations would have enlightened Habermas to this fact, particularly at the time of the writing of the text in the ideologically ripe era of the 1960's. The same can be noted for the influence of science on public discourse as many positivists' ontological theories believed in the superiority of scientific proof for understanding the essence of being. (Zaret, 1992)

3.4.4 Social Movements

The bourgeois public sphere neglects the fact that social movements are "crucial to reorienting the agenda of public discourse, bringing new issues to the fore," and presenting the opportunity for new voices to be heard. (Calhoun, 1992; Postone, 1992; Eley, 1992) It presents an idealized time when individuals engage in civil meaningful discourse. Social movements were assumed to be the methods of other un-recognized publics where proletarian society engaged in non-discursive strategies, such as force, as an attempt to transform society.

3.4.5 Power Relationships

> *" ... a world where difference of race, class and gender cannot be ignored would profit from less emphasis on the role of rationality as defined by Habermas. (Hohendahl, 1992)*

Many critics of Habermas' theory argue for the existence of multiple public spheres that may be contentious or complementary. These multiple public spheres can overlap, be orthogonal, or contain non-intersecting boundaries, (Eley, 1992; Baker, 1992; Garnham, 1992; Fraser, 1992) Calhoun calls for a "pluralistic, open approach" to envisioning the public sphere. (Calhoun, 1992) He suggests that it is more productive "to think of the public sphere as involving a field of discursive connections" that are organized by issue rather than different affinities of different public spheres.

Whereas, Habermas addressed power relationships as they relate to the refeudalization of the public sphere, the greater question for Calhoun is: how a given cluster of connections is organized, "how it maintains its boundaries and relatively greater internal cohesion in relation to the larger public...," through social organization, division and force. Fischer suggests an alternative to the one public sphere as one that is constructed discursively through creation and critique of narratives. People have a natural competency for storytelling. The narrative approach guarantees efficacious engagement in public discourse. (Schank, 1990) Schank takes the role of the narrative and storytelling in the public sphere a step further by claiming that all communication is storytelling. (See appendix A for more information on Schank's theory.) McCarthy offers a revisionist model of the public sphere much in the spirit of Benhabib. (Calhoun, 1992, McCarthy, 1992) He believes that there are no universal value standards and that attainment of consensus is impossible. Consensus must be "grounded in an intersubjective understanding and assessment of needs." (Hohendahl 1992; McCarthy, 1992) Forms of rational consensus are relative based on the society, culture, group, and individuals who are engaged in the act of communication and negotiation.

3.4.6 The Derivative Proletarian Public Sphere

Discourses of the insurgent have always pushed up against and influenced the demands and actions of the power class whose goal is to maintain dominance over civil society. Habermas pays little attention to the so-called proletarian public sphere of artisans, workers and others and their impact on the bourgeois public sphere. (Negt & Kluge, 1972) The irony lies in the fact that successes attributed to the bourgeois public, such as freedom of the press, were greatly influenced by the demands of inclusion by activists who made up the proletarian public sphere. (Calhoun, 1992)

3.5 Alternative Models of the Public Sphere

3.5.1 The Proletarian Public Sphere

> *"The public sphere is the site where struggles are decided by other means than war."*
> *(Negt & Kluge, 1972, p. ix)*

Sociologists Oskar Negt and experimental filmmaker Alexander Kluge, two of Habermas's earliest critics, state that, "If one considers its [public sphere] true substance, then it is not at all unified but rather the culmination of individual public spheres merely abstractly related to one another." (Negt & Kluge, 1972, p. 15) The public sphere is redefined as a complex association of heterogeneous organizations in which certain social aspects are represented and "motivation, practical actions, and mental activity converge." (Negt & Kluge, 1972, p. 27) Their definition of experience is shaped by the object world, labor processes, relationship to production and socio-cultural factors that call for the inclusion in discourse of multiple counter-publics [*Gegenöffentlichkeit.*] The multitude of counter-publics is then the *proletarian public sphere* and serves as an alternative to the overly commercialized contemporary public sphere of advanced capitalistic states.

The *proletarian public sphere* served as a conceptual place for finding common ground between various groups and affiliations, particularly those admonished from the *bourgeois public sphere*. The *proletarian public sphere* provides a means for masses of working class people to form a platform, not as a labor movement, but as a mechanism to autonomously articulate their own needs and define a "new framework of experience." (Hohendahl, 1979, p. 107) Negt and Kluge ask whether or not it is possible to maintain the public-service structure of knowledge production, education, and television when society is inundated by the "private consciousness industry." They supported the development of public access media alliances as the best solution in changing the producer versus consumer of knowledge production relationship. Filmmaker Kluge suggested that public access production should include "correspondence courses, audiovisual university teaching aids, data banks, university information systems on the industrial scale [to create] a lasting

effect on the character of this public sphere of knowledge production." Kluge's 1972 vision of the power of media continues to be the mission of government sponsored research in the digital library and grassroots media advocacy efforts. (NSF EHR, NAMAC) Several critical artists and arts collectives also engage in the dissemination of new knowledge and ideas parallel to the efforts of government and non-government organizations. (Next 5 Minutes, 2003) Negt and Kluge's theory of the proletarian public sphere, particularly in its relationship to media production, can be viewed as a precursor to contemporary Free/Libre/Open-Source Software (FLOSS) movement. (FLOSS, 2006)

3.5.2 Challenges to the Speaker/Hearer Model of Communication

> *"As subjects of publicity – its hearers, speakers, viewers, and doers – we have a different relation to ourselves, a different affect, from that which we have in other contexts. No matter what particularities of culture, race and gender, or class we bring to bear on public discourse, the moment of apprehending something as public is one in which we imagine, if imperfectly, indifference to those particularities, to ourselves. We adopt the attitude of the public subject, marking to ourselves its non-identity with ourselves. There are any number of ways to describe this moment of public subjectivity: as a universalizing transcendence, as ideological repression, as utopian wish, as schizo-capitalist vertigo, or simply as a routine difference of register. No matter what its character for the individual subjects who come to public discourse, however, the rhetorical contexts of publicity in the modern Western nations must always mediate a self-relation different from that of personal life." (Warner, 1992, p. 377)*

The dyadic relationship between a speaker and hearer, as Habermas promotes, is a model that fails to incorporate the many modes of communication in our highly mediated modern society. This speaker/hearer dichotomy does not adequately model real communicative practices. (Lee, 1992) Garnham and Warner build their critiques from this paradox despite their differing perspectives on the role of cultural difference in the public sphere. Both challenge Habermas's emphasis on the speaker/hearer model as being at odds with our actual communicative practices.

Garnham, from the United Kingdom, supports a historical precedence for modern democracy in "that large numbers of human beings from different cultures have actually believed in it and fought to realize it." He discredits the post-modernist argument of the

impact of cultural identity (the "utopian and romantic pursuit of difference for its own sake,") on the development of the public sphere. To include cultural specificities as a defining factor in the formation of the bourgeois public sphere is to degrade its culturally limited idealistic impact. For Garnham, the demise of the bourgeois public sphere into a refeudalized welfare state was triggered by partisan interest and cultural politics which has been ushered forth by our all pervasive mass media consumer culture.

> *"It is at the very moment of recognizing ourselves as the mass subject, for example, that we also recognize ourselves as minority subjects. As participants in the mass subject, we are the "we" that can describe our particular affiliations of class, gender, sexual orientation, race or subculture only as "they." This self-alienation is common to all of the contexts of publicity, but it can be variously interpreted within each. The political meaning of the public subject's self-alienation is one of the most important sites of struggle in contemporary culture." (Warner, 1992, p. 387)*

Warner's model of the public sphere is based on American cultural identity politics and how civil rights, feminism, and multiculturalism challenge the concept of the culturally homogenized bourgeois public sphere. Difference becomes integral to the development of the public sphere. Warner points out the inadequacies of the speaker/hearer model in that it fails to consider the complex "large-scale communicative modes characteristic of modern societies." (Lee, 1992, p. 409) Modern society, a mesh of intertextual and multi-mediated public spheres requires multiple communication models that support the dynamic dialectic between its generalized, embodied and historicized components. (Lee, 1992)

3.5.3 Critique of Deliberative and Aggregative Models of Democracy

> *"We have got on the slippery ice where there is no friction and so in a certain sense the conditions are ideal, but also, just because of that, we are unable to walk. We want to walk: so we need friction. Back to the rough ground." (Wittgenstein, 1958, p. 107)*

Agonistic democracy is a method for arriving at rational consensus that deconstructs the *us versus them* dyad by allowing contestation and divisiveness to be the seeds for cultivating a pluralistic democracy. Adversarial discourse is included as a communicative process in the public sphere and power and antagonism is at the core of the agonistic democracy model of the public sphere. (Laclau & Mouffe, 1985)

Deliberative democracy is based on the premise that all subjects in a democratic state contain natural rights. However, these rights are "abstracted from social and power relations, language, culture and the whole set of practices that make the individuality possible." (Mouffe, 1999) Mouffe observed that the process of abstraction inherent in the deliberative and aggregative models relies upon the privatization of identity from the public sphere, creating extreme forms of individualism that threaten society.[1] [2] The denial of the ability to integrate individual value systems into the broader public discourse has "deprived" some the opportunity to identify with a general sense of citizenship. Exclusion from the mainstream has set forth the pursuit to search "for other forms of collective identification [e.g. religious, moral, ethnic fundamentalism], which can very often put into jeopardy a civic bond that should unite a democratic political association." (Mouffe, 1999)

Compounded with the problem of extreme individualism, traditional models of democracy are based on concepts of the reasonable and communicative rationality which encourages the suppression of emotions, particularly passion and antagonism, in the public sphere. Disruptive issues are suppressed and moved from public discourse to the private sphere and "the crucial role played by passions and emotions in securing allegiance to democratic

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[1] The aggregative democracy model is attributed to Joseph Schumpteter. (Schumpeter, Capitalism, Socialism and Democracy, 1947) The concept of the elected official through the aggregation of votes was a key element for empowering the individual, who was permitted to vote, to elect the leader who would best represent his self-interest. The model was based on the 17th century concept of popular sovereignty which originated from the social contract school, represented by Hobbes' "Leviathan," Locke's "Second Treatise of Government," and Rousseau's "The Social Contract". Each of these works places supreme authority in a political community in the hands of the elected officials or the concerned individuals.

[2] Deliberative democracy, which dates back to 5th century Greece is represented by Rawls and Habermas. It is based on the premise that political decisions should be generated by deliberations between free and equal citizens. Deliberative democracy encourages public debate that is regulated by a set of validated rational rules. Habermas and Rawls share the belief that public authority and legitimacy is formed through rational public reasoning, as indicated by Rawl's concept of "reasonable" and Habermas's "communicative rationality." Rawls held that liberal institutions must remain neutral in respect to differing moral, philosophical and religious views. He privileged the concept of the "original position" as the ultimate truth that rises above individual situations. Habermas's solution for negotiating value-based pluralism was to separate ethics and morality and thus taking care of the problem of "confused pluralism" he refers to in his modified theoretical framework of the public sphere. (Habermas, 1992). Ethics define the "good life" and allow for multiplicities of beliefs and acts that provide richness to society.

Morality is a procedural matter that is based on the "ideal speech act and validity claims." Mouffe humorously uses the following analogy to understand Habermas's stance. "Thou shall not kill (moral) but may sleep with anyone they please (ethics). (Mouffe, 1999)

values" is denied. (Mouffe, DDAP) Without emotion, the formation of the empathetic society is at danger.

3.5.4 Mouffe's Agonistic Democracy

> *"... by resisting the ever present temptation to construct identity in terms of exclusion, and by recognizing that identities comprise a multiplicity of elements, and that they are dependent and interdependent, a democratic politics informed by an anti-essentialist approach can defuse the potential for violence that exists in every construction of collective identities and create the conditions for a truly "agonistic" pluralism. Such a pluralism is anchored in the recognitions of the multiplicity within oneself and of the contradictory positions that this multiplicity entails. Its acceptance of the other does not merely consist in tolerating differences, but in positively celebrating them because it acknowledges that, without alterity and otherness, no identity could ever assert itself. It is also a pluralism that valorizes diversity and consensus, recognizing in them the very condition of possibility of a striving democratic life." (Mouffe, 1999)*

Agonistic democracy is grounded on the concept that "social objectivity is constituted through acts of power." Agonistic democracy challenges the concept that an external relationship of consistency and balance exists between subjects. Rather the relational quality between subjects is defined according to a model of dominance and submission. Mouffe works from Derrida's theory of différance to critique the essentialist position that dominates the social sciences and liberal thought. Différance, discussed in chapter five, describes the indeterminacy in the act of assigning a definitive meaning to an object, subject or event when that object, subject or event holds the capacity to denote and connote a myriad of legitimate, sometimes complementary and other times dissonant, meanings. Mouffe's reading of Derrida's theory of différance implies that identity can only be established by recognizing a comparative difference, based on socially defined ontological hierarchies (e.g. man and woman, adult and child, black and white, etc...). It is through the affirmation of différance, the conception of something that is external and "other" to the self, that identity is established.

The agonistic process respects Bakhtin's heteroglossic richness of languages, ideas and beliefs where compromise is a temporary pause, a moment to re-group, in an on-going adversarial conversation. "To accept the view of the adversary is to undergo a radical change in political identity." Antagonism, a fight between enemies is transformed into

agonism, a struggle between adversaries. (Mouffe, 1999) Antagonisms between the self and other, or us and them, occur when the "other" is perceived as a threat to one's identity. It is at this point, Mouffe states that différance becomes political. However when différance is recognized in agonistic democracy, the "other" is no longer seen as an enemy to be destroyed, but as an "adversary." The other becomes someone whose ideas can be struggled against, but nevertheless, has the right to espouse those ideas without fear of censure. The adversary remains an enemy, but a legitimate one, with whom a common ground of ethical – political principles based on liberal democracy can be confronted in a neutral territory.

This break from essentialist views critiques both the neo-liberal notions of social identity as formed through historical processes (Rawls and Habermas) and the post-modern fragmentation that challenges the existence of relational elements between disparate counter-cultures. Mouffe notes that, "such a view leaves us with a multiplicity of identities without any common denominator and makes it impossible to distinguish between differences that exist but should not exist and differences that do not exist but should exist." (Mouffe, 1999) Identity is a constant process of hybridization where the individual, as nomad, is placed in a situation where she must either comply or resist a multitude of internal and external interactions. The porous borders of identity formation allow for a constant flow of discourse, power structures and other influential matter that target the kernel of the self. Ironically, a pluralistic society needs the conflict of political struggles to verify its existence and assumed relevancy to society as a whole. Rather than contesting this point as a negative attribute, Mouffe explains that we should embrace it as a means to celebrate and use pluralism as a social feature that can lead to positive ends.

3.6 Habermas Re-thinks the Bourgeois Public Sphere

> *"If a collective identity would emerge in complex societies, it would have a form of community identity hardly prejudiced in content and independent of well-defined organizations. The members would develop their identity-related knowledge about competing identity projections discursively and experimentally, that is, while critically recalling tradition and through the inspiration of science, philosophy and art." (Hohendahl & Silberman, 1979, p. 117)*

Habermas acknowledges that the *Structural Transformation of the Public Sphere* has been similar to a text book for contemporary critical theory and a source for productive debate about the nature of the public sphere. Despite its popularity, his interests from that ambitious early interdisciplinary work shifted to the theory of communicative actions, and he decided to not write a formal response to his critics addressing the fallacies pointed out by Calhoun. Habermas acknowledged the weaknesses inherent in his earlier writing in an essay published later in *Further Reflections on the Public Sphere*. The collection of critical essays about the public sphere, ends with a proposal for an updated framework for the public sphere, one which he hopes will continue to stimulate discussion and debate. (Habermas, 1992)

In his self-reflective moment, Habermas acknowledged his lack of qualifications as a historian of 18th and 19th century European culture and his lack of access to or knowledge of primary texts that would have challenged his idealistic notion of civil society during that time period. With this caveat, he continues to support his premise on the development of the public sphere during this period of enlightenment and rapidly evolving society in the 18th century to be a unique time when the formation of cultural associations, secret freemasonry lodges and orders of illuminati, based on voluntary membership, encouraged egalitarian social practices, free discussion and majority decision making. (Habermas, 1992)

Habermas confessed that it was not until reading Bakhtin's *Rabelais and His World* that he understood the complex nature of the exclusion of the proletarian culture.

"This culture [referring to Rabelais and His World] of common people apparently was by no means only a backdrop, that is, a passive echo of the dominant culture: it was also the periodically recurring violent revolt of a counter project to the hierarchical world of domination, with its official celebrations and everyday disciplines..." Ironically, this statement comes from a philosopher who reflects in his later writings the influence post World War II German politics played in his theories about the public sphere. Habermas continues to reflect on the poignancy of Bakhtin's writing on the 19th century by stating, "Only a stereoscopic view of this sort reveals how a mechanism of expulsion that locks out and represses at the same time calls forth counter-effects that cannot be neutralized. If we apply the same perspective to the bourgeois public sphere, the expulsion of women from this world dominated by men now looks different than it appeared to me at the time." (Habermas, 1992, p. 427)

The exclusion of women can be equated with the exclusion of workers and peasants who lack the prerequisite ownership of property. (Fraser in Calhoun, Benhabib in Calhoun) He resolves this issue in his own thinking by recognizing the inter-relational qualities of these various public spheres. Setting forth the premise that the "exclusion of underprivileged men and the exclusion of women had structural significance." He recognizes that the responsibility for insuring outsider inclusion into the bourgeois public sphere fell (and continues to fall) on the shoulders of those who are systematically excluded. This is a process that generally guarantees that the excluded remain excluded. For how can transformation of a known social structure occur when the transformers are not invited to be part of the mechanism for change? An alternative could be and is for the excluded to simply construct new structures, new mechanisms for public discourse and engagement.

Habermas's revised framework was greatly influenced by grass roots movements [Burger Initiative] in West Germany in the 1970s. These movements sought to bypass official communication and political mechanisms in hopes of reforming the public sphere into a collective identity based on universal norms and equal opportunity. The modified theoretical framework for the public sphere is founded on a discourse-centered concept of democracy in which the theory of communicative actions plays a crucial functional and analytical role.

3.6.1 Habermas's Modified Theoretical Framework for the Public Sphere

The first premise of the modified framework is that normative foundations for critical theory of society must be laid at a deeper level as a means to discover normative cultural and societal communicative practices which transcend historical specificities. This is accomplished by incorporating the theory of communicative action to understand the "rational potential intrinsic in everyday communicative practices."

Second is the recognition that a holistic notion of society is ill suited for understanding the realities of a multifaceted society that is molded both through economic market systems and power brokering administrative systems.

Third, the recognition of complementary and conflicting lifeworlds presents a complex problem in terms of finding a democratic solution for negotiating "competing interests and political power claims." (Habermas, 1992, p.445) Multicultural societies challenge the so-called simplicity of the homogenous society where individual convictions were founded upon agreed belief structures. Habermas refers to this phenomenon as a "confused pluralism" that sets forth an arena for competing lifeworlds. One must ask if Habermas continues to hold onto

an ideal fictional notion of some prehistoric time when all individuals held the same beliefs, dreams, and intentions?

Fourth, the discourse-centered concept of democracy is a means by which conflicts can be resolved using discourse to negotiate and find consensus. Habermas's discourse-centered approach to ethics supports the premise that social conflicts can be mediated to serve the common interest of all involved parties through public argument and negotiation aimed at the goal of a "rational formation of will." (Habermas, 1992, p. 446) Fair negotiations rely upon the procedural conditions of the argumentation process. Fairness, in this case, is determined by moral judgment which can be guided by Habermas's normative seeking validity claims as defined in his theory of universal pragmatics.

Fifth, success of the discourse-centered approach in connecting self-interest and orientation to the common good requires two pre-conditions – impartiality and transcendence from one's initial preferences. These preconditions guarantee the "complete inclusion of all parties that might be affected, their equality, free and easy interaction, no restrictions of topics and topical contributions ..." (Habermas, 1992, p.449)

Finally, Habermas emphasizes that "discourses do not govern." Their communicative powers cannot replace the role and functionality of administration, but it can influence the formation of administrational policies. "Communicative power cannot supply a substitute for the systematic inner logic of public bureaucracies. Rather it achieves an impact on this logic "in a siege-like manner."

3.6.2 The New Political Public Sphere

More closely aligned with Negt's and Kluge's theory of the proletarian public sphere, Habermas avoids the trap of idealizing the main culture and romanticizing the counter-culture by emphasizing the political public sphere. Articulating the importance of the informal structure of the new collective identity, Habermas's goals are the democratization and politicization of its members. (Habermas, 1976) The political public sphere survives by the inclusion of cultural institutions that comprise the core of "civil society" (e.g. religious institutions, cultural and academic associations, independent media organizations, sports and leisure clubs, debating societies and grass-roots organizations). These institutions support the task to both "maintain and redefine the boundaries between civil society and state..." (Habermas, 1992; Keane, 1988, p. 14)

3.7 Conclusion

Habermas and his critics' response to the *Structural Transformation for the Public Sphere* sets the foundation for Broeckmann's argument for the re-visioning of the public sphere as a physical or virtual location capable of facilitating complex forms of interaction and argument, through discourse, negotiation and compromise. In particular, by harnessing the network and database potentials of information technologies to develop new, creative projects and applications that support people to become visible, to become present, to become active and to become public. (Broeckmann, 2000)

This is a call for proactive engagement by artists, critical theorists, community workers and technologists to work toward harnessing the communicative potentials of electronic media to facilitate discourse, argument and negotiation to create new possibilities for designing agents of negotiation and change for the public sphere. Discourse cannot change policy but it can influence policy, as Habermas said, in a "siege-like manner." Here a

commonality between Habermas's discourse-centered approach to ethics and the action-oriented processes incorporated into the work of many media artists (film, television, radio, electronic media, etc...) can be analyzed. The controversy with Habermas lies in his insistence in the existence of universal normative values that are required for achieving consensus through discourse and argument. To reach consensus requires the ability to articulate and negotiate differences as Mouffe describes. However, Habermas's theory of communicative action categorizes any communicative act that is not aligned with the rules of universal pragmatics validity claims, as a violation of those validity claims. In our society, a violation is typically handled by censure, fine, or other punishment. These methods serve to suppress dissension and enforce compliance. In essence, Habermas contends that as long as communicative actions are employed that do not follow the rules of universal pragmatics, then resolution through discourse, argument and negotiation is impossible because dissenting views, which are required for argument, are repressed by the very system set forth to facilitate negotiation in the public sphere.

Habermas remains ambivalent about the lasting effects of electronic media on the political public sphere even with the potential for reaching egalitarian ideals. Habermas notes how the behavior of the public has changed with the influence of electronic mass media, advertising, the fusion of entertainment and information along with a collapse of "liberal associational life" (e.g. social institutions) and proliferation of surveillance in the geographical and virtually localized public domains. Mass media pre-structures and dominates the public sphere with its internal corporate battles, unspoken agendas, and monopolized power grabs.

The propagation of electronic media, as a means to support public discourse, can be viewed as having the potential to transcend structural boundaries of time and space to support the creation of a global political public sphere. This is certainly an

argument that was reinforced by Negt and Kluge's *Public Sphere and Experience*. The nomadic characteristics of electronic media has been equated to hunting and gathering societies whose constant environmental changes lead to more egalitarian social structures between men, and women, children and adults, leaders and followers. In other words, "the difficulty of maintaining many separate places or distinct social spheres tends to involve everyone in everyone else's business." (Meyrowitz, 1986, p. 456) Media, a vehicle for the dissemination of public interest information, always plays an ambivalent role in society. The promise of electronic media may be regarded as an unlikely prophecy cloaked by naiveté or as a hopeful cautious optimism. The argument about the potential benefits of electronic media can be examined in light of an understanding of critical theories of technology, reviewed in the following chapter.

Chapter 4 Critical Theories of Technology

In this chapter, I review and critique contemporary critical theories of technology that span the continuum from instrumentality to Feenberg's critical theory of technology. This deep dive into Feenberg's theories on technology sets the foundation for the practice /theoretical platform I call *critical creative technology*; in particular, the design of computer interactive technologies and activities that facilitate communicative actions in public spaces. The chapter following this one is an examination of Feenberg's *dialectics of technology* with the inclusion of examples of contemporary practices and theories from human computer interaction, interaction design, new media art, and pedagogical practices that further elaborate, and broaden Feenberg's framework.

4.1 Technology and the Public Domain

> *"Likewise, the essence of technology is by no means anything technological. Thus we shall never experience our relationship to the essence of technology so long as we merely conceive and push forward the technological, put up with it, or evade it. Everywhere we remain unfree and chained to technology, whether we passionately affirm or deny it. But we are delivered over to it in the worst possible way when we regard it as something neutral; for this conception of it, to which today we particularly like to do homage, makes us utterly blind to the essence of technology."*
> *(Heidegger, 1977, p. 4)*

Andreas Broeckmann, introduced in chapter three, is a critical thinker who is concerned with the integration of technology into the public domain, provides the following framework to understand the impact of technology on the public domain.

The first principle in his framework involves understanding the ever changing spatial and temporal parameters of networked spaces. Information technologies have had a profound effect in changing our arenas for discourse. Face-to-face and synchronous temporal relationships between communicators are no longer required for communication. The instantaneity of pushing the "send" button becomes a desired convenience over walking down the hall or picking up the phone to converse. Technology-mediated distance is not determined by physical measurement of the proximity of bodies. Communication and

presence become bound by the affordances and limitations of technology. On the other hand, face-to-face communication, in public spaces, is rapidly becoming a domain of suspicion with the pervasive presence of authoritarian surveillance systems.

Broeckmann's second principle addresses the urgency in the need for us to understand the information technologies being developed and their impact on our methods of communicating, doing business, and engaging in political activities in our pervasively changing environments. As result of this new understanding, we must be willing to "reinvent ourselves," and our way of doing in the world within very short time frames. The awareness of the changing information technology tapestry sets a strong argument for synergistic reflection between the domains of technology development, critical thinking, humanities, and the arts as a means to understand the impact and unforeseen uses of new technologies by examining the discourses used for their development.

Finally, Broeckmann's framework calls for the understanding of "the new habits, routines, and behaviors we are confronted with, that we may have to learn or unlearn." (Broeckmann, 2001, p. 103)

4.2 Instrumental and Substantive Theories of Technology

Feenberg's critical theory of technology was developed in reaction to the neutral optimism of the instrumental and the critical suspicions put forth by substantive theories of technology. Both are widely held views that paint technological advances that calculate differently the impacts of technology in the modern world.

Instrumental theory supports the ideas that technology only provides a means to an end for the goal or task at hand. Technology, its form and function, do not implicate cultural or political value attributes to the situation in which it is used. Substantive theories of

technology view technology as a cultural system that transforms the social world into an object that can be manipulated and controlled. Here, technology is not a means to an end (instrumental), but is its own socio-cultural entity that maintains substantive impact on society and the consequences of technologies hold greater impact on society than its original intended goals. Substantive theories romanticize about an earlier, simpler life bound by non-technology motivated cultural traditions. Returning to this "oasis" of contentedness and balance is then the only way to escape our technology-controlled realities. (Feenberg, 1991)

4.2.1 Instrumental Theories of Technology

The following four premises set the framework for Instrumental theories of technology.

1. Technology, as pure instrumentality is indifferent to the variety of ends it can be employed to achieve. This neutrality of instrumental means is contingent on the substantive processes served by the technology.
2. Technology is indifferent with respect to politics in the modern world, particularly in capitalist and socialist societies. A hammer is a hammer regardless of the situation or location that it is used. Economics is the only factor which limits the tools availability.
3. The socio-political neutrality of technology is usually attributed to its "rational" character and the universality of the truth it embodies. Technology is based on verifiable causal propositions which are not socially and politically relative – like scientific ideas, maintain their cognitive status in every conceivable social context. What works in one society can be expected to work just as well in another.
4. The universality of technology also means that the same standards of measurement can be applied in different settings. Technologies are neutral because they stand essentially under the very same norm of efficiency in any and every context. (Feenberg, 1991)

A review of early theories and visions of computer technology -- from Vannevar Bush's Memex, Weiner's cybernetics, Englebart's H-LAM/T (Humans using Language, Artifacts, Methodology, *in which he is* Trained,) augmented reality and Weiser's ubiquitous computing -- present a history of computer-based technology developments that were positioned to augment the relationships of people to machines and one's environment followed the logic of instrumental theories of technology, particularly in terms of devaluing and down-playing the role of human contribution to the ecology of the environment in which the tool was to be used.

4.2.1.1 Vannevar Bush Thinking As We May

> *"It is readily possible to construct a machine which will manipulate premises in accordance with formal logic simply by the clever use of relay circuits.... Put a set of premises into such a device and turn the crank, and it will readily pass out conclusion after conclusion all in accordance with logical law and with no more slips than would be expected of a keyboard adding machine." (Bush, 1945)*

In his famous 1945 article, *As We May Think*, Vannevar Bush states that "inventions are at hand which, if properly developed, will give man access to and command over the inherited knowledge of the ages." As Director of the Office of Scientific Research and Development for the United States government, Bush was at the forefront of the effort to transfer technical and scientific knowledge developed during World War II to alternative uses in a post-war society. Many of his visionary ideas have been realized into commonly-used technologies (e.g. digital cameras, computers, associative indexing) Whereas other ideas such as the MEMEX, fully augmented and associative linked work space continue to be the subject matter of many university and industry research initiatives. Despite the optimism of Vannevar's article, the underlining tone in his writing begs for critique.

Bush notes that WWII was a time when physicists "[had] been thrown most violently off stride." Rather than pursue academic research, their resources of mind and innovations where diverted to the development of instruments of war. Bush was determined to illustrate how these technologies of destruction could be used to build new knowledge and

peacetime inventions for the progressive society. He notes that wartime technology research (e.g. photocells, infrared photography, cathode ray tubes, and micro-electronics): increased man's control over his material environment; improved his food, clothing and shelter; increased security; and increased his knowledge of his own biological processes thus freeing him from disease and expanding his life expectancy. In essence, wartime technologies [had] the potential to release man from the "bondage of bare existence." (Bush, 1945) It is important to note that the generic "he" is the producer and beneficiary of these new and refurbished technologies. His gender bias is revealed in his text by suggesting that his prophesized stenography machine, the Vodor, would replace "a girl who strokes keys languidly and looks about the room and sometimes at the speaker with a disquieting gaze." (Bush, 1945) This statement completely dismisses the tacit knowledge and skills of "the girl" that are required to perform her job. Rather he proclaims that methods available for transmitting, reviewing and recording data, in the 1940's, were archaic, inadequate, fault-ridden and counter productive in the promotion of new scientific knowledge for the good of society. In essence, the machine would solve this problem of inefficiency. Creative thinking, a catch-all for anything that is not quantifiable, is required for selecting data for a given process according to Bush. Once the data is selected, the creative task is complete and the resultant process is "repetitive in nature and hence a fit matter to be relegated to machines." Complex machines then can be mass produced and thus a new industry is born. Creativity, though allowed in the initial stage of processing data, appears to not have a role in the actual processing of that data. Bush proclaims that science "has enabled man to manipulate and make extracts from that record so that knowledge evolves and endures throughout the life of a race rather than that of an individual." All faith is handed to the rules and methodologies, which thinkers like Bush, believe are infallible. This view illustrates Feenberg's fourth premise of instrumental theories of technology, the belief in a rational and universal perspective to truth.

4.2.1.2 Cybernetics and Human – Machine Symbiosis

A critical look at the theory of cybernetics, developed by Norbert Wiener and a group of distinguished researchers in fields as broad as cognition, technology, and social-psychology, during Macy conferences series between 1943 and 1954, will also reveal a tendency toward the universalizing standards of measurement. Cybernetics, a systems based theory, supported the development of an interdisciplinary approach to understanding human systems and consciousness while simultaneously celebrating a human -machine relationship that relegated the machine as superior in completing certain critical tasks. Cybernetics introduced a change in the perception of human functioning where the human was viewed purely as a processor of information that could be replicated into a machine. (Hayles, 1999) This contentious relationship between humanism and machine-centric visions continues today in systems research and development in the fields of artificial intelligence, cognitive systems, and service oriented robotics. (Nakauchi & Simmons, 2002; Lee & Kiesler, 2005; Baker, Roll, Corbert & Koedinger, 2005)

Cybernetics were interested in understanding the relationship between homeostatic or self-regulating control systems in biological and mechanical systems. Based on the metaphor of a feedback loop, the cybernetic theory incorporates concepts from information theory, neural physiology, cognition, artificial intelligence, and social psychology. Using a human to test the efficiency of a man/machine task was and continues to be a task that is prone to errors in accuracy in a domain that values efficiency over expression.

Early cybernetic studies were used to test the efficiency of war aircraft bombers and human performance during mission critical tasks by removing the human from the test and replacing him with a machine. This method of research remains prevalent today in the cognitive branch of human computer interaction called GOMS (Goals, Operators, Methods, and Selection Rules). GOMS is concerned with integrating the development of cognitive

models of human performance with the task of producing quantitative predictions of performance. This view of technology task evaluation is viewed by GOMS researchers as requiring less effort than prototyping and standard methods of user testing. (John, 2003) Cognitive tutors, based on computer simulation of cognitive models for problem solving, also emphasize the efficiency of the machine, over human to human interaction. The goal of cognitive tutors is to guide and correct human thinking, learning and problem solving in a variety of knowledge domains. (Koedinger & Anderson, 1998)

4.2.1.3 Douglas Englebart HLAM/T Theory

Douglas Englebart developed the HLAM/T (Humans using Language, Artifacts and Methods in which they are Trained) theory of intelligence amplification in the late 1960's. Engelbart's hypothesis, that individual limitations in comprehending and solving complex problems could be aided by the use of modern technology, was demonstrated with the design of computer-based tools that could, 1. Extend the limitations of a user's productivity in the work space and; 2. Improve accessibility to knowledge resources. His research at SRI International and subsequently Xerox PARC ushered forth innovations in desktop computing including the mouse, hypertext and early experiments with the Arpanet and the revolution in research in augmented intelligence and reality. (Englebart, 1967) Englebart's tools were initially developed for use by his primary community of practice, computer engineers. (See chapter five for further elaboration on Gerhard Fischer's theory of community of practice.) When watching his 1969 live demonstration of the first computer mouse, keyboard and hypertext system, CRT screen via a live Arpanet transmission, it becomes evident that Engelbart's fascination lies in the cleverness and novelty of his invented tools. (e.g. the mouse, alternative typing devices, associatively linked hypertext authoring computer program, etc...) Englebart's awkwardness, and apologetic demeanor, during the live demonstration created an ambiance of innocence and acceptance of the imperfections by the emerging computer literati audience. Gone are the

days of risky live presentations. They have been replaced by sterile, safe and dull power point presentations. Englebart's live 1968 demonstration ushered forth major contributions, some along the lines of Bush's dreams, to support the global information age.

4.2.1.4 Contemporary Instrumentalism: Ubiquitous Computing

The instrumentalist trend in technology is most prevalent in ubiquitous computing research that is focused on industrial ends or the continuation of Englebart's HLAM/T dream. This form of technology development and research invokes Feenberg's four premises of instrumental theories: 1) indifference to the ends created; 2) indifference to its influence on the political nature of society; 3) assumed neutrality as an embodiment of universal truths; and 4) the development of universal standards of efficiency that function in all imaginable contexts. Ubiquitous computing was first envisioned by Mark Weiser, formerly of Xerox PARC, who proclaimed that, "the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." (Weiser, 1991) Weiser's prediction was that ubiquitous computing would "make individuals more aware of the people on the other ends of their computer links," by reversing the unhealthy machine-centric focus on personal computers in life and the workplace. He held tight to the dream that ubiquitous computing was the cure for the ills of desktop computer, namely the death of human to human interactivity. It is interesting to note that, like his predecessors in computer technology development, Weiser supported the development of new technologies as neutral entities to be seamlessly integrated into one's environment. While being concerned about human to human relationships as mediated by computing, much research in ubiquitous computing, including that in affective computing, merely employs computer data to reveal one's presence, either explicitly or implicitly, in a particular location. These experiments in efficient presence awareness do not address methods for true connectedness, intersubjective experiences, or transmission of the users intentions beyond that which can be implied. This point is brilliantly addressed in the research of Pheobe Sengers and her theory of the Affective Gap between computer science

research on affective computing and the results produced by these technologies. (Sengers et al., 2005; Dourish et.al. 2004)

Returning to Bush's statement about the grumpy girl stenographers, one could ask, "Why are they grumpy?" Is it because of the tools they use, the environment they work in, or some combination of both? Rather than following Weiner's cybernetic argument that privileges the mechanistic system over the human system, Weiser emphasizes the need to design machines that fit with and are not forced into the human environment. These machines disappear from human observance, yet are ever present and observing the environments in which they are embedded. However, will this reveal why the girl stenographer is grumpy? I don't think so.

Weiser's vision was of computational invisibility, however, most of the research from Xerox Parc and its competitors during the 1990's in this area produced tablet and handheld computers in smaller awkward packages and countless prototypes for shared whiteboard technologies. As with the tablet PC, research based on the concepts of ubiquitous computing have focused on the transformation of physical spaces into information spaces using such techniques as tangible bits, ambient rooms,\physical computing, natural interfaces, ubiquitous computing, pervasive computing, out-of-the-box concepts, idea spaces, multi-modal interfaces and affective computing. Ubiquitous computing research generally falls into two categories; (1) the development of technologies designed to "push" personal or logistically relevant data to the user; and (2) to provide a means to survey activities in the user's environment to guide the user in the "correct" or "appropriate" ways to achieve performance metrics of optimum efficiency. Research experiments in smart offices, smart classrooms, smart bathrooms, talking refrigerators, windshields with transparent global positioning satellite systems and head mounted displays with partially occluded vision augmented with a constant stream of data (Mann, 1997) are pervasive. The

omnipotent presence of embedded sensors that are aware of my presence; my availability to be "interrupted;" my plans for the day; my tasks priorities and efficiency in getting them done; the amount of cream to pour into my coffee in the morning continue to be developed at research think tanks such as: IBM (Selker, 1998), (Hoffman, Jennings, Vogt, 1998), (Zimmerman, 1996); MIT Media Lab (Colella et. al., 1998), (Ishii, et al., 1997, 1998)(Minar, Kramer, and Maes, 1999); Xerox PARC (Harrison, et. al., 1998) (Want et. al, 1999); German National Research Center (Streitz, et. al, 1998, 1999); SRI International (Cheyer and Julia, 1999), (Julia, Bing, and Cheyer, 1999), (Julia and Cheyer, 1999); and other research think tanks, (Georgia Tech, 1999), (i3Net, 1997), (Phillips Design, 1999), (HIPS, 1999), (Persona Project, 1999), (Pederson, 1998, 1997a, 1997b)

It can be argued that ubiquitous computing is an extension of cybernetics, which places emphasis on the technology-assisted homeostatic state of one's environment. For example the new PYXOS sub-miniature self-organizing microcontrollers that are designed to relay the state of particular functions in the operation of a larger automation machine (e.g. Food dispenser, conveyor belt, copy machine, etc...) have graduated from the research lab and are now on the market. (Echelon, 2006)

4.3 Phenomenology and Pragmatism: Perspectives on Substantive Theories of Technology

Heidegger's substantive critique relegates technology to be a means by which to master one's environment. Understanding the impact of technology on society becomes a spiritual pursuit that transcends as his argument unfolds in his text. Heidegger points out that the word technology originates from the Greek *technikon* and *techne*, or bringing forth the production (*poiesis*) of the craftsman and fine artists by incorporating four attributes, or causes, of design; material (*causa materialis*), form (*causa formalis*), function (*causa finalis*), and craftsman (*causa efficiens.*) This ancient definition of technology, based from the Greek etymological origins, emphasizes the underlying powerful essences of

technology, "where revealing and unconcealment take place, where *aletheia*, truth, happens." (Heidegger, 1977, p. 13) Modern technologies, according to Heidegger, neither reveal their essence nor support the Aristotelian notion of poiesis, a balance between craft, art and production. Rather, modern day technologies challenge [*Herausfordern*], nature and demand a continuous "supply energy" for its use regardless of the natural capabilities of the availability and flow of that supply. In other words, we use technology to bend, manipulate and satisfy societal needs regardless of nature's capacity to provide. Technology is employed to command and transform our world, into "standing reserves," as a means to assert power over nature and society.

Feenberg points out that the choice to not incorporate technology into a process or aspect of life based on moral, spiritual or religious grounds is in itself a form of technological determinism that has been deferred to a higher power. For example, the "intentional design" debate supported by evangelical Christians is in fact a "supertechnology," which they believe trumps all other scientifically derived knowledge. Therefore, even the most technology and science phobic attitudes and approaches are bounded to and by a technological sphere that flickers between instrumental and substantive modes of being and methods of explanation. (Feenberg, 1991)

This critique is framed by phenomenological questions of the lifeworld and *dasein* ("being in the world") for Heidegger. In comparing Habermas's critic of technology and Heidegger's phenomenology we see that Heidegger's substantive phenomenological approach to understanding the role of technology in society is bounded by one's experience of the world as it negotiates forces that exist outside of one's volition, be it religious, spiritual, or natural.

Habermas's view of the substantive pragmatic position is founded on socio-political positioning framed by the ideals of pragmatism. The development of public institutions and alternative ways of being in the world with technology that support discourse, debate, negotiation and understanding are methods by which to resolve and transcend the sometimes contentious relationship between technology and democratic institutions.[1]

4.4 Feenberg's Critical Theory of Technology

Feenberg's *critical theory of technology* focuses on the transformative qualities of technology as a "framework for ways of life." (Feenberg, 2003) This theory wavers in-between the contending poles of catastrophic and idealist models of technology. The critical theory of technology uses the substantive model as a platform to develop an alternative theory that supports the holistic integration of technology into the ecological and social structures of society. Technology and its use is ambivalent, forever wavering between possibilities of use. From this ambivalence, social values are implied and, "technology is not a destiny but a scene of struggle. It is a social battlefield, or perhaps a better metaphor would be a parliament of things on which civilizational alternatives are debated and decided." (Feenberg, 1991, p.14) Feenberg's theory supports the argument that oppressions caused by modern industrialization must be examined and challenged in order to position the contemporary "radical intelligentsia" for developing new and alternative methods that technology "can be redesigned to adapt to the needs of a freer society." (Feenberg, 1991)

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[1] Habermas' stance on the neutrality of technology stands in direct opposition to Marcuse's position. He argues that substantive theories exaggerate the impact of technologies on society. To correct this exaggeration technology must be given a neutral position such that purposive-rational action remains the primary means for forming and maintaining a more democratic industrial society. (McCarthy, 1979, p. 22) Feenberg brilliantly points out the absence of technology as a theme in Habermas' definition of societies "steering media" (money, power, influence, and value commitment.) Nor is technology listed in the index of *The Theory of Communicative Action* (Habermas, 1987 ; Feenberg, 1996) It is later in Habermas' project involving the public sphere and after much critique and personal exposure to independent media production that Habermas recognizes the influence and power of technology, in particular, new forms of public access broadcast media on the shaping of the public sphere. (Habermas, 1992)

Feenberg observes that, "technical rationality consists of various loosely related dimensions with different social implications," that defy categorization as being either purely instrumental or purely substantive. The critical theory of technology encourages the absolution of ahistorical theoretical models in order to acknowledge the multifarious impacts of technology on culture. Whereas Feenberg disagrees with the belief in a "unity of scientific-technical reason," he does agree that there are basic characteristics, or family resemblances -- as Wittgenstein would describe, that separate technical systems from other societal phenomenon.[2]

4.4.1 Bias and Neutrality in Technology

Feenberg's framework relies upon two basic categories of bias, substantive and formal, to identify and distinguish genres of technology. Both categories of bias are tangled by the concept of technology neutrality. What appears to be a paradox, something that is biased cannot be neutral, is in fact not one. The relationships between neutrality and bias are deconstructed to reveal a tight coupling of the two concepts. (Feenberg, 1991) A method for understanding the interwoven relationship between these concepts is to observe the standards applied to individuals as they interact with an object.

4.4.1.1 Substantive Bias in Technology

Substantive bias towards an object, person, or group, is the easiest to recognize since it is based on prejudicial acts often supported by judgments and ideologies. It is not associated with a neutral stance to technology. "Since unfair treatment cannot be justified on the

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[2] Marcuse' utopian dream of politics and techno-science, and Habermas's and his critics' theories on the formation of the public sphere, contribute concepts which Feenberg develops and critiques in his critical theory of technology. Both positions contain problems for Feenberg's theory, but his approach is to understand the strengths, weaknesses, fallacies and potentialities of other theories as a means to "reconstruct the critique of technology in a new way that eliminates romantic subtexts and opens positive perspectives on the future." (Feenberg, 1991, p. 165) His ultimate goal is to define a theory of action which moves beyond merely attacking our technically driven political state, but offers viable solutions. Marcuse' proposition for the development of technology is to understand its potential effects on the context of use of raw materials in order to balance the relationship between nature and humans. His theory is strongly aligned with concerns from aesthetic production and feminist critique of the design of technologies. His ontology promotes a holistic approach that honors "creative receptivity versus repressive productivity." (Marcuse, 1974, p. 286) Marcuse goal is to reveal the political in the scientific and technical thinking as well as modes of production to understand the dimensions of society and nature that are suppressed by its power. (Marcuse, 1964, p. 233 – 234)

basis of mere personal preferences, such norms are generally represented as factual judgments arbitrarily attributing abilities or merits, disabilities, or demerits to the more or less favored groups." (Feenberg, 1991, p. 180) Substantive biases are generally easy to identify as long as the identifier understands the social codes that are at play. They are not as interesting to examine as the far more subtle category of formal bias.

4.4.1.2 Formal Bias in Technology

When a biased perspective is integral to an institution, belief or action which is designed to diminish the negative effects of a biased stance the bias is said to be formal. Similar to institutional racism, formal biases are elusive, hard to identify and generally occur when there is a contradiction between what is assumed to be equitable characteristics and the efficacious reality which controls access to a technology, social institution, or other social amenity. As an example of formal bias, Feenberg discusses the debate in the United States about cultural bias in standard achievement tests. In this case, the tests repeatedly produce patterns of achievement that fall along lines of ethnicity and class. The formal bias becomes evident in the fact that "fair treatment seems to be rendered through an equal application of the same standards to all. But in that context, it becomes clear that the apparent fairness of the system can, in isolation, hide systematic unfairness of another sort." (Feenberg, 1991, p. 181) To critique and correct systems that promote formal bias requires that the very foundation on which the institution in question stands be deconstructed, analyzed and transformed or re-designed. (See chapter five for more on the New London Groups' theory of Multiliteracies and re-design as a method for empowering people with the tools that are needed to change their relationships to social, political and other societal institutions.)

Chapter 5 Dialectics of Technology and Contemporary Practices in Creative Digital Media Practices

"The dialectics of technology is thus not a mysterious "new concept of Reason," but an ordinary aspect of the technical sphere, familiar to all who work with machines if not to all who use them." (Feenberg, CCT, p. 183)

5.1 Feenberg's Dialectics of Technology

Feenberg's dialectic of technology is founded on Simondon's theory of concretization and intelligent engineering design where the design and materials of the technical object generate the conditions that create a harmonious relationship between the functioning of that object and the environment in which it is situated. Examples of concretization include compost heap waste disposal that re-generates organic garbage into fertilizer or an engine constructed from materials that enable it to be more fuel efficient by repurposing its radiant heat to support its mechanical functions. Feenberg's *dialect of technology* steps beyond the responsible design argument and includes the integration of components of society that are often not viewed as relevant to the development of technology. Compounded with the inclusion of hidden societal norms, the premises of the *dialectics of technology* are based on primary and secondary instrumentalization characteristics, or technical practices, of technology. These technical practices determine the socio-political essence of that society in which the technology is used.

Primary instrumentalization characteristics are indicators for capitalistic societies. They include the following four properties: decontextualization, reductionism, automization and positioning. The emphasis for primary instrumental characteristics is placed on the functionality and efficiency of technology. Secondary instrumentalization characteristics include: concretization (*systemization*), vocation, aesthetic investment (*mediation*), and collegiality (*initiative*.)[1] Secondary instrumentalization characteristics describe a socialist stance that values "reflexive meta-technical practice that treats finished technical objects

[1] Secondary instrumentalization characteristics in italics are the semantics Feenberg uses in his paper, "From Essentialism to Constructivism: Philosophy of Technology at the Crossroads, www-rohan.sdsu.edu/faculty/Feenberg/talk4.html)

and the technical relationship itself as raw material for more complex forms of technical intervention." (Feenberg, 1991, p. 183)

Attributes of both primary and secondary instrumental characteristics exist in modern society and determine the socio-political climate of the society in question. A capitalist-centric society will favor primary over secondary instrumentalization and devalue or treat as non-technical issues that arise due to the inclusion or neglect of factors defined in the secondary category. For example, the United States, an "alpha-capitalist" society, provides far more resources in the advancement of science and technology than in the arts and humanities. It is a society that is very cautious to recognize the synergies that could be nurtured between arts and technology research and falls far behind the progressive funding policies that are prevalent with its northern neighbor Canada, and many other Euro-centric countries. Feenberg's notion of the traditional society, one managed by close community-based relationships as opposed to world economic imperatives, views technique as part of a holistic system that includes "non-technical human relations." Interestingly, he points to the arts as an example where technology is integrated into practices not only for functional means but also for inquiry and aesthetics. To understand the reactionary stance of Feenberg's *dialectics of technology* it is important to layout the foundation from which his framework is built.

5.2 Primary Instrumentalization Characteristics in Technical Practice

Primary instrumental characteristics are classified into four defining moments, (1) decontextualization, (2) reductionist, (3) automization, and (4) positioning. (Feenberg, 1991, 183 - 188) Feenberg remarks that the four moments of primary instrumentalization lead to systems of alienation.

1. *Decontextualization* is the moment that an object is artificially separated from its context and systems in which that object originated and operates. Isolating the object enables a generalization of its utility such that it can be incorporated into a variety of applications.

2. The *reductionist* moment is characterized by the separation of primary and secondary attributes of a technology such that its utility can be abstracted while disregarding the larger impact of a particular application. For example, with the legal precedence of eminent domain a person's property can be taken over by the government if deemed necessary for a greater, usually economic, agenda while disregarding the important secondary non-economic factors such as the quality of lives of the persons living, working, and growing up in the community that is being reclaimed. Another example, as I experienced as a child, occurs when a town decides that real estate initiated segregation is not conducive to promoting tolerance and community, and a reductionist solution to the problem is implemented, which forces the children of one neighborhood to travel via bus to a new neighborhood that is passively hostile to the presence of the bussed children. The primary goal of physical integration is achieved while a strong secondary effect that continues to foster segregationist behaviors remains unaddressed.

3. The moment of *automization* separates the subject from the object such that the object no longer needs the subject to function. Therefore, the functional mechanics of object do not match the impact of the actions of the object. Feenberg's examples clearly articulate this concern: the driver of an automobile accelerates to high speeds while experiencing only a slight pressure and small vibrations; a marksman shoots and experiences only a small force transmitted to his shoulder by the stock of the gun (and thus a vice president shoots his companion with bird shot!); and the tall smoke stack carries pollutants from the city power generators that reach high above the city buildings such that their particles are dispersed over the countryside to fall back to earth elsewhere.

4. The moment of *positioning* is the act of strategically placing oneself in an advantageous position to an object to successfully employ that object to fulfill one's personal desires.

5.3 Dialectics of Technology and Secondary Instrumentalization Characteristics in Technical Practice

The *dialectics of technology* is based on the four moments of secondary instrumentalization: concretization; vocation; aesthetic investment; and collegiality. Together the four moments of secondary instrumentalization define a "new technical code" for the development of "concrete technologies" that "includes nature in its very structure" and "contradicts the commonplace notion that technical progress is a form of 'conquest' of nature." (Feenberg, 1991, p. 193) The process Feenberg describes is analogous to the *autopoiesis* systems theory, which values an ecological system as one that constantly adjusts to keep the relationships between its entities in balance to insure the survivability of its ecology.[2]

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[2] An alternative reflexive and multi-directional metaphor for the cybernetic feedback loop is Maturana and Varela's theory of autopoiesis. The theory of *autopoiesis* states that cognition is a creation of circularity and complexity in a system that maintains its selfsame form. Based on the study of biology and the evolution of living species, the theory provides a rigorous theoretical framework for addressing the interaction between living beings and their environment, including humans and the social systems in which they live. These social systems can include the designed creative interactive experience.

The theory of autopoiesis is based on the philosophy of structural determinism. That is the idea that all changes in living beings are determined by their structure and are the result of their own dynamics and interactions. Structural determinism is contrary to the constructivist learning theory and the social and historical influences on self-identification and cognitive development described later in this thesis. If we overlook this positivist tendency in the theory to observe some of the functional components of autopoiesis we will find relevant descriptions of the interactive processes and qualities of interactive art.

In the theory of autopoiesis, the unity is the nomenclature used to describe living beings. The primary characteristics of the unity are:

- The ability to continuously self-produce
- The ability to maintain a distinction from its environment as a result of its own dynamics
- A constantly updating ontogeny or history of structural change in the unity
- Structural change is triggered by interactions with the environment in which the living unity exists or as a result of internal dynamics.
- The process ceases only when the unities or environment disintegrates.

If two or more living beings have recurrent interactions and are in a state of mutual coordination with one another's behavior, then they are structurally coupled and become operationally dependent on each other for survival. Changes are brought about by a disturbing agent but determined by the structure of the disturbed system. In other words, the environment does not determine the internal changes of the living being. It is the structure of the living being that determines what changes occur within its structure. (Maturana and Varela, 1998)

Research and projects that complement Feenberg's framework have been developed in the fields of new media arts, interaction design and human computer interaction. References to these synergistic works are absent in his elaboration of the role of secondary instrumentalization characteristics to the *dialectics of technology*. The remainder of this chapter will present Feenberg's framework along with relevant work from research and practice fields. My goal is to broaden the perspective of influencing practices on society and form a new platform of critical *creative technology* that is based on and amends Feenberg's *dialectics of technology*.

5.3.1 Concretization (*systemization*)

The secondary instrumentalization category of concretization is the process of recovering contextual characteristics which have been disregarded in the act of decontextualization by re-connecting relationships between technology and their context of use.

5.3.1.1 The Theory of Multiliteracies

The New London Group, a collective of education researchers from the United States, United Kingdom and Australia formed to discuss the synergies between their various approaches to teaching literacy skills in contemporary society that host a "multiplicity of communications channels and media, and [an] increasing saliency of cultural and linguistic diversity." The consortium produced a manifesto for contemporary pedagogical practices that foregrounds the impact of changing economic, cultural, and social climates on literacy efficacy.

The premise of the manifesto was to broaden the domain of literary skills practices that teach how to manage critique and thrive in a broadly discursive environment. This is an environment where cultures, groups, individuals create unique genres of communicative tools that are influenced by mass media's many agendas. The term *multiliteracies* was

selected to describe the phenomenon of multiple forms of literacy that need to be mastered for individuals to engage fully in contemporary society. (New London Group, 1996)

The goal of *multiliteracies* is to develop a critical framework for literacy education that includes: text, visual, audio, spatial, and behavioral components of discourse; technology integration; and contemporary work ethics "as a way to focus on the realities of increasing local diversity and global connectedness." The rapidly changing nature of work ethics brought forth by the global movement toward postFordism or "fast capitalism" is an expressed concern of the New London Group. (Piore & Sable, 1984) PostFordism (fast-capitalism) refers to a post-industrial era system of work that challenges the positioning of the worker as merely a part of a much larger mechanistic process that is completely subordinate to a hierarchical management chain. The post-Fordist, fast capitalist work environment generally replaces that hierarchical chain of command with the ideals of life-long learning and training for the worker and the organization and "pulling one self-up by their bootstraps" mentality. The new fast capitalism awards entrepreneurial structures and the accompanying processes and languages that support entrepreneurial progress. Contemporary pedagogical practices are responsible for teaching individuals skills in management, negotiation, critique and survival for the rapidly evolving, dynamic, diverse, and global work environments that, despite the entrepreneurial spirit, often have subtle rules for successful inclusion.

5.3.1.2 Multiliteracies and Agonistic Democracy

> *"The decline of the old, mono-cultural, nationalistic sense of 'civic' has a space vacated that must be filled again. We propose that this space be claimed by a civic pluralism. Instead of states that require one cultural and linguistic standard, we need states that arbitrate differences." (New London Group, 1996)*

The theory of multiliteracies aligns with Mouffe's theory of agonistic democracy, addressed in chapter three. The New London Group recognizes, like Mouffe, the polarization occurring in the public sphere among sub-cultures and special interest groups,

which have a limited voice in the world of policy making. These subcultures create their own counter-societies as a means for expression and survival while simultaneously undermining the "concept of collective audience and common culture." The New London Group names the political public sphere or agonistic democracy as a place for civic pluralism. Here, multiliteracies is viewed as a method to construct a neutral framework structure where differences can be discovered, arbitrated and transformed into productive resources for building common-ground and common-purpose two essential components for a peaceful and productive world. The multiliteracies framework supports the juxtaposition of different languages, discourses, styles, and approaches by incorporating design thinking as an integral process in the development of meta-cognitive and meta-linguistic abilities. Design thinking implores us to engage in a deeply reflective practice. This is the very essence of my theory of *critical creative technology* and the *Constructed Narratives* project as described in chapter six through eleven.

5.3.1.3 Multiliteracies and the Design Metaphor

The theory of multiliteracies recognizes the role of various pedagogical practices from overt instruction to situated practice to critical inquiry as methods for teaching design thinking, problem solving, for multimodal literacy skills. Design, in this case, refers to the creative semiotic activities of discourse, discovery, and production across all disciplines, activities and actions that may be aesthetic, functional and/or policy related.

Metaphorically, the concept of design is founded on the premise of creative intelligence as a means to: (1) observe; (2) analyze; (3) make decisions; and (4) change one's course of action. All human beings are active designers of what, Bakhtin called, discourse genres, which means we are not only designers of meaning but "designers of social futures" that

will impact the workplace, the public sphere, and the community.[3] (New London Group, 1996)

Three incremental design categories are identified in the theory of multiliteracies, which are: (1) available design, (2) design, and (3) re-design. Tools and techniques employed in each category determine the level of discourse, discovery and learning that is facilitated.

> *"That which determines (Available Designs) and the active process of determining (Designing, which creates The Redesigned) are constantly in tension." (New London Group, 1996)*

5.3.1.3.1 Available Design

Available design is analogous to the grammars of a semiotic system, whether it be language, visual arts, sounds, gestures, cultural tropes and regional slang, or techno-speak (e.g. SMS language, computer literati anachronism – TCP/IP). Available design contains an order of discourse and the way components of a given grammar or combinations of grammars interact, influence and repel off each other. To logistically place the act of available design in relationship to the analogy of "thinking outside of the box" available

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[3] Nigel Cross, an industrial designer, supports an explicit understanding of the nature of design ability by outlining a theory of the legitimacy of designerly ways of knowing, thinking and doing. His core features of designability are: the ability to: resolve ill-defined (wicked) problems; adopt solution-focused strategies; employ abductive, productive, and appositional thinking; and use a variety of sign systems and tools for expression of a design solution. In defense of design as a unique discipline, Cross points out how design differs in procedural and theoretical precepts from the sciences. For example, the natural sciences are concerned with how things are, design is concerned with how things ought to be. Science investigates existing forms; whereas design creates novel forms. The most relevant premise from Cross' theory on design ability to critical interaction design and the Constructed Narratives project is the concept that design ability is possessed by everyone. Design ability is possessed by all who make decisions and arrange objects in their environments. Note that Cross' argument focuses on the cognitive components of design as realized by acts of design. These cognitive functions that support design ability are fragile and can be nurtured or lost. (Cross, 1995)

I find the societal impact on the damage of design ability far more interesting and relevant. In a recent New York Times article *Feet and Minds Need to Wander*, recent MacArthur Fellowship Genius grant recipients commented on the effects of being constantly plugged into technology on the basic ability to daydream, think and solve problems. Below is a thought-provoking quote from the New York Times article *Feet and Minds Need a Chance to Wander*. (Haberman, 2005)

"They [New Yorkers] are hooked to iPods or whatever new device may have happened along yesterday. They punch away at BlackBerries. They yak on their cellphones, talking business nonstop or telling friends that they're at Fifth Avenue and 23rd Street and - hey, you know what? - Fifth and 24th is coming up....

Whatever pleasure or benefit they derive from this compulsion to be wired at all times, one thing they are almost certainly not doing is thinking freely, letting their minds wander. You wonder sometimes what eureka moment may have been missed in all this busyness. Did the world lose the cure for cancer? Or the plot for a great novel? Maybe a way to fix the Yankees' woeful bullpen?...

It troubles Majora Carter, another 2005 winner and founder of a group called Sustainable South Bronx that many young people are wired all the time. "They don't have the ability anymore to create things in their own head, to create fantasies, to create dreams for themselves."

design is situated deep inside the box. The six walls are out of reach and cannot be challenged, let alone touched, by the level of discourse supported by available design. However, available design provides the basic semantic seeds that can be used to challenge the limited discourse parameters of available design should one engage in deeper inquiry by engaging the tools of *design*.

5.3.1.3.2 Design

Design is the process of shaping meaning using the discourses of available design. This process complements Feenberg's secondary instrumentalization notion of concretization. Where available design exists within a closed limited structure of practice, design supports a transformative opportunities for "new constructions and representations of reality" which are limited only by the latitude of the tools used, the transferable knowledge of the individual, and the breadth and depth of her final vocabularies.

Through the act of design, relationships between people are challenged, reaffirmed and changed. This is a self-refletive process where self-transformation also occurs. However, the transformative process is limited by the tools of available design. Hearkening back to the "out of the box" analogy, the latitude of proficiencies one has with the tools of design – available design materials - the more likely that the process will create new forms. If an individual, adept in the discourse rules of a particular culture situated in urban blight is given a hammer, she may be able to tear down the walls of the box that is keeping her from progress in attaining her goals. However, she will end up with rubble with no means to reconstruct that box to a sustainable structure. Broaden the latitude, scope or variety of her tools and skills and she is enabled with the capacity to reconstruct her world.

5.3.1.3.2 Re-design

Re-design, the most transformative of the design processes, involves the making of new meaning, knowledge and understanding from current discourse. To transform meaning is to transform relationships among people and to transform the individual through the process of examining, deconstructing and negotiating a new common ground for discourse and learning. Tools developed to support the process of re-design support the concept of the individual as constructor of new available designs that become the building blocks for new realities. These tools empower the user to transform meaning and effect change in the intersubjective relationships between the self and others through this process of examining, deconstructing and negotiating a new common ground for discourse and learning. To re-design is to not only think outside of the box, but to get outside of the box, disregard the box, change its form, or build a new larger, more encompassing shell around the box to expand one's potential and possibilities.

Illich's concept of convivial systems, which encourage users to be actively engaged in generating creative extensions to the artifacts used in their practice, could be be viewed as a method to support the process of re-design. The design of convivial tools enables "users to invest the world with their meaning, to enrich the environment with the fruits of their vision and to use them for the accomplishment of a purpose they have chosen." (Illich, 1973)

5.3.1.4 Fuller's Critical Models for Software Development

Matthew Fuller has addressed the importance of developing software tools that focus on critical, social, and speculative perspectives in his book *Behind the Blip: Essays on the Culture of Software*. (Fuller, 2003) His three perspectives on software development critique the current status-quo of blind acceptance of technology. Rather he sets an agenda to instigate and influence discourses about the impact and role of software on society.

5.3.1.4.1 Critical Software

Referring to Barthes' quote, "Sarcasm is the condition of truth" Fuller defines *critical software* as the creation of applications that contain rhetorical tropes such as sarcasm programmed into its functionality. (Barthes, 1957) He suggests that critical software can be designed to challenge normalized constructs of the functionality and interface design of software applications to reveal a "truth" behind its binary discourse or as a means to reveal its underlying structure to the user by surfacing the methods used for managing and negotiating data and the practical/ethical decisions implemented by the programmers and management.

5.3.1.4.2 Social Software

Social software is synonymous to open-source production. Fuller claims that social software is a means to include a community of potential software developers who are or have been excluded from commercial industry. The process of producing social software is malleable and supports quick changes in development direction, goals or usage based upon the continuous social activity of its users and developers. This sometimes inadvertently occurs to a commercial product that takes on a new purpose for a sub-culture, such as Pod-casting with the iPod or the transformation of mobile phone SMS text messaging into a rich communication tool for various sub-cultures from teenagers to migrant workers.

5.3.1.4.3 Speculative Software

Speculative software is analogous to "software as a science fiction" or Dourish's notion of software that self-generates. (Fuller, 2003; Dourish, 2001) Although equated to science fiction, aspects of speculative software exist in advanced software agent technologies, cognitive tutors, and robotics. These are self-reflective systems capable of adjusting and correcting its processes to accommodate environmental requirements. Fuller's notion of

speculative software – applications that are capable of asking deeper questions about the intentionality of a given process – are envisioned to be technologies that make tangible the connections between the data being processed and its effects on the tools and environments in which that data impacts. (Fuller, 2003)

5.3.1.5 Fogg's Persuasive Computing

Whereas Fuller comes from a cultural theory approach, B.J. Fogg's is situated in human computer interaction research. B.J. Fogg's theory of *captology* supports the development of non-coercive persuasive technologies as a means to change user communities' attitudes and behaviors. He defines these seven design methods that can be built into software interfaces that can be used to persuade people to make behavioral changes on a macro or micro level.

- **Reduction**: Making a task easier by consolidating and reducing steps.
- **Tunneling**: Leading the user step-by-step through a process.
- **Tailoring**: Customization of an interface to reduce the amount of irrelevant or general material a user has to wade through.
- **Suggestion**: Suggesting a possible interaction at an opportune time based on the users previous interactions with the software application.
- **Self-monitoring**: User can monitor some aspect of their performance in real-time to use as an adjustment metric for achieving a specific goal
- **Surveillance**: Enabling surveillance by an outside party to monitor and modify the user's behavior.
- **Conditioning**: Incorporating Skinner's notions of operant conditioning in the software system such that the user is praised or corrected during opportune moments in their interaction with the application.

There are two categories of persuasion – macrosuasion and microsuasion. Macrosuasion involves the explicit intentionality to persuade the user to behave in a particular manner. Microsuasion includes techniques that imply a particular way to behave such as subtle or secondary design techniques and interaction patterns used in the interface design. Incorporating Fogg's paradigm of persuasion into technologies that are developed for the social pubic domain can contribute to the construction of new social futures.

5.3.2 Vocation

The secondary instrumentalization category of vocation recognizes the contributions of the individual as a contributing member of community who holds valuable insight to the effective design and employment of tools for the functioning of that community. "In vocation, the subject is no longer isolated from objects, but is transformed by its own technical relation to them." (Feenberg, 1991, p.189)

Vocation calls for the design of embodied technologies and tools that integrate smoothly into the fabric of the overall ecology in which it is used. This includes a harmonious coupling between the technology and the human user following along the lines of Heidegger's notion of 'ready-at-hand' and 'present-at-hand'. (Heidegger, 1977) Paul Dourish has proposed embodied interaction as a new human computer interaction research agenda that integrates 20th century philosophical theories of phenomenology and pragmatism. (Dourish, 2001)

5.3.2.1 Philosophical Influences on Computer Science Research

Dourish initiates his theory of embodied interaction on the premise that contemporary computer science research is based on pre-1930's philosophical ideas that are rooted in the reductionist positivist traditions of scientific rationality. Positivism or "Religion of Humanity" (Comte, 1830-42) seeks to identify fundamental scientific laws that explain and validate real-world phenomenon. It was developed in reaction to the egocentric idealism and theological dogmatism that prevailed in the 18th and 19th centuries. Positivism is aligned the Descartes' *cogito ergo sum* which ranks cognitive processing as superior to our senses in coming to understand and make meaning in the world.

Matthew Fuller also critiques the methods of human computer interaction (HCI) research and their primary concern in the "empowerment and sovereignty of the user" without critically reflecting on which "model" of human is being engineered. Similar to Dourish's

critique, Fuller comments that contemporary HCI practice is strongly influenced by positivist philosophies and behavioral psychology that strive to define standards by which humans do, can or should function. (Fuller, 2003)

Twentieth century philosophies, referred to by Dourish as seminal in the development of embodied interaction, provide alternative theoretical bases for incorporating subjective and phenomenological experience as a means for understanding the world. We can now amend Descartes famous first meditation, cogito ergo sum, to "I feel, taste, hear, see, smell, and intuit therefore I am." Embodied interaction is based on an analysis and comparison of: Hurssel's phenomenology and lifeworld; Heidegger's concept of tools as an extension of the body and *dasein* "being-in-the-world" as inseparable from the world itself; Wittgenstein's *language games*; Lucy Suchman's *situated actions;* and Schutz's *Phenomenology of the Social World*, rooted in an ethnographic observation of societies. (Husserl, 1936; Heidegger, 1977; Suchman, 1987; Wittgenstein, 1958; Schutz, 1967) One common thread that ties these disparate philosophical frameworks together is their emphasis on inquiry about the nature of making meaning, asking questions, and communicating as a method for understanding the world in which we live.

5.3.2.2 Where is the Action in Human Computer Interaction?

Dourish's theory of embodied interaction is a *message to the medium makers*, primarily human computer interaction and computer science researchers, in terms they may be willing to comprehend that "*the medium is the messa*ge." Dourish is articulating a plea to the developers of the information age to become cognizant of influential thoughts, ideas and concerns which have been prevalent in critical theory, anthropology and arts theory for decades. He proposes that critical 20th century philosophies regarding the tangled relationship between technology and society are extremely relevant in the development of computer-based tools that are designed to enhance the quality of living.

Dourish's model for interactive system design is based on the observation of two trends in the research and development industry with tangible and social computing. Research in tangible computing investigates methods for using physical objects to manipulate computationally derived data. This research area is a natural extension of the H/LAMT project initiated by Englebart in the late 1960's which initiated a robust field of research on facilitating human interaction with computer-based information, using various original input devices (e.g. mouse, keyboard, stylus, gesture, eye gaze, voice, etc...). Social computing, (e.g. computer-supported collaborative work, computer supported collaborative learning and social navigation) incorporates theoretical concepts in social psychology, social networks, anthropology and ethnographic studies into the design of interactive systems as a means to facilitate optimum dialogue and exchange of information between two or more people. Concepts about social navigation have been generously incorporated into the most economically successful e-commerce web portals and recommendation engines by integrating customer recommendations as a form of trusted referral and preference profiles. Recommendation engines are based on the premise that people will gravitate toward each other for information explicitly – by asking, and implicitly – by copying. Technology is used to develop tools that enable individuals to use the actions and preferences of others as a means to inform their own actions and decisions. (Dourish, et. al. 1999)

Embodied interaction shares properties with Winograd and Flores theory of ontological design, the process of combining cultural critique and computer science to build better tools as a means for self-conscious cultural intervention. The goal of ontological design is to use a reflective practice to create new artifacts, equipment, buildings and organizational structures that improve upon breakdowns, errors and faults from earlier generations of tools and /or systems. Ontological design looks to traditions of the past to inform the

design of technologies that will transform our lives in the future. The opportunity, as identified by Winograd and Flores, lies in the creation of computer systems and tools capable of "coaching" us toward beneficial evolutionary interpretations of actions on the world. (Winograd & Flores, 1987) The act of making meaning and understanding its implications then enables the development of "dynamic new forms of technological practice," or embodied interaction. (Dourish, 2001)

5.3.2.3 Principles for the Design of Embodied Interactive Technologies

Embodied interaction is not a technique but an influential foundation for the development of interactive systems based on the reality that people interact with tools as an embodied experience that is part of a large ecosystem of mechanisms that explicitly and implicitly perform consequential acts on each other. Embodied Interaction is a means of possessing and acting through a physical manifestation of the world in "real time" and "real space". It is the synergistic combination of tangible and social computing, both popular research and development platforms. Embodied Interaction places emphasis on the quality of the interactive experience facilitated by the tools rather than a dominant focus on task efficiency. This is not meant to place interactive experience and efficiency in a polemic relationship: it is a call for better integration of the two, which may require a compromise of one or both properties.

Dourish's five principles are aligned with his four core premises on the design of embodied technologies and tools. (Dourish, 2001) These principles integrate theories and methodologies that are recognized by an interdisciplinary group of practices by interaction designers, human computer interaction researchers, and new media artists.

5.3.2.3.1 PREMISE 1

Social and tangible interactions stem from the underlying principles that the world is a malleable material.

Principle 1: Computation is a medium.

Fig. 14: Seymour Papert visionary research led to the development of LEGO Mindstorms robotic construction toy.

Dourish stresses that "meaning is conveyed not simply through digital encodings, but through the way that computation enlivens those encodings with semantic and effective power." (Dourish, 2001, p. 166) Here we see similarity to Matthew Fuller's critical, social and speculative models for software development. However, rather than develop self-critical machines as Fuller supports, Dourish advocates for the continued development of technologies along the line of Seymour Papert's Mindstorms research which opened an entire movement of project based learning from LOGO programming with "turtles," to LEGO Mindstorms. (Papert, 1993) The work that continues in the MIT Media Lab Epistemology and Learning Lab exemplifies best practices in integrating constructivist pedagogies, inquiry and play with the design of technologies that allow children to computationally manipulative computational representations of the world. (Epistemology and Learning Lab, 2006)

5.3.2.3.2 PREMISE 2

Embodiment is both physical and participative and is profoundly effected by the state of the environment including the quality of work, social discourse, and play afforded by a particular environment.

Principle 2: Meaning arises on multiple levels.

Although Dourish does not reference McLuhan, he is advocating that the medium, in this case computation, is the transmitter of meaning and that the quality of the transmission can transform practice negatively by restriction or positively through enhancement. In other words, "the meaning is the message." (McLuhan, 1964, chap. 7) Dourish suggests that the

meaning of an object can be located on a two-dimensional grid system that places the iconic/symbolic relationship of the object, or its semiotic properties along one coordinate. The opposing coordinate maps the object to action relationship. Action in this definition

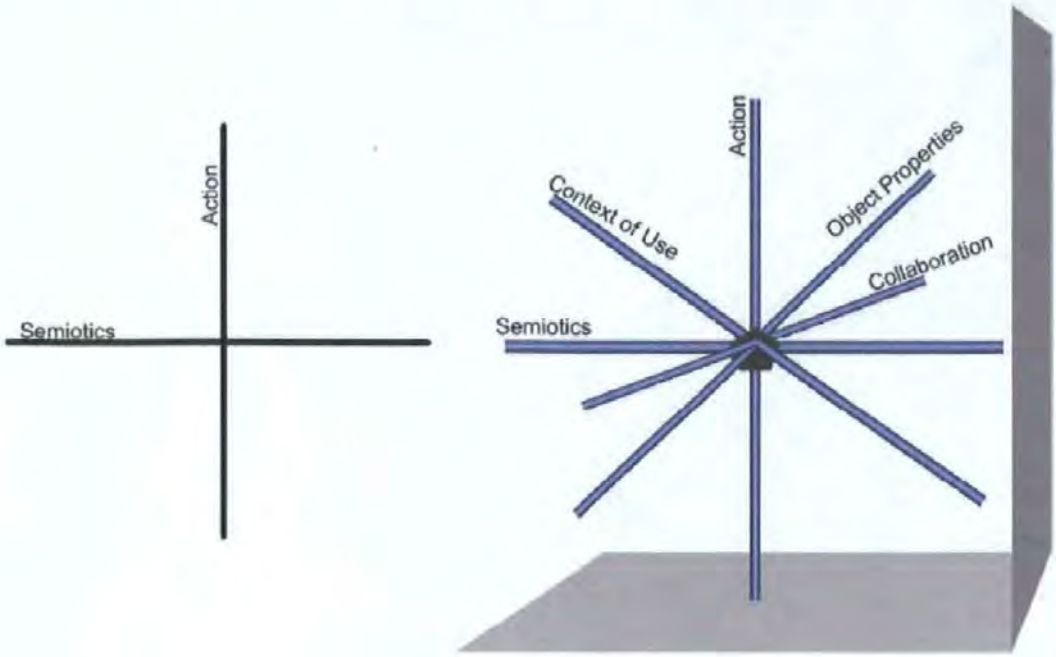

Fig. 15: Dourish's two-dimensional grid vs. my proposed five dimensional space for situating the meaning of an object in its environment.

refers to the events, operations and behaviors projected and/or supported by the object. It is ironic that Dourish uses a Cartesian coordinate system that emanates from the very philosophical stance of rational-positivism that he so strongly critique, to envision the indeterminate space of assigning meaning to objects, people, and events. I propose that his concept be reconfigured from a two-dimensional grid to a multi-dimensional space that contains at least five intersecting planes, semiotics vs. object properties vs. action vs. context of use vs. collaboration potentials as sketched in figure 15. By extending Dourish's grid into a multi-dimensional space of meaning we begin to understand the complexity and opportunities involved in designing new tools and technologies to support embodied interaction.

Principle 3: Users, Not Designers, Manage Coupling

Dourish introduces user-centric design principles from human computer interaction research into his framework of Embodied Interaction. The designer is not the user. The designer is responsible for the form and function of the artifact, but could never imagine all of the actual uses that the designed artifact facilitates. The community of use will inevitably transform an artifact from its intended use, imbuing that artifact with meaning, purposes, and functions that serve the communities immediate needs regardless of the designer's intention. This human computer interaction principle changes the stance of the designer from one who manages interaction patterns between users and artifacts through the implementation of certain tools and functionalities, to one who facilitates users with "raw" materials that can be fully appropriated and used according to the user's needs.

5.3.2.3.3 PREMISE 3

The concepts of embodiment, phenomenology, and pragmatism are crucial for the understanding of the current and potential impact of computer technology research and development industry on the world.

Principle 4: Embodied technologies participate in the world they represent and users, not designers, create and communicate meaning.

The unique characteristic of embodied technologies is their participative status in the world. Through direct participation, the technology or artifact can convey information about its state. And in return, the state of the artifact conveys information about the state of the world and community of practice in which it is placed. For example, the worn, dog-eared pages of a library book conveys the popularity of that particular book artifact and points to the importance of the information in the book to a particular community of use.

5.3.2.3.4 PREMISE 4

The concepts inherent in the philosophy of phenomenology provide a framework for the design of embodied interaction systems that not only includes tangible and social computing, but provides methods for the design, analysis and evaluation of such interactive systems to understand how they work and their impact on society.

Principle 5: Embodied interaction turns action into meaning.

By researching the community of use of that worn library book, new insights into issues, interests, inquiries of that community can be determined and, in return, referenced for the development of new tools and technologies that facilitate the needs of the community.

5.3.2.4 Constructivism: a Meta-theory for Feenberg's Concept of Vocation

Constructivism focuses on the role of the individual or group to engage their agency to make meaning of their world(s) while recognizing the role of the social, historical, and in later adaptations of Vygotsky's theory, cultural influences on the individual's ability to learn (Penuel& Wertsch, 1995). The theories of embodied interaction, multiliteracies, convivial systems, metadesign are connected to the philosophy of constructivism, which I am declaring as the meta-theory from which Feenberg's notion of vocation or the recognition that the subject is a contributing, insightful and valued member of a community.[4] There are a few basic tenants that all constructivist theories support including: (1) Humans, either as individuals or as collectives are portrayed as constructive agents, and their meanings and knowledge are portrayed as constructed products; (2) The mind is "creator" imposing its categories on what it encounters, rather than mind as "order-preserving copying machine;" (3) There is an emphasis on the generative, organizational, and selective nature of human perception, understanding and memory; (4) People are constructive agents; and (5) Knowledge is built rather than passively received.

In other words, the ways people know, see, understand and value are influenced by what is known, seen, understood and valued. (Spivey, 1996) All flavors of constructivist theory focus on the capability of the individual or intersubjective group to conjure meaning from

[4] Constructivism is practiced in disciplines as broad as: cognitive and developmental psychology; social networking and collaboration; social psychology; pedagogy and rhetoric. Its forms include cognitive-developmental constructivism; personal construct theory; radical, social, cognitive and collaborative constructivism. Studies in disciplines as broad as social, cognitive, clinical and developmental psychology, history, education, rhetorical and literary studies, socio-cultural studies in anthropology, sociology and computer science have also been influenced by constructivist thinking.

information gained from prior experiences in order to understand new experiences.[5] (Petraglia, 1998)

Situated cognition is part of the tripartite foundation for the second wave of Constructivism: it argues that everyday learning always takes place within a socially and culturally informed context that shapes both the knower and knowledge by informing and extending our lifeworld(s). The individual is recognized as a node of a much larger cognitive network (Perkins, 1999) –has been articulated in several theories discussed thus far.

The two other core components of second wave constructivism are activity theory and information technology mediated (distributed) knowledge networks. (Pea, 1993) Activity theory emphasizes that an artifact (e.g. objects, tools, symbolic systems and language) can mediate between a subject and his or her objective. However, the artifact and the thing it is mediating undergo transformation as a result of this mediation that is coated with the residue of the social and historical implications from its creation. Activities become dynamic processes that transform as: they unfold; motives shifts; tools become available or unavailable; and objects and objectives form and reform. (Petraglia, 1998) The late 20th century interest in distributed knowledge networks has been boosted by the rapid development of the Internet and other asynchronous modes of communication that can be used for community building.

5.3.3 Aesthetic investment (*Mediation*)

The secondary instrumentalization characteristic of aesthetic investment serves to enrich the technical object with aesthetic and ethical characteristics of the materials and their

[5] Various constructivist theories define methods by which we see, think, and come to know. These methods for ordering and interpreting the world in which we live have been described as frames, schemas, scripts, perspectives, filters, lenses, interests, and mental sets by such notable psychologists, sociologists, computer scientists and pedagogues as Vygotsky, Piaget, Bartlett, Kelly, Goodman, Schank, Goffman, Minsy, etc...

relationship to the society in which the technical object is used. It is a call to eliminate the artificial separation between aesthetics, ethics, functionality and purpose of technology. This move toward the integration of aesthetics and ethics emphasize the essential qualities of these characteristics for the functionality and utility of technology.

The rational-positivist approach to technology development typically views aesthetics as an unnecessary and possibly distracting attribute that contributes little value to the purposefulness of the technology. Feenberg's critique of the modern industrial world calls for the end of the artificial separation between aesthetics and ethics and the utility and function of technology.

5.3.3.1 Looking for a Place at the Table: Experience Aesthetics and Technology Development

> *"Since the artist cares in a peculiar way for the phase of experience in which union is achieved, he does not shun movements of resistance and tension. Rather he cultivates them, not for their own but because of their potentialities, bringing to living consciousness an experience that is unified and total."*
>
> *"In contrast, the scientific man is interested in problems, in situations wherein tension between the matter of observation and of thought is marked. He cares for their resolution, but he does not rest in it; he passes on to another problem using an attained solution only as a stepping stone from which to set on foot further inquiries." (Dewey, Art as Experience, p. 15)*

There has been a growing movement within contemporary interaction design methods (e.g. design and emotion, ambient environments, tangible bits, etc.) to acknowledge the role of aesthetics and emotions as primary motivating properties that can strongly influence the user's interactive experience, engagement and task efficiency with technology. However, these interaction design methods tend to focus on making technology more appealing and pleasurable to the human senses. The focus on the pleasurable misses, or purposely ignores, the impact of the alternative framework for interpretation, reflection and transformation offered by aesthetic experiences. By focusing on the attributes of the aesthetic experience that extend beyond surface qualities, the object transcends the simple task to emanate pleasure and becomes a facilitator for a transactional experience of

participation and communication of resistance, tension and negotiation with materials, ideas, people, and cultures.

There has been a slow movement toward re-acknowledging the role of the aesthetic in the development of technologies for human-computer and human-human interactions. This movement is evident in such design initiatives and creative production initiatives as: designing pleasurable products; design and emotion; interaction design; affective computing, convivial design, ludic design and tangible user interfaces, etc.... Research agendas are gradually becoming more responsive to the inclusion of intersubjective, often phenomenological experiences as described in this text (e.g. embodied interaction, persuasive computing, speculative software, and meta-design.) In addition, projects developed by an international community of new media artists continues to push the boundaries in the re-design of new tools that are aesthetically informed by critical and social agendas. The theme of aesthetics and creativity has even pierced, ever so lightly, the great empirical turf of the United States National Science Foundation workshops on *creativity support tools*, and funded research on affective computing. (Sengers & Matteas 2006; Sengers, 2003; Norman, 2004; Shneiderman, 2006)

5.3.3.2 The Role of the Artists in a Technology Driven World

The artists' role is not diminished by this new dialogical relationship between the artists, the artwork and the participant. Rather she is summoned "to generate new carrier waves for the modulations of contemporary experience" as defined by a cybernetic society. (Ascott, 1967) The cybernetic society, commonly referred to as the global information age, is optimized for instant communication and constant accessibility with profound effects on the economic and social components of society. The cybernetic society infiltrates all spheres of leisure, class, political, and economic issues. It demands daily revision and rethinking of society's modes of being and existing in the world.

Ascott declares two options for the artists' engagement in the cybernetic world. The first is to "be carried along in the stream of events, mindlessly half aware and perhaps bitter and hostile" or the second, to "come to terms with his world, shape it and develop it by understanding its underlying cybernetic characteristics." (Ascott, 1967) By doing this the artist will be empowered to construct a vision in art, which will enhance the cybernetic society as much as it will be enriched by it.

Rokeby agrees with Ascott that the interactive artists are in a particularly unique position to contribute both creative and critical discourse to the development and integration of new technologies into society. The nature of interactive art assumes that both creative and technical inquiries are combined to deliver results, which may range from popular culture entertainment to profound critical examinations of contemporary culture and societies in the world. This rich continuum of practice is transdisciplinary in that it transcends the known and institutional boundaries of any one discipline. Artists are engineers, engineers are artists, critical theorists are community organizers and web designers, and designers are technologists.

Rokeby attempts to identify methods used by practitioners and researchers that define the approaches of various disciplines that are involved in technology production. The engineer strives to maintain the illusion of transparency in the design and refinement of media technologies. The engineer's concern is to make and invent technology that is efficient, robust, and hidden. Their work is what makes our technology function reliably and transparently at the machine level. The technologist, as distinguished from the engineer, works with a medium not necessarily in a transparent mode, where the message that the resulting work relays may be more aligned with a specific service, functionality or

commercial end. Typically, the research and products developed by human computer interaction researchers and designers fall under this category.

The intention of the interactive artists is creative expression through the very "opacities and idiosyncrasies of the media they appropriate and invent." The interactive artist challenges the technologies and techniques of the information age to bring about or at least suggest alternative approaches that may transform society's collective passive acceptance of technologies in their lives. This brings us back to Dewey's quote earlier in this chapter.

> *"Since the artist cares in a peculiar way for the phase of experience in which union is achieved, he does not shun movements of resistance and tension. He rather cultivates them, not for their own but because of their potentialities, bringing to living consciousness an experience that is unified and total."... "In contrast, the scientific man is interested in problems, in situations wherein tension between the matter of observation and of thought is marked. He cares for their resolution, but he does not rest in it; he passes on to another problem using an attained solution only as a stepping stone from which to set on foot further inquiries." (Dewey, 1934, p. 15)*

Returning to Ascott's observation about the differences between the traditional modern artists and the behaviorist artists, the modern artists methods of art practice and rules of spectatorship are based upon solitary arts of creativity and on control of the viewing environment. Rokeby points out that the product produced by the artists, who is not engaged in interactive art processes, works from a *tabula rasa* – the blank canvas or empty sculpture pedestal. The act of realizing a work is a process of progressively narrowing the range of possibilities by a series of creative choices until the work has been manifested in the finished work. (Rokeby, 1996) The traditional artist applies, covers, erases, and molds the materials to invent a unique visual language which can only be interpreted by the spectator from an outside subjective stance. On the other hand, the interactive artist may also invent her own visual language or semiotic ontology as the structure of her work. The participants' multiple and various modes of interaction with the work are anticipated in the overall design and development of the work to provide options for the open and potentially endless readings and interactions that may be acted upon by the participants.

5.3.3.3 Habermas's Aesthetics Denial

Habermas's understanding of the impact of aesthetics on discourse was greatly limited and determined by traditional notions of the aesthetics and art as exemplified through the canons of western arts. He acknowledges the value in aesthetic experiences as a process that "opens our eyes that provoke new ways of seeing things, new attitudes and new modes of behavior." (Habermas, 1998, p. 245 - 246) However, he denies that these aesthetic experiences are common experiences that incorporate "cognitive-instrumental skills and moral ideas." (Habermas, 1998, p. 246)

Habermas supports a dyadic model of experiences that is divided between acts of world disclosure and problem solving. Aesthetics fall under the category of world disclosure acts. According to him, they are simpler to understand and do not require simultaneous analysis across the four validity claims. Problem solving acts are based on Kantian principles of rationality and typically fall in the domains of science, morality and law, which are more conducive to the bantering about of validity claims. (Habermas, 1987b) Habermas's denial of the impact of aesthetics on communications is further illustrated with his disagreement with the inclusion of literary theory, which is situated in the category of "world disclosure" to the processes of critical theory and philosophy as supported by Rorty and Derrida.

5.3.3.4 Langsdorf's Amendment to Habermas's Validity Claims

> *"Language fails.... Not because thought fails but because no verbal symbols can do justice to the fullness and richness of thought." (Dewey, LW 5: 250)*

Art, for Dewey, is not the thing, the object, the painting, but its dynamic process of inquiry that leads to the attainment of individual and/or societal goals. The aesthetic experience extends across all domains of inquiry and can serve as a tool to aid in analysis, discovery and innovation. It is because of the fluid state of aesthetic experience that Langsdorf

integrates it as a neglected component of Habermas's fourth validity claim, intelligibility. Aesthetics, according to Langsdorf, is "a dimension of creative potential within the cognitive, moral/legal, and expressive dimensions of communicative experience." (Langsdorf, 2002, p. 158) The integration of the aesthetic experience into the rhetoric of rational consensus is easier to theorize than to do. This requires overturning and finding alternatives for centuries of thought based on assumptions of Platonic separation of art from life, which, as Langsdorf points out, continues to thrive in Euro-American culture.

Lenore Langsdorf proposes to re-examine Habermas's intelligibility validity claim as an opportunity to introduce the Deweyian concept of communicative experience and aesthetics as a core component of discourse.[6] (Lenore Langsdorf, 2002) She observes that the three validity claims of truth, normative rightness, and sincerity are substantive qualities focused on the representation of the object. The act of intelligibility – understanding another's stance or making one's stance understood – is a process of constant interpretation that could be harnessed for "meliorative" goals. Langsdorf identifies three problems with Habermas's validity claims: (1) The use of "neutral language" as opposed to inquiry as a constitutive component in unfolding emergent notions of truth; (2) The focus on speech acts as opposed to non-verbal communications and bodily expressions as the platform for analyzing communicative actions; and (3) The use of linguistics as the model for pragmatism based upon de Saussure's structuralist analysis of language as opposed to a more process driven approach as is often used by ethnomethodologists. (Langsdorf, 2002)

[6] Revisiting Habermas four validity claims, truth, normative rightness, sincerity and intelligibility, it becomes evident that the fourth claim, intelligibility, refers to the comprehension of language a core component of the theory of communicative action, is underdeveloped. Habermas shifts his descriptive terms for this category from "aesthetic-practical rationality" to "dramaturgical action" and is eventually deemphasized it from the list of validity claims. (Habermas, 1984; Habermas, 2001)

By denying the separation between art and science/technology we challenge our tendency to segregate forms of experience, knowing, doing and making. Recognition of the synergistic potentialities between the arts and science/technology divide can be enlisted in progressive discourse to support the re-design of our cultural, economic, physical, political, and social experiences. Langsdorf explains that this proposed reconstruction of Habermas's theory of communicative action contributes provocative insight for social theorists and activists since, "the aesthetic experience transcends any particular process and cumulatively shapes its shaper. In the process of shaping (constituting) space and time into an art object, the creative process also constitutes a work of art, namely its maker." (Langsdorf, 2002, p. 158)

5.3.3.5 Dewey's Non-Aesthetic Worlds

Dewey articulates that through communication all events and entities are "subject to reconsideration and revision," creating new possibilities for public discourse. (Dewey, LW 1:132, 1938) Aestheticized technology presents new methods for challenging, contemplating and developing alternative forms, ideas, possibilities and realities that transcend the utility, efficiency model of technology development. The dialogue that can be supported by the aesthetic intentionality of a designed technology is synergistic with the theory of multiliteracies concept of "re-design."

Dewey identifies two conditions when a society is incapable of supporting aesthetic experiences. The first is a world in constant flux and filled with instability making impossible the reflective process necessary to recognize experience. [7] The second is a world that has completed its course in history and has no need of or facility for experiential reflections. (Dewey, 1934)

[7] See reference 5 that describes the New York Times article on technologies isolating qualities that keep us from being able to reflect on the here and now.

5.3.4 Collegiality (*Initiative*)

> *"Considering the loss of public sphere and diminishing venues for encountering the other, the dialogue is a rarity and must be called forth with effort. The net and the web retain enclaves from the commercial and instrumental exchange of information. Despite their newness, these networks are part of an infrastructure that is a material social sculpture, created and tended slowly and incrementally over generations. Infrastructure – arteries, ducts, membranes – cannot be separated from the bodies of a people; thus, to destroy infrastructures is not a selective or temporary or trivial act." (Margaret Morse, 2001, p. 130)*

The secondary instrumentalization characteristic of collegiality challenges the primary trait of automization by integrating voluntary cooperation and initiative back into the production process. Instrumentalization emphasizes the alienation of the subject (worker or user) in the production and use of technical objects. Initiative and collegiality are viewed as means to produce more harmonious and resourceful technological innovations.

5.3.4.1 Consciousness as a Social Construct

Tom Burns' (Professor Emeritus of Sociology at the University of Uppsala, Sweden) theory on the social construction of consciousness presents a social-psychological theoretical approach to developing a framework that describes the influence of social engagement on both collective and individual consciousness. (Burns, 1998) Identification with a collective is typically denoted with the use of the plural pronoun "we." Characteristics of a collective, a group of individuals, consists of an overall representation of itself that includes the values; goals; methods and strategies for interaction within and outside of the group; and strengths and weaknesses. This may be reflected in the collective's beliefs, norms, codes of dress, linguistic attributes (e.g. preferred language, regionalisms evident in accents, etc..) The survival of a collective is reliant upon self-reflective acts similar to those performed by individuals that are the foundations of human consciousness. Collective self-reflection may reveal itself in the way the group: frames a problem or solution; conceptualizes its environment, events, cultural forms, institutional organizations; or the way the group develops beliefs, strategies, and judgments of itself, individual members of the group and others outside of the group.

The idea of consciousness can have as many definitions as the broad spectrum of disciplines (natural scientists, mathematicians, philosophers, cognitive psychologists, computer scientists, artists, philosophers, Zen Buddhists) and practices that are engaged in understanding and defining the phenomenon. Some disciplines locate consciousness in the mind, others the body, sometimes both, sometimes in a higher order. Some disciplines claim that consciousness does not exist and others believe that it is an entity so poignant and yet basic that it doesn't need to be explained. Chalmers presented a tripartite definition of consciousness that includes:

1. **Physical or material processes** including biological, neurophysiological, perceptual, and cognitive processes.
2. **Sentience and phenomenological processes** that bring awareness of one's environment to oneself.
3. **Socially based cognitions, representations and reflective processes** formed from language, collective representations, and discursive reflective acts. (Chalmers, 1995)

Burns' definition of consciousness aligns with Chalmers third definition "as a type of reflective activity (observing, monitoring, judging, 'self', among other things) that is encoded in language, and generated in conversations about collective and individual 'selves.'" (Burns, 1998, p. 69)

Like Habermas, Burns argues that language is the central locus for generating collective consciousness.[8] Burns' goal is to understand methods by which collective and group

[8] Burn introduces four arguments to support his theory of social consciousness.

1. A cultural cognitive frame carried by the members of a community provides common knowledge that includes the conceptions, definitions, meanings, and practices that are the basis for intersubjectivity and collective discourse and reflection.
2. Human groups (as well as individuals) have the capacity to acquire types of self-description and self-knowledge and to reflect on and regulate themselves. An individual becomes the object of her own awareness. This self-awareness has the potential to become a new object for reflection and judgment.
3. Self-reference, as a reflective process, involves a collective conceptualizing, reflecting, adapting, and transforming its values and goals, conceptual framework, organization, collection of strategies and practices. Burns notes that contemporary vehicles that support the transformative process of self-reflexivity include social science research, mass media reporting and discussions and political discourse. All of his examples are echoes of theories of the public sphere.

behavior influences and is influenced by language, institutional and cultural arrangements, collective representations, self-conceptions and self-reference. Systems of social rules are universal and bind social collectivity. Every culture functions via social rules. These social rules are embodied by each collective through cultural forms, institutions, practices, languages, customs and codes of conduct, norms, laws, and social institutions. Although social rules are unique to each collective, Burns identifies key factors and characteristics of social rule systems:

- to create constraints or limitations on possible action and interaction;
- to provide opportunities for individuals to behave in ways that would otherwise be impossible;
- to coordinate with others;
- to gain systemic access to strategic resources;
- to command and allocate substantial human and physical resources;
- to solve complex social problems by organizing particular collective strategies and processes.

Individuals, or social actors, gain knowledge and skills that may be beneficial for "reforming rules in concrete interaction settings" by negotiating and challenging social rule systems that have been defined by other social actors, who by virtue of historical or cultural precedence, have been empowered to construct the rules that "impose order on the world." (Burns, 1998, p. 71-72)

5.3.4.2 Metadesign and Communities of Interests and Communities of Practice

Metadesign, as defined by Gerhard Fischer, from the Center for Life Long Learning and Design at University of Colorado, is a framework for designing technologies that empower individuals or a collective group of users to act as designers. Although not referenced in the primary metadesign literature, the theory is aligned with the design analogy in the

4. Individual 'selves' are conceptualized in a collective and become objects of observation, discourse, and judgment by the nature of their group interactions and discussions. Thus individuals identify with collective representations as collective concepts, structures and processes are incorporated into the personal life of each individual. Therefore, individual consciousness is dependent on collective representations of 'self' and 'other' and the capacity to reflect on feelings, cognitions, dilemmas and predicaments, actions and interactions involving self – the individual subjective experience. (Burns, 1998, p. 69 – 70)

theory of multiliteracies – where direct engagement by individuals is a means of cultivating new knowledge and the design of new futures.

Schön's notion of reflection-in-action or 'thinking on your feet' is focused largely upon the construction of the problem and strategies of action or models of the phenomena that are employed. There are three dimensions of the design process outlined by Schön's theory of reflection-in-action. The *use of the language of design* involves the domains of language in which the designer describes and appreciates the consequences of his/her choices. The *implications behind a decision* require a designer to mentally map and manage a number of tentative options that can lead to apprehension of new problems and potentials. Finally, the designer must remain *flexible and able to accommodate changing his stance* as is required throughout the design process. (Schön, 1983) Schön's concept of the *reflective practitioner* is inferred in the theory of multiliteracies and implemented in the methodologies of metadesign.

Fischer recognizes the potentialities when people are enabled to become designers and active contributors to a collective design and problem solving situation. Closed technological systems position the user as a passive consumer. The passive consumer, similar to a television watcher, has little or no opportunity to shape the development of the technology. Open systems, on the other hand, enable the skilled user to participate in the design of technological systems. The international movement, FLOSS (Free/Libre Open Source System) is prime example of an open system where practitioners, who have the necessary technical skills, can participate in the development of range of projects from operating systems (e.g. Linux) to esoteric tools for enabling non-technologist to develop web applets (e.g. Processing). (Linux Online, 2006; Processing, 2006)

Fischer's group has been involved in the development of domain-oriented design environments (DODEs) that are open systems for empowering collectives of people to solve problems by constructing and manipulating artifacts that represent various variables in a problem set. *The Envisionment and Discovery Collaboratory* enables community leaders to visualize the consequences of design choices for public transportation systems. *Agent Sheets*, an end-user graphic programming environment, provides an "easy" entry into the syntax and logic of programming and development of simulation demonstrations through the manipulation of graphic representations in a game-like environment. (Arias et al., 1997; Arias et al., 1999; Agent sheets, 2006) Recently, the Center for Life Long Learning and Design has incorporated collaborative new media art projects incorporating the metadesign framework with the inclusion of scholarly research from Elisa Giaccardi (graduate of the CAiiA Planetary Collegium Ph.D. program at the University of Plymouth, U.K.). (Giaccardi, 2004)

Fischer's current research, as of 2005, focuses on methods used by individuals and communities that engage in social creativity to develop new knowledge across communities of practice and communities of interest. The two factors that support social creativity are distance and diversity as means to bring stakeholders from distinct cultures of production together. Distance is defined as spatial (physical), temporal (time), technological (between people and artifacts), and conceptual (across communities). The first three forms of distance are readily recognizable and have been well researched. (Olson, & Olson, 2001; Dawkins, 1987; Fischer, 1994) The fourth distance category, conceptual, is dependent on methods by which the diversity, the range of domain specific roles represented in a collaborative design team, is managed. (Basalla, 1988; National-Research Council, 2003)

Fischer's theory of social creativity is based on a dyadic definition of collaborative communities, community of practice (CoPs) and a community of Interests (CoI). (Wenger, 1998) Communities of practice are defined by a collective of individuals who are engaged in domain specific tasks. The social-actors in a community of practice may represent a range of expertise that is focused on a specific discipline, for example industrial design, artificial intelligence research or knitting circles. A community of interest brings together stakeholders from various communities of practice for the purpose of solving a problem that exists outside the realm of any one community of practice. In essence the community of interest is a meta-community – a community of communities. A key challenge to the sustainability of a community of interest is the *wicked problem* of establishing a common ground that supports the shared understanding across multiple linguistic practices and domain specific-codes.[9]

The use of boundary-objects – physical or textual objects used to concretely externalize a concept or idea that may otherwise be too complex to envision abstractly or articulate in language, is one method to facilitate discourse in a community of practice. The boundary object is an open-system method for supporting the development of new knowledge across individual collective knowledge-bases in a community of interest. (Arias, et.al., 1999; Sugimoto et al., 2004; Giaccardi, 2004; Ye, 2001; Fischer, 2005) Further elaboration on boundary objects as they were used during the development of the Constructed Narratives project are described in chapters six through ten.

[9] "Wicked problems are a 'class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing." A concept formalized by industrial designer Horst Rittle, recognizes that design is a wicked indeterminate activity whose subject matter is dependant upon the designers weltanschauung or intellectual perspective. The properties of wicked problems in design include the lack of definitive formulation, stopping rules, list of prescribed procedural rules. There is an abundance of plausible explanations and solutions and each wicked problem is a subset of a larger wicked problem, while maintaining its uniqueness from other wicked problems. No formative evaluative test exists to test the validity of a selected solution. With all of these characteristics of the wicked problem, there is little tolerance for trial and error in finding a solution. In other words, the solver of the wicked problem "has no right to be wrong" and must accept full responsibility for her choices. (Buchanan, 1995)

5.3.4.3 International Creative Digital Media Communities as Models for Collegiality

"New Media Culture as emerging archipelagos of inter-bridged islands, Micro cultures, socially active art, information technologies, creative workshops, critical discourse, education alternatives, connections and links, cached in the global net, lifeworld of communication, challenging the borders of powers and overcoming limitations of knowledge, seed is scanning its soon-to-be-born paths though the concrete jungles, raising the voice of the speechless, discovering the music of silence, bringing play and colour to our reality, designing the environment, in order to open minds, this is new territory, compared to the old geographical setup and historical similarities, we are part of a changing architecture of Baltics, new Europe and the globe, with open societies, integrated outskirts, and a variety of culture" – The front page of the Network for Inter-cultural Exchange (N.I.C.E.) newsletter 2001

Fischer's theory of metadesign and models for communities of practice and interest are primarily focused on the formation of interdisciplinary teams to design collaborative tools and methods for computer supported collaborative work and learning domains. Communities of interest certainly exist in other collective domains and are particularly strong in various domains of creative digital media practices. The creative digital media communities take form as long-term collaborations, consortiums, and international interdisciplinary conferences. Examples include: the Center for Advanced Inquiry in Integrative Arts, University of Plymouth; Planetary Collegium; Re-approaching New Media, Northern Europe; Network for Intercultural Exchange, Northern Europe; V2, The Netherlands; Next 5 Minutes, International; Critical Art Ensemble, United States; Symbiotica, Australia; Saria, India; Mongrel, United Kingdom and the Netherlands; RTMark and the Yes Men, United States ; and many more.

As the impact of creative digital practices reaches beyond the aesthetic sphere creative digital media research-in-practice share many research concerns with human computer interaction design and computer science This form of research and practice is an open platform for the experimentation and integration of philosophical and critical discourse, aesthetics and design and technology development as a means to produce new forms of collaborative information technology applications.[10] (Wilson, 2002; Wardrip-Fruin &

[10] Creative practices in new media culture form a rapidly growing international platform for the development of applications that integrate philosophical and critical discourse, aesthetic and design practices and new information technology as means analyze, inform and produce new tools for meaning making in today's globally networked world.

Montfort, 2003) Many works generated by this growing international platform are at the forefront of culturally and socially innovative approaches to the development of technology.

5.3.4.4 European Re-approaching New Media (RAM) Forums

While in Latvia in 2001, I was introduced to a collective of young politically, socially and culturally aware creative digital media artists and activists from the Baltic region, Eastern and Northern Europe who were members of the Network for Inter Cultural Exchange (N.I.C.E.) consortium. As a close knit group, members shared resources, project concepts, and developed intercultural initiatives to address issues of the "digital divide," public domain, free /libre open source software and socially-motivated digital media projects.

5.3.4.4.1 RAM4: "Survival Kit"

Several members of the N.I.C.E. consortium are involved in Re-Approaching New Media (RAM) a related consortium. Participants in the RAM forums believe in working with available resources – new or more commonly-recycled technologies, to develop techniques, pedagogies, and methods to educate and instigate constructive critique and change. RAM has hosted a series of regional and international forums that addressed issues ranging from the impact of the gaming industry on artists-made games, to global politics.

The Helsinki Agenda acknowledges that New Media practices encompass a broad spectrum of innovations and creative strategies, with artists working both as individual practitioners as well as in highly collaborative professional contexts. New media practices internationally have attained levels of competence and maturity that suggest that the following key principles be recognized – excerpts from the Helsinki Agenda on International New Media Art Practice. (Helsinki Agenda, 2004)

The Helsinki Agenda principles

1. Art practice and research in new media is a key generator of new knowledge in arts, science, technology, communication and education.
2. Art practice and research in new media inform the dialogue between practitioners, researchers, creative industries and the public.
3. New media practices have developed forms and protocols of knowledge sharing and access based on principles of openness, collaboration and creative freedom.
4. New media practitioners can revitalize museums, archives and other heritage contents by allowing for greater public access, public renditions and imaginative readings.
5. New media artists create transformative cultural experiences that inspire communities and individuals and expand the scope of creative industries and technology development.
6. New media cultural practice informs larger social policies. By enabling and establishing deeper, as well as more pervasive modes of contemporary communication systems these practices lead to richer possibilities of social, inter-generational and inter-cultural communication, participation and access in our increasingly complex and multi-cultural societies.

(RAM, 2006).[11] Consortiums such as RAM and other international digital media arts conferences, symposia, and expert meetings have addressed issues and concerns that are often identical to those on the agendas of government, foundation and industry supported computer science, social, and policy research.

Lisa Haskel (U.K.) and Juha Huuskonen (Finland), organizers of RAM 4: Survival Kit, published a fabulous booklet for distribution to forum participants to read prior to attending the event. The "Survival Kit," booklet was designed to function as a boundary object (Fischer, 2005) to introduce common terms and example digital media projects that would be referenced throughout the meeting. The "Survival Kit," provided information about alternative initiatives, programs, and projects that demonstrated techniques for re-purposing and re-directing various forms of information technologies for the benefit of community development, open publishing and dissemination of new ideas, and creative critique and generation of alternative models for connecting communities though technology.

The "Survival Kit" booklet demonstrated artist and community activist best practices and resources across a variety of international initiatives from: open system development (FLOSS); listserves and blogs; digital divide initiatives; and community networking. The digital divide and community networking projects demonstrate the power behind networking, collegiality, and pooling of resources to empower disempowered

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November, 2002	RAM 1: Representation and Control Interaction in Computer Games	CRAC (Creative Room for Art and Computing) Stockholm, Sweden Game Programme, Gotland University College, Sweden
February, 2003	RAM 2: A Joker in the Global Bunker	Atelier Nord - Oslo, Norway
October, 2003	RAM 3: Reclaiming Cultural Territory in New Media	E-Media Center - Tallin, Estonia
November, 2003	RAM 4: Survival Kit	Olento – Helsinki, Finland
May, 2004	RAM 5: Open Source Media Architecture	RIXC - Riga, Latvia
June 2004	RAM 6: Social Interaction and Collective Intelligence: Methods Approach and Strategy	VILMA – Vilnius, Lithuania
March, 2005	RAM 7: Models of Collaboration	Minsk Centre for Innovative Practice in Collaboration with CRAC (Sweden) and RAM – Network – Minsk, Belarus

Table 3: Re-Approaching New Media (RAM) since 2002.

communities. Following are examples of projects highlighted in the "Survival Kit" booklet.

5.3.4.4.2 Neurotransmiter (nT) Project

The Neurotransmitter (nT) project (2001) is a radio collaborative that converts everyday analog technical devices into low-power radio frequency devices that broadcast locally in limited distance ranges. The collective has produced community-designed radio projects of experimental music, pirate radio broadcasts in the United States, Brazil, Denmark, Finland, Spain, etc... (Neurotransmitter, 2001; Haskell, et al., 2003)

Fig. 16: Com_muni_port is a self-contained backpack transmitter unit used for broadcasting "on the fly." Its transmission range is determined and limited by the plateaus and canyons of urban space. The dispatch distance updates with movement of its user.

5.3.4.4.3 Grassroots Community-based Technology Initiatives Around the World

European based TrashTech organizations including: the Redundant Technology initiative (RTI), Sheffield UK; ASCII Café, Amsterdam, Netherlands; Community Linux Training Centre, U.K.; Cyberpipe, Slovenia; Access to Recycled Technology, UK; and Seeds for Change, U.K. are forging new paths into grassroots community-based technology initiatives. (International Digital Divide Efforts, 2006) The concept is to find a solution for the crisis of the abundance of obsolete computer technology driven by the computer industry to produce new products at breakneck speeds. Organizations and community groups involved in the TrashTech culture movement are refurbishing working machines that have been discarded, installing "free" software applications developed under the GNU

(general public license) and Linux systems and donating the equipment, along with time and instruction to underserved communities that represent the multifarious digital divide.

Refurbishing and donating recycled technology is only one aspect for bridging the digital divide. As important is the design of programs to empower individuals and communities with the means to successfully integrate these technologies into their environments as tools of for accessing knowledge, growth and inclusion. International initiatives such as the collective SARAI of New Delhi, India developed the Cybermoholla project to introduce low cost and free software technologies into working class New Delhi neighborhoods that have been neglected by the digital revolution in India. SARAI established a community-based computer lab for youths between 15 and 20 called Compughar. The goal of the project was to teach youth how to use computer technologies by designing projects that reflect their own lives. The Center for Digital Story Telling project in Berkeley, California and Plugged In located in East Palo Alto, California operate by very similar principles and goals. (Sarai.Net, 2006; Center for Digital Story Telling, 2006; Plugged in, 2006)

Genderchangers Academy in the Netherlands and ad hoc group in the United Kingdom was designed to empower women with the knowledge and confidence to work with computer-based technology, not only as a white collar administrators and civil servants but as engineers. The strategy of these initiatives is to bring small groups of women together in a learning environment to reconstruct a working computer from basic electronic components. This constructivist approach encourages discovery and learning through uninhibited exploration of the internal workings of the computer. (Genderchangers, 2006; Haskell, 2003)

The Container project, in Palmers Cross, Jamaica, was started by Mervin Jarman, member of the U.K. based digital media art collective "Mongrel." Jarman set up a community-

based computer lab in a converted forty foot freight container. The Container lab is available for community members to use in a variety of ways including self-initiated instruction on office software, hardware and networking technologies, web and software development and video and audio production. The container is equipped with sixteen locally networked computer systems donated by the Redundant Technology initiative in the U.K., SkyBuilders in the U.S.A., and ReSource in Canada. The project has received funding from HEART-NTA in Jamaica and The Arts Council England. (The Container Project; Haskell et al., Mongrel; Redundant Technology)

5.3.4.5 Community-based Technology Initiatives in the United States

StoryCorps, one of my favorite community-based technology projects that also operates under a similar goal as the Center for Digital Storytelling in Berkeley, California with a slightly different framework. Whereas, the mission for the Center for Digital Storytelling is to empower people with both technical skills and a platform to share personal stories, to support dialogue across cultural boundaries, StoryCorps does not focus on teaching technology skills.[12] Rather, this project is a mobile sound recording booth for two people, or more, who have a familial, friend or mentor relationship, to interview each other. The interviews, though brief, span a variety of topics from personal anecdotes, philosophical musings, and memories of the past and hopes for the future. A small sample interviews that can be heard on the StoryCorps web site are highlighted in figure 17. The original StoryCorps booth was installed in Grand Central Station in New York City, a historic landmark that supports the daily ebb and flow of millions of people. This project is currently sponsored by Saturn Car manufacturers. Selected stories are broadcast weekly on the National Public Radio (NPR) stations across the United States.

[12] The digital divide and community technology centers (CTC) has been the subject of many government funding agencies and educational technology research agendas. A very good overview about various programs in the United States can be found in the 2001 *Community technology centers case study report: Learning with technology in six communities*, prepared for the United States Department of Education and subsequent reports prepared by the SRI International Center for Technology in Learning. (Penuel, Michalchi, Kim, Shear, Daniels, Jennings, Stites and Yarnall, 2001 SRI International, 2006)

5.3.5 Conclusion

The framework for critical creative technologies is founded on the goal of exploring how interactive technologies can be developed to facilitate critical discourse among people using techniques of play, inquiry, semiotics, and computer-based technologies. The amendments to Feenberg's *dialectics of technology*, as discussed in this chapter, creates the foundation for the *critical creative technology* framework and the development of tangible social interfaces as explored in the *Constructed Narratives* project.

"When I was growing up, I didn't think I was going to live long."

Tyondra Newton to her youth counselor Sally Nixon

"All I know is I was given the bag complete, which they had filled with about fifteen pigeons."

Mitchell Agoos remembers protesting the 1955 Carnegie Hall debut of Herbert von Karajan, a former member of the Nazi party.

"As much as I learn, I never feel like I've learned enough."

Robyn Einhorn talks to her husband, Matt Barinholtz, about battling a blood disease while attending graduate school.

"Even though I was very comfortable living and presenting as a woman, there was still part of me that felt like I was hiding."

Laura Jacobs, who is transsexual, to her friend Katherine Katsanis.

"Tell me about mom."

Gregory and Lloyd Porter remember their mother.

"If you could do anything again, would you raise me differently?"

11-year old Connor Murphy interviews his mother Patricia

Fig. 17: A selection of participants in the StoryCorps project. All interviews are available as MP3 files on the StoryCorps website.(StoryCorps, 2006)

Chapter 6 Design Principles for Critical Creative Technology Projects

6.1 Critical Creative Technology: an agent of negotiation and change

The previous chapters focused on theoretical and practice-based developments that have influenced my incipient theory of critical creative technology. This chapter introduces and develops an argument under which the theory of critical creative technology can mature and take on the role as an agent of negotiation and change by encouraging intersubjective communication in public spaces. The *tangible social interface* (TSI) is introduced as a contextual tool to facilitate this process. The description of the *tangible social interface* is presented as a prelude to the development of the *Constructed Narratives* project.

> *"The challenge to the creative use of media technology is fostering the diversity of public actors and terrains and to develop strategies of articulating the new public domains that connect physical urban spaces and potential public sphere of electronic networks." (Broeckmann, 2000)*

My story about traveling through Latvia, an experience that helped to form the research questions and projects explored in this text, was told in chapter one of this text. I previously noted that "the key issue revealed through reflection on the clash between myself and the young boys, was the method of resolution taken to dampen the impending crisis. Rather than striking back with fiery tongue or fist, I chose to engage the boys through recognition, conversation, and thought provoking questions." Realizing from this experience (and many others) the need for mediation between people, I embarked on this research project to develop interactive experiences that would serve as "discourse wranglers" facilitators for communication between disparate people in public spaces by engaging them through play and creating a trusted space to ask questions and become "visible, present, and active."

The development of the theory of *critical creative technology* and the *Constructed Narratives* project was founded on the theoretical premises explored in this text and the

hypothesis that except under *unique circumstances*, most people do not engage in *meaningful* discourse with others they encounter in public spaces with whom they have limited relations. *Meaningful* discourse is defined as conversation between individuals that extends beyond basic introductions of name or personal logistics (e.g., my name is or can you tell me how to get to ....?). An example of a *unique circumstance* is when an unusual event occurs that creates a shared experience (e.g. street performer, automobile accident, shared physical experience such as dancing or playing sports, or an unexpected person, animal, thing or event enters the shared space.) All of these unexpected events have the potential to create a bonding experience – a moment of shared experience or knowledge that builds a bridge for recognizing common ground between individuals. Although that link may be temporary it can leave a lasting impression in the minds of those who experienced the unique circumstance in the form of memory, stories of recollection, and/or changed attitudes.

6.2 Principles for the Design of Critical Creative Technologies

The design of critical creative technology is founded on three principles: (1) place as connected Space; (b) empathetic intersubjective experience; and (c) discourse facilitated through deep play. These principles inform the design of tangible social interfaces, which have been explored throughout the development of the *Constructed Narratives* project, which is introduced at the end of this chapter and described in detail in chapters seven through eleven.

6.2.1 Principle 1: Place as Connected Space

"Space is the opportunity; place is the understood reality". (Harrison & Dourish, 1996)

6.2.1.1 Spatial Metaphors

Space and place are identified by their references to the physical or social constitution of a location. Space denotes a virtual or real location that can contain things (e.g. people, objects, icons, avatars). Regardless of the physical or virtual nature of space, a person, or her virtual representation can only occupy one point in space at a time. She cannot be simultaneously here and there in a space. Spatial metaphors can be used to understand how an individual or a collective of people organize and prioritize other objects in their surroundings. Objects tend to stay where they are placed, unless they are imbued with a sense of agency that enables them to shift positions based on a set of conventions or rules. As well, Information about the relationship of objects in space is determined by the distances between them. For example, a person can have the agency to move in space if she is in a crowded room and too short to see other objects or people in the space. Conventions of the relationship of her to other objects in that space, the place-ness of space, will determine whether she feels entitled and has the volition to optimize her position by moving. Her sense of agency is dependent upon external factors such as, is there room to move, is she able to become mobile, does she hold the belief that she can move, and does she have the desire to move. In virtual space, agency can be a representation of either the person who directly manipulates and controls that representation or an event-driven application-based action that is triggered based on a prescribed hierarchy of coded rules, written by an unknown, most likely human, entity.

Observing and analyzing human movement and interaction patterns is necessary for the design of physical spaces, be they parks, urban landscapes, buildings, classrooms that facilitate interactive and intersubjective experiences among its co-inhabitants. The goal is

to design space that supports encounters, congregation, interaction and dwelling rather than hinder these activities by promoting xenophobic behavior, avoidance, and hostility.[1]

6.2.1.2 Space Syntax

Space Syntax is an observational and computer-based statistical method to map human movement patterns in a specific environment to create a quantitative analysis on the use of that space based on the volume of pedestrian flow through the space. The quantitative measures of traffic flow patterns in a space, urban or architectural, are used to infer information about the qualitative attributes (accessibility and desirability) of the space. Space Syntax visualizations are typically presented in a top-down blueprint view of the space with an overlay of color coded lines of various hues and densities that denote pedestrian movement patterns and volume. (Hillier, 1996)

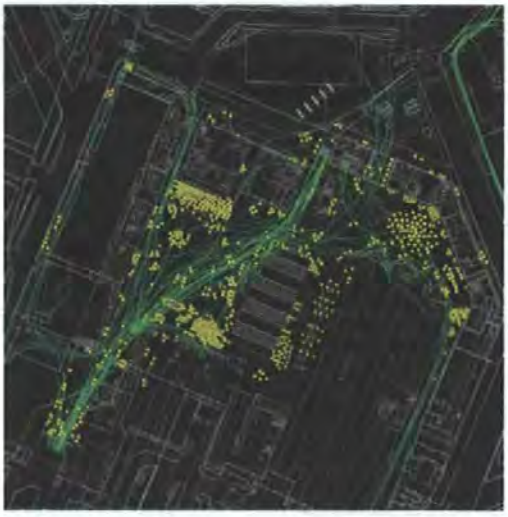

Fig.18: Space Syntax project at Victoria Station, London. Image is an analysis based on an observation study of existing passenger activity as a means to understand the effects of renovations at the station.

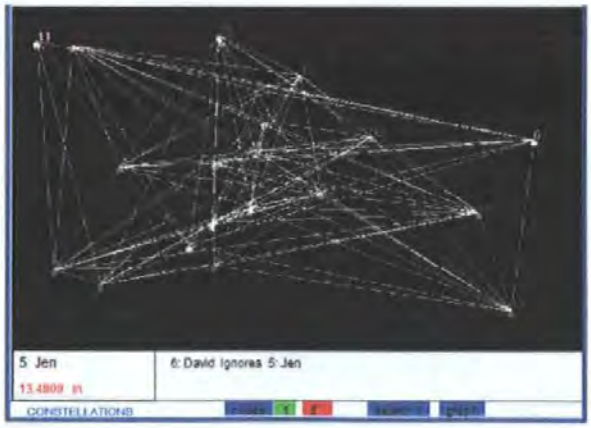

Fig: 19: Screen shot from constellations PathFinder application which is being developed by the author to map physical distances between people as they move in an open public space. The metaphor for the nodal interaction in this application is influenced by the metaphor of the rhizome as articulated by Deleuze & Guattari.

[1] In Heidegger's essay *Building Dwelling Thinking* the semantic relationship between building, the constructions of structures, and dwelling, the place where one lives and finds home –"basic character of thinking," explores the role of space as a place to find harmony between people, community, and sustainable infrastructure. In regards to the role of public spaces, Heidegger says, "The spaces through which we go daily are provided for by locations; their nature is grounded in things of the type of buildings. If we pay heed to these relations between locations and spaces, between spaces and space, we get a clue to help us in thinking of the relation of man and space." (Heidegger, 1971, p. 156)

"In contrast to centered (polycentric) systems with hierarchical modes of communication and pre-established paths, the rhizome is an acentered non-hierarchical, non-signifying system without a General and without an organizational memory." (Deleuze and Guattari, 1987)

6.2.1.3 The Rhizome as a Spatial Metaphor

The rhizome, a metaphor for the intertwined and interdependent relationships between people, values and beliefs, and objects in contemporary society, is a system of interconnections among plateaus of continuous, pulsating regions of intensities. The plateau, a concept borrowed from Gregory Bateson, is a continuous, self-vibrating region of intensities whose development avoids any orientation toward a culmination point or external end. (Deleuze and Guattari; 1987, Bateson, 1972) The plateau is a multiplicity connected to other multiplicities in a vast web of connecting arcs (connecting lines). The multiplicity has no subject or object, only determination, magnitudes and dimensions that cannot change in number without also changing the nature of the rhizome. The multiplicity is an agent of intentions. Unlike a tree structure, the rhizome has no beginning or end, no tree or root, only lines. There is no simple heuristic that can define its many layers of plateaus and lines of sight. They constantly fluctuate between a state of being itself and becoming other – of de-territorialization and re-territorialization. Rupture in the rhizome is simply an opportunity for new lines of sight to be generated as they maintain their connection to the whole.

6.2.1.4 Differentiating Space and Place

Space Syntax can surmise that a lack of pathways will prevent people from following certain paths in an urban setting, but it cannot identify the "lines of flight," the multiplicities of plateaus between people or the contextual domain of relationships that is more closely aligned with the theory of the rhizome. Properties of space are not the only determinants in the quality of experience in an identified space. "Place" denotes the social component of an environment where social norms have strong influences on an individual's behavior. Methods such as Space Syntax can identify pedestrian movement patterns. However this technique remains in

the geometrical Euclidean domain of measurement and data analysis and cannot measure attributes aligned with the quality of interaction that may be supported or hindered by various social and/or cultural attributes such as social norms and behaviors. Dourish and Harrison were employed by Rank Xerox Research in the United Kingdom and Xerox PARC Research in the United States at the time of their collaborations on space and place. During that time there were very strong corporate research interests and motivations to work on finding methods to augment, highlight and facilitate collaborative and or awareness-enhancing interactive experiences, particularly for applications in computer supported collaborative work. [2]

Despite the various approaches to analyzing, understanding and designing for public spaces, connectedness, "the degree to which a place fits with its surroundings" (Dourish & Harrison, 1996) was the core concern of the theories of Dourish and Harrison, Fitzpatrick, and Hillier. Connectedness is two fold. First, it is determined by the structural attributes (e.g. color, material and form) of the space in which interaction occurs. Dourish and Harrison claim most collaborative environment design is focused on the physical attributes of space. For example, distance is used by large virtual environments, such as DIVE and MASSIVE, to measure functionality and accessibility. This form of analysis focuses on the dynamics of space as appropriate and adequate means for evaluating the facility of collaborative aspects of the virtual applications. (Frecon & Stenius, 1998, Greenhalgh & Benford, 1995; Dourish, 2001) Connectedness is also determined by the degree to which the place-ness of the place both reinforces its context (space of existence) and can also be understood as distinct from its context. (Dourish and Harrison, 1996)

[2] Dourish's primary concerns about the differences between space and place are reaffirmed in Fitzpatrick's locales framework. The five primary components of the locales framework are: (1) foundations; (2) civic structure; (3) individual views; (4) interaction trajectory; and (5) mutuality. (Fitzpatrick, *2003*) The social world defines the foundation component which is a setting for actions. Actions are influenced by the history and projections of future activities. Civic structure is concerned with the form and function of the public domain and other governing entities. Differing individual perspectives, roles and participative engagement in the locale are recognized by individual views. Interaction trajectories indicate the formation of a course of action which is influenced by the flow of time and the combination of individual and intersubjective goals. By observing interaction trajectories of individuals and groups the structure of the social world becomes tangible. Mutuality is the way individual and social trajectories are made known and manifest to the social world by the "interplay of presence and awareness for interaction purposes, mediated by capability and choice." (Fitzpatrick, 1998: p. 134)

Place and the social behaviors that shape it cannot be designed – only observed and designed for. (Dourish, 2001)

Valuing "place" over "space" shifts the perspective of design from structural properties to the activities that form relationships of interaction in an environment. Knowledge shared by people based on common experiences is amplified and behavioral patterns become a crucial element for understanding the qualitative properties of the space. Place-ness leads to the development of community where focus is placed on understanding collective associations and experiences. When place-ness is recognized the structure of a space becomes malleable and can be shaped to reinforce particular emergent practices and patterns of behavior.

6.2.1.5 Space as a Cultural Construct

There is, however, an intelligible question about human association – not the question about how individuals or singular beings come to be connected – but how they come to be connected in just those ways which give human communities traits so different from those which mark assemblies of electrons, unions of trees in forests, swarms of insects, herds of sheep and constellations of stars. (Dewey, The Public and Its Problems, 1927, p. 23-24)

Space is not a neutral construct. The theory of Constructivism reveals that the artifact of space holds, supports, suppresses, and encourages interaction patterns that are culturally and socially significant. (Spivey, 1996; Pea, 1993; Penuel & Werstch, 1995) Autopoiesis also emphasizes that structural coupling is required among living beings and their environments to maintain a self-same state through structural coupling. (Maturana & Varela, 1998) Deleuze and Guattari's theory of de-territorialization illustrates that beings, objects and nodes – plateaus in a rhizome – frequently traverse the boundary between being self and being the other. (Deleuze & Guattari, 1987) Edward Hall notes that "space perception is not only a matter of what can be perceived but what can be screened out." As children we are taught by our cultures what to focus on and what to screen out in our environments. These "perceptual patterns" remain consistent throughout life unless challenged by a profound experience that overpowers the culturally-reinforced pattern. (Hall, 1969) Cultural differences are the main determinate on how people define the structure of space and their surrounding environments. Hall defined three categories of space in his theory of proxemics; (a) fixed; (b) semi-fixed; and (c) dynamic. Within the structure of proxemics, some spaces are

sociofugal – a space of solitude and others are sociopetal and support communication between people. (Hall, 1968) Hall's work brings to light that our perception of space is culturally-driven and not a universal construct.

6.2.2 Principle 2: Empathetic Intersubjective Experience

> *... For notice of the effects of connected action forces men to reflect upon the connection itself' it makes it an object of attention and interest. Each acts, in so far as the connection is known, in view of the connection. Individuals still do the thinking, desiring and purposing, but what they think of is the consequences of their behavior upon that of others and that of others upon themselves." (Dewey, 1927, p. 23 – 24)*

Intersubjectivity, discussed in chapter two, attempts to understand the mechanisms that enable two or more people to share experiences in the world and to understand each other, without direct access to the other's mental state. "Individual human consciousness is formed in the dynamic interrelation of self and other and therefore, is inherently intersubjective." (Thompson, 2001)

Thompson's definition of empathy is two-fold relationship that he calls the core-dyad where 1. Empathy is the precondition (the condition of possibility) for the science of consciousness; and 2. Empathy is an evolved, biological capacity of the human species and probably of other mammalian species (e.g. apes). Through empathy that we experience the other as a "unified whole" (Stein, 1964) – another being who is worthy of a similar treatment to that expected by the empathizer. The three stages of empathetic experiences are: (1) the emergence of the experience; (2) the fulfilling explication; and (3) the comprehensive objectification of the explained experience. These stages form the bases for reflexive sympathy which is a state of causality where the empathizer can be empathetic towards the other and the other's empathetic experience of the empathizer can be perceived and processed by the empathizer.

Evan Thompson defines four categories of empathy: (1) passive association; (2) imaginative transposition; (3) understanding oneself as an interpretation of the other; (4) ethical responsibilities which flow from the previous stage. The *passive association* of one's lived body with the lived body of the other indicates that the experience is sense-based rather than cognitive-based. For example, when an individual, the seer, views another person on the street, the body of the other is recognized as a member of a similar category to the body of the seer. However the seer does not have an affective of emotional attachment to other. *Imaginative transposition* of oneself to the place of another, also known as reiterated empathy, occurs when the empathizer becomes aware of the context of the other's experience. Prerequisite for this category of empathy is the recognition of similarity of the other's body to oneself. This is not a literal similarity but a comparative similarity where the other continues to occupy an egocentric space that is separate from the empathizer. Here is noted that one's sense of self-identity cannot be separated from empathetic recognition of another being. The Husserlian phenomenological notion of the "here" and "there," is an alternative description of imaginative transposition. Hurssel held the premise that one's experience of space and self identity is tightly coupled around the "zero point" or the "here." The other is perceived as occupying space that is "there."[3] (Husserl, 1936)

The empathetic concept of *imaginative transposition* helps to complete Husserl's broken metaphor of the "here" and "there" by recognizing the vectors or lines of sight connecting individual bodies in space while simultaneously maintaining unique egocentric points-of-view that are located at the "zero-point" of being. "I see myself from your perspective. I empathetically grasp your empathetic experience of me. As a result, I acquire a view of

[3] Habermas critiques the Husserlian notion of the "here" and "there" as inadequate in explaining intersubjectivity. The "here" and "there" denotes a spatial perspective that Husserl claims makes possible the interchange of world perspectives. Habermas questions equating these concepts of space and context and claims that Husserl is speaking about two different things. Where the metaphor of space presents a framework of a self-centered perspective of moving bodies – or bodies co-existing in a space and yet separate from each other with no obvious links beside their co-occupation of the space. Thus the "here" and "there" is a missed metaphor for describing the phenomenon of intersubjectivity between bodies because the metaphor does not provide the image of connectivity between the "here" and "there.".

myself not simply as a physical thing, but as a physical thing empathetically – grasped – by-you-as –a-living-being. In other words, I do not merely experience myself as a sentient being 'from within', nor grasp myself as also a physical thing in the world; I experience myself as recognizably sentient 'from without', that is, from your perspective, the perspective of another." (Stein, 1964)

The *interpretation or understanding of oneself as an interpretation by the other* along with *ethical responsibilities* in the presence of the Other, supports the theories on the public sphere, discourse, and change that are the core themes of this text and the bases upon which critical creative technologies are founded. That is enabling people to explore, mold, and excavate new intersubjective and empathetic experiences with the assistance of computer-supported collaborative, aesthetic, critical, and playful experiences.

6.2.3 Principle 3: Discourse and Play

Play as a concept has been used to mold, inform and guide Western culture and thought. (Spariosu, 1989) Play is a global phenomenon that exists in all cultures past and present, even though method, technique and values equated with play may differ. Mihai Spariosu stresses that play should be treated as an adverb rather than a name for a class of activities or the affective attributes generated by subjects engaging in play. The pervasive presence of play defies any attempt to define methodologies or rules sets to describe the phenomenon. Wittgenstein's theory of "language games" and "family resemblances" (introduced earlier in the text in reference to Habermas's analysis of theories of communication based on intersubjective experiences and Mouffe's theory of agonistic democracy) can be used to understand the essence of play as an activity, a philosophical concept and as an essential building block of civilization.[4]

[4] The theory of family resemblances, for Wittgenstein, is his way of describing the indeterminacy of language.

> *65. Here we come up against the great question.... For someone may object against me: "You take the easy way out! You talk about all sorts of language-games, but have nowhere said what the essence*

6.2.3.1 Strategies in Pre-rational and Rational Forms of Play

Play, or agon, can be divided into two realms; (1) pre-rational agon - an unrestrained form of play based on arbitrary, violent, conflict-ridden strategies that are driven by chance, necessity and imitation (mimesis-play) and; (2) rational agon - a nonviolent play that constrains freedom of action by incorporating rule-determined interactions and also employs strategies of chance, necessity and imitation. (Spariosu, 1989)

Pre-rational methods of play engage strategies of chance, necessity and power that tend to credit superhuman entities, such as nature, gods and spirits, as primary forces in the development and determination of world order. Whereas, rational play employs the same category strategies, (chance, necessity and power,) however, the strategies are mediated by rule-based structures that reflect the socio-cultural and historical precedence of the society in which the form of play resides. The superhuman forces that determine the destiny of pre-rational play are trumped by abstract philosophical and scientific reasoning of a *rational* society.

> *of a language-game, and hence of language is: what is common to all these activities, and what makes them into language..."*
>
> *And this is true. – Instead of producing something common to all that we call language, I am saying that these phenomena have no one thing in common which makes us use the same word for all, – but that they are related to one another in many different ways...*

Language games are not derived from a set structure or rules.

> *66. Consider, for example, the proceedings that we call "games" (Spiele). I mean board-games, ball-games, Olympic games, and so on.... For if you look at them you will not see something that is common to all, but similarities, relationships, and a whole series of them at that... We see a complicated network of similarities overlapping and crisscrossing...*

Invoking a metaphor from genetics, Wittgenstein observes that there are commonalities among various language games that are analogous to "family resemblances."

> *67. I can think of no better expression to characterize the similarities than "family resemblances"; for the various resemblances between members of a family: build, features, color of eyes, gait, temperament... overlap and criss-cross in the same way. And I shall say: "games" form a family.* (Wittgenstein, 1953, pp. 31e-32e)

The concept of play and games as a metaphor is engaged by Wittgenstein, to understand how people communicate and make meaning in their worlds. His own enlightenment to the relevance of play and games was a result of teaching school-age children during his own re-invention as a philosopher and educator.

Fig. 20: Clockwork image from the scene the "Worker's City" in Fritz Lang's 1927 film "Metropolis".

Rational play is "fashioned after the model of a giant clockwork, it regulates all competition according to the principles of universal justice or fair play, and guides chance with an iron hand." (Spariosu, 1989, p. 17) The image of the timekeeper in Fritz Lang's *Metropolis* comes to mind (fig.20). The giant hands of the deterministic clock are constantly monitored and adjusted to maintain structure and control the work ethic that represents progress at the turn of the 20th century. A correlation can be drawn between the two categories of play and the two core theories of technology. Substantive theories of technology, with their association of forces beyond humans as the deterministic power force driving the relationship of technology to society draws a family resemblance to re-rational play. Rational play, as envisioned by Spariosu's relentless clockwork analogy, clearly demonstrates a similarity to the determinism ethic of instrumental theories of technology.

Mimesis is also an attribute for both pre-rational and rational play. Pre-rational mimesis is based on mimicry, the direct representation and embodiment of the appearance, actions, and/or utterances of animals, humans and supernatural entities. This form of mimesis is often enacted by vocalization and movement gestures and serves as a method for storytelling, culture preservation, education, etc.... Critiqued by early western thinkers as a crass form of communication, mimesis-play transformed from pre-rational embodiment to the rational enactment of mimesis as imitation. The act of mimesis evolved from playing "as" to playing "as if" one were the object of expression. The call and response nature between enactor and observer typical of oral storytelling was transformed into a

clearly delineated boundary made evident by the barrier between the proscenium stage and tightly aligned audience.[5]

6.2.3.2 Kant can't Play Today

Kant proclaims, in the *Critique of Pure Reason*, that competitive play (*sensus omnium*) has interfered with the serious business of philosophy (pursuit of scientific knowledge.) Kant insists on "orderly establishment of principles, clear determination of concepts, and insistence upon strict proof, and avoidance of venturesome, non-consecutive steps in our inferences." To defy the natural order of the procedures listed above is to have "no aim than to shake off the fetters of science altogether, and thus to change work into play, certainty into opinion, and philosophy into philodoxy." (Kant, 1781) The antithesis to reason is play. Art, associated with play, are both frivolous enterprises devoid of cognitive value and conducive to error. Kant maintains a hierarchical status of reason over imagination, philosophy and science over art and morality and seriousness over play, despite Kant's acceptance of the validity of aesthetic judgments in his Third Critique. Aesthetics and play continued to maintain a status of "purposiveness without purpose" (*Zweckmässigkeit ohne Zweck*). (Spariosu, 1989, p. 39; Kant, 1790)[6] Kant writes that, "to surrender oneself to the "play of the unpremeditatedly creative imagination" is to "reverse the natural order of the cognitive powers, since then the rational elements do not take the lead (as they should) but instead follow behind." (Kant, 1798; Spariosu, 1989, p.51)

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[5] Contemporary critical theorist, such as Baudrillard challenged the pre-rational – rational bifurcation of play. In his theory of simulacra, Baudrillard examines the excess of imitation in contemporary society and how the original referent is lost and eventually transformed into a new culturally-accepted reality.

"... age of simulation thus begins with a liquidation of all referentials – worse: by their artificial resurrection in systems of signs, which are a more ductile material than meaning, in that they lend themselves to all systems of equivalence, all binary oppositions and all combinatory algebra. It is no longer a question of imitation, nor of reduplication, nor even of parody. It is rather a question of substituting signs of the real for the real itself; that is, an operation to deter every real process by its operational double. ... Never again will the real have to be produced... A hyperreal henceforth sheltered from the imaginary, and from any distinction between the real and the imaginary, leaving room only for the orbital recurrence of models and the simulated generation of difference." (Baudrillard, 1998)

[6] Kant presents a hierarchy of three categories of art that correlate with three epistemological divisions: (a) arts of speech (thought); (b) formative arts (intuition); (c) arts of play using the as if (als ob) approach. Poetry is the highest form of art. It is "the art of conducting a free play of the imagination as if it were a serious business of the understanding." (Kant, 1931, p. 51) Poetry understands its subordinate role in understanding and merely acts as a mediator for reason, sin, and judgment between abstract ideas and the senses. (Spariosu, 1989, p. 49)

Play, in contrast to work, is more harmful than beneficial, even in light of its positive effects such as energy rejuvenation, self-reflection and its role in teaching and awarding adherence to social norms. Overindulgence in play leads to "bad habits, causing the weakening of the mental powers." Play encourages laziness. (Kant, 1798, p. 33) Games of chance foster the illusion of control when in reality the players are "mere toys in the hands of nature." (Kant, 1798, p. 86) The social factor of play runs the risk of becoming a means for passion and obsession, whereas, music, dance and play in general "are conducive to company without conversation" that does not encourage "mutual exchange of thought," thus denying the union of social living with virtue. (Kant, 1798, p. 88) In the *Critique of Pure Reason*, Kant angst situates play as an elusive concept in need of discipline. Yet, play thrives throughout all cultures by the fact that it escapes universal discipline. (Spariosu, 1989) Kant's philosophical perspective forms the epicenter from which most contemporary western critical thinkers develop alternative principles and concepts regarding the role of play in society.

6.2.3.3 Schiller's Spieltrieb (play-drive)

> *"Art can carry out the task of reason precisely because of its double nature as semblance and reality, play and seriousness, entertainment and morality." (Schiller, Aesthetic Letters IX, 3)*

Art is situated as an arbitrator between play and seriousness, sensuousness and rationality, utility and superfluity in Frederick Schiller's seminal 1795 work *Über die asthetische Erziehung des Menschen in einer Reihevon Briefen (Aesthetical and Philosophical Essays.)* As a philosopher and artist, Schiller positions the fine arts as equal to the sciences in the role of mediator between philosophical-scientific discourse and the unknowable reality and the chaotic physical world and human morality. He noted that, "both rejoice in absolute immunity from human arbitrariness," where "truth and beauty will always struggle to the surface." (Schiller, 1793- 95, Aesthetic Letters IX, 3) Art dares to unearth

and poke at questions that do not have answers that can be derived from rational methodologies, but are imperative in the development and survival of humanity. Within that text, Schiller elevates the notion of play to that of the "noblest" activity of reason. Schiller was influenced by Kant's enlightenment and acceptance of the validity of aesthetic judgments toward defining desire, beauty and the artist as genius. Schiller calls for an "aesthetic state" to replace the traditional European State that was born from the destructive violence of the French revolution. Schiller challenges Kant's stance on the frivolity of play by viewing it to be a primary enabler of reason and as an integral component in the structure of society. He identifies it as an important motivating factor in philosophical discourse.

Schiller's theory of society is based on three essential human drives: (a) sense-drive (*Stofftrieb, Sinnlicher Trieb*); (b) form-drive (*Formtrieb, Vernünftiger Trieb*); and (c) play-drive (*Spieltrieb*). Sense-drive and form-drive are engaged in a potentially agonistic relationship. Sense-drive develops from the physical essence of humans. This drive is malleable and evolves over time. Form-drive develops from the rational relationship between humans, nature, and objects. Form-drive is "intent on giving him [a person] freedom to bring harmony into the diversity of his manifestations, and to affirm his person among all his changes of condition." (Schiller, 1793-95) Law is generated by form-drive and individuality by sense-drive.

> *"The seriousness of your principles will frighten them [the artists' contemporaries] away, but in the play of your semblance they will be prepared to tolerate them... In vain will you assail their precepts, in vain condemn their practice; but on their leisure hours you can try your shaping hand. Banish from their pleasures, caprice, frivolity, and coarseness, and imperceptibly you will banish these from their actions and, eventually, from their inclinations, too," (Schiller, IX, 7; Spariosu p. 58)*

Play-drive recognizes play to be a rational fiction that has great influence on moral imperatives and is an essential element to the composition of humans: "For to mince matters no longer, man only plays when he is in the fullest sense of the word a human

being, and he is only fully a human being when he plays" (Schiller, 1793 – 95, XV, 9) Play-drive provides connecting glue between the sense and form-drives. It assists in reconciling differences and recognizing similarities between rational thought and sensual desires. Schiller's emphasis on play as serious work and mediator for cultural, social, and moral existence sets the stage for all subsequent contemporary theoretical discussions about play. (Spariosu, 1989)

6.2.3.4 The Artist-metaphysician and Play

The artist-metaphysician incorporates art and play into his argument to better understand existence and maintain a presence of culture in western critical thought. Hans-Georg Gadamer and Jacques Derrida are among the critical thinkers classified as artists-metaphysicians. (Spariosu, 1989) Their work, addressing the elusiveness of language and the importance of play, contribute to the theories I am developing in support of *creative critical technology*.

6.2.3.5 Gadamer: Art and Play as Transformative Experiences

> *Nur dann erfüllt ja Spiel den Zweck, den es hat; wenn der Spielende im Spielen aufgeht. Alles Spielen ist ein Gespieltwerden. Das Spiel ist es, was den Spieler in seinen Bann scwägt, was ihn ins Spiel verstrickt, im Spiel hält. Der Spielende erfahrt das Spiel als eine ihn übertreffende Wirklichkeit.*
>
> *(Play fulfills its purpose only when the player is wholly involved in play. All playing is being played. The play's the thing that captures the player, enraptures him and holds him in play. The player experiences play as a reality that surpasses him.) (Gadamer, 1990)*

Gadamer's belief that art and play are transformative experiences aligns with Dewey's premise of art as a transformative process as he articulated in *Art as Experience*. Gadamer exclaims that "human play finds its true perfection" in art that is an "independent and superior mode of being." (Gadamer,1989; Gadamer, 1990; Spariosu, 1989; Dewey, 1934) Art and play do not occur outside of the participants' experience but is made manifest through the participants' engagement with each other and/or objects designed to facilitate a physical or contemplative act. Games and art are simply different forms of play. Games,

as a form of rational play, are based on rule structures that integrate integral components of play as stated earlier, chance, necessity and mimesis. The art experience is born from interplay between audience and subject. The audience, participant, interactor, builder... is the interpreter and the interpreted, the player and the played, the designer and the re-designed.[7] Gadamer sets forth the premise that the mirroring process of language, art and play is the means of connecting processes of "Being" and "becoming." This notion of interplay is wonderfully aligned with Rokeby's metaphor of the transforming mirror as a motivating factor in the design of interactive technologies. Designing computer-based interfaces as a transforming mirror provides a vehicle for the audience, participant, interactor, builder to reflect and enhance, rather than, simply mimic the player's actions.[8] (Rokeby, 1996)

6.2.3.6 Literature and Play

> *"viewed in this functional light, literature is neither illusion nor higher truth but a linguistic construct like any other, participating in the creation, perpetuation, and destruction of a certain discursive power configuration....its effectiveness depends upon its being able to create a free, self-enclosed space or neutral play ground, where certain models for or alternatives to reality can be proposed, tested, adopted, and rejected at will." (Spariosu, 1989, p. 26)*

Literature is a form of play and power. Through its fictional position, literature enables other linguistic constructs (scientific, philosophical, historical, ethical, political, juridical, and religious) "to be invested with the authority of knowledge and truth. (Spariosu, 1989) Language does not have a "being-in-itself which is different from its reproduction or the contingency of its appearance." (Gadamer, 1989, p. 432) Gadamer, like many critical theorists discussed thus far, views language to be a fundamental binding property in our relationship in the world. Language is the "advent-event of Being," and provides the

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[7] The terms participant, user, interactor, builder are used together to express a desire to label the human component of an interactive system. My using all terms also expresses my dissatisfaction in the inadequacy of any of these terms to give the role of the human component of an interactive system the justice that role deserves. However, I choose to use the term builder to identify the person(s) engaged in the act of building with the Constructed Narratives project.

[8] Further elaboration about David Rokeby's Models for Interactivity can be found in Appendix A: Narrative, Storytelling, Interactivity and Intelligence.

structure by which presence is manifest. (Gademer, 1989) The emphasis on language, as a generative process of Being, challenges the concept that semiotic signs are neutral and easily interchangeable using techniques of syntagym and paradigm. (De Saussure, 1994) Language is slippery. It is a game, as Wittgenstein proclaimed, dependent on the context in which it is used.

6.2.3.7 Derrida's Free Play (jeu libre) with Language Slippage

Derrida's critique of the elusiveness of language forms its own serpentine chain where elusiveness of language is used to critique the elusiveness of language. His theory plays on linguistics semiotics, modes of delivery, reception and interpretation via his well-worn concepts of deconstruction, difference, play (*jeu libre*), and history (*trace*).

A 1983 response to a colleague's inquiry regarding the concept of *deconstruction* led Derrida into an introspective reflection about the illusive nature of language, meaning and methodology. (Derrida, 1983) Derrida acknowledged that the word "deconstruction" does not hold great significance in the French language. However, he turns to the dictionary (*Littre*) in search for etymological assistance in responding to his colleagues initial question, "what is deconstruction?"

> *"Deconstruction: action of deconstruction. Grammatical term. Disarranging the construction of words in a sentence. 'Of deconstruction, common way of saying construction', Deconstruire: 1. To disassemble the parts of a whole. To deconstruct a machine to transport it elsewhere. 2. Grammatical term.... To deconstruct verse, rendering it, by the suppression of meter, similar to prose. ... 3. Se deconstruire [to deconstruct itself]... to lose its construction...." (Derrida, 1983)*

Though descriptive of a material and mechanic processes involved in the act of deconstruction, Derrida notes that this definition is inadequate in understanding the theoretical implications of the term *deconstruction*.

> *"To be very schematic I would say that the difficulty of defining and therefore also of translating the word 'deconstruction' stems from the fact that all the predicates, all the defining concepts, all the lexical significations, and even the syntactic articulations, which seem at one moment to lend*

themselves to this definition or to that translation, are also deconstructed or deconstructible, directly or otherwise, etc.... and that goes for the word deconstruction, as for every word." (Derrida, 1983)

The meaning and act of *deconstruction* is liquid. Its elusive qualities can only be anchored by secondary semantic concepts and words (e.g. différance, trace, ecriture). These secondary concepts seek to add dimensionality to the quest of making and missing meaning and create an endless and indeterminate condition of substitution. Derrida concludes his letter exclaiming, "And as 'deconstruction' is a word, as I have just said, that is essentially replaceable in a chain of substitution, then that can also be done from one language to another." (Derrida, 1983)

What then do we make of Derrida's concept of différance and jeu libre (free play)? Derrida's emphasized the essence of written as compared to spoken language. His exercise with the terms difference and différance drew attention to the impact of the medium of language or information delivery on the reception of the meaning. Différance is not a word in the French language. Rather it is an amalgamation, a weaving together, of the words difference and to differ, as an attempt to describe the relationship between time, space and difference. The meaning of différance can only be discerned by its contextual and strategic placement within the text. The "a" in différance is silent and "cannot be exposed," it cannot become present. The difference between difference and différance can only be discerned visually in a "purely graphic" comparison. (Derrida, 1982) Because of the graphic nature of the term, Derrida annotated his spoken lectures about this topic to insure that the listener followed his spoken exegesis on the slippery properties of language.

Différance is an imaginary word formed from Derrida's language game with the Latin verb *differer* which has two distinct meanings. The first meaning is the "action of putting off until later, of taking into account, or taking account of time of the forces of an operation that implies an economical calculation, a detour, a delay, a relay, a reserve, a

representation." This definition of the word *differ* aligns with the concept of temporization, "to take recourse consciously or unconsciously, in the temporal and temporizing mediation of a detour that suspends the accomplishment nor fulfillment of 'desire' or 'will' and equally effects this suspension in a mode that annuls or tempers its own effect." Time is inserted between the subject and its contemplation and presence. The present, is constantly shifted, renegotiated by readjusting spaces between the past (history), the present, and the future. The second meaning of the Latin verb *differer* describes the relationship of being other and not identical. Space is inserted between the subject and its comparison. (Derrida, 1982)

Understanding the meaning of language, while considering Derrida's dance with différance, is an articulated generative process mediated by free play (*jeu libre*) of differences, oppositions, joining, colliding, negotiating, consuming and being consumed. The term différance becomes Derrida's shorthand to refer to both meanings of the Latin root *differer*. The context in which the term is used determines its meaning as temporization, spacing or both. Différance is "the movement according to which language, or any code or system of referral is constituted 'historically' as a weave of differences." Différance, as a means to understand the significance of a sign system is a process that is complicit with history, production and constitution of the subjects and defies points of origin, a center, or transcendental inception. For the notion of a structural center limits the "play of the structure." (Derrida, 1978, p. 278) However, structure that lacks a center leads to a lack of coherence for the realization of structure or definitive meaning.

Derrida rallied for the necessity of challenging the very locus of the center, "the center could not be thought in the form of a present-being, that the center had no natural site, that it was not a fixed locus but a function, a sort of non-locus in which an infinite number of sign substations came into play." (Derrida, 1978, p. 280) Rather, Derrida supported the

concept that the structural center is a space of refraction that hosts "an infinite number of sign-substitutions..." The transgression of domains by which signifiers reside is the *jeu libre* (free play) of infinite substitutions in a finite field of possibilities. Discourse is born where "the central signified, the original or transcendental signified [e.g. god, nature, divinities, chance, etc...], is never absolutely present outside a system of differences. "(Derrida, 1978, p. 280) In other words, there is no absolute transcendental figure that exists outside of the discourse that describes this figure.

Play is the act of *supplementarity* where the sign that temporarily takes the center, the foundational core of the structure is but a mere supplement, a *temporary authoritative occupant*. (Derrida, 1978, p. 289) "Play is the disruption of presence," a disruption that provokes a tension between play and history and play and presence. Attributes of pre-rational play (open structures where signifiers are influenced by transcendental entities) and rational play (regularized structures where signifiers are determined by rule-based structures that reflect socio-cultural and historical tendencies) become strange bedfellows in Derrida's playground of refractive discourse.

6.2.4 Putting Theory (nouns) into Action (verbs)

> *"Without external embodiment, an experience remains incomplete; physiologically and functionally, sense organs are motor organs and are connected, by means of distribution of energies in the human body and not merely anatomically with other motor organs. It is no linguistic accident that 'building,' 'constructions,' 'work,' designate both a process and its finished product. Without the meaning of the verb that of the noun remains blank." (Dewey, 1934, p. 51)*

The following section introduces the *Constructed Narratives* project, a tangible social interface that is designed to encourage collaborative play among people in public spaces by physically manipulating physical objects that are dynamically-imprinted with language.

That language is both associated to the builder and elusive as meaning switches with each addition, subtraction, or change applied to the co-built tangible structure. [9]

The game is designed as a creative tool to aid in the excavation of modes of différance. The goal is to make différance visible and malleable – like a sculptor's lump of clay that can be molded or constructed into a myriad of forms and associated meanings; producing a common ground for initiating discourse, and hopefully establishing engaging interaction and dialogue between builders.

6.2.4.1 The Tangible Social Interface

In chapter five the theory of multiliteracies was introduced as a complementary theory to Feenberg's principle of concretization in his dialectics of technology. Re-design, the most transformative design process, involves the making of new meaning, knowledge and understanding from current discourse. (New London Group, 1996) Tools developed to support the process of re-design emphasize the concept of the user as constructor. These tools empower the user to transform meaning and effect change in the relationship between the self and other through the process of inquiry, deconstruction, discourse, play, negotiation of space, naming of place, and empathetic intersubjective experiences.

The Constructed Narratives project is the beginning of a research-in-practice platform to develop methods for harnessing the powers of information, tangible and ubiquitous technologies for computer-mediated collaborative environments that are open, flexible, and receptive to the unique interactions of each participant engaged in the activity. In particular, the work is exploring a domain of practice and research I have named *computer-*

[9] As I edit this text, I sit in the waiting room of a hospital waiting room. I can't help but realize the appropriateness for the Constructed Narratives game application in a setting such as this – a place of people, friends, family waiting for news of their loved ones, watching television, eating snacks, talking about memories of the city of Pittsburgh, school bus politics and global warming.

supported collaborative play (CSCP) that creates a vehicle for collective self-reflection, creative problem solving, negotiation and learning through play.

Fig. 21

Fig. 22

Fig. 23

Fig.24

Fig. 21: Augusto Boal's "Theater of the Oppressed" enacted community activism method.
Fig. 22: LEGO Serious Play group, "an innovative, experiential process designed to enhance business performance.
Fig. 23: Family reunion collaborative puzzle game, Virginia Beach, Virginia, 2005.
Fig. 24: Human Computer Interaction Consortium ice-breaker puzzle Winter Park, Colorado, 2005.

There have been, throughout time, many methods for facilitating a dialogical space that is not driven by technology, including participatory theater and situational dialogue, team building and trust activities, games and brainstorming. (Figures 21-24) (Boal, 1982; Kelly, 2001; Newstrom & Scannell, 1997; LEGO Serious Play, 2006). My goal is the incorporation of technology as a tool for conjuring and supporting dialogue in public spaces.

6.2.4.2 Principles for the Design of Tangible Social Interfaces

By observing the three principles of critical interaction design: (a) place as connected space; (b) empathetic intersubjective experiences; and (c) discourse facilitated through deep play, tangible *social interfaces* are designed to fulfill the following five goals:

6.2.4.2.1 Observe

Observe human interactions in public spaces, not as a means of surveillance, but to publicly display, illuminate and reflect upon social interaction patterns, to reveal the *language games* and strategies of interaction in public spaces.

6.2.4.2.2 Integrate

Integrate advanced IT technologies (e.g. computer networking, multimodal and agent software, local and global logistical identification methods) with practices in the interactive arts, interaction design, contemporary critical theories and project-based learning theories as a means to celebrate, critique and provoke current practices in human computer interaction, new media art and interaction design.

6.2.4.2.3 Engage

Engage by designing activities using tangible social interfaces that are both reactive and receptive based upon participant's interactions with each other and the tangible interface as a means to engage the public sphere into being visible, present and active.

6.2.4.2.4 Aggregate and Analyze

Aggregate and Analyze information input into the system by participants directly and through their interactions with the interface to generate inferences about the relationships, differences, synergies and dissonances inferred using the *semantic engine* – a rule-based "inference" engine that for the development of speculative software.

6.2.4.2.5 Give

Give an enhanced reflection back to the participants that picture them simultaneously as individuals and members of a collaborative effort. Thus leverage the interactive patterns in the space as a means for supporting the participant as designer and participant as re-designed by the discovery of broader communities of interest.

6.3 Overview of the Constructed Narratives Project

The following is an introduction to the Constructed Narratives project presented in the form of a fictitious scenario that takes place in an international airport waiting lounge. The

scenario was written to describe a possible encounter with the game, as well as an overview of the enabling technology. The Constructed Narratives project is described in detail in chapters seven through eleven.

> *....while singular beings in their singularity think, want and decide, what they think and strive for, the content of their beliefs and intentions is a subject-matter provided by association. Thus man is not merely de facto associated, but he becomes a social animal in the make-up of his ideas, sentiments and deliberate behavior. What he believes, hopes for and aims at is the outcome of association and intercourse. (Dewey, The Public and Its Problems, p. 25)*

6.3.1 Constructed Narratives Scenario: An Unlikely Encounter at the Auckland International Airport

Fig. 25 : Captured people who are waiting in the Vienna, Zurich, and Philadelphia international airports

> *A modern airport is based on the assumption that everyone's from somewhere else, and so in need of something he can recognize to make him feel at home; it becomes, therefore, an anthology of generic spaces – the shopping mall, the food court, the hotel lobby – which bear the same relation to life, perhaps, that Muzak does to music. There are discos and dental clinics and karaoke bars in airports today; there are peep shows and go-carts tracks and interdenominational chapels. (Iyer, 2000)*

Seated at the *Constructed Narratives* game table, in the frequent flyers lounge at the Auckland International Airport, is Sara, a 25-year-old college student and Thomas, a 40-year-old banker. They both have a two-hour layover before their connecting flight to Los Angeles. Sara arrived from Sydney, Australia. Her final destination is Pittsburgh, Pennsylvania where she is about to begin her graduate studies at Carnegie Mellon University.

She was born outside of Sydney in a small fishing village. Her father is aboriginal and her mother is from a long lineage of British expatriates. Thomas is from Christchurch, New

Zealand. He grew up on a sheep farm and is the first member of his Anglican farming family to work as an executive for a major corporation. He commutes to Auckland, a one-hour flight, three times a week for meetings. He spends on average of six hours a week waiting in the airport for his flight. Occasionally, he travels to executive meetings at the bank headquarters in Los Angeles. Generally, the flight layover time is too short for him to concentrate on work related tasks so he spends the time reading the newspaper, talking to his children on the mobile phone, or watching other people.

Fig. 26: Constructed Narratives demonstration at the Kiasma Museum for Contemporary Art in Helsinki, Finland, 2004.

Placed on top of the *Constructed Narratives* game table is a set of connectable geometrically shaped building blocks. The college student and banker are wearing a RFID (radio frequency identification) ring on their dominant hand. Each time they connect a physical block to the emerging networked construction, a virtual screen-based representation of the construction is updated, in real-time, and projected on a large 180-degree video screen that surrounds the game table.

> *"Place-making, then, would appear to be a complex enterprise. It reflects the conscious arrangement of elements to create a space that accommodates activity, and (here is the hard part) the interplay of reflective design and happenstance to give expression to the values of the occupants and their wider community. In other words, as we have observed, a space can only be made a place by its occupants. The best that the designers can do is to put the tools into their hands. Trying to do more – trying to build places – is not our job." (Harrison & Dourish, 1996, p. 74)*

The blocks in the virtual rendition are shaded a unique color that identifies the person who was responsible for placing the block onto the emerging physical construction. A word is printed onto each block in the virtual replication of the physical construction. These words are descriptive of concepts relating to issues of self-identity, origins, types of environments

where people live, work and play, and belief and value systems. The semantic engine is an inference engine which selects the words based upon patterns, recognized by the underlying software system, of the connected blocks the person/builder for placing the block and a few simple questions each builder answered in the builder's profile application prior to game play.

College student Sara and banker Thomas are amazed that the words, though poetically juxtaposed, refer to topics and events that relate to their lives and interests. Particularly since the pre-game questionnaire only asked basic questions about their lives and interests.

Fig. 27: CAD model of the current Constructed Narratives block. The block design is elaborated in further detail in chapter seven through eleven.

Each block they add to the construction alters the relationships between the words and their associated meanings. Working together, they quickly realize that they have similar ideas about world ecology founded from different perspectives. Sara is an activist who participates in tactical media events and street protests with friends on her college campus. Thomas supports the New Zealand environmental protection agency. He is an avid recycler. Of course, the words on the blocks didn't spell all this out in detail. Rather the act of construction and using language as a fundamental building block provided a place for establishing common ground – a situation where an unlikely conversation between two people could occur. Sara and Thomas have collaboratively constructed a world in which their ideas, beliefs, interests, concerns, and pleasures are the very material from which their constructed world is made.

> *"Thus conversation that is shaped creatively by all its participants can be both a vehicle for cultural change and the social sculpture that results – a semi-public sphere composed of 'invisible distance lines' drawn by the erotics of encounter.... Unlike information, conversation as social sculpture is autotelic: it achieves its pleasures and purposes simply by virtue of coming into being" (Margaret Morse, 2001, p. 124)*

A boarding announcement is heard over the crackling public address loudspeaker. They remove their RFID identification rings, gather their bags, and head to the gate. Thomas bids a fond farewell to Sara as he proceeds to the front of the line to board in the business class section. Sara patiently waits among the gathering crowd of travelers for her coach row to be announced.

6.3.2 Overview of the Development of the Constructed Narratives Project

Fig. 28

Fig. 29

Fig. 30

Fig. 28: Constructed Narratives Test Server.
Fig. 29: Hand soldering SMT component circuit boards
Fig. 30: Current circuit soldered circuit board.

The *Constructed Narratives* system is divided into four development areas: (1) experience design; (2) block artifact design; (3) hardware; and (4) software architecture design. The iterative process for the block artifact resulted in a modular design that originated in wood and evolved to a stereo lithography CAD model in which a small number of blocks were cast and assembled. The block design enables up to forty surfaces for connection and four orientation positions per connected side. The software architecture includes: the system interfaces and communication protocol between the blocks and database resources from the builder's profile application; the host application which keeps a dynamic graph of all data as the construction emerges; and the semantic engine that applies a series of rules and iterative searches to find patterns in the data to be used to seed the word search. The virtual build application is responsible for printing the results into a 3D real-time navigable environment (Figure 31).

The *Constructed Narratives* builder's profile application is a means by which to personalize the participant's experience such that the social aspects of the tangible interface may be realized. The purpose of the builder's profile questionnaire is to provide a persona profile for each builder.

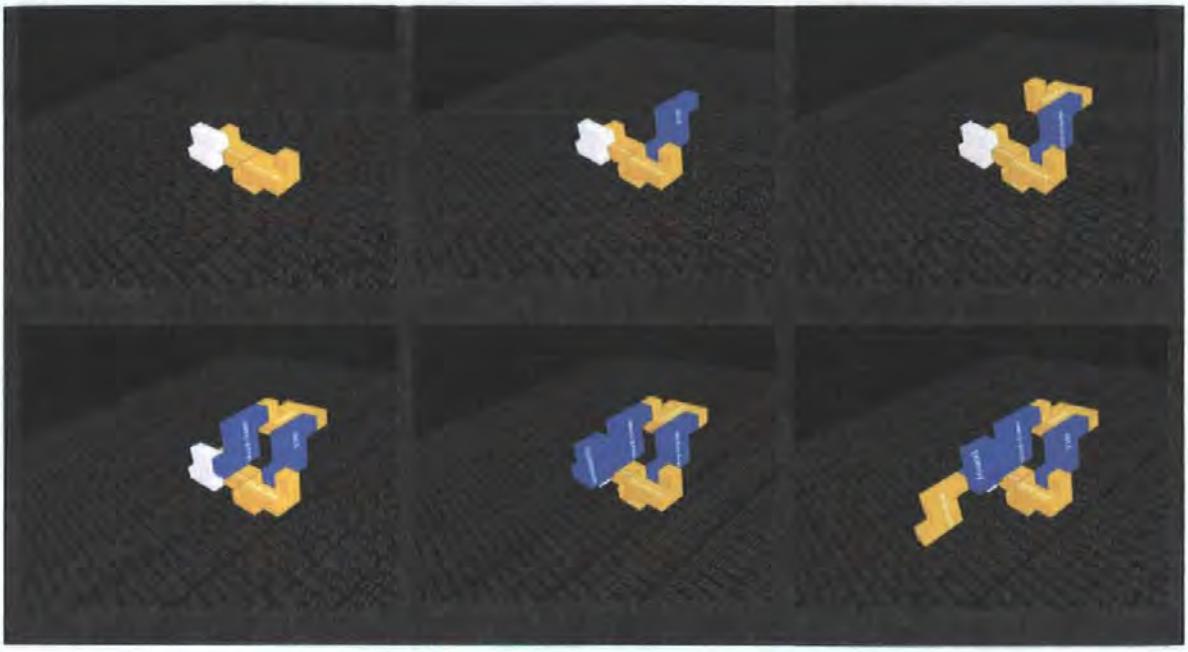


Figure 31: Screen images from the Constructed Narratives real time Virtual Build Application. The series of images show a progressive construction with the physical blocks recorded and mirrored in a navigable virtual environment. Recognized patterns in the physical construction are found by the pattern search engine. The pattern data is used to form the parameters for a semantic search in a computer based lexicon of the English language. The found words are printed onto the blocks in the virtual environment.

The hypothesis for the development of the Builder's Profile Application is that the intersubjective relationships between participants can be inferred and amplified by making visible manipulative notions of the participant's definition of self. The semantic engine design is based on a rules matrix for visual semiotics and rhetorical operations that was originally developed for understanding meaning of visual objects and codes in print media advertisements. (Durand, 1970) From Durand's matrixes, I have developed plans for a rules based inference engine that maps the appropriate components from Durand's scheme onto the surfaces of the three-dimensional block. The result is a reconfigurable structural language that can be dynamically applied to the evolving built structure while reflecting the collective profile of the group of builders who are participating in the game.

The following chapters provide an in-depth explanation of the block design and software and hardware development for the Constructed Narratives project. These chapters are followed by an explanation of the research team development process, evaluation of the project in exhibition at the Kiasma Museum for Contemporary Art in Helsinki, and future plans for the continued development of the Constructed Narratives project.

Chapter 7 Constructed Narratives Block Design

7.1 Goals of the Design of Constructed Narratives

The Constructed Narratives project is an experiment in the design of a *critical creative technology* that emphasizes problem solving, negotiation and construction of new knowledge through computer-supported collaborative play (CSCP). To construct is to creatively invent one's world by engaging in creative decision-making and problem solving activities. The act and metaphor of construction is used to demonstrate how a simple artifact – a building block – can provide an interactive platform to support discourse between collaborating participants. The technical goal for this project was the development of a platform for the design of critical creative technology applications that can process a dynamic flow of logistical and profile data from multiple system users and return in real-time an analysis of the state of the tangible social interfaces along with other contextual information (e.g. word search results) to support real-time interactive experiences.

Constructed Narratives is a construction kit of blocks that, when connected, form an open topology network. This *tangible social interface* is designed to uniquely respond to each builder based upon his/her profile and interactions with the blocks as they collaboratively build abstract structures with other builders at the game table. Construction patterns and keywords, drawn from each builder's profile completed prior to game play are used to seed a word search using the WordNet API (Princeton, 2006). The results of the word search are printed onto a three-dimensional virtual replication of the physically-built structure that is projected into the game space. Each action performed by a builder is recorded and cycled back into the environment, creating a persistent memory that is bounded by a reflection of the physical construction and layered with text that is themed around each builder's profile based on their self-identity, origins, home, work and play environments, and beliefs and value systems.

The Constructed Narratives project included the design of an extensive hardware and software system, and an experience design concept that not only engages the participant, but is greatly informed by the participant. It was designed with the following research goals in mind:

- Design an innovative interactive experience that integrates context-aware computing into applications for informal learning, arts and entertainment.
- Design an application that can facilitate learning and discovery of one's environment through the process of collective reflection and creative problem solving.
- Contribute to the development of interaction design methods for supporting face-to-face collaborative learning and play.
- Design tangible social interfaces that enable various modes of visualizing the knowledge and social networks in shared public spaces.

7.2 Design Methodology for the Constructed Narratives Block Artifact

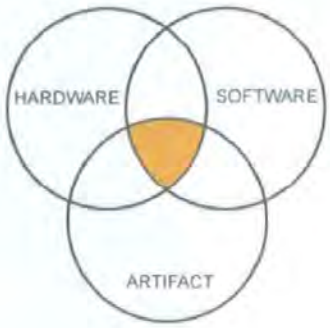


Fig. 32: Core Design Areas of the Constructed Narratives project.

An extensive series of iterative design sketches, scaled drawings, and prototypes in cardboard, wood and metal and plastic were produced throughout the design process. These boundary objects (Arias et al., 1997) guided an iterative process of simultaneous development of the block form factor, software and hardware in simultaneous development throughout the design of the project. Early revisions of boundary objects and designs are documented in appendix D.

The goals of the artifact design were to create a device that is robust, functional, eloquent and yet simple in form. The block artifact must facilitate deep play that enables builders to freely engage with other builders at the table about topics of the self in relationship to how that perception is mediated by the understanding of others at the table. Accomplishing these goals required that the design of the tangible social interface transcended the technical wizardry involved in its functioning, to present an inviting, simple, and technically-flexible device. It is important to state this as an objective because it has had profound implications on the design process itself. The process that is described below is

focused on developing a solution that is both a technically feasible and aesthetically coherent with the poetics of the project.

Five key design constraints that impacted technical and aesthetic decisions:

1. Software and hardware communication protocol used to facilitate data transfer between the blocks and the host-computer application.
2. The selection, including size and cost, and placement of internal electronic components for each block.
3. The development of a durable structure that can withstand handling by multiple people over an extended time.
4. The design of a modular assembly process that enables easy access to internal components and assembly of a variety of block shapes.
5. Access to technical, assembly, material and funding resources to achieve the items listed above.

Three basic requirements for the block design were identified including: (1) Simplicity – the block must resemble a simple primitive shape; (2) Material – the block must be made of wood with a minimum of other visible types of materials such as metals or plastics and; (3) Modularity – the block must be able to work aesthetically and technically as modular component of a larger set of blocks. Many compromises and alternative strategies where tested and applied during the project development. For example, the design of a simple primitive that could support asymmetrical stacking of blocks required that the basic block shape contain connection nodes I called appendages. As the design process progressed, a cost versus production time analysis forced the substitution of plastic casting rather than wood.

The following section seeks to capture the design motivations behind each design stage. The process was full of changes of directions based on, technical and aesthetic considerations.

7.2.1 Primary Generators for the Design of Constructed Narratives

"Complexity in design arises from the need to synthesize different perspectives of a problem, the management of large amounts of information relevant to a design task, and understanding the design decisions that have determined the long-term evolution of a designed artifact." (Fischer, 1999)

Fig.33: Children's construction toys descriptions categorized on art studio wall. The toys were categorized according to style, connector technique, and abstract quality of the primitive block form.

Designers typically employ early conceptual ideas or primary generators to frame a design process. The primary generator is a seed from which the development of concepts and solutions are cultivated into a producible artifact. (Darke, 1978) The SER Model: Seeding, Evolutionary Growth, Reseeding process (Fischer & Scharff, 2000; Fischer, 1999) is an alternative description of the horticultural metaphor for design process. The SER model emphasizes the transformation of complex design systems over time. The seed or primary generator is developed to allow modularity, extensions, and adjustments as the design process matures. The iterative nature of design lends itself not to the immediate design of final solutions but to the creation of design spaces where the primary generator or seed can be mulled, sampled, and coaxed into a plausible design solution. The primary generator for the block artifact, the seed of the Constructed Narratives project, was based on the computational architecture design methodology of Shape Grammars. One primary generator for the Shape Grammar theory was Froebel's kindergarten gifts. (Stiny, 1980)

Another great source of inspiration for the design of the Constructed Narratives project came from an extensive literature search on children's construction toys, including antiques such as A.C. Gilbert's 1913 "Mysto Erector Structural Steel Builder," and John Lloyd Wright's 1916 "Lincoln Blocks," to the contemporary LEGOS, Zoob, and

educational construction toys from the Hammetts Co. Learning Worlds catalog. It is interesting to note that both John Lloyd Wright and A.C. Gilbert were inspired by architectural construction sites; Wright, by the construction of the Tokyo Imperial Hotel designed by his father, Frank, and Gilbert by the steel beam supports for electrical power line towers he encountered daily during his train commute between New Haven, Connecticut and New York City. The design of Constructed Narratives was also inspired by the many research initiatives on electronic construction kits based on Jonathan Frazer's Universal Constructor project. (Frazer, 1995) Many electronic construction kit projects are reviewed in appendix B.

7.2.2 Shape Grammars: a Generative Methodology for the Design of the Constructed Narratives Block: Shape Grammars

"All children show an irrepressible longing for what we ... call play. Their whole life and soul, all their energies, all their thoughts seem absorbed by it.... It is through play that nature develops in the child all the faculties both of body and mind, in a safe and healthful manner. It is by playing that the child, when properly guided, acquires habits of industry, perseverance, order, regularity, and punctuality; that the nature of things reveals itself to him in a clear manner, easily intelligible to his capacity." (Hoffman, 1874)

Fig. 34: Froebel's Kindergarten Gifts, Enlarged 5th gift wooden blocks.

George Stiny described two exercises in formal design that demonstrate how shape grammars, based upon simple geometrical primitives, could be used to form original compositions and analyze existing design languages in architecture in his 1976 paper, *Two Exercises in Formal Composition*. (Stiny, 1976) Stiny's generating seed for the theory and practice of shape grammars was Frederick Froebel's kindergarten gifts, the first wooden block kits designed for the education of young children. Froebel's kindergarten gifts and early learning pedagogy held significant impact on the course of child education in the late 19th and 20th century. Froebel's kindergarten gifts demonstrated how compound, and sometimes complex designs could be built from simple primitive shapes. The kindergarten gifts pedagogy was developed as a tool for

socializing the young child, by empowering her with the tools to constructively replicate and re-design common objects in her environment as a means to implicitly understand the relationship between her and others and those objects of replication. Stiny recognized that many modernist artists and architects used techniques that relied heavily on repeated or signature patterns that could be broken down to primitive grammatical shapes. By identifying these primitive grammatical shapes the work of a particular style or practitioner could be recognized. By defining a shape grammar, complex forms could be designed. Much of the work about pattern languages in art using shape grammars is published in Stiny and Gip's 1978 book, *Algorithmic Aesthetics*. (Stiny & Gips, 1978; 1975)

Stiny noted similarities between Froebel's methods and the design studio process of designing. He proposed an approach to generating original grammars based on the Kindergarten pedagogies and methods of Frederick Froebel. This inspiration led to the development of the theory and practice of shape grammars, a method for identifying three-dimensional architectural referent grammars and new design languages based on a five-stage rule system including: a vocabulary of shapes; spatial relations; shape rules; initial shape; and shape grammars. (Stiny, 1976, 1980)

Although Stiny compared the process of directed play, inquiry, and construction of Froebel to the methods of creation and problem solving in the design studio, shape grammar theory was influenced foremost by the formal qualities of Froebel's kindergarten gifts. The use of shape grammars to define the block shape and experience design in the Constructed Narratives project is an attempt to forge a stronger connection between Froebel's pedagogical theories and Stiny's architecture design pattern generating theories.

7.2.3 Shape Grammars Methodology in Research and Practice

Shape grammar theory has been used to analyze many areas of creative production from the paintings of Mondrian and Chinese architectural styles to the architectural style of Frank Lloyd Wright.

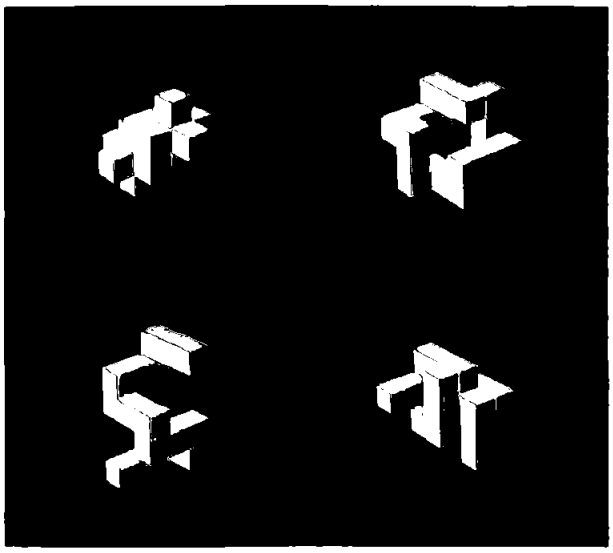


Fig.35: Shape Grammar examples from Terry Knight's online essay Shape Grammars in Education and Practice: History and Prospects. (Knight, 1999)

Terry Knight completed Ph.D. in shape grammars and has continued to research multiple facets of the theory. Her scholarly research includes: a proposed a way to develop grammars from past or existing ones (Knight 1981a); shape grammars for Japanese tea rooms (Knight, 1981b); Greek motifs (Knight 1986); color grammars (Knight 1989a, 1993, 1994a); paintings of De Stijl (Knight, 1989b); Mughal gardens (Knight, 1990); analysis of styles in visual arts (Knight, 1994b; and constructive symmetry and infinity patterns (Knight, 1995; 1997). In 1990 Flemming proposed a way of reading the work of an architect to derive the shape grammar rules and recombine them into new visual semantic systems. (Flemming, 1981; 1987a,; 1987b; 1987c) John Cagan at Carnegie Mellon University (CMU) has developed a computational approach to shape grammars and is using them in his engineering design computation group to develop methods and advanced tools for conceptual and configuration design of engineering systems. Application areas for Cagan's research group include: topology and shape configuration of innovative structures; automated layout of three-dimensional mechanical and electro-mechanical products; and design of mechanical consumer products. The research uses the shape grammar methodology to design coffee makers, Harley Davidson motorcycles, geodesic domes, and perform automatic annealing for

complex compact design spaces.(Reddy & Cagan, 1995; Cagan & Mitchell, 1993; Agarwal & Cagan, 1998; 1999; Agarwal, Cagan & Stiny, 1999; Schmidt & Cagan, 1996;Shea &Cagan; 1996; 1998; and Pugliese & Cagan, in press) Ramesh Krishnamurti, in the Carnegie Mellon University School of Architecture, incorporates shape grammars as a means to define formal and algorithmic aspects of a generative construction for geometrical modeling. (Krishnamurti & Stouffs, 1997; 1993; Krishnamurti & Roe, 1978; Krishnamurti & Earl, 1998; Krishnamurti & Earl, 1992)

Knight has also been very active in the integration of shape grammars theory into university level curriculum in architectural computational design. Continued research in shape grammars as a tool to analyze architectural styles has been an ongoing area of doctoral research at the Massachusetts Institute of Technology (MIT) in such projects as: Birgul Colakoglu's grammars of traditional housing in Bosnia; Andrew Li's shape grammar of Chinese building systems from the 12th century; and Jose Duarte's grammar of Portuguese architect Alvara Siza's housing systems. (Li, 1998a & 1998b; Duarte, 1998; 1997; 1999; Colakoglu, 2002)

7.2.4 Tools for Designing and Analyzing Shape Grammars

Knight points out that a critical problem in authoring an original grammar is the development of a system that will meet the goals and constraints of the project. Even the simplest design rules can produce very complex results. This can be a welcomed complexity as it opens up design possibilities that would have been very difficult to generate without the aid of a system of rules. However, this complexity can also quickly become unwieldy if limiting rules are not carefully set. (Knight, 1999)

Two techniques have been used to design three-dimensional structures generated by shape grammars. The first is to draw the rules and the shape combinations by hand using two-dimensional or three-dimensional tangible artifacts for visual reference. This process can be a long and arduous exercise that may eliminate potential designers from using shape grammars. Using physical artifacts as a reference to understand the relationship of basic primitive shapes is a technique that was used throughout the design of the Constructed Narratives project. More about this technique follows in this chapter.

The second technique for generating shape grammars is by software that generates the patterns computationally. The few software programs I found were task-specific research applications and not designed for general use. These programs were also often hard to use with many implied functions that were not fully developed into a usable graphical user interface. Such programs include the: AutoGrammar plug in for AutoCAD; 2D Shaper; Synthesizing three-dimensional shapes and rapid prototyping, and others. (Tapia, 1996; Tapia, 1999; Duarte & Simondetti, 1997; Wang &Duarte, 1998; Knight, 1998 McGill, 2001; Celani, no date)

A general process for analyzing shape grammars does not exist. The only way to test the rules of a shape grammar is by multiple enumerations of the design results that are generated by the rules. This process, when applied by hand, is tedious and can create erroneous results. The alternative approach to testing shape grammar rules is to develop the rules without a prescribed idea of their outcomes and then to use an automated search and test strategy to "explore the space of designs generated." The design exploration involves sampling and testing the designs to see if they meet the goals of the project. Jonathan Cagan's shape annealing method is an example of this approach. (Flemming, 1987; Knight, 1999; Cagan & Mitchell, 1993)

7.2.5 Methodology and Experiments in the Constructed Narratives Shape Grammar Design

Off the shelf tools for developing a shape grammar methodology for generating the Constructed Narratives block shapes and pattern language simply did not exist, as was clearly indicated in the previous section. Alternatively, I developed a unique shape grammar methodology that came into fruition during six cycles of learning through iterative trials, errors and successes. This process included quick prototypes made from wood scraps, hand drawn shape grammar rules, and the development of a shape grammar generating software. The six cycles of iterative methodology design were:

1. Wood prototypes exercise
2. Hand drawn shape grammar exercises
3. Patternfinder1 shape grammar software
4. Paradigm shift in Block design model
5. Patternfinder2 shape grammar software
6. Shape grammar visual attributes matrix

Fig. 36: Stage 1 wooden prototype based on two basic compound shapes.

7.2.5.1 Cycle 1: Wood Prototype Exercise

Rough tangible prototypes made from scraps of wood were initially assembled to aid in the visualization of the Constructed Narratives shape grammar. The use of these simple prototypes guided early inquiry and brainstorming activities at a time when the overall concept of the system was headed in a viable direction, but at an early stage when concrete plans for the functional design were at a nascent stage of development. At this early stage, I knew I wanted to design a block that encouraged orthogonal connection points to challenge the typical stacking qualities of most simple primitive shaped blocks. (See Appendix B, Construction Toys and Electronic Tool Kits for more information.) Each block was assigned a female (green) and male (red) connectable side. Each side contained six possible connection locations. A method was designed for recording the connected

block faces. This simple Boolean system of either connected or not connected did not provide enough detail to record the orientation (direction) of the attached block. The annotation system, the stickers, were applied by hand in a very tedious and error prone process. A system had to be developed to understand and map all of the possible connection combinations and patterns. Despite the limitations of this system, early basic physical prototypes of multiple-block constructions were constructed and visually studied.

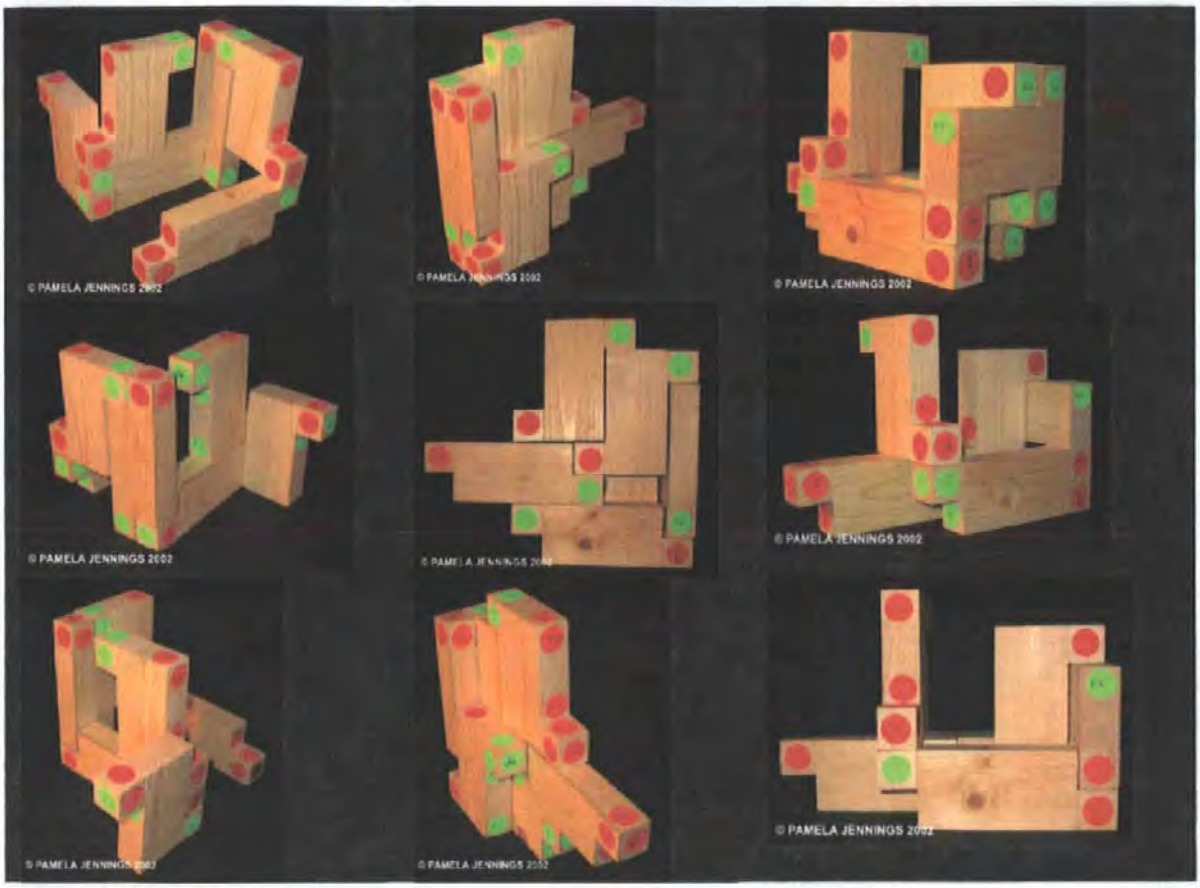


Fig. 37: Preliminary CN Shape Grammar Studies with early wood block prototypes. After working with the wood shape grammar prototypes it became evident that the possible design combinations made from only two shape primitives could be infinite and a computer program was required to optimize the shape grammar rules.

After working with the wood shape grammar prototypes it became evident that the possible design combinations made from only two shape primitives presented an intractable problem. This fact would have great implications on the development of a rules-based software architecture that could analyze the construction patterns. Alternative methods for the design of the Constructed Narratives shape grammar in relationship to the underlying computer software were sought.

7.2.5.2 Cycle 2: Hand Drawn Shape Grammars

CONTACT 1		CONTACT 2	
M1	F1	M2	F6
M1	F1	M4	F6
M1	F1	M5	F6
M1	F1	M6	F2
M1	F1	M6	F4
M1	F1	M6	F5

Table 4: Excerpt from the hand drawn shape grammar connection table.

The hand drawn shape grammars where calculated by manipulating the labeled wooden blocks and recording the connectable faces. The legal connections, meaning that the connected blocks did not intersect each other, were recorded in a table that indicated eighty two rules, not counting redundancies with thirty-six sets or categories of connections that were made from twelve possible contact points, six from the male side and six from the female side, per block. Table 4 presents set 1 from the hand drawn rules table.

Below each sketch of two block connections is the formula for that connection. Most connections referenced two faces for each block. For example the first rule quadrant of set 1 is `M1->F1 & M2->F6 or M1->F1 & M6->F2` which indicates that this rule is fulfilled when male face 1 is connected to female face 1 and male face2 is connected to female face 6 making one block connection. Figure 38 shows the illustration of the set 1 rules. Rather than grapple with three-dimensional drawing of the shapes the color tones are varied to indicate image plane depth. The darker the tone, the further back in the picture plane is the object. As mentioned earlier, the hand drawn process was necessary to lay the seeds for the subsequent shape grammar generating process adopted for this project.

The hand drawn process was a tedious and error prone process with no guarantee that all combinatorial patterns could or would be represented in the drawings. Despite the fallacy of this method, the repetitive meditative action enabled me to continue thinking about the design methodology while my hand attempted to tangibly embody the thoughts. The hand drawn shape grammars did not provide the details required to understand the orientation relationship of one block to another. It only accounted for the whole face (or side) connection points. The orientation of the connected blocks was not notated because the

wooden block prototypes where marked to indicate the face or surface of connection but not the orientation of the connected block. Drawing the blocks as three-dimensional objects was tedious and not deemed to be a valuable use of time.

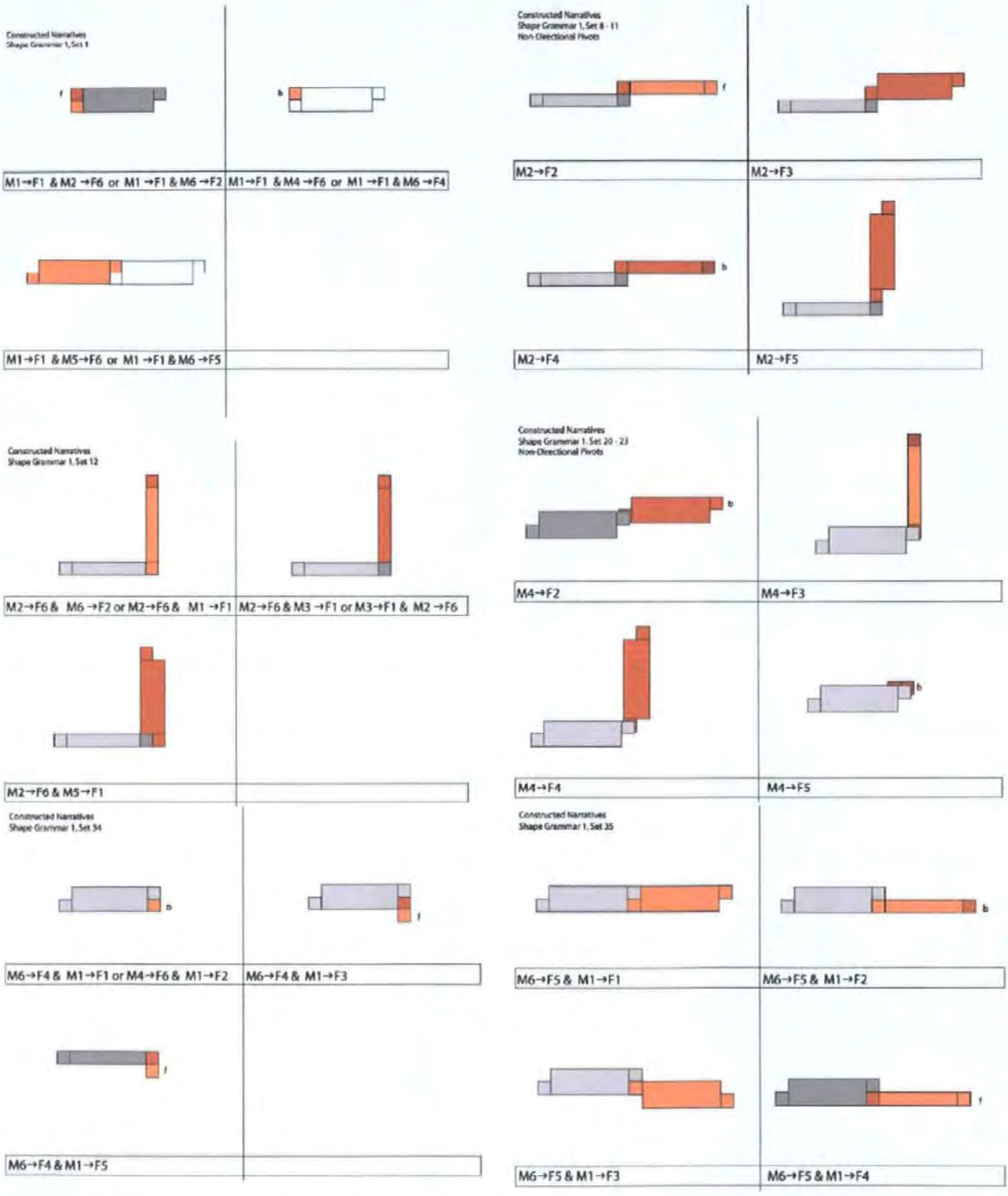


Fig. 38: Illustration of combinatorial patterns from Sets 1, 8-11, 12, 20-23, 34 & 35 of the hand drawn shape grammars.

7.2.5.3 Cycle 3: PatternFinder1 Shape Grammar Software

To solve the hand counting problem a computer software program called "PatternFinder1" was written in the Macromedia Director programming environment to calculate all possible combinations between the two block shapes. Thirty-six basic pair combinations, meaning one male surface connected to one female surface to make a connection and one thousand two hundred and ninety-six double pair combinations, two sides of each block formed connection points, were calculated. Even though the final list was not filtered for combinations when the blocks intersected each other, the number of plausible combinations continued to present an intractable problem which would have required an incredible amount of computer memory and processing speed to parse for any type of near-real-time interactive response.

7.2.5.4 Cycle 4: Paradigm Shift in the Block Design Components

The first conceptual model for the Constructed Narratives shape grammar involved the patterns created when two complete blocks were connected. This turned out to be a difficult and intractable problem to reduce to a small set of basic rules that could describe all possible block combinations in a Constructed Narratives structure. A paradigm shift occurred in cycle 4 of the block design methodology process. The shape grammar was initially though of as the pattern formed when two or more complete block shapes were connected. The paradigm shift moved the process from the macro perspective to the micro perspective and the shape grammar rules were applied to the generation of the form factor, or shape, of a single block. One single block, a shape grammar, was made of three modular units, the body that contained all of the network enabling circuitry and two appendages used to make the electrical structural connections between the blocks. This modular shape grammar system could be used to define thousands of block shape types that when combined could create complex structures. This new design space opened the possibilities

for developing a system that could support a large variety of open, extensive, abstract and expressive multi-block constructions.

7.2.5.5 Stage 5: PatternFinder2 Shape Grammar Software

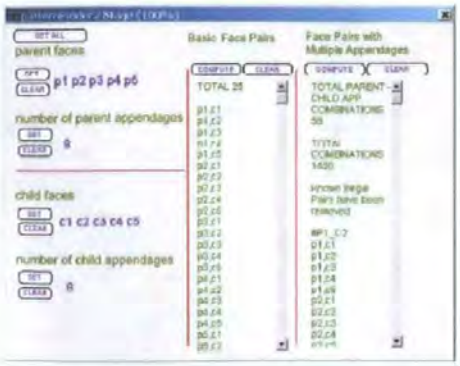


Fig. 39: PatternFinder2 application screen.
Fig. 40: Cardboard prototypes of component block design.

The PatternFinder2 software program was used to generate a list of all possible combinatorial sets for the three modular shape components: the body male and female appendages. This software program returned one thousand four hundred and fifty possible modular block shapes.

The shape grammar constraining rules reduced the set of plausible block shapes to fifty-eight, which was still a very large set of block shapes to design and implement into the Constructed Narratives system. The next task at hand was to develop a method by which to reduce the fifty-eight blocks for a set of optimum shapes to design and build.

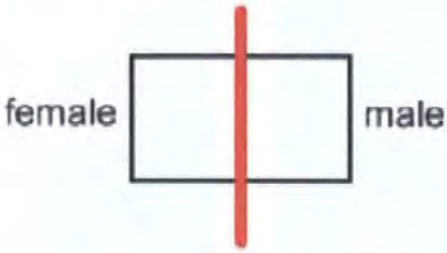
Table 5: Shape Grammar Constraining Rules for Constructed Narratives

1. Each block has two types of components, the body and the appendage.
2. Each block has only two appendages.

Body

Appendage

3. The body is divided in half through the longest side of the rectangle.
4. The left side is labeled "Female" and the right side is labeled "Male."

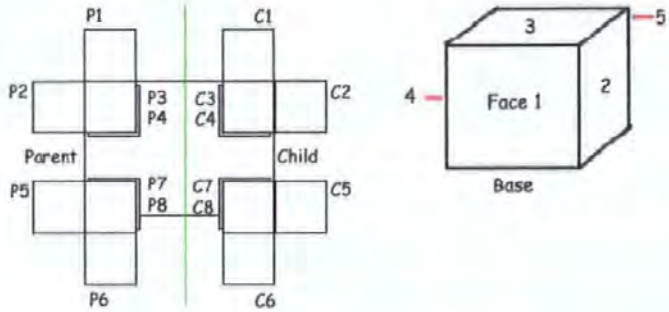


5. There can only be one appendage on the female side and one appendage on the male side.

6. The appendages can be applied to several locations on the body.

7. Appendages cannot be applied to the same lateral face on the body.
8. There are sixteen possible locations for the placement of an appendage.

9. Each Appendage has five faces that are connectable.



The first step was to reduce the duplicate solutions by examining the results output from the PatternFinder2 program. For example there may have been a pair (P6, C1) and (C1, P6) one would be eliminated from the final group of shape grammars. Once duplicates were removed, cardboard prototypes of the block modular components, the body and two appendages were made. The prototypes were assembled to represent the shape configurations and photographed.

7.2.5.6 Stage 6: Shape Grammar Visual Attribute Matrix

Photographs of cardboard prototypes for each shape grammar combination that passed the constraining rules weretaken and assembled into a visual matrix (fig. 41). The vertical axis represented the male (child) appendage positions relative to the block body and the horizontal axis represented the female (parent) appendage position relative to the block body. An earlier nomenclature used the parent/child relationship. It became evident as the network communication protocol was developed that the parent/child metaphor denoted a different relationship between network nodes than simply the opposite nodes on the block body. The resulting matrix was projected onto a whiteboard in the studio for visual examination and comparison of the uniqueness and/or similarity of each shape grammar (fig. 43 & 44).

Five key visual features, that referenced the placement of the appendages on the block body, were identified. The features identified the compositional relationship of the three block components and included: horizontal and vertical; balance and un-balanced; and mirror. The "horizontal" attribute occurred when the two appendages on the body rendered the horizontal dimension disproportionably longer than the vertical dimension. The vertical attribute indicated the opposite. The "balanced" attribute occurred when the appendages were placed on opposite sides of the block, i.e. top and bottom or left and right. The "unbalanced" attribute occurred when the balanced condition was not true. And the "mirror" attribute occurred when the appendages were on opposite sides of the block and diagonally across from each other. In other words, when the block shape was flipped over, it would look the same, except as a mirror opposite. The features were denoted using the symbols HB, HU, and HM for horizontal balanced, unbalanced and mirror and VB, VU, and VM for the vertical attributes (fig. 42).

Through the process of visual examination of the matrix: four horizontal-mirrors; eight horizontal-unbalanced; two horizontal-balanced; thirty-one vertical-unbalanced; four vertical-balanced; and four vertical-mirrored shapes were defined. The relationship between the shape description and its visual attributes can be made by comparing figures 41 and 42. All but fourteen were removed because they were duplicates. This made evident when the shapes were rotated. The final fourteen shape grammars are highlighted in red in figure 42. All fourteen shape grammars were viable solutions for block shapes. Resources and time dictated that three final shapes be selected based upon considerations of the difficulty of artifact design and desired aesthetic outcomes for a built multi-block construction. The final three shapes, P1C6 (horizontal mirrored), P1C7 (vertical unbalanced), and P3C8 (vertical mirrored) (fig. 45).

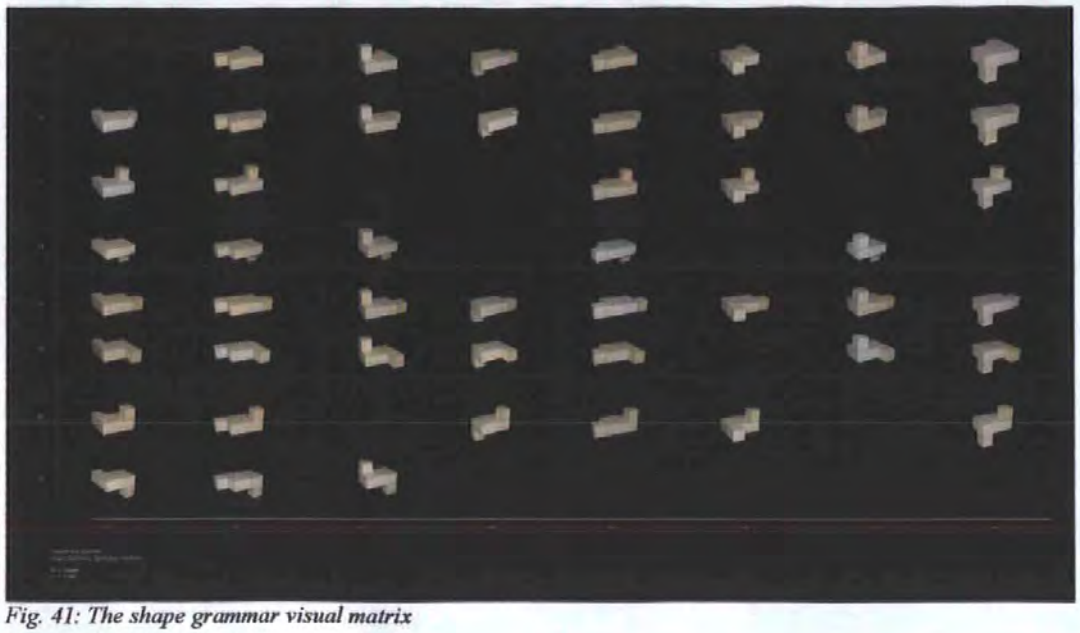


Fig. 41: The shape grammar visual matrix

14	Possible physical aesthetic relationships								
15		Horizontal		Balanced/Unbalanced/Mirrored			HB HU HM		
16		Vertical		Balanced/Unbalanced/Mirrored			VB VU VM		
17									
18	c1		HU	VU	VU	HU	HM	VU	VU
19	c2	HU	HB	VU	VU	HM	HU	VU	VU
20	c3	VU	VU		VB	VU	VU		VM
21	c4	VU	VU	VB		VU		VM	
22	c5	HU	HM	VU	VU	HB	HU	VU	VU
23	c6	HM	HU	VU	VU	HU	VU	VU	VU
24	c7	VU	VU		VM	VU	VU		VB
25	c8	VU	VU	VM		VU	VU	VB	
26		p1	p2	p3	p4	p5	p6	p7	p8
27									
29									
30		HM	HU	HB	VU	VB	VM		
31	Total	4	8	2	31	4	4		

Fig. 42: Excel sheet tabulation of shape grammar visual attributes.

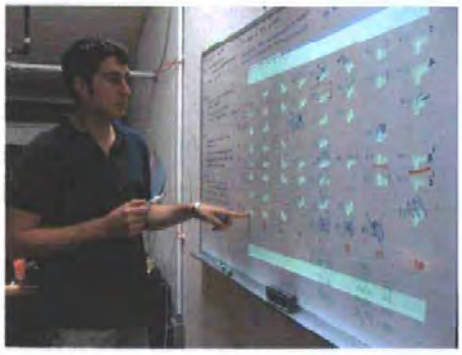
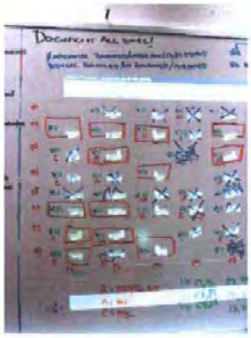


Fig. 43: Research Assistant helping to identify visual shape grammar attributes.



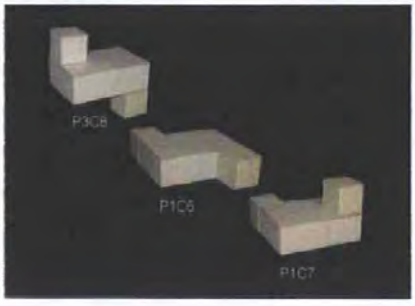


Fig. 44: Shape Grammar Visual Attributes exercise with projection on white board.
Fig. 45: The final three shape grammars for the Constructed Narratives blocks.

7.2.6 The Design of the Constructed Narratives Block

Once the Constructed narratives shape grammars were determined, I and my research team embarked on the physical construction of several working prototypes. The sections below begin with prototype design version 4.0. Earlier prototype design sketches and models followed design ideas that were generated before the shape grammars methodology was incorporated in the design process. To present a complete picture of the block design, information about prototype versions 1.0 – 3.0 are available in Appendix E "Early Design Prototypes."

7.2.6.1 Block Design Version 4.0 Functional Prototype

7.2.6.1.1 Design Features

Version 4.0 of the block prototype design was the first to follow the rules as defined by the Constructed Narratives shape grammar design methodology. Refined sketches drawn to scale indicated the placement of internal electronic components and unique structural features for aesthetics, stability, and airflow (fig. 46 – 48). Solutions were found to optimize the limited internal space and provide access to all of the internal components during testing and assembly. A technique to connect and disconnect the appendages to and from the block body, as well as maintaining access to the internal electronic components was a requirement for the modular component design. Design requirements introduced various constraints in the selection of electrical and mechanical connectors, the placement of sub-miniature screws for "easy" assembly, and routing of multiple internal wires.

The RFID antenna was attached to the lid of the body and a stacked circuit board with three layers was indicated and developed simultaneously (See chapter 9 "Hardware Development".) The problem of housing sixty-five connecting wires from the appendage to the circuit boards housed in the body continued to be a hard to solve and will continue to be researched in future block designs.

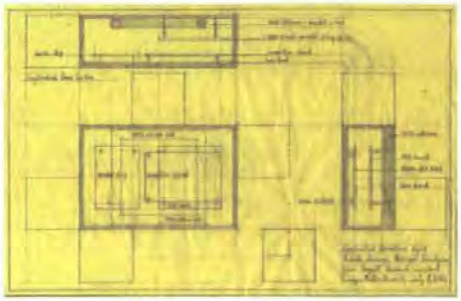


Fig. 46: Block Version 4.0 scaled sketch.

Fig. 47: Air flow built into the block seams.

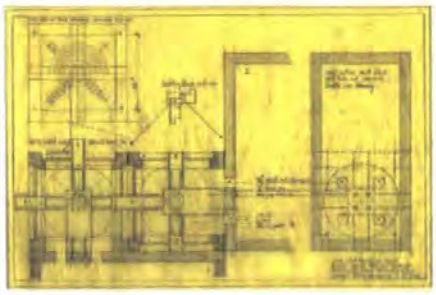


Fig. 48: Scale sketch of the internal supports and structure of the block body and appendage.

7.2.6.1.2 Design Materials

Wood, a historical reference to Froebel's kindergarten gifts, was viewed to be a very important material for a desired aesthetic experience for the builder. Wood, a familiar organic material, could be a familiar haptic experience for all Constructed Narrative builders, regardless of their age, nationality or background. For a certain generation of adult builders, wood would hopefully conjure memories about youthful play. Of course, younger Constructed Narrative builders may have less formative experience playing with toys made from natural materials, but their knowledge of building with LEGO blocks and Erector Sets, and countless other construction toys would suffice for the lack of experience of playing with toys made from natural materials. Wood was also viewed as a metaphorical material for building architectural structures. The natural tones and abstract material qualities would open the mind of the Constructed Narratives builder to be inventive with her construction explorations.

7.2.6.1.3 Appendage Design

Finding a robust method to design the appendages proved to be a difficult task. At first sight, the appendage looks to be a mere cube that is attached to the block body. However, the assembled cube had to: support five small circuit boards; not be permanently affixed to the block body; be structurally sound to handle multiple connections and pulling apart; and robust enough to hold the weight of other connected blocks; and complement the desired aesthetics of the form factor. The hardware solution for the blocks was designed

simultaneously along with the software system architecture. All three of these development processes greatly influenced each other as they related to the design of the appendages, block connection circuit boards, and software communication protocols.

Sketch, cardboard, wood, and brass quick prototypes that experimented with techniques for reinforcing the corners of the appendage cube and affixing the appendage circuit boards were explored (fig. 49 & 50). Starting with a solid cube of wood, a subtractive process was explored, where the inside of the appendage was routed out to accommodate electronic components and wires. This sculptural approach was discarded once it was realized that the appendage was a much more complex structure. Additive methods were then explored that enabled the construction of the appendage from unique lengths of wood resulting in a wire frame structure. Several design iterations were required to develop methods to accurately align all five circuit boards into the appendage. Given the irregular shape of the overall blocks, accuracy was required to assure a solid electrical and structural connection between blocks. Several eloquent design concepts were hard if not impossible to make given the lack of appropriate prototyping tools such as a CNC machine. Those concepts were shelved for a later time when the appropriate resources for the concepts can be identified and accessed.

7.2.6.1.4 Design Constraints

The block had to be constructed to withstand manipulation by many hands. Methods for reinforcing the box corners were explored including dovetail joints, brackets, and internal scaffolds made from wood and metal. Various wood joint techniques were considered including glue, pegs, nails, screws and bolts. Baltic birch plywood was selected because of its relative stability with temperature fluctuations, after experimenting with various types of wood and composites from pine to MDF (medium density fiberboard) (fig. 51 & 52).

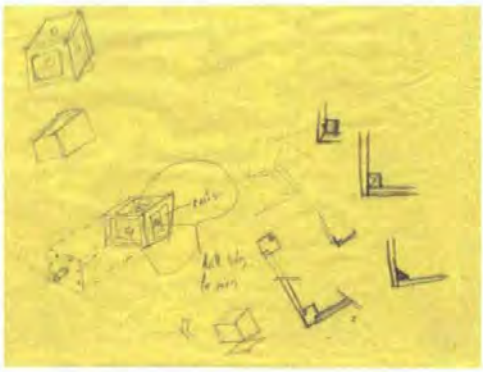


Fig. 49

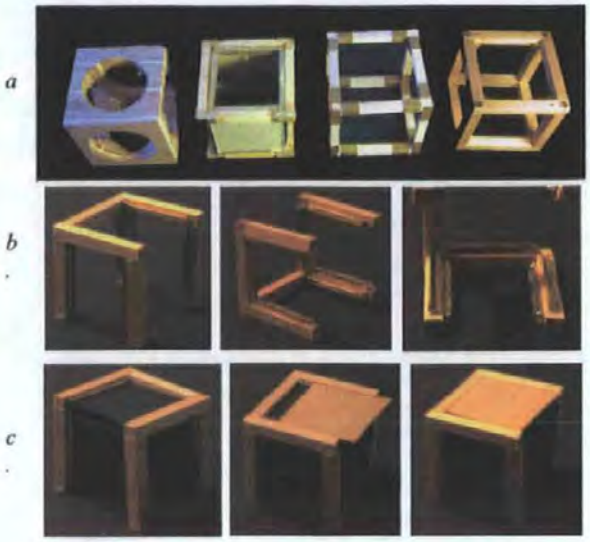


Fig. 50

Fig. 49 Rough sketch ideas for the assembly of the appendage cube.
Fig. 50: (a) Four prototype ideas for the structural design of the appendage. (b) and (c)prototype concepts for circuit board support.

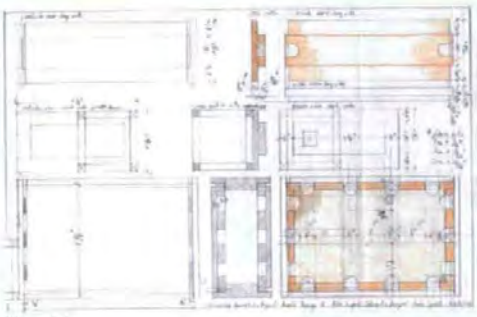


Fig. 51

Fig. 52

Fig. 51: Scale drawing of wooden block construction plan.
Fig. 52: Models of the first three wooden Constructed Narratives block, some with early electrical connection circuit boards along with two of the cardboard prototypes.

Each block body would contain several heat emitting electronic components, which made necessary the development of a techniques for unobstructed air circulation. Ideas explored included visible air flow ducts on the sides of the block and techniques that recessed the air flow ducts into the adjoined sides of the block body. The latter technique, shown in figure 47, proved to be the most promising in terms of integrating the airflow requirement smoothly into the block design.

In summary, Design constraints that greatly influenced the iterative design process of the wooden block prototypes included: 1. the order of assembly of each component of a complete block; 2. construction techniques; 3. ability to reverse the design process for

substitution of solution parts; 4. development of a system with components that could be fixed or replaced; 5.electrical and structural connection solutions; and 6. the cost of the solution. As the prototyping proceeded information about the relevance of these constraints in relationship to viable solutions was learned. It became apparent that the cost of designing a functional simple looking artifact turned out to be quite costly in terms of development time and the number of solutions proposed to solve the design problems. Some of these constraints were easier to address using CAD (computer aided design) for processing plastic components rather than wood as explained in section 7.2.8.

7.2.7 Electrical Connections

Several techniques for providing electrical connectivity and structural stability between the blocks were examined. Quick ideation sketches were generated to understand the relationship between the shape of the block, network communication protocol, connector facets, probes, and supports for structural stability (fig. 53 & 55). These sketches helped to clarify the implications of combining or separating electrical and structural connectors. Early design assumptions supported the wisdom of separating the electrical and structural connectors, so that a fault in one would not cause a fault in the functionality of the other.

Prototype design version 1.0 and 2.0 (described in Appendix D) were based on the Dallas/Maxim I-button technology. The I-button is a small microprocessor embedded in a snap-like connector and is typically used as a unique identifier for security applications (e.g. access to a computer, or passage into a restricted area of a building). The concept involved interfacing the I- Button with the network enabled microprocessor embedded inside each block. The thick form factor of the I-button (fig. 54) coupled with the convex surface of the "H" shaped block, from prototype version 1.0 – 3.0, presented unacceptable constraints on how the blocks could be connected in a construction.

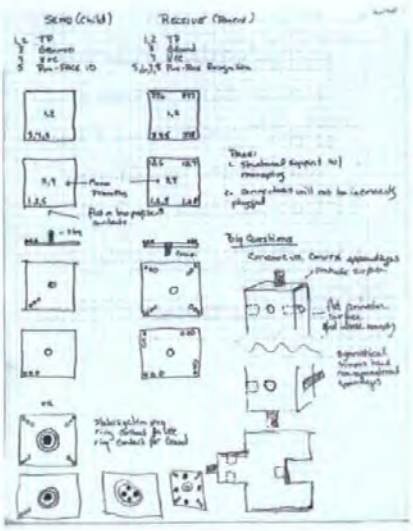


Fig.53: Quick idea sketches made to understand the implications of the connectors on the block shape.

Fig. 54: I-Button from Dallas/Maxim.

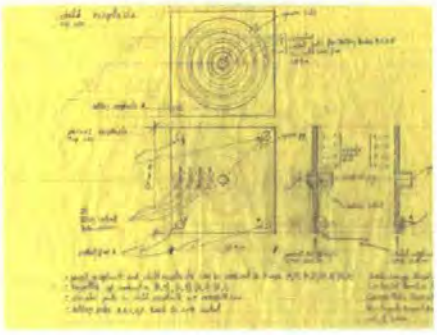


Fig 55: Sketch for a Battery Probe Design.

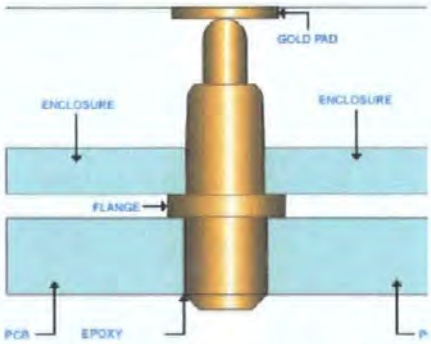


Fig. 56: IDI Battery Probe Soldering diagram.

Other evaluated connector technologies that included: mono; stereo and four connector jacks; DC connectors; snaps; I-buttons; Mill-Max probes; and IDI battery contact probes. (Mill-Max, 2006; Interconnect Devices, 2006) Interestingly, the initial solution for the electrical connections was the IDI spring battery probe (fig. 56). Less optimal solutions were implemented early on due to the difficulty in acquiring spring probe samples and a developing knowledge-base about the implementation process. As the knowledge-base for the assembly of industrial components increased, such as the design of multi-layered circuit boards, the IDI probes were re-introduced and incorporated into the current design prototype. The current electrical connector solution provided the means to add information about the block orientation using a minimum number of probes. More information about the two bit block sensor system is in chapter nine "Hardware Design".

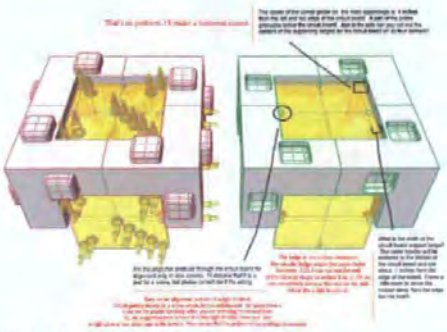


Fig. 57

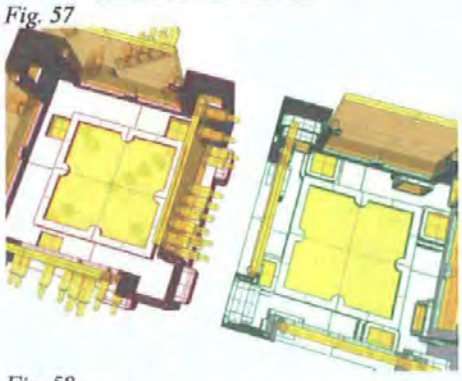


Fig. 58

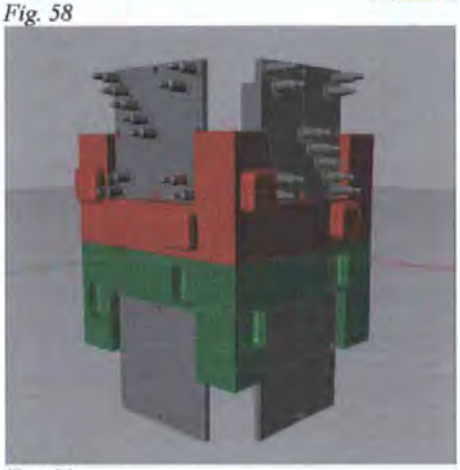


Fig. 59

Fig. 57: 3D CAD design sketches with notes with annotations about design specifications.
Fig. 58 & 59: Details of 3D CAD design.

7.2.8 Optimizing the Prototype Production using Rapid Prototyping Methods

Despite my "love" of wood as a metaphorical material, many design constraints could not be met and the block prototype was redesigned as CAD model and for plastic castings (fig. 57 – 59). As a quick re-cap to the theory of multiliteracies, as addressed in chapter five, the Constructed Narratives project was trapped in the multiliteracies definition of "design." The process was victim to the limitations of the available development tools. Switching to a three-dimensional CAD process for stereolithography output solved many of the design issues encountered with wood but also highlighted some new issues stemming from the process of designing for urethane molds. Chapter eleven "Public Presentations and Future Plans" outlines the next directions for the block design.

7.2.8.1 CAD Modular Design

The most important attribute learned from the wood prototype experiments was the implementation of gestalt principles in the design – mainly the construction of a complete shape grammar from modular components. The wood solution viewed the three shape grammar components, body and two appendages, as unique objects. Although the male and female wood appendage frames were identical (with the different functionality of the appendage determined by the electrical connectors), the methods required to affix them

securely to the block body required that each block body be uniquely designed to fulfill the arrangement requirements for the shape grammar.

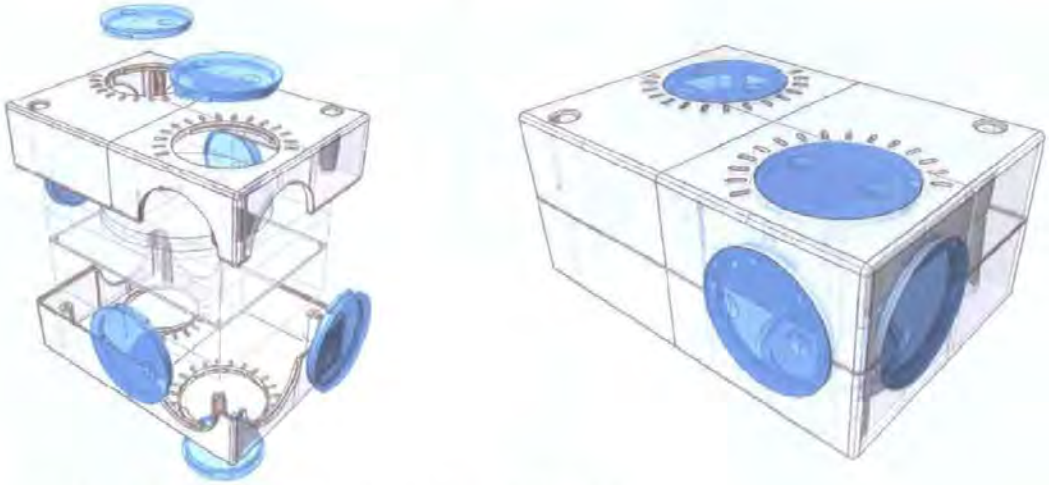


Fig.60: Exploded and assembled view of the block body CAD model.

A modular assembly process was built into the design of the CAD model (fig. 60). The block was now exploded into seven unique openly configurable components. Two components fit neatly together to make the body, two components for the female appendage, two for the male appendage, and the final component -a cap - to cover strategically placed appendage portholes in the body. The portholes were strategically placed allowing flexibility in the placement of the appendages and providing a means to build several shape grammars with the same parts, a new contribution to the overall design afforded by the design methodology. The caveat here is that, in viewing the on-screen CAD model, the solution seemed optimum. Placing the circuit boards by hand was another challenging task – one that would be much easier and more efficient if the parts were automatically assembled using a milling machine process or directly pluggable into the plastic block shell. (See chapter eleven "Public Presentations and Future Plans".

The CAD models were processed as seven unique stereo lithography models. The models were then used to make urethane molds and a small run of duplicates were cast in plastic. Although the rapid prototyping process using stereo lithography was a much faster process,

it was a far more costly because of the small number of plastic castings to be made. Therefore only four CAD designed blocks have been assembled. As a note, the cost of this process would be greatly reduced if multiples minimally in the hundreds were made.

Fig. 61: Stacked male and female appendages CAD model.

The CAD model was produced in roughly four weeks. The speed of this process was made possible by knowledge gained during earlier design versions.

7.2.8.2 Structural Connections and Supports

Structural supports could be easily molded directly into the walls of the appendage structure with this process. A mechanical connection solution of protruded asymmetrically nodules where built into all connectable sides of the appendage to assist in alignment when blocks were attached (fig. 61). This solution solved the problem of keeping the blocks in alignment. However, it was not designed to provide strength to hold the blocks together and maintain the integrity of the electrical connections. Many rare earth magnets with ten pound holding strength were permanently placed inside the appendages with epoxy putty and glue (fig. 62 & 63).

This may seem excessive, but once the blocks are completely assembled with all components and magnets, the magnetic bond was barely enough to hold attached blocks with a left or right bearing load. This is a problem that will be solved when the block size and internal components can be miniaturized in future design rounds. See chapter eleven for more information about project future plans. The technique for placing the magnets was discovered through many experiments with various epoxy glues. It would have been preferred to design a chassis to hold the magnets in the plastic structure.

Fig. 62

Fig. 63

Figs 62 & 63: Student research assistants using epoxy to place magnets into plastic appendages.

The chassis molded into the plastic added conditional cost to the process and the design was simplified with a compromise of a harder assembly process.

7.3 Learning by Doing: Reflections on a Generative Design Process

It is important to notice that in designing a three-dimensional working prototype, learning occurs primarily in reflection in action. (Schön 1983) This means that one understands about proposed solutions by building them with physical models and, to a lesser degree, by drafting solutions on paper that represent the complexity of the three-dimensional design. Through the act of building a functional prototype important questions regarding materials and strategies for approach are discovered. Theoretical solutions can work in the stage of ideation but can only be tested after they are built. In the process of drafting and building prototypes one is physically confronted with problems that are not anticipated in brainstorming or ideation phases. The Constructed Narratives shape grammar design process demonstrates that optimal solutions are built upon experimentations that prompt a deeper examination of the problem and an arrival at the most advantageous solution that optimizes and while finding a compromise to the stated constraints.

Donald Schön's notion of reflection-in-action or 'thinking on your feet' is focused largely upon the construction of the problem and strategies of action or models of the phenomena that are employed. There are three dimensions of the design process outlined by Schön's theory of reflection-in-action. The *use of the language of design* involves the domains of language in which the designer describes and appreciates the consequences of his/her

choices. The *implication behind a decision requires* a designer to mentally map and manage a number of tentative options that can lead to apprehension of new problems and potentials. Finally, the designer must remain *flexible and able to accommodate changing their stance* as required throughout the design process. (Schön, 1983)

Multiple iterations of sketches, scaled drawings and physical models led to the design of the *Constructed Narratives* block. The fluidity of this process enabled the research team to draw upon the technique that could best answer the design or development question of the moment. Simple drawings and quick cardboard mockups were the most useful in aiding the brainstorming process. The development of scaled drawings with exact measurements and scaled physical models were important to the integration of hardware components. Functional and aesthetic design requirements were negotiated through iteration brainstorming and experimentation that supported a process of adding, substituting and removing design elements to invent an optimized solution.

The five design constraints mentioned earlier in this chapter were all met, challenged, grappled with, defeated and/or forced into compromises for the current design. The issue which presented the toughest hurdles was the lack of appropriate development facilities to properly realize the construction of the design. Despite this issue, three wooden prototypes were realized which were invaluable in informing design techniques for the CAD model and stereo lithography process. Four CAD model plastic blocks were built and presented as working prototypes at the Inter-Society for Electronic Arts (ISEA) 2004 Kiasma Center for Contemporary Art in Helsinki, Finland. More information about presentation can be found in chapter eleven.

Chapter 8 Constructed Narratives Software Development

"To identify predictable patterns is of course useful for controlling events or taking advantage of them. But beyond control, could a certain kind of sensitivity to the complex eddies and flows of intersubjective exchange allow one to help precipitate the unknown? Could one, say, recognize pattern formation and intervene where a new pattern could possibly come into formation? Or in another direction: could an aesthetics of patterned consciousness reveal the social nature of human autonomy? Could one learn to accept one's own interventions as precipitating a shared unknown? Could this become a more powerful and pleasing game than proprietary accumulation?"
(Andreas Broeckmann, 2001, p. 104)

8.1 System Architecture Overview

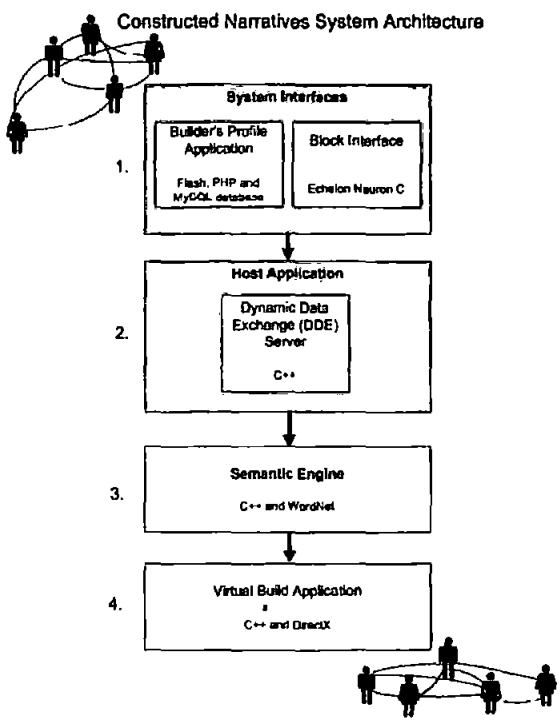


Fig. 64: Constructed Narratives System Architecture Schematic.

The *Constructed Narratives* system architecture consists of four interconnected development layers: (1) system interfaces; (2) host application; (3) semantic engine; and (4) virtual build application. (fig. 64) In the schematic, each development layer is viewed as a separate component for understanding their interdependent relationships. However, layers two through four merge into a single application. Software development platforms and API's (application program interface) used in this project include Neuron C, C++, PIC Basic, PBasic, DirectX, Flash, WordNet, PHP, MYSQL and Director Lingo. API's for the code are available upon request.

8.1.1 System Interfaces

The system interfaces include the Builder's Profile application and the Constructed Narratives blocks. Together, these interfaces provide a means for participating builder's to input and manipulate data with the Constructed Narratives game.

8.1.1.1 Builder's Profile Application

The Builder's Profile application is an online questionnaire completed by each participant prior to game play. The questionnaire is used to create a self-descriptive profile of each builder that is incorporated into the system of the semantic engine as a method to create a uniquely responsive interactive experience for each builder. Further information about the Builder's Profile Application can be found in section 8.3 of this chapter.

8.1.1.2 Physical Interface Devices: Building Blocks

The building blocks as described in chapter seven are the primary input mechanisms. Blocks in a construction form an open-topology network that transmits its status in real-time using a twisted-pair communication protocol to the host computer application. Further information about the microcontroller software can be found in section 8.5 of this chapter and the hardware design in chapter nine.

8.1.2 Host Application

The host computer application is responsible for aggregation of the data coming from the builder's profile and topographical data about the placement of the physical blocks. Data from the physical interface devices is passed to the host computer application using a DDE (dynamic data exchange) server. Given the dynamic nature of this network, the host application records the relationships between blocks in the real-time as they are physically connected. Real time data collected by the host application is passed to the Semantic Engine for further contextual processing. Further information about the Host Application can be found in section 8.5.2 of this chapter.

8.1.3 Semantic Engine

The semantic engine is responsible for identifying and processing patterns found in connected blocks in the physical construction. The patterns are associated with data from the Builder's Profile application. The patterns and properties of the blocks (e.g. connection

points and block ownership) are used to seed a word search using the WordNet API. The search algorithm is based on a visual semiotics and rhetoric theory developed by visual semiotician Jacques Durand. Further information about the Semantic Engine can be found in section 8.6 of this chapter.

8.1.4 Virtual Build Application

The Virtual Build application is a three-dimensional navigable environment that matches in real-time the construction made with the physical blocks. It was designed to be projected into the play arena. Results from the Semantic Engine word search are printed on each block in the Virtual Build application. Further information about the Virtual Build Application can be found in section 8.5.3 of this chapter.

8.2 Software Development Principles

Four software development principles helped to guide the development of a near real-time, modular, open-topology network for physical devices. First, the system must grapple with amorphous computing issues and correctly handle seemingly infinite combinatorial relationships between its components. Second, the system must prove to be robust enough to handle any and all possible properly formatted input data. Third, principles of web extensibility, interface design aesthetics, data accessibility and persistence were adhered to guarantee system interoperability. And finally, implementation skills and technology learning curves for the research team were considered in all aspects of the system development.

8.2.1 Web Extensibility

The current version of the Constructed Narratives built for a single physical environment. Future versions of the game will be designed for online play with the potential of connecting builders and locations through the Internet. Designing a software system that

can be converted to a web-based application with minimum revisions was a major criterion in the selection of the enabling technologies. Web-enabled technologies (e.g. XML, PHP, MYSQL, Flash) where selected when possible over development environments that are not readily web-enabled.

8.2.2 Interface Design Aesthetics

The aesthetic appeal of the screen design of the Builder's Profile and Virtual Build applications as a means to "seduce" prospective builders to engage in the activity was a high priority. Applications such as Macromedia Flash and Director were selected for the Builder's Profile application because of their support of many types of multimedia assets and advanced programming functionalities. The Virtual Build application was written in C++ using the DirectX API.

8.2.3 Data accessibility and Persistence

The ability to "seamlessly" access (push or pull) data on demand between components of the software and hardware system was another system requirement and careful attention was made in the selection of technologies for their integrated communication functionalities. For example PHP is used as a common gateway interface between Flash and MYSQL database. The MYSQL data is output in a tabulated data format that can be read and parsed by the host computer application written in C++. That data is then fed into the Semantic Engine for processing.

8.2.4 Implementation Skills and Technology Learning Curves

It was crucial that the skills required for the selected enabling technologies matched the skills of the development team or were learnable in a relatively short time frame. The challenge to implementation did not lie solely in the learning curve for any one component

but in understanding the connection between system components and the impact of how a decision or processes greatly affected each component of the design.

8.3 System Interface: Builder's Profile Application

Constructed Narratives is not simply a smart construction kit connected to a computer for tracking component configurations. Rather it is a system following a philosophical premise of designing interactive technologies to serve as public discourse mediators or discourse wranglers. The hypothesis for the development of this tool is that the intersubjective relationships between builders can be inferred and amplified by making visible notions of the builder's concept of self in relationship to his or her immediate lived environment. A primary goal for the design of *Constructed Narratives* system was the design of an intersubjective interactive system that reflects the preferences, profiles and thoughts of each unique builder in the system. The method developed to achieve this goal begins with the Builders' Profile Application. The Builders' Profile Application is simply and online questionnaire. Upon completion of the short survey a persona profile is created and used to initiate a rules-based word search algorithm in the Semantic Engine. The word search result should reflect ideas, concepts, and concerns that are relevant to the builder in relationship to other builders at the play table.

8.3.1 Builder's Profile Application and Social Science Research on Personality

Inference is a key concept here. This tool is not being developed to analyze or validate factors about personality types, values or beliefs systems. However, its design is influenced by research methods developed by social scientists including the five-factor model for personality and social attitude factors. (Costa & McCrae, 1992; Saucier, 2000)

8.3.1.1 The Five Factor Model

The five-factor model (FFM) is a hierarchical organization of personality traits characterized by five basic dimensions: extroversion, agreeableness, conscientiousness,

neuroticism and openness. The five-factor model is used as a tool to analyze various constructs of personality in the psychology and behavioral science research communities. It was not until the 1980's that researchers, studying personality from different traditions, were in consensus about the core five personality factors based on numerous versions of self-reports, natural languages and theoretically-based questionnaires that have been administered to children, college students, and older adults both men and women, as well as within different cultures. A cumulative review of these various personality assessment tools were used to determine the five fundamental dimensions (five factors) of personality by experts in the field.

Two methodological approaches have been used to research attributes of the five factor model. The first is language analysis. The second is the use of tools for self-assessment such as questionnaires. The five factor model (FFM) originated with the lexical study of terms used to describe personality traits in a given language. Descriptive adjectives are used to classify the five factors (table 6). (John, 1990) These terms were abstracted from a dictionary and categorized into synonym clusters. The lexical approach was based on the fact that the layperson regularly engages personality trait terms as a way to understand themselves and others. (Gough 1987) The hypothesis of the lexical approach to personality studies is based on the idea that speakers of a natural language, at some point in the evolution of language, have articulated all important individual trait differences. If it is possible to decode this lexical labyrinth using language analysis, then a "comprehensive taxonomy of personality traits" will emerge. (McCrae & John, 1992) However, there are at least 4,500 trait terms in the English language. (Allport & Odbert 1936; Catell 1946)

Extraversion (E)	Agreeableness (A)	Conscientiousness (C)	Neuroticism (N)	Openness (O)
Active	Appreciative	Efficient	Anxious	Artistic
Assertive	Forgiving	Organized	Self-pitying	Curious
Energetic	Generous	Playful	Tense	Imaginative
Outgoing	Sympathetic	Reliable	Touchy	Insightful
Talkative	Trusting	Responsible	Unstable	Original
		Thorough	Worrying	Wide Interests

Table 6: Examples of Adjectives that define the Five Factors Personality Scale.

Most personality assessments have been based on specifically applied questionnaires and not language analysis, which has played a small role in this area of social science research. Questionnaires and scales for testing personality have been as numerous and diverse as the descriptive adjectives that have been correlated with the five factors. There are a few well known tools among the myriad of approaches including: the Hogan Personality Inventory (HPI; Hogan 1986); NEO Personality Inventory (NEO-PI; Costa & McCrae, 1992); California Psychological Inventory (Gough 1987); Multidimensional Personality Questionnaire (Tellegen; 1982); MMPI Personality Disorder Scales (Hathaway & McKinley, 1940); Minnesota Multiphasic, Guilford-Zimmerman Temperament survey (J.S. Guilford, Zimmerman & J.P. Guilford, 1976); and Myers-Briggs type Indicator. (Myers & McCaulley 1985)

8.3.1.2 Cross-cultural Research

Most of the researchers in personality factors have been from the United States; therefore English has been the main language of choice for lexicon-based studies. (John et al., 1984) Cross-cultural research in personality factors did not become prevalent until the 1990's. The first non-English studies were completed in Dutch and German with similar five factors to those used in English language personality research tools. However, a simple one-to-one correlation between factors across cultures is not possible. For example, the fifth factor of intellect and imagination was replaced with unconventionality and rebelliousness in the Dutch studies. (De Raad, Mulder, Kloosterman, & Hofstee, 1988, Hofsee et al., 1997) Studies in a wide variety of non-Germanic languages have been conducted including: Chinese (Yang & Bond, 1990); Czech (Hrebickova & Ostendorf,

1995); Hebrew (Almagor et al., 1995); Hungarian (Szirmak & De Raad, 1994); Italian (De Raad, Di Blas, & Perugini, 1998); Polish (Szarota, 1995); Russian (Shmelyov & Pokjil'ko, 1993) Pilipino Tagalog; (Church, Reyes, Katigbak & Grimm1997); and Turkish (Somer & Goldberg 1999). Generally, the Five Factor Model is adapted in these languages and cultures to include additional factors that account for cultural/social differences in the description of emotions. (John & Srivastava, 1999)

8.3.1.3 NEO PI-R Test

In particular, the NEO PI-R test was evaluated for use in the Builder's Profile application. This personality assessment tool consists of a series of questions for each of the five personality factors. Examples of the NEO PI-R questions include: Neuroticism – "I am easily frightened." or "I often get angry with the way people treat me."; Extraversion – "I really like most people" or "I like to be where the action is."; Openness – "I have an active fantasy life." or "I have a lot of intellectual curiosity." Agreeableness – "I believe that most people are basically well-intentioned." or "I would hate to be thought of as a hypocrite." and Conscientiousness – "I pride myself on my sound judgment." or "I've worked hard to accomplish my goals." (Costa & McCrae, 1992) These questions require the participant to reflect on his/her immediate emotional state ("what I feel") rather than intersubjective cognitive awareness ("what I do and think"). However, my review of the five-factor model methodology provided validity for the development of a cross-cultural profile tool for use in the Constructed Narratives project.

8.3.1.4 Social Attitudes

> *Social attitudes are sets of beliefs "whose referents have shared general societal relevance to many people in religious, economic, political, educational ethnic and other social areas." (Kerlinger 1967)*

Personality research is concerned with consistencies in patterns of behavior. Research in social attitudes and beliefs is concerned with patterns of cognition. Saucier's study, in

social attitudes, seeks to understand if the two domains, personality and social attitudes influence each other. Whereas, the NEO PI-R test focuses on the individual's emotional state, Saucier's study focuses on the cognitive and, to some degree, the intellectual aptitude of the participant as it can be aligned with personality types. Saucier's initial 400 question mega-tool was reduced to a twenty-eight item shortened version comprised of contemporary value and belief systems. He admits his methodology is laden with potential fallacies. However, the share brute force by which he analyzed the English dictionary to develop a lexicon approach to the study of social attitudes is to be commended. Saucier's research offered insights for the design of the Builder's Profile application. (Saucier, 2000)

Saucier's research is based on the premise that beliefs strongly influence an individual's opinions, positions and evaluations. Saucier asks, "What are the basic dimensions of individual differences in social attitudes and beliefs? How can they be suitably measured? In his journal paper *Isms and the Structure of Social Attitudes*, three broad orthogonal factors in the structure of social attitudes are defined. These factors were shown to be virtually independent of personality factors with the exception of the factor of openness. Historically, the study of social attitudes has focused on three constructs: Conservatism; Authoritarianism; and Dogmatism with an added fourth construct called Religiousness. All four constructs have been observed to be highly correlated through various studies dating back to the early 20th century. (Vetter 1930; Likert 1932; Lundberg 1926; Thurstone 1934; Wilson 1970; Ostendorf 1996). Authoritarianism has been analyzed based on a study of anti-semitism and ethnocentrism (Adorno et.al 1950) and religiousness (Gregory 1957; Martin and Nichols 1962; O'Neil & Levinson 1954). Rokeach's dogmatism scale was developed to "measure general authoritarianism regardless of ideological content." (Kerlinger & Rokeach, 1966, p. 391). As well, numerous studies on dogmatism correlated with conservatism (Altemeyer 1996) and authoritarianism (Bagley 1970, Stone 1980).

Additional factors for social attitudes have included: humanitarianism (Ferguson, 1939, 1940); nationalism (Fergurson, 1942); humanism; hedonism/self-interest; and work ethic (Lorr et al., 1973); tough-minded versus tender-minded (Eysenck, 1944, 1954); realistic/rational versus emotional/sentimental (Johnson, 1942); machiavellianism (Christie & Geis 1970); social-dominance orientation (Pratto, Sidanius, Stallworth & Malle, 1994); epistemological orientation (Perry, 1981); belief in a just world (Lipkus, 1991); mysticism (Hood, 1975); and personal versus political (Sanai, 1952). Saucier notes that the failure to replicate social attitude factors is based on inconsistency in criticality from one study to another, irregular variations in the sample pool and size, and limit on study variables making the testing of independency of factor variables incomplete. (Saucier, 2000) Saucier suggests that techniques used to define personality factors, most notably the lexicon approach, be used to define factors for social attitudes. The concept is similar to that of the lexicon approach for personality factors. Individual differences in social attitudes and beliefs are socially meaningful phenomena, so it is likely that people would develop a distinct vocabulary for describing them. If this is true, lexical studies might help build a more differentiated, comprehensive, and consensual model for the domain of social attitude research. (Saucier & Goldberg, 1996)

8.3.1.4.1 Saucier's Social Attitudes Questionnaire

Saucier's lexical approach was based on data mining the dictionary for adjectives encoded with the suffix -ist, which denotes a type of noun (e.g. Communist, Fundamentalist) and the suffix -ic (e.g. Individualistic, Democratic). Many adjectives can also be encoded as referent nouns (e.g. abortion, hippies) and attribute nouns for social attitudes and beliefs represented by nouns with the suffix -ism (e.g. communism, fundamentalism, and individualism). Saucier based his study on the attribute-noun form with nouns that contain the suffix -ism to limit the lexical ambiguity presented by the entire family of adjective forms. The selection of adjectives was completed by surveying the third edition of the

American Heritage Dictionary for words that aligned with his adjective search criteria resulting in seven-hundred and twenty-one identified terms. Irrelevant terms, words not referring to a belief or social attitude, were removed (e.g. metabolism, alcoholism, aneurism, etc...) resulting in three hundred and seventy-four words.

Calvinism	God is all powerful, and those whom God chooses will be saved by God's grace alone.
Secularism	Religious considerations should be excluded from civil affairs and public education.
Sensualism	The pleasures of the senses are the highest good.
Liberalism	I put little emphasis on religious dogma.
Materialism	Physical well-being and worldly possessions are the greatest good and highest value in life.
Fascism	The government ought to suppress and censor the opposition.
Ethnocentrism	I believe in the superiority of my own ethnic group.
Patriotism	I love and am devoted to my country.
Humanism	I emphasize reason, scientific inquiry, and human fulfillment in the natural world.
Functionalism	I stress purpose, practicality, and usefulness.
Hinduism	I believe in a supreme being of many forms and natures.
Logical Positivism	Observable data are necessary to find out whether factual statements are true.
Bergsonism	All living things arise from a persisting natural force, a vital living spirit or glow.
Transcendentalism	There is an ideal spiritual reality that goes beyond sense experience and science and is knowable through intuition.
Zen Buddhism	Enlightenment can be gained through meditation, self-contemplation, and intuition.

Table 7: Example questions from Saucier reduced set social attitudes questionnaire.

The 374 adjectives were converted into a survey tool with questions carefully crafted to reflect the definition of the word rather than using the actual word to correct for ambiguity in terms with multiple definitions, the subject's knowledge of the terms, and the tendency of participants in a self-assessment questionnaire to hesitate when identifying with a social label (table 7). For example, the term monotheism was identified with the sentence, "There is only one God," and skepticism with " I have a doubting and questioning attitude". This approach was used to make abstract theoretical concepts more accessible to a general participant subject pool that consisted primarily of college students. The final study consisted of four-hundred questions divided into two sets of two-hundred questions each. Study participants responded to each question using a Likert 5-point scale ranging from strongly disagrees to strongly agree.

Saucier's study resulted in a three factor social attitude model with the factors labeled after the Greek alphabet: alphaisms; betaisms; and gammadeltaisms. The third factor can be split into two categories, gammaisms and deltaisms to create a four factor model of social attitudes. Saucier notes that the three factor model is historically anchored in Western language and culture, which is made apparent with the many -isms that are named after historical figures. (Saucier, 2000)

Three-factor solution		
Alphaism religion vs. secularism	**Betaism** Subjective motivations	**Gammadeltaisms** civic and spiritual principles
Ecclesiasticism Pietism Creationism Evangelisms Religionism Salvationism Institutionalism Monotheism Atheism Humanitarianism Secularism	Materialism Sensualism Machiavellianism Solipsism Fascism Ethnocentrism Rationalism Nihilism Hedonism Chauvinism Cynicism	Liberalism Environmentalism Existentialism Humanism Romanticism Intellectualism Patriotism Hedonism Zen Buddhism Constitutionalism Pacifism

Four Factor Solution	
gammaism civic	**deltaism** spritual
Liberalism Patriotism Logical Atomism Intellectualism Hedonism Fundamentalism Benthamism Moralism Realism Objectivism Humanism Functionalism	Hinduism Bergsonism Asceticism Spinozism Taoism Zen Buddhism Totemism Pacifism Pantheism Spiritualism Fetishism Animism

Table 8: Example Variable labels from the three and four factor models of Saucier's study on social attitudes.

Alphaisms involve a polarity between religious sources of authority (e.g. the church, the holy book, and the inerrant tradition) and either secular sources of authority (e.g. evolutionary theory) or an attitude of denial or skepticism about religious sources. Betaisms involve subjective motives for personal behavior that may be carnal, egoistic, and materialistic, reflect in-group favoritism, or be "politically incorrect." Gammadeltaisms involve allegiance to a set of civic principles characteristic of modern Western

democracies (e.g. classical liberalism, humanism, individualism, existentialism, romanticism and utilitarianism). The gammaisms focus on collective nationalistic, patriotic and constitutionalist themes. Deltaisms, as indicated in the four factor model, focus on spiritual individualism that represents a synthesis of Eastern religious ideas, New Age, and transcendentalist philosophies (table 8).

8.4 Builder's Profile Application Questions

The builder's profile application is concerned primarily with the intersubjective cognitive, rather than the emotional, state of participant builders. My hypothesis is that the intersubjective cognitive reality of the participant can by inferred based on basic information about how an individual chooses to identify themselves and information about their origins, environments where they live, work and play, and the people, things and ideas that they value.

Inference, as stated earlier, is a key concept here. I am simply influenced by the methods of the social and behavioral psychologies as a foundation for developing interactive art and human computer interaction interfaces that serve as transformative mirrors and tools for the transformative re-design of the ways in which we live in the world. (Rokeby, 1996; New London Group, 1996)

The builders' profile questions must provide ample data to support the functionality of a tangible social interface. Specific questions that would reveal the person's identity outside of the play arena, such as name and address, are of no interest or use for this interface and are not requested. However, to make an engaging collaborative experience the underlying system requires a persona sketch that represents the builder, keeping in mind that the builder can choose to "creatively" answer the questions.

8.4.1 Alternative Questionnaire Techniques with Images, Symbols and Matrices

The design of the Builders Profile Application will implement an alternative graphic image and icon questionnaire where appropriate. The participant will be presented with graphic icons and silhouetted images. Thus the questionnaire becomes a visual game.

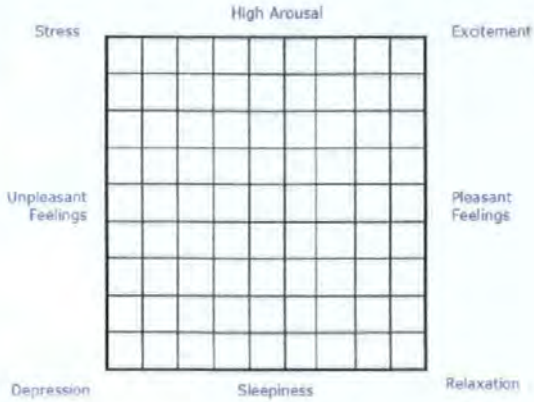


Fig. 65 *Fig. 66*

Fig. 65: Screen interface of the Project Implicit tolerance test.
Fig. 66: Example of an Affect Grid survey tool.

Project Implicit (fig. 65), from Harvard University, is an example of a research tool that uses a screen-based graphical game-like interface to understand implicit beliefs that people subconsciously harbor. (Project Implicit, 2006; Tolerance.org, 2006) The *Affect Grid* (fig. 66) is another example of a visual tool designed to record judgments about single instances of affect including mood and feeling. (Russell, et al, 1989) It is particularly effective in reducing the number of time consuming multiple-item checklists that typically populate questionnaires by implementing a single-item scale designed as a method to assess affect along the dimensions of pleasure-displeasure and arousal-sleepiness. Russell notes that the Affect Grid is potentially suitable for any study that requires judgments about descriptive or subjective affect.

8.4.2 Key Factors in the Design of the Builder's Profile Application

These are three key factors in the design of the builder's profile application:

- Minimum number of questions
- Multimedia presentation of the questions (e.g. text, visual, or audio)

- Presentation for cross-cultural question comprehension (and or interpretation)

The questions are subdivided into the four categories including: self-definition; origins; environments; and values and beliefs. General identification information such as gender and age fall under the category of self-definition. Questions in the origins category inquire about the participant's country, language, ethnic and racial identified groups. Environment questions are concerned with the types of communities in which the participant lives, works, attend school, and socialize. Values and beliefs questions explore the builder's epistemological stance, the ideas and ideals that drive his or her sense of self.

Many questions will be presented visually as a method to present questions about the participants' lifestyle, family unit, community environment (rural, urban, suburban, etc...), level of integration in their environments, type of work, and level of economic security. For example, a question about a participant's neighborhood where they live may appear as silhouette cutouts of various types of built structures in different environments (e.g. urban skyline or country farmhouse.) The values and beliefs question category will be designed to capture the builder's ideological landscape. Rather than present explicit questions about a builder's national and cultural allegiances and preferences, they will be given a selection of visual icons and symbols and requested to select the icons that best represent them.

The selection of icons and symbols for builders to choose will be drawn from common icons and symbols encountered in a pluralistic urban western environment. My hypothesis is that people wear, watch and listen to their cultural influences and preferences. For example, wearing one's cultural identity, beliefs and values may be signified by a type of head adornment and hair styles (e.g. burka, yarmulke, turban, buzz cut, dreadlocks), a symbol permanently tattooed on the skin (e.g. armband tattoo, Celtic pattern, logo of a favorite sports team, a lover's name, etc...), or a cultural/religious symbol in a piece of jewelry (e.g. Cross, Star of David Fatima hand, horn or LeChaim), or the style that one

wears a garment or piece of jewelry (baseball cap worn backwards, thumb ring, handkerchief in back pocket). Saucier's observations show that people tend to hesitate or answer moderately when asked to explicitly categorize their beliefs. For example, asking the player to reflect on the level of integration in their various environments requires that they view their subjective reality objectively – a task which is very difficult, if not impossible to achieve. Once again, this is the structure for an inference-engine not a revealing engine. A handkerchief in the back pocket of a gang member in Los Angeles may mean something completely different than a handkerchief in the back pocket of a gay man walking down Castro Street in San Francisco. The significance is that membership in a counter-culture is important to both persons.

8.4.3 Precedence for Interfaces that Function Based on Personal Inquiry

Several interactive art installations and community-based technology projects have successfully created interactive experiences that enable participants to feel very comfortable sharing personal information to the general public. Rachel Strickland's *Portable Effects: A Design Vocabulary of Everyday Life* required participants to empty their pockets, pocketbooks and backpacks such that the contents could be photographed and attached to the owner in a vast database (fig. 68). (Strickland, 2006) George LeGrady's *Pocket Full of Memories* follows a similar scheme (fig. 67). Participants are requested to empty one item from their pocket for inclusion in a dynamic visual database that reflects on the stories behind the objects people carry. (Legrady, 2006) Earlier in chapter five, I discussed the StoryCorps project that originated in Grand Central Station, New York City and now travels throughout the United States with selected stories aired on National Public Radio (fig. 17). (Storycorps, 2006)

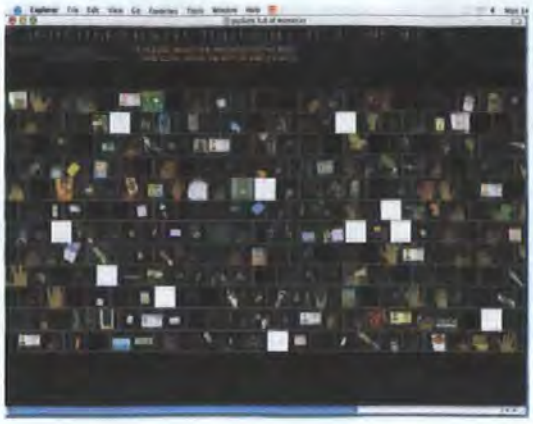


Fig. 67 *Fig. 68*
Fig 67: Screen interface from George Legrady's "Pocket Full of Memories".
Fig. 68: Scanning desktop from Rachel Strickland's "PortableFX" projects.

8.5 System Interfaces Block Network and Host Computer Application

A primary and complex issue to address in the system architecture was the development of a robust communication protocol that could interpret and transmit data through an open-topology network. Whiteboard flow chart schematics and diagrams, interaction function specifications and the very important cardboard prototypes as described in chapter seven were used to understand the interwoven relationships between objects in the physical network, software communication protocols, and data handling. These boundary objects, quick prototypes and devices used to explain and explore a complex design, were critical in aiding the visualization of connection, detachment, and system implications that were hard-to-picture without a visual surrogate.

8.5.1 Block Network Communication Protocol

The Echelon Neuron Chip was selected as the core embedded microcontroller installed inside each block after several microcontroller systems were evaluated. (Echelon, 2006) (See chapter nine for more information about the implemented hardware solutions.) LonWorks, a proprietary development environment from Echelon was used to program the network communication protocol for transmitting data between the Neuron Chips using the proprietary Neuron C language, which is a derivative of the C programming language.

The software communication protocol for the Neuron chip contains three message types: attachMale; attachFemale; and childRemove. After defining the blocks communication message protocol, a highly extensible object-oriented design for the host application was developed to encapsulate each message type in a separate object class. Each object class contained functions for parsing and transmitting block state information.

Prior to the consideration of writing any code, several schematics were designed to map the interaction steps, required functions, and communication protocols to facilitate a successful connection and removal of a block from a built structure. An interaction function map (fig. 69) was created to illustrate the order of messages sent and received by the blocks and the host computer which is also represented by the state diagram (fig. 70).

Male	Female	Host
Off	Off	On
Set attached male faces to None	Set attached female faces to None	Waiting
Loop For each male face: If new signal – send AttachMaleMsg to Host. If lost signal – send ChildRemoveMsg to Host	Loop For each female face: If new signal – send AttachFemaleMsg to Host. If lost signal – send ChildRemoveMsg to Host	On receiving: AttachMaleMsg – Add to Male Response Queue Check For Connection AttachFemaleMsg – Add to Female Response Queue Check For Connection

Fig. 69: Interaction function chart technique used to write pseudo code for network communication protocol.

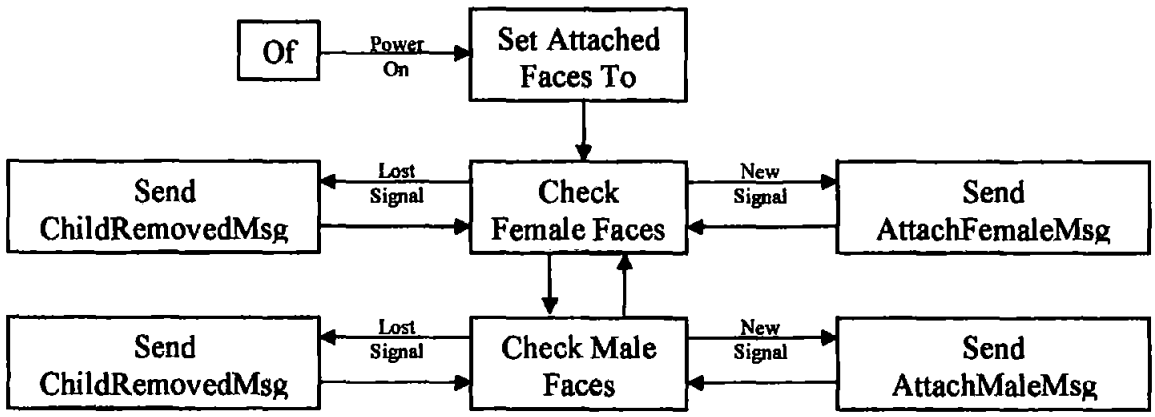
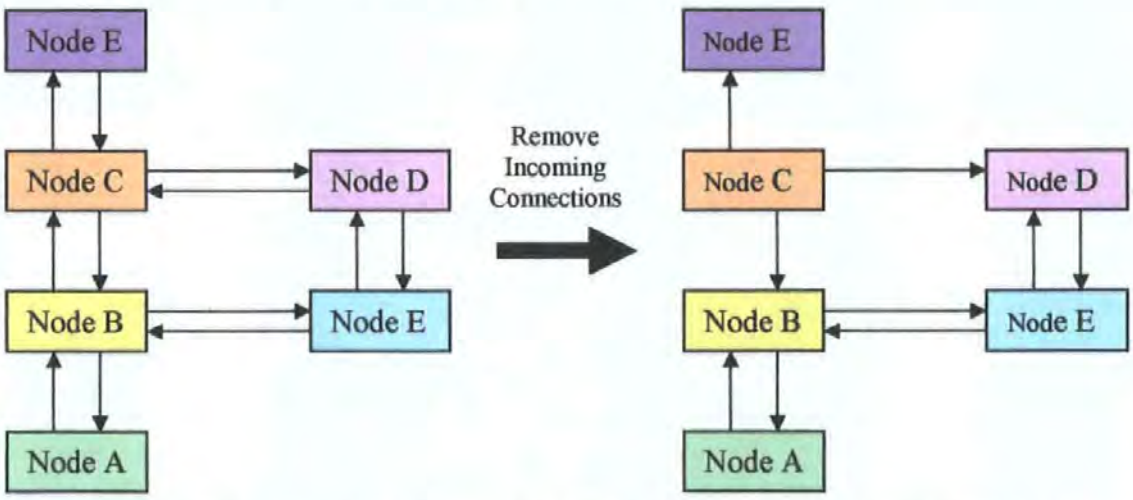


Fig 70: State diagram for the block network communication protocol.

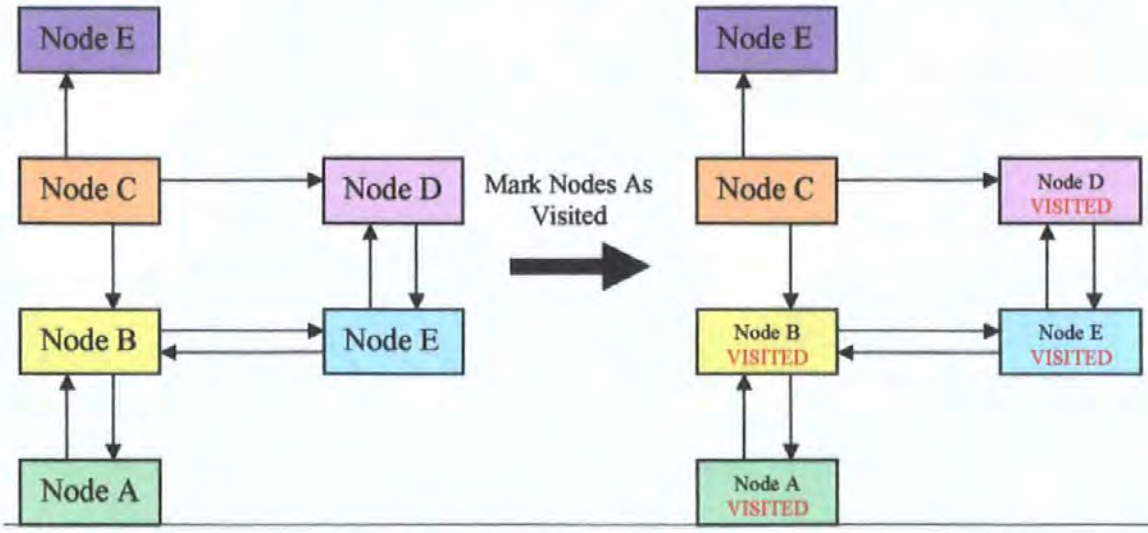
Adding blocks to the network is a rather straight forward operation. Removing blocks is a slightly more complicated matter. The block removal function is responsible for correctly removing from the node graph all blocks connected to the initial removed block. This includes feedback loops in the construction and graph where a block attached to the removed block may still be attached to the network via another connection point, a problem commonly called the graph reachability problem where paths between nodes must be identified, marked and checked with the dynamic linked list of all nodes (blocks) in the network to insure that they are not connected to the structure through an alternative route. Figure 71 shows a tree graph representation of the childRemove function.

Fig. 71: Sequential state diagram for the block network communication protocol.

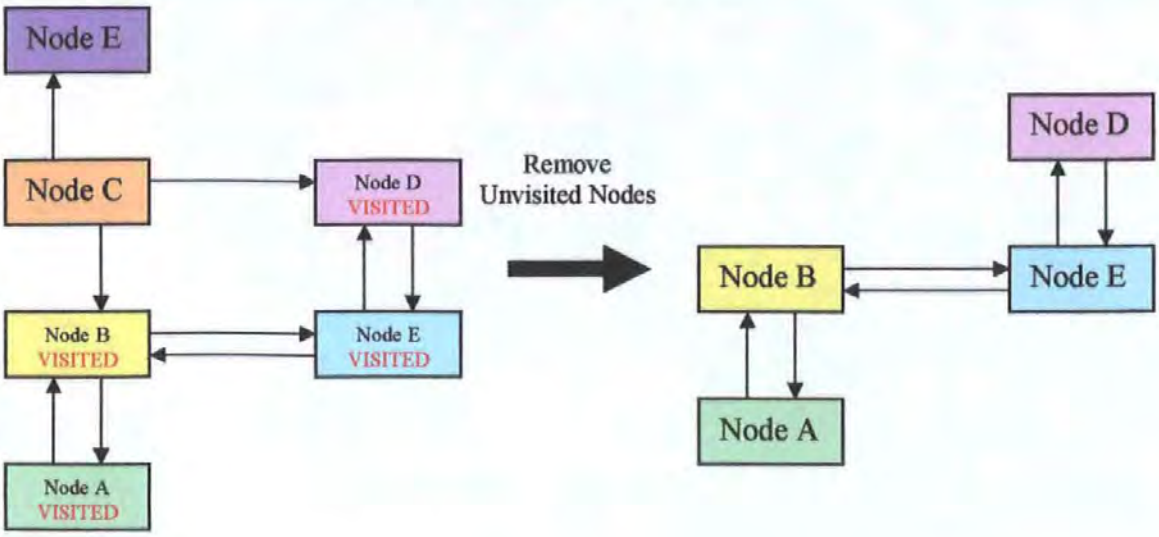
1. Host computer application receives a childRemove message from the network and all connection messages pointing to the removed block are cleared from the node graph.



2. Starting with the base block in the construction, each block or node is traversed and marked as visited.



3. All nodes that were not visited are removed from the node graph.



8.5.2 Host Computer Application

The host application integrates communication protocols for the Echelon Neuron Chip microprocessor and has been developed in C++. It functions as a "message factory," and is responsible for the aggregation of the data coming from the builder's profile and topographical data about the placement of the physical devices by users of the system via a dynamic data exchange (DDE) server. Real-time data collected by the host application is passed to the Semantic Engine for further processing as illustrated in the message system class diagram (fig. 74).

Fig. 72 &73: Screen shots from the DDE server application designed to aid in testing the communication protocol during project development as well as functioning as the real-time server.

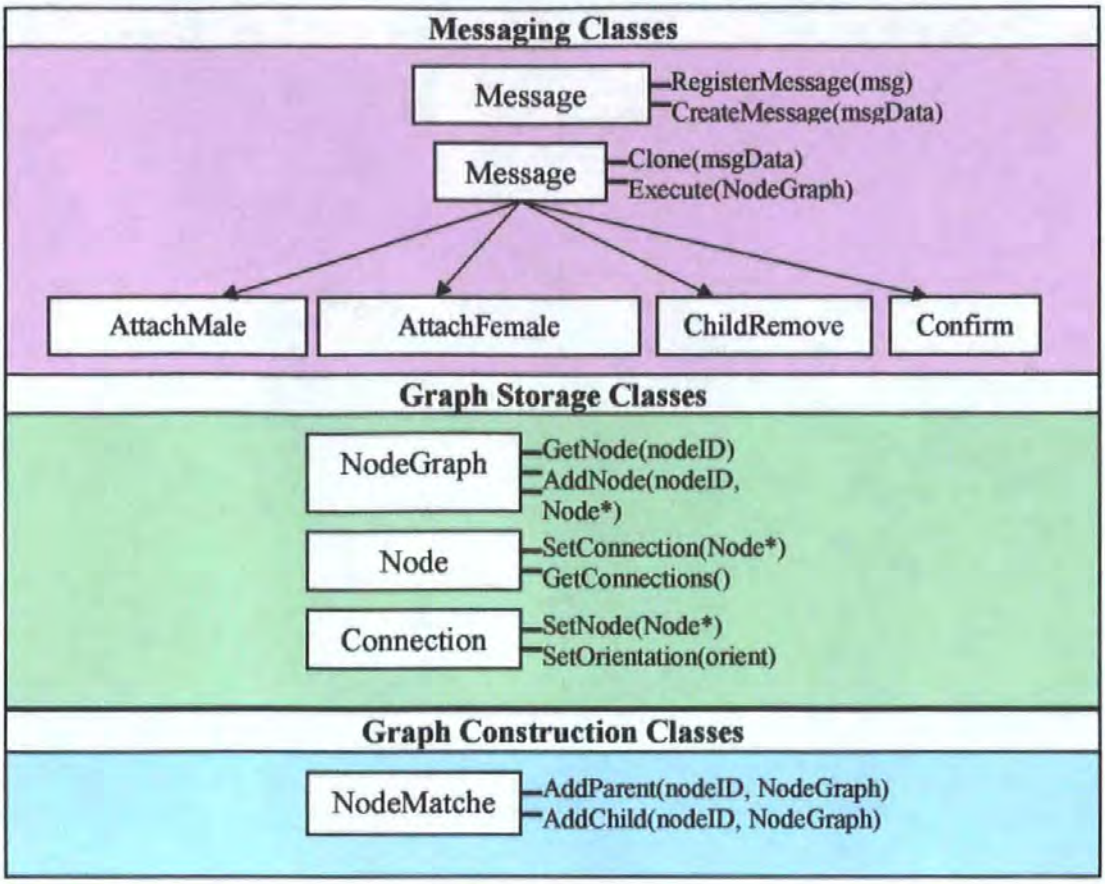


Fig. 74: Messaging system diagram from the block microcontroller and Host Computer Application.

In order to facilitate simultaneous development of the software and hardware systems a test DDE server was designed to stand in as a surrogate for the physical blocks (fig. 72 & 73). In essence, the test DDE server is a completely functional server and works in real-time with the Neuron Chip microcontrollers. However, functions and controls in the interface were developed to provide message transmissions identical to those received from the hardware without the hardware. This tool was very helpful in debugging the host application and aiding in developing a robust piece of software without the interference of hardware debugging and continues to be invaluable in the development of the overall system.

8.5.3 Virtual Build Application

The Virtual Build application handles the visual output of the Semantic Engine and near real-time screen replication of the physical structure. This component of the system software was built using the DirectX API with C++ and integrates smoothly into the host computer application and semantic engine code. Hindsight suggests that this application should have been built using Java3D for web portability. Never-the-less, the Virtual Build application is a robust piece of software that has served both as a visual verification test of the validity of the software graphs and their interpretation and fantastic demo of the system (fig. 75 &76). Early versions of the Virtual Build application were used for extensive validation testing. Functions were written into the code to allow the placement of a texture map of containing the numeric coding system on each block.

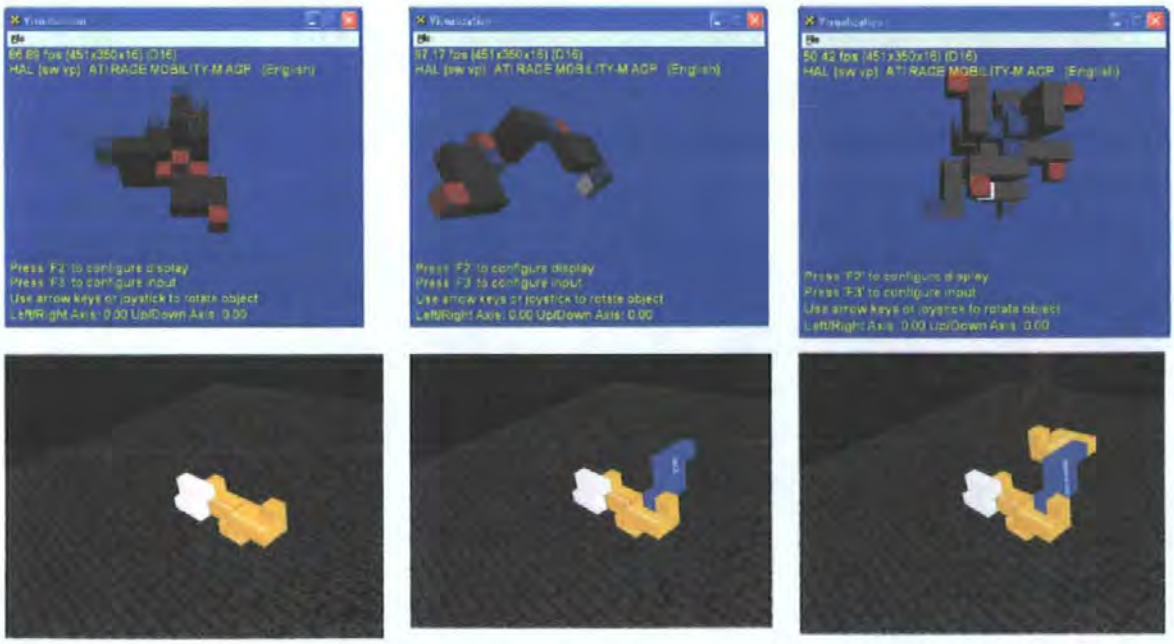


Fig. 75: Screen grabs from early Virtual Build application code validity testing sessions.
Fig. 76 : A succession of images from a construction built using the test DDE server.

8.6 The Semantic Engine: A Lexical Framework in Software Engineering

The semantic engine is the heart of the *Constructed Narratives* projects and is the key component that separates this project from other electronic construction kit research projects as described in the literature search of this thesis in Appendix B.

Metaphorically, the Semantic Engine is an open vessel that can hold and manipulate any data placed inside. This occurs when that input data is properly formatted from the Builder's Profile application, interacts with information from the physical blocks and the rules system from the Semantic Engine. The vessel output for the Semantic Engine is words that are neither hard-coded nor randomly selected. The output is characterized by repeatability and malleability based upon interactions and combinatorial patterns made with the blocks. Word search results, based on the same construction pattern, may be different while maintaining a strong semantic relationship. The output is variable allowing the participant to learn the implications of her construction choices. For example, a repeated construction pattern may return "school" the first time and then "education".

In essence the Semantic Engine is analogous to Searle's "Chinese Room" problem – a challenge to the widely held beliefs in strong AI that a machine is capable of understanding meaning of symbolic systems. In Searle's fable, the human mind is locked in a room (or a black box) designed for processing Chinese symbols. Searle's mind or the black box does not understand Chinese characters, yet he is capable of associating meaning to the characters with procedural instructions in a language he understands. The first input he receives is a batch of Chinese characters – or the "script." The second input received is a set of rules in English that instruct on how to correlate one set of symbols with another set of symbols – the "story." The third input received is instructions on how to format the output of the results – the "questions." From the external point of view, if his mind, the black box, is able to follow the rules of operation, then it appears that the Chinese symbol are analyzed and interpreted based on true comprehension of the symbols. (Searle, 1980)

8.6.1 Structuralism and Semiotics as Models for Software System Design

George Stiny's shape grammars theory, which was referenced in the artifact design section of this text, is in essence a structuralist theory of design. Shape grammars are concerned

with reducing the elements of a built structure to the minimum shape elements that when combined create quite complex and exquisite structures. It felt quite natural to start the development of the semantic engine by referencing systems of structuralism that aided in the reduction of the primary complexity of the Constructed Narratives blocks form factor and potential construction patterns.

The conceptual design of the Semantic Engine began with research on linguistic and visual semiotics and structuralism. The relativistic nature of language, as made evident through de Saussure's theory of structuralism provided a foundation for me to understand the possibilities of the word search functions. Structuralism maintains a bifurcated model of language. La langua denotes the entire social-linguistic system and parôle denotes specific speech acts that are analyzed based on knowledge of la langua. During the early conceptualization phase of the semantic engine, deSausurre's Cartesian model for constructing meaning – the paradigm and syntagym – presented a promising approach for mapping words onto the virtual build blocks. This theory of language supported the associative nature of the semantic blocks. In particular, it supports the hypothesis that the builder will naturally force a relationship between any two entities, much like the game of magnetic poetry. I was nonetheless dissatisfied with the over simplification of structuralism, in particular the reductionist rules of syntagym and paradigm for generating and understanding language. (de Saussure, 1994)

The field of semiotics takes its lead from structuralism, where in its purest form defines language as a system of signs, or words, to be studied as a complete system. Each sign is made up of a signifier (sound, image, graphic) and signified – the meaning embodied by that sign. The relationship between the signifier and signified, what it stands for, is arbitrary. Each sign in the system has meaning only by virtue of its difference from others. Semiotics, the study of signs, defines three basic types of signs: iconic – sign that

resemble its meaning (e.g. photograph of a person); indexical – a sign that is associated with what it is a sign of (e.g. smoke with fire, spots with measles); and symbolic – a sign that is arbitrarily linked to its referent (e.g. bitten apple as the symbol for a computer brand). Semiotics distinguishes between denotation (what the sign stands for) and connotation (other signs associated with it) codes (the rule-governed structures which produce meaning) and the messages transmitted by them. Theories in visual semiotics, the application of semiotic phenomenon to visual entities, form the foundation for the structure of the semantic engine, as described below.

8.6.2 Network Models to Support Narrative Structures

> *I think of narrative as a wandering accretion in a three dimensional cube. And I've never been involved in story or plot in a traditional sense. I tend to work with narrative as an accretion and look for different kinds of engines that move it through time. ... I think that there are more complex possibilities for creating a dimensional narrative, and it may not be something that is completely non-linear. It may not be non-linear in a looping random access logic tree structure. It may be something that you move through in some linear fashion but has a different sense of dimension.*
> *– Toni Dove interview with Pamela Jennings (Jennings, 1995)*

Creative digital media practices have provided fertile ground for experimenting, expanding and inventing alternative narrative structures and methods to realize those structures. Narrative structures used in this discipline span from linear models replicating the dramatic arch of Aristotle's *Poetics* to Toni Dove's "wandering accretion" model. (Laurel, 1993; Jennings, 1996; Jennings, 1995) (See appendix A for more about theories about narrative, interactivity storytelling and intelligence.)

The task at hand for the Constructed Narratives project was to develop a method for mapping associative text, as a generative narrative form, onto a dynamically assembled structure. Two metaphors, based on the structural qualities of two popular construction toys – LEGO blocks and Tinker Toys, where investigated as viable models for mapping narrative onto inter-connectable physical objects and the development of the semantic engine. The Lego system has one universal type of connection that supports linear

stacking. The TinkerToy system supports numerous connection modes based upon its node and arc graph-like structure. These models were used to understand and decode the relationship between shapes, connection points and methods and their implication on semiotic structures.

8.6.2.1 Linear Stacking Model

Fig. 77 : LEGO Blocks from http://de.wikipedia.org/wiki/LEGO

The LEGO brick is a three-dimensional object designed for connection by vertically stacking. Although the bricks can be placed beside each other a "network" connection can only be made by connecting a new brick on top or bottom of another brick. Therefore, the LEGO bring system is actually a two-dimensional stacking system that uses three-dimensional blocks (fig. 77).

The linear stacking model is that the structure forces compliance with a rather inflexible relationship between the properties that determine the content of the nodes. It is ideal for supporting structuralist and linear narrative models should the nodes in such a model be assigned semantic images, signs, or symbols, as most of the projects sited in the construction kit literature search in appendix B.

For example, suppose there are four LEGO blocks, each different color denotes a different part of speech. When assembled in the correct order, the colored blocks form a grammatically correct sentence or when assembled in an incorrect order nonsense phrases are formed. In this case the color represents the syntagym of the structuralist system. While the actual semantic content represents the paradigm. Although fun to interact with, this structuralist stacking game would quickly become familiar and tedious (fig. 78).

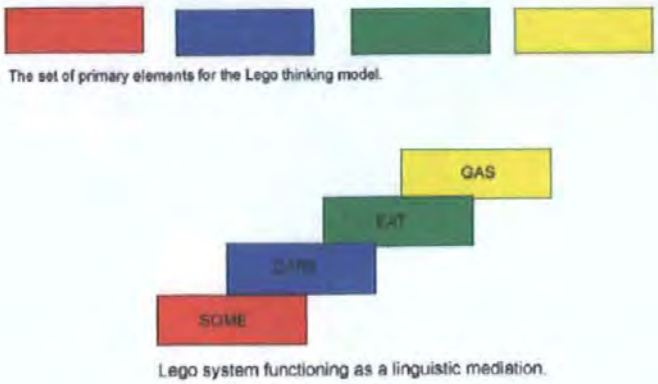


Fig. 78: Using LEGO metaphor to explore semiotic relationships. The Lego pieces can be mapped to linguistic parts: Red is the set of possible words that describe a quantity (some, few, all), blue is the set of nouns (dogs, boys, cars), green is the set of actions (bark, work, eat) and yellow is the set of adjectives or nouns (gas, loud, hard). A linguistic interpretation of the visual construct from the previous example could read: "some cars eat gas".

8.6.2.2 Associative Linking Model

Fig. 79: Detail image of a TinkerToy Node. Image from http://www.kidwind.org/materials/buildingwindmills/tinkertoy.html and www.realwebmarketing.com/

The TinkerToy metaphor offers as many degrees of freedom as the main donut shaped connector provides (fig. 79). This nodal structure can be compared to the associative linking method of Vannebar Bush's MEMEX work environment. (Bush, 1945) To transcribe the associative linking model, as represented by TinkerToys, to a computer program requires advanced methods that incorporate graphs, linked lists, and other programming abstractions.. The ThinkMap Visual Thesaurus (fig. 80), populated with the WordNet English lexicon software, and research information visualization methods such as the Inxight StarTree (fig. 81) are examples of a graphical user interface based on associative mapping. (ThinkMap, 2006; Inxight, 2006)

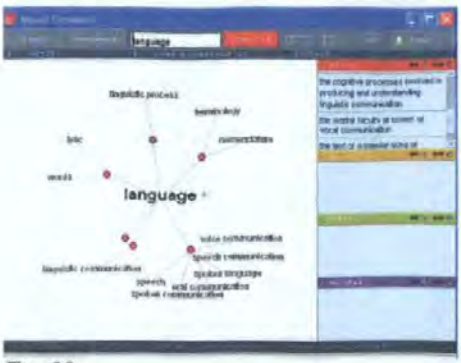


Fig. 80

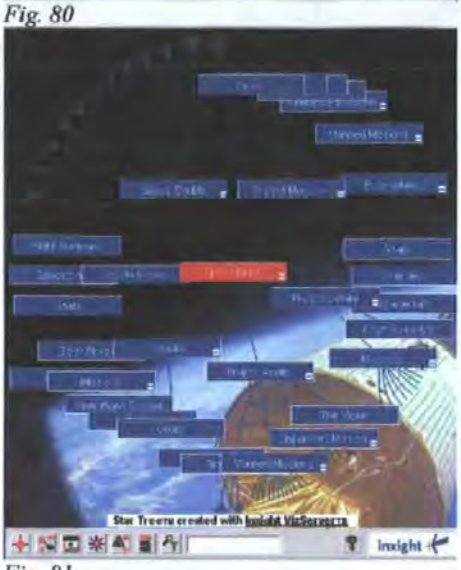


Fig. 81

Fig. 80: Interface from the ThinkMap Visual Thesaurus online thesaurus of the English language. (http://www.visualthesaurus.com)

Fig. 81: Insight StarTree demo for a NASA space history information repository.

8.7 Constructed Narratives Visual Language

"The development of a grammar of visual language seemed in fact dependent on the determination of the traits of the primary elements which permit them to evolve as a system of variations capable of carrying meaning."
(Saint-Martin, 1990, p. 2)

The LEGO and TinkerToy construction toys provide metaphors to understand how meaning can be constructed from a set of primitive shapes and a connection method system.

Fernande Saint-Martin notes in his book *Semiotics of Visual Language* that elements of the visual language have "to be defined in relation to their potential for interrelating as linguistic elements. Once these basic elements are determined, semiotic syntax must provide the laws which regularize their combinations and transformations in the production of multiple statements." The combination of these three operations enables the design of "more complex perceptual schemas." (Saint-Martin, 1990)

Saint-Martin's basic elements of a visual language are:

1. **Primary elements**: the paradigm or unique set of primitive objects
2. **Primary traits**: the process of differentiating attributes of the objects as is evident through the primary element
3. **Syntactic rules**: the relations and operations that govern the construction of grammatical statements using various object types of the visual language.

The design of the Constructed Narratives semantic engine will now be addressed with a focus on how the engine and its components relate to Saint-Martin's structure for elements of a visual language and to Jacque Durand's theory of visual semiotics.

8.7.1 Constructed Narratives Primary Elements

Fig. 82

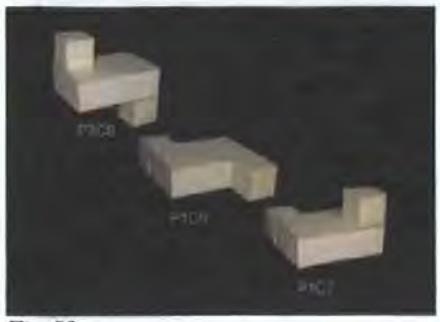


Fig. 83

Fig. 82: Three components of the Constructed Narratives block.
Fig. 83: Example of three complete block shape grammars.

The Constructed Narratives shape grammar, as described earlier, is a composite of three physical connections, the block body and two appendages - one male and one female. Blocks are connected via opposite appendages. The three components are shown separately in figure 82. The three original block shape grammars are shown in figure 83. The shape grammar for the blocks consists of a set of primary elements that define the primary traits. The primary traits determine which syntactic rules are applied by the underlying software when the blocks are attached.

Primary block elements listed in a hierarchical relationship of sub-systems are:

1. The complete shape grammar:
   Distinguishes one block shape from another.
2. The appendage:
   Each block has two appendages, one male and one female.
3. The appendage face:
   Each appendage has a maximum of five connectable faces.
4. The orientation of the connected blocks.
   Each block face can be connected in one of four (east, west, south, and north) positions.

8.7.2 Constructed Narratives Primary Traits

> *"By definition, visual grammar is required to describe the operations by which basic elements are determined and interlinked through basic rules so as to form more complex ensembles. These rules are interrelated in an orderly fashion and in such a way that the first level operations are necessarily accomplished before the second levels, and constitute their indispensable foundation. The first level rules provide a basis for the higher-level operations, which regroup a greater number of elements in more and more complex perceptual schemas." (Saint-Martin, 1990, p. 67)*

8.7.2.1 Jacque Durand's Visual Semiotics Model

The Constructed Narratives semantic engine is based on a revisionist approach to grammatical rules that have been applied in the field of visual semiotics. (Durand, 1970) Durand's methodology for applying semiotics in the analysis of advertising photographs has served as a foundation upon which to develop a visual grammar for the Constructed Narratives shape grammar. The structure of the visual grammar serves as the multi-dimensional syntagym for this new language. The application of Durand's semiotic matrixes is the basis of the development of the paradigm. Together the matrixes form the Constructed Narratives langua. The parôle is generated based on the builders' profiles as they are manipulated by the builder's construction choices with the physical blocks.

Jacque Durand's visual semiotics system is based on the theory that rhetorical operations, though generally thought of in linguistic domains, can be applied to photographic images as a means of understanding the visual tropes used to denote and connote the relationship between the photographed objects and/or compositional style used in the image. Durand's method is based on two matrices. The first matrix defines the relationship between objects across the properties of form and content with three primary traits, "same," "other," and "opposed." The second matrix applies a rhetorical rule that describes the quality of the relationship identified in the first matrix.

	FORM RELATION		
CONTENT RELATION	**SAME**	**OTHER**	**OPPOSED**
SAME	Identity	Similarity of Content	Paradox
OTHER	Similarity of form	Difference	Opposition of Form
OPPOSED	Ambiguity	Opposition of Content	Homologous Opposition

Fig. 84: Durand's form and content relationship matrix for his theory of visual semiotics.

Durand's theory was designed for two-dimensional photographic images where the photographer's intentions are articulated by his/her representation of objects, persons, or

places, and inferred by the photographer's and/or editor's choice in framing and visual effects. I developed a method to transcribe the essence of Durand's form/ content relationship matrix and theory of rhetorical operations to the three dimensional tangible block interface. Where necessary, arbitrary yet consistent sets of rules were devised to maintain integrity with Durand's system in the case were Durand's rule was based on semantic interpretation rather than structural comparisons of form, as described below.

8.7.2.2 Semantic Engine Revision of Durand's Model

The block shape grammar follows the structure of Durand's first matrix and is divided into two core components – form and content (fig. 84). The form represents the physical attributes of the block including its actual shape and are categorized into relationships of *same*, *other*, and *opposed*. *Content* referred to the owner of the block. Following Durand's form/content matrix, nine pattern combinations of blocks based on form and content are defined in the software search algorithm (table 11). The categories of *same* and *other* followed the Durand's original criteria. *Same* occurs when the entities being compared belong to a paradigm or comparison consisting of a single term. This occurs in Constructed Narratives when the same shape grammars are connected together. *Other* occurs when the entities being compared belong to a paradigm that includes more than two terms. This relationship occurs in Constructed Narratives when blocks that are not the same shape grammar. *Opposed* refers to a dualistic relationship. It occurs when entities of comparison belong to a paradigm that is limited in its terms. For example, black as opposed to white – the paradigm being a color or racial reference; man as opposed to women – the paradigm being a person or gender identification. The relationship of *opposed* requires a semiotic relationship that must be based upon the meaning of the entities and the equivalent for the Constructed Narratives block form was not as easy to assign. Therefore, the relationship *opposed* was assigned a predefined combinatorial pattern of four connected blocks.

Once the primary trait relationships between form and content are identified into one of nine patterns with accompanying properties (identity, similarity of form, similarity of content, etc…), Durand's second matrix, rhetorical operations, is used to apply a rhetorical attribute, (e.g. repetition, ellipsis, hyperbole, etc…,) to the properties. (figure 85) He further develops his theory by applying syntactic rule operation, addition, suppression, substitution, or exchange, as a means to deepen the selection of equivalent rhetorical attributes for each property. These syntactic rule operations are applied according to the orientation of the connected block (north, east, south, west). Table 14 shows a portion of the Constructed Narratives Rhetorical Operations matrix. The entire matrix is available in Appendix C.

RHETORICAL OPERATIONS				
	Addition	Suppression	Substitution	Exchange
Identity	Repetition	Ellipsis	Hyperbole	Inversion
Similarity of Form Similarity of Content	Rhyme Simile	-- Circumlocation	Allusion Metaphor	Hendiadys Homology
Difference	Accumulation	Suspension	Metonomy	Asyndeton
Opposition of Form Opposition of Content	Zeugma Antithesis	Dubitation Reticence	Periphrasis Euphemism	Anacoluthon Chiasmus
Homologous Opposition Ambiguity Paradox	-- Antanaclasis Paradox	-- Tautology Preterition	-- Pun Antiphrasis	-- Antimetabola Antilogy

Fig. 85: Durand's Rhetorical Operations Matrix based on his form and content relationship matrix.

8.7.3 Constructed Narratives Semantic Engine Syntactic Rules

The function of the semantic engine is an iterative pattern searching, optimization, rules look-up and word searches. The approach used in the current design of the Semantic Engine integrates theoretical constructs of structuralism, visual semiotics, and rhetoric into a computational algorithm. Data from the Builder's Profile application is not currently implemented into the system. Rather, a pre-defined look-up table of meta-level keywords is used in conjunction with found block patterns to seed the WordNet API word search. The following section presents the schematics of the Semantic Engine in three steps; (1)

construction block pattern rules; (2) search optimization algorithm; (3) lexicon word search as envisioned and currently implemented.

Block Shape Grammar	Player ID Content Ownership
P3C8	A
P3C8	A
P3C8	B
P3C8	B
P3C8	C
P3C8	C
P1C6	A
P1C6	A
P1C6	B
P1C6	B
P1C6	C
P1C6	C
P1C7	A
P1C7	A
P1C7	B
P1C7	B
P1C7	C
P1C7	C

Table 9: Initial block type and player assignment used to configure the syntactic rules for the Semantic Engine.

8.7.3.1 Step One: Block Pattern Rules

The current schematic for the semantic engine is based on an initial set of eighteen blocks, three players (A,B and C), and three block types (P3C8, P1C6 & P1C7 later defined as block type 1, 2, & 3 in table 9). Construction patterns are defined by a combination of shape grammar type and block ownership as illustrated in table 10. Three shape grammars and up to three builders can conceivably create hundreds of combinations. For simplified calculations and the development of an algorithm that can be generalized, the shape grammar/

	Form Relations Shape Grammar 1, 2 and 3		
Content Relation owner A, B and C	**SAME**	**OTHER**	**OPPOSED**
SAME	**Identity** Block1 Block2 1A 1A 1B 1B 1C 1C 2A 2A 2B 2B 2C 2C 3A 3A 3B 3B 3C 3C **Algorithmic Equivalent** Same owner, same blocks *mx & mx*	**Similarity of Content** Block1 Block2 1A 2A 1A 3A 2A 3A 1B 2B 1B 3B 2B 3B 1C 2C 1C 3C 2C 3C **Algorithmic Equivalent** Same owner, different blocks *mx & nx*	**Paradox** Block1 Block2 Block3 Block4 1A 2A 2A 1A 1A 3A 3A 1A 1B 2B 2B 1B 1B 3B 3B 1B 1C 2C 2C 1C 1C 3C 3C 1C ... 2A 3A 3A 2A 2B 3B 3B 2B 2C 3C 3C 2C **Algorithmic Equivalent** Four block mirror relationship *mx & nx & nx & mx*

Table 10: Constructed Narratives form/content matrix long form with block type and block ownership relationships articulated.

ownership combinations were described by algebraic relationships (table 11).

	Form Relations **m n p** = block type(form), **x y z** = builder(content)		
Content Relations	**Same**	**Other**	**Opposed**
Same	**Identity** P_0 *mx & mx*	**Similarity of Content** P_1 *mx & nx*	**Paradox** P_2 *mx & nx & nx & mx*
Other	**Similarity of Form** P_3 *mx & my*	**Difference** P_4 *mx & ny*	**Opposition of Form** P_5 *mx & ny & ny & mx*
Opposed	**Ambiguity** P_6 *mx & my & my & mx*	**Opposition of Content** P_7 *mx & ny & nx & my*	**Homologous Opposition** P_8 *mx & mx & ny & ny*

Table 11: Constructed Narratives form/ content matrix with algebraic pattern finding equivalents.

This method was used to identify simple two and four block patterns based upon the block shape grammar and the owner of the block as recorded through the RFID Identification bracelet worn by the builder. Each block contains ten possible surfaces for connection with four unique connection positions per face. Thus each block has up to 40 possible connection positions or 40 degrees of freedom. The schematic for the Semantic Engine maps each face to a category of questions from the Builder's Profile Application, with "interests" added to make five categories. All possible block orientations – north, south, east and west – are mapped to one of the four rhetorical operators from Durand's second matrix, as illustrated in tables 12 and 13. See section 8.8 for the current implementation of this function in Semantic Engine version 1.0.

Block Face Question Category		
Female Face	**Male Face**	**Syntax**
0	5	Origins
1	6	Self-Definition
2	7	Environment
3	8	Values
4	9	*Interests*

Table 12

Block Orientation Operator	
Orientation	Operator
0 (north)	Addition
1 (south)	Suppression
2 (east)	Substitution
3 (west)	Exchange

Table 13

Table 12: Block Face assignments in Semantic Engine version 1.0.
Table 13: Block Orientation assignments in Semantic Engine version 1.0.

8.7.3.2 Step Two: Search Optimization Algorithm

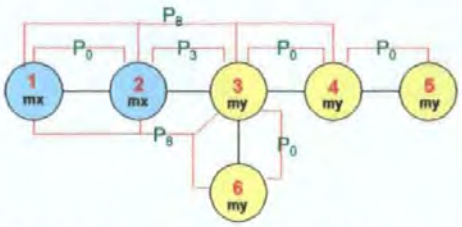


Fig. 86: Sample graph of a block construction notated with found patterns.

The entire graph is searched for all instances of the nine recognized patterns, as defined in the pattern matrix (table 11) in this step. This includes patterns nested inside of each other. The graph in figure 86 represents a construction of six blocks.

Figure 87a shows the relationship of nodes to patterns as sets of adjacent nodes. Figure 87b labels the adjacent nodes in recognized patterns as sets. There are six sets in this graph example. Figure 87c shows the set membership of each node that is in a recognized pattern. For instance Node 1 belongs to sets S_0, S_5, or S_6.

Pattern	Priority
P_0	1
P_1	2
P_2	5
P_3	3
P_4	4
P_5	7
P_6	6
P_7	8
P_8	9

Fig. 87a

Set	Set of nodes
S_0	(1,2)
S_1	(3,4)
S_2	(4,5)
S_3	(3,6)
S_4	(2,3)
S_5	(1,2,3,4)
S_6	(1,2,3,6)

Fig. 87b

Node	Set
1	$S_0 S_5 S_6$
2	$S_0 S_4 S_5 S_6$
3	$S_1 S_3 S_4 S_5 S_6$
4	$S_1 S_2 S_5$
5	S_2
6	$S_3 S_6$

Fig. 87c

Fig. 87a – c: An illustration of the search optimization algorithm for the Semantic Engine.

	ADDITION (orientation_0)	SUPPRESSION (orientation_1)	SUBSTITUTION (orientation_2)	EXCHANGE (orientation_3)
IDENTITY mx & mx	**Rule 1 : Repetition** The use of repeated words or phrases.	**Rule 2 : Ellipsis** The omission of one or more words in a sentence which would be needed to express the sentence completely.	**Rule 3 : Hyperbole** A figure of speech consisting in exaggerated statement used to express strong feelings or produce a strong impression and not intended to be taken literally.	**Rule 4 : Inversion** Repetition of words in inverse order
SIMILARITY OF FORM mx & my	**Rule 5: Rhyme** Agreement in the terminal sounds of two or more worlds or metrical lines.	**Rule 6:** *(rhyme, allusion or hendiadys)*	**Rule 7: Allusion** A covert or implied reference.	**Rule 8: Hendiadys** One idea is expressed by two ideas which are given identical grammatical form ; e.g. « the vastness and the space' for 'the vast space'
SIMILARITY OF CONTENT mx & nx	**Rule 9: Simile** The act of comparing one thing to another	**Rule 10: Circumlocution** The use of several words instead of one, or many instead of few. A roundabout expression.	**Rule 11: Metaphor** The figure of speech in which a name or descriptive term is transferred to some object to which it is not properly applicable.	**Rule 12: Homology** A figure which constitutes a correspondence between the ideas and the way these ideas are expressed.

Table 14 : A section of the Semantic Engine rhetorical operations table. The complete table is available in appendix C.

The total number of pattern combinations can be found if the number of sets for each node is multiplied. Based on figure 87c the total number of recognized patterns is $3 \times 4 \times 5 \times 3 \times 1 \times 2 = 360$.

An optimization algorithm was implemented to: prioritize the patterns search for acceptable data processing time delay. The search optimization algorithm is based on two conditions. First, more complex patterns have a higher priority for selection than the less complex patterns (figure 87a). Therefore, if pattern number P8 and pattern number P0 are nested inside each other, P8 would be selected for the word search algorithm. And second the priority algorithm is weighted to select patterns with the least number of overlapped nodes. The red lines in figure 86 indicate the seven patterns from the 360 possible patterns that have been identified in the search optimization algorithm.

$$S_i = \sum_{i=0}^{8} n_i P_i - wL$$

n_i is the occurrence of pattern i in the graph
P_i is the priority of pattern i,
w is the weight of overlapped nodes
L is the number of overlapped nodes

```
S_i = 0, Max = -1000, MaxC = 0
For each combination C_i in graph G
   S_i = Score(C_i)
   If ( S_i > max)
         Max = S_i
         MaxC = C_i
   end if
end for
```

S_i : score for the specific pattern.

Max: maximum score for the combination, which is initialized to infinite small.

MaxC: combination which has the maximum score.

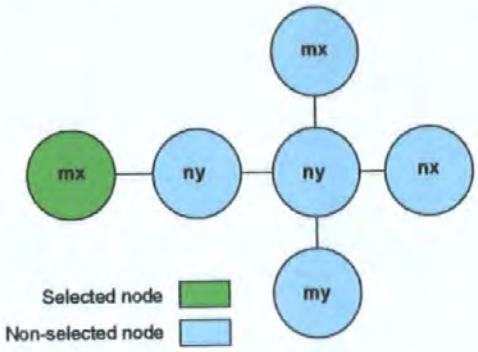
Score: function which calculates the score by equation.

Fig. 88: The pattern search optimization algorithm and pseudo implementation code.

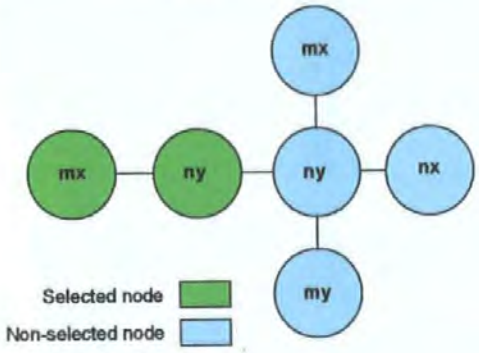
The pattern search is divided into three steps (1) two-node pattern search; (2) four-node pattern search; (3) search optimization procedure. The following illustration steps through the node-graph traversal for a four-node pattern search

Fig. 89: Graphical illustration of the search algorithm function.

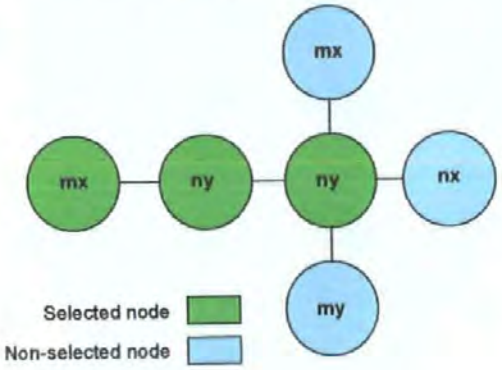
1. Start from the root node.



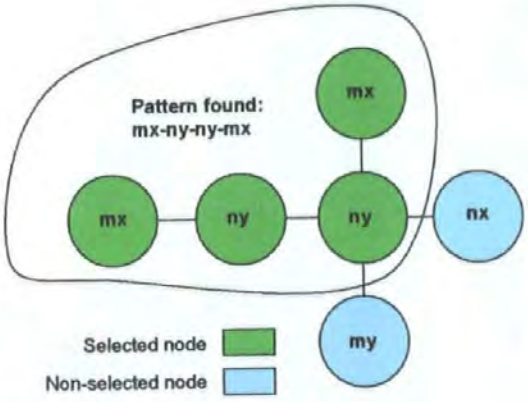
2. Select its connected node.

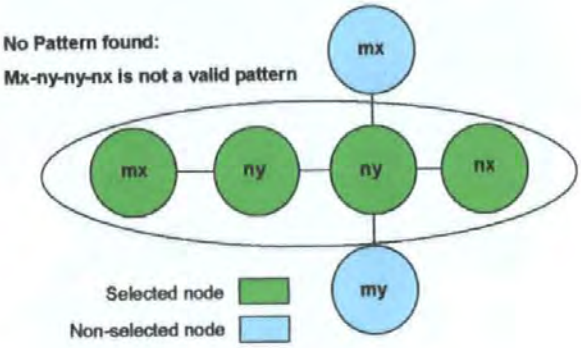


3. Select 2nd node's connected node.



4. Select 3rd node's connected node and then check the pattern type.





5. Iterate through each node in the graph and repeat step 1 to 4.

Local minimum search approaches could reduce the search time once two and four node optimum patterns are identified. However, global search was implemented to ensure that the optimal solution could be found. The maximum number of blocks in the current schematic is limited to eighteen (six blocks with three players). The maximum patterns in a graph are around 20-30 with this number of blocks. Since 2^{20} searches can be completed within two seconds, a temporary acceptable delay time for the prototype, a global search, such as the one described above, is feasible. If the system is expanded in the future, alternative search optimization methods may have to be implemented.

8.7.3.3 Step Three: Lexicon Word Search

WordNet Search Type	
Troponym (particular ways to...)	? command
Synonymy	-syns(n |v |a| r) or -simsv
Pertainyms (pertains to)	-pert(a | r)
Coordinate Terms (also see...)	-coor(n |v)
Antonymy (opposite)	-ants(n | v| a| r)
Attribute (adj. Values for noun and vice versa)	-attr(n |a)
Hypernymy (*word* is a kind of)	-hype(n | v)
Meronymy (has part, member, substance)	-meron
Cause (cause to relations of *word*)	-causv
Entailment (entailment relationships)	-entav
Holonymy (part, member, substance of)	-holon
Hyponymy (*word* is a kind of)	-hypo(n |v)

Fig. 90: WordNet search criteria.

The WordNet online lexical reference system is integrated into the semantic engine as the source for word searches. (WordNet, 2006) WordNet is a hyper-linked thesaurus of the English language that links relational attributes between nouns, verbs, adverbs and adjectives into synonyms, antonyms, meronyms, super and sub class relationships, etc.... (see figure 90). WordNet lacks some essential link categories that would make it easier to infer semiotic relationships that are not based on word structure or antonym/synonym relationships, such as pun, paradox, or tautology. Research studies for inferring meaning based upon multiple WordNet searches were reviewed. In particular, a study that presented methods for correcting malapropisms in texts offered insight into a methodology

that might be resourceful in developing search algorithms to find words based upon rhetorical operations. (Hirst & St-Onge, 1998) Developing methods to use a lexicon like WordNet to find rhetorical functions will be a continued area of research.

8.8 Current Semantic Engine Implementation

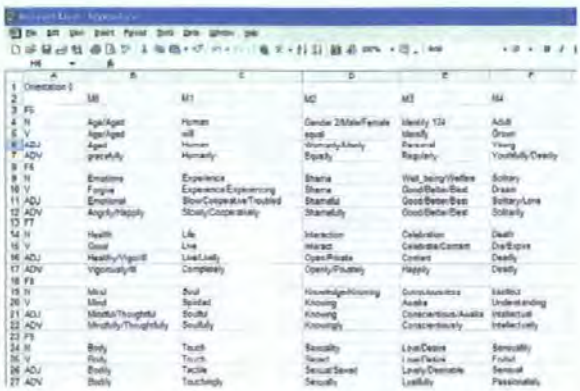


Fig. 91: Keyword look-up matrix for alternative WordNet Search for Semantic Engine version 1.0.

The current working prototype of the Semantic Engine uses a simplified WordNet search. The search is not pre-determined or hard-coded and incorporates a keyword look-up table of meta-level terms that are aligned with the four topic areas of the Builder's Profile application – self-identification, origins, environments, and values. This alternative search procedure serves as a functional placeholder while research continues on search functions for rhetorical operations. The implemented search is based upon a keyword look-up that is determined by the male and female faces of the blocks that are connected and the orientation of the female connecting face. These three data points are matched to a keyword matrix (figure 91) for a seed word for the WordNet search. WordNet can return a plethora of word results. I decided to use the floor plane of the virtual build application for this rich, dynamic cornucopia of text overflow. The floor plane updates each time a new word search is performed.

8.9 Alternative Tools for the Semantic Engine Natural Language Processing

My vision of the Semantic Engine runs parallel to current research in natural language processing and the semantic web. Portions of the application can be implemented, while other aspects address larger computational research questions that will not be addressed within the scope of the current version of the Constructed Narratives project. Several

computational methods were reviewed for the semiotic components of the Semantic Engine. Software agent technology was considered as a method to display the output and management of the Semantic Engine content. In particular, the RETSINA Agent Foundation Classes developed at Carnegie Mellon University was reviewed. (Sycara et al., 2003) The RETSINA application programming interface (API) it would make it possible to implement two distinct agents one for information gathering and the other for information processing and output. The information agent is designed to "provide intelligent access to a heterogeneous collection of information sources," primarily on the Internet Scott Fahlman's, SCONE project, "a practical system that can represent a large body of real-world knowledge and that can efficiently perform the kinds of search and inference that seem so effortless for us humans," was also considered. (Fahlman, 1988) Neither of these systems is used in the current version of the Constructed Narratives system architecture however, these technologies will be considered for future versions of this and other tangible social interface projects.

Chapter 9 Constructed Narratives Hardware Development

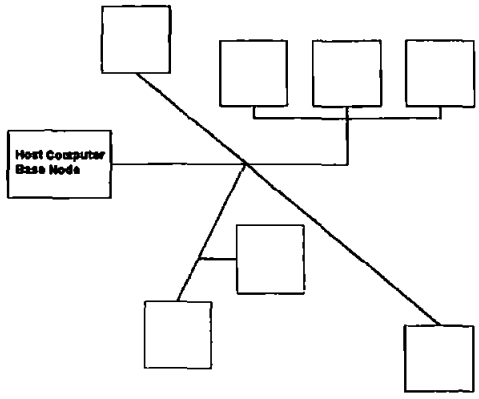


Fig. 92: Open-topology network diagram with one terminator at the host computer

The hardware components for the Constructed Narratives project were designed in tangent with the software architecture and block design. The hardware supports an open-topology network design using twisted pair protocol for the transfer of data. The open-topology network supports any combination of attached nodes (blocks) including cases where the block connections create a loop in the network structure due to being connected into the network with more than one face (fig. 92). This chapter provides an overview of the hardware as well as a description of the circuits designed for the project.

9.1 Hardware Overview

Hardware components embedded inside each block include: a Neuron C microcontroller; RFID reader and antenna; and microchip PIC microcontroller that serves as a serial data translation device between the RFID reader and the Neuron Chip. In addition to these components are proprietary circuit boards that facilitate block sensor data, connection status messages, linked power and twisted-pair communication between blocks and the host computer. Each Neuron Chip is a node in the open-topology twisted-pair network. To avoid individual batteries for each block one central power source is used and each block is powered by its neighboring block in the construction.

9.2 Circuit Design

The design of the main and appendage circuit boards was an iterative process of brainstorming, problem solving, and incremental solution discovery across four stages; (1)

inline resistors; (2) binary solutions; (3) functional prototype test circuit; (4) printed circuit boards version one and two. Each iterative solution brought the design closer to addressing the following four design requirements.

- Identify and implement the appropriate connector components
- Identify the minimum number of connections required to pass required data and power
- Develop a system that fully incorporates the network functions of the Neuron Chip
- Develop a schematic to optimally use the limited (eleven) I/O (input/ output) ports on the Neuron Chip including two for twisted-pair communication and one for the RFID serial receive function.

9.2.1 Stage 1: Inline Resistors

A lattice resistor network was investigated as a means to determine the orientation and face identification of a new block added to the network. The concept was that each possible connection point on the block appendage would pass a different amount of resistance to be interpreted through an analog to digital converter.

Although this solution could work in theory, it would have been very buggy due to inconsistent readings from the inline resistors and current management would be problematic with a large construction of blocks given the single power source. Although it was surmised that some of the instable resistor readings could be corrected in software. However, this solution would be very costly in terms of fault-error detection, debugging and headaches.

9.2.2 Stage 2: Two bit orientation sensor

Available upon request

Fig. 93: Constructed Narratives Two-Bit Sensor Schematic

The Neuron Chip has eleven I/O (input /output) pins, three which are reserved for specific functions such as twisted pair and serial communication. A solution was needed to manage data from all ten faces and their

respected four possible orientations using the remaining eight I/O pins. This was accomplished using a set of 8:3 multiplexers which consolidate 25 input signals to three I/O input ports and four I/O multiplexer control ports. The multiplexers receive data from a two-bit sensor that is embedded in each appendage face. This solution provided an eloquent method to economically use the limited I/O pins on the Neuron Chip and reduce the number of components needed to process the forty possible connection position states for each block connected to the network.

9.2.3 Stage 3: Prototype Test Circuit

To enable simultaneous development of the software and hardware systems a breadboard circuit that emulated the functionality of the final circuitry was designed. This breadboard

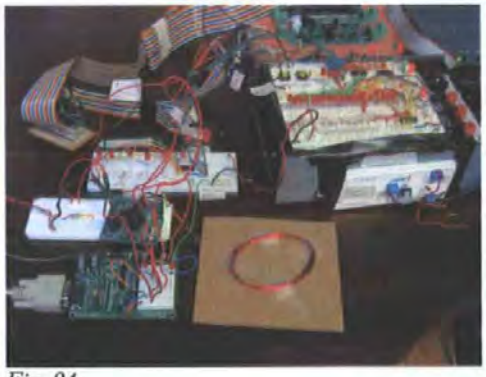


Fig. 94

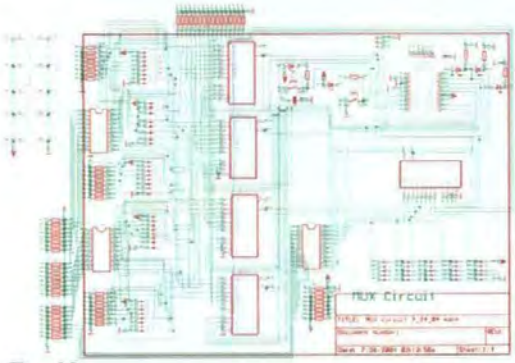


Fig. 95

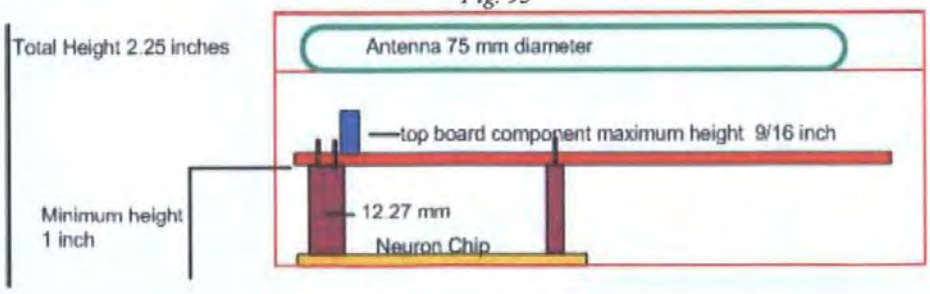


Fig. 96

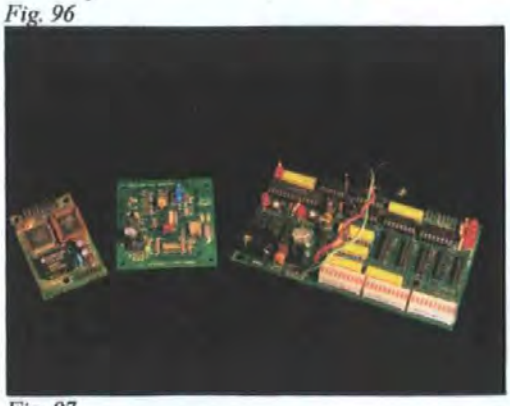


Fig. 97

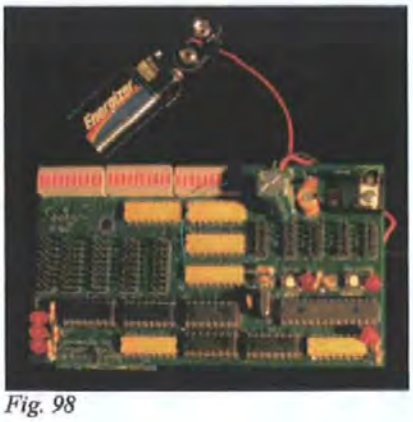


Fig. 98

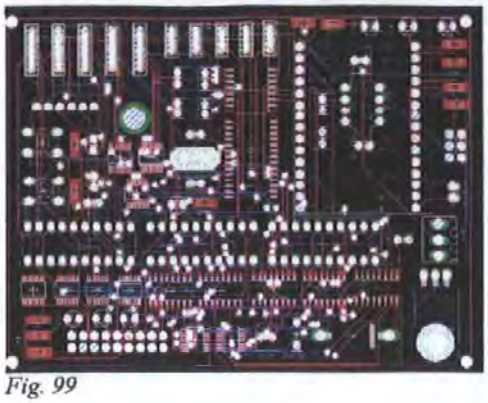


Fig. 99

Fig. 100

Fig.94: Hardware version 3 working prototype used for simultaneous software development.
Fig. 95 &99: Screen shots of the Eagle CAD circuit schematic and component layout design.
Fig.96: Circuit board stacking schematic The two smaller boards are stacked underneath the larger board.
Fig. 97 &Fig. 98: First printed circuit boards. The components pictured are (1) Neuron Chip; (2) Intersoft RFID reader; (3) main communication switchboard circuit.
Fig. 100: Current printed main circuit board.

(fig. 94) now a diminishing piece of sculpture in my studio, served as an important tool to develop and debug the software and circuit logic before printing the boards (fig. 98 & 100).

9.2.4 Stage 4: Printed Circuits Boards

The Constructed Narratives hardware solution consists of five circuit boards that combine OEM (original equipment manufacturer) products and proprietary hardware. Three proprietary boards include the main communications switch board and the male and female appendage boards. The circuit boards where designed using the EagleSoft PCB CAD software and processed with services provided by AP Circuits and PCB Express. (AP Circuits, 2006; PCBExpress, 2006) (Figures 95 & 99)

9.2.4.1 Echelon Company Neuron Chip

Fig. 101 : Echelon Neuron Chip and Node Builder Development Kit. (Echelon, 2006)

Several microcontroller systems were evaluated for features, platform flexibility, and ease of implementation, including the Microchip PIC, and Basic Stamp platforms. The Neuron chip, licensed by Echelon, was selected for its optimized design to facilitate large-scale embedded network systems. (Figure 101) The Neuron chip

was also incorporated into the hardware system for the ActiveCube project, developed at Osaka University, Japan. (Kitamura et al., 2001) Please see appendix B for more information about this project. The Neuron chip is designed specifically to facilitate data across large-scale embedded networks such as the management of lighting and HVAC (heating, ventilation and air conditioning) systems for large buildings.

The Echelon Neuron Chip is optimized for data transmission in complex network configurations and includes several options for the transmission of data, from wired to radio frequency. Its development environment includes software functions for packaging, replicating and updating messages between chips and the host computer. The system also provides a convenient desk-top interface for accessing and altering communication patterns between network nodes. The development environment has several modules including Nodebuilder (a Visual C++ like application), Visio 2000 plugin for graphically binding nodes in the network, and several other components for creating and monitoring the network. The Neuron Chip is coded using a derivative of the C programming language called Neuron C. There was a steep learning curve for the system, but once conquered, the network maintenance features proved invaluable in the development of both the software and hardware system for the Constructed Narratives project.

9.2.4.2 RFID (Radio Frequency Identification) Board

Several RFID reader solutions were considered. OEM-developed RFID readers that are designed for microcontroller control exist and are expensive. However, early test circuits were built using an OEM 125 kHz RFID reader from InterSoft. Several companies sell RFID antennas at an exorbitant cost for a tiny amount of magnetic cooper wire. To save money, I found the RFID antenna recipe, bought an impedance meter and spun my own magnetic copper wire antennas (fig. 102). The most recent circuit board design replaces the Intersoft RFID reader with the smaller footprint Texas TI reader.

Fig. 102

Fig. 103

Fig. 102: Home spun RFID antenna.
Fig. 103: Author models transponder bracelet.

The RFID transponder is worn as a bracelet on the builder's hand (fig. 103). Rather than incorporate one RFID reader with multiple transponders, the Constructed Narratives hardware system embeds a RFID reader inside each block in order to identify each builder. By inverting the typical RFID reader / transponder integration practice each artifact can independently track the identification of the recent builder who touched, or came within operational reach of the embedded RFID antenna.

9.2.4.3 Main Communication Switchboard Circuit

The main communication switchboard circuit board incorporates the multiplexer circuit for managing the block sensor input. The main communication switchboard also includes a PIC microprocessor that facilitates serial data translation and transmission between the 9600 baud RFID reader and the 2400 baud Neuron Chip. This solution for translating the RFID data through the PIC was much easier to implement than adding a hardware UART (universal asynchronous receiver-transmitter) to the Neuron Chip (Fig. 97 & 98).

9.2.4.4 Male and Female Appendage Signal Connection Circuits

As stated earlier, each block has two appendages (male and female) in the shape of a cube, that house a total of ten small connection boards that is mounted on each exposed side of the appendage. The appendage circuit boards facilitate the flow of six electrical

connections between blocks including source, twisted pair communication and position sensors (Fig. 104 - 106).

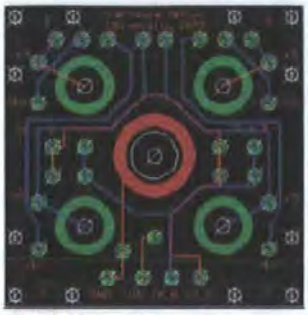


Fig. 104a

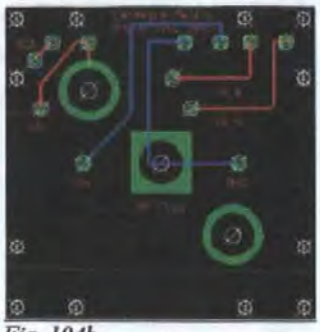


Fig. 104b

Fig. 105

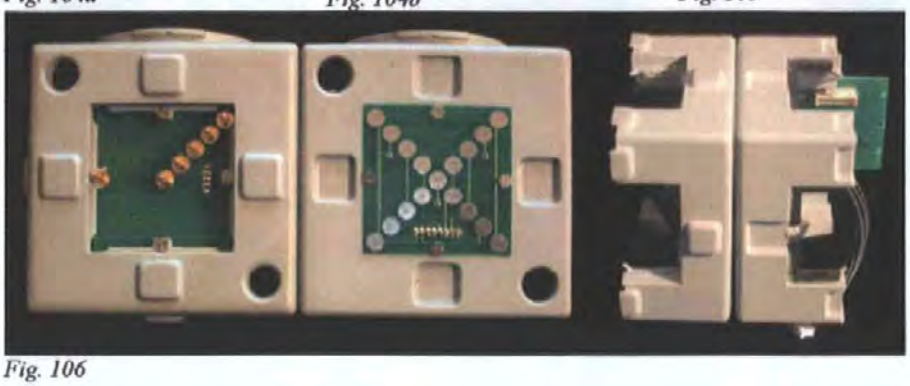


Fig. 106

Fig.104 a &b: Appendage circuit layout diagrams.
Fig. 105: Initial wood block working prototypes with appendage connectors.
Fig.106: The appendage circuits for current block design version using spring probe connectors.

9.2.4.5 Printed Circuit Boards Version Two

This version has the same core components of earlier versions with a few changes to reduce the overall footprint of the board (fig. 100). The Intersoft RFID reader was replaced with a "postage" sized reader. Several components on the main communication switchboard circuit were replaced with surface mount components, once again to optimize space on the board. The boards were hand soldered using a convection oven process in my Carnegie Mellon University School of Art Studio.

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Chapter 10 Interdisciplinary Pedagogical Practices

In this chapter I will discuss the process undertaken to form an interdisciplinary team of students at Carnegie Mellon University for the development of the Constructed Narratives project. Throughout the design process my team of students and I engaged in a lively collaboration where we played various roles from brainstorming to technical facilitation of the project's system architecture.

10.1 Wicked Problems and Multiliteracies in the Design Process

Wicked problems in design and the theory of multiliteracies, introduced in chapter five "Dialectics of Technology and Contemporary Practices in Creative Digital Media Practices," are theories that inform the design and goals of the project. These theories were also integral in problem solving, and opportunity discovery during the design and development of the Constructed Narrative project.[1] [2] Developing software and hardware architectures to support an open-topology network of tangible objects facilitated by a system that identifies block patterns and initiates word searches based on the pattern data presented its own set of wicked problems and negotiations for processes of problem identification, planning and production.[3]

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[1] Wicked problems are indeterminate. The initial design question can be formed in multiple ways that can serve to highlight or suppress important factors that affect the design solution. Wicked problems do not have stopping rules or scientific tests to validate the result, rather they generate a bevy of plausible explanations and solutions, whose breadth, complexity, and applicability of solutions, are dependent on the weltanschauung (intellectual perspective) of the designer. (Buchanon, 1995; Rittle, 1984)

[2] The theory of Multiliteracies promotes the metaphor of design as a means to re-construct, re-position and generate alternative methods and solutions for becoming more wholly integrated into the processes, decisions, and other influential aspects of life in contemporary society. The concept of re-design emphasizes the development of tools which empower individuals to construct, from their perspectives and needs solutions and ways of being that are hampered by the more restricted tools and metaphor of living that is supported by available design and design. (New London Group, 1996)

[3] Buchanan puts forward the theory that design is the new liberal art that "contributes to a new awareness of how argument is the central theme that cuts across the many technical methodologies employed in each design profession." This new liberal art challenges the notion that solving a wicked problem is only limited by the scope of one's imagination and *weltanschauung*. Design then is a discipline of practical reasoning and argumentation that may be realized in the acts of communication, construction, strategic planning or systemic integration. These solutions can be found by challenging limitations of verbal and other forms of symbolic argument to examine and interconnect "the signs, things, actions and environments that address the concrete needs and values of human beings in diverse circumstances." (Buchanan, 1995)

10.2 Project Team Development

> *"We live in a world where problems often require the collaboration of stakeholders from different communities, each seeing the world from their own perspective, each having their own background knowledge and their cognitive, computational and physical tools and artifacts. Exploiting the symmetry of ignorance as a source of power requires not only a willingness to talk to collaborators, but also externalizations that allow people to think and to argue about and that help them to create incrementally a shared understanding of the design problem." (Fischer, 1999)*

Innovation is born from diversity of approaches, ideas and experiences. With diversity comes difference, which can be neutralized or utilized. Each member in an interdisciplinary team has the potential to contribute to the attainment of the overall project goals. Team management techniques for overcoming hurdles presented by differences in method and uses of technical or discipline specific semantics are required for effective and efficacious integration of the beneficial attributes of diversity.

To achieve this integration, I implemented a learner-focused, nurturing and respectful working environment that recognized the synergies between team members by practicing *inclusive wholeness*. *Inclusive wholeness* is a management strategy that insures success in pedagogically research, while discouraging and dissolving hierarchical ranking between disciplines represented in the interdisciplinary research team.

A factor that was integral to the purposeful diligence of the Constructed Narratives team – which consisted of designers, artists and technologists – was the incorporation of the benefits enjoyed from acknowledging the *symmetry of ignorance*. The "symmetry of ignorance" recognizes that no individual possesses all the needed knowledge, insight and exposure for finding solutions for a complex problem opportunity. Rather, resolving and/or inventing complex systems requires the pooling of methods, experiences, successes and failures represented by a collective knowledge network. [4] (Fischer, 1999)

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[4] Knowledge networks have been developed for the domains of education, computer science, business management, etc. as a means to harness the powers of information technology to accumulate the collective knowledge of a "community of practice."

10.3 Project Team Selection

Carnegie Mellon University students with solid technical and design skills can select from many high profile research projects to augment their academic and intellectual curiosities. The recruitment of this same pool of students to work on a critical creative technology project situated in the School of Art was a challenge, though by far not impossible and at the end quite successful. (Figure 107)

Fig. 107a *Fig. 107b* *Fig. 107c* *Fig. 107d*

Fig. 107a, b, c, & d: Members of the Constructed Narratives research team, representing, Drama, Design, Human-Computer Interaction Institute (HCII), Entertainment Technology Center, Masters in Information Network Systems, Art and Cognitive Science.

My final selection criteria was based on each students' academic major; prior work experience; participation in activities outside of their academic major; and a contagious enthusiasm to work on a complex project that required focus and flexibility for effective team work.

During the interview process it became evident that some candidates possessed optimal technical skills for the project. However, their suitability did not always match their enthusiasm for the challenge. On the other hand, several prime candidates, who demonstrated requisite skills and enthusiasm for the project, had several options for research projects. They preferred not to take the risk of working on a research project in the School of Art and opted instead for research projects in the Robotics Institute or the School of Computer Science.

(Petraglia, 1998; Pea, 1993; Kelly, 2001; Fischer, 2005; Perkins, 1999) Techniques include using online tools and physical interfaces to create information rich navigable collaborative applications to provide methods that enable individuals to use the actions and preferences of others as a means to inform their own actions and decisions and are typically developed for research, business, and commerce applications. (Dourish, 1999; Badner et al, 1998;, Kellogg & Erickson, 2000)

Several applicants were categorized as junior researchers. These where students who had great enthusiasm for the project, were in the right academic fields for the project tasks yet lacked the level of required experience. These students were not told of their "junior researcher" rating. I only used the term as a means to categorize the approximately fifty applications I received from students over a two year time period. I tried, but without success to recruit them onto the team in a "training" type of position that would require full project participation but require less responsibility for critical aspects of the design. This strategy proved to be unsuccessful, in that those students deemed to be junior researchers, still had many high profile research options.

The Constructed Narratives research team has included Carnegie Mellon University undergraduate and graduate students representing the School of Art, School of Design, School of Drama, School of Computer Science, School of Architecture, Electrical and Computer Engineering, Masters in Information Management Systems, Human Computer Interaction Institute, the Entertainment Technology Center and Cognitive Psychology.

10.4 Team Meetings

The task at hand was development of the system architecture for an open-topology network of the tangible social interface. Fully engaging an interdisciplinary research team on such a complex task required a neutral meeting place where collaboration, creativity and risk taking could transpire. My studio in the School of Art served as this neutral space where social creativity flourished. Although the space was familiar to one team member, this was the first opportunity for the other team members to spend a significant amount of time working in the School of Art.

The work process was divided into activities that involved project management, interface and artifact design, user experience design, hardware design and software design. The segregation of design and technology development is very common in computer interface development projects. It is not unusual for the design team to be brought into a project after the specifications have been developed. My technique of integrating all members in full team meetings from the inception of the project, as well as having team members who were both designers and technologists engendered an appreciation for all aspects of project development. This technique, along with an implicit acceptance of the theory of *symmetry of ignorance* supported an efficacious environment for learning and producing.

Team membership rotated between 2002 and 2004 due to graduation and one voluntary discontinuation with the project. Therefore, maintaining a project memory for team transitions was crucial. Each member was required to submit a concise digital report every week that included notes about the processes they were assigned to investigate. The reports were compiled into a project notebook that was duplicated and made available to all team members.

Mandatory full team meetings were held at the end of each week as a forum for each team member to report on their recent research. The order of reports was alternated each week to give the topic of most importance ample time for discussion. The issues of aesthetics, experience design, network communication protocols, and hardware solutions were the source of hours of great discussion, debate, brainstorming, and whiteboard diagramming.

Smaller focus group meetings, held in the beginning of the week, provided a forum for development of specifications for components of the design. Focus group meetings were divided into two categories software and hardware technology development and artifact and user experience design. Although it became necessary to create separate meetings for

technology and design considerations, these core components of the project were not segregated or relegated to a rank of overall importance in the process.

10.5 Team Work Process

Fig.108: Brainstorming and diagramming during a full team meeting.

The ability and willingness to learn and teach in a collaborative knowledge-based environment is paramount for the successful design of a complex system. (Illich, 1973) Each team member contributed a high level of diverse knowledge in their core research areas, yet they experienced steep learning curves as a result of the integrated system design. For example, all team members were required to learn about the influences and implications of software, hardware, electronics, critical and semiotic theories, industrial design solutions, and experience design on their individual tasks and the overall "big picture" of the project. This macro approach to research, which is more prevalent in research-in-practice approaches, challenges the typical research practice which drills down into micro details of an abstract component of a research domain.

Each team member was a vital stakeholder in the success of the project. Giving the stakeholders decision-making responsibilities was empowering. This act of empowerment ensured the development of optimum design solutions given the scope and level of the team members' skills. The act of empowerment also promoted an efficacious attitude that transcended individual concerns over task difficulty or the level of effort required to achieve a solution. The core hardware system required that each team member learn the basics of electronics to understand its implications on the block artifact, software and hardware development. The design of the block artifact presented many hard problems to solve, despite its simple visual form. The user experience design work required team members to grapple with understanding theories of semiotics and shape grammars.

Software development required learning a proprietary network communication application programming interface and the development of a component system architecture comprised of a variety of programming languages. See chapters seven through nine for more information about these processes.

Exploiting opportunities inherent in "symmetry of ignorance" requires the use of boundary objects that serve as external explorations of ideas. These boundary objects are used to articulate tacit knowledge and ideas that may be too complex to describe verbally yet not far enough in development for the creation of functional specifications. It provides a means for team members to interact, react and negotiate around a concept using concrete representations to create a common language for understanding and critique. (Fischer, 1999) Boundary objects used throughout the design and development process included whiteboard diagrams, schematics, application program interfaces (API), sketches and prototypes made from paper, cardboard, wood and metal, and diagrams mapping semiotics and narrative structure to the Constructed Narratives blocks.

Recognizing the steep learning curve, elements of the Extreme Programming (XP) software development methodology were borrowed and molded to fit our work process. Extreme Programming is a team-based approach to software design that emphasizes the gestalt principle that "the whole is much greater than the sum of the parts." Extreme Programming emphasizes four essential elements – communication, simplicity, feedback and courage. Programmers keep their design simple and clean. They get feedback by testing their software starting from its inception to its implementation. An important technique of Extreme Programming is programming in teams. This process is supported by the fact that better software design and problem solving can occur with greater diversity in the thought process. [18] The concept of Extreme Programming was extended to all aspects of the *Constructed Narratives* project from programming to artifact design. Standards for

writing code and artifact prototype development were established in the beginning of the project. Methods for testing software and hardware designs were implemented that enabled a parallel and independent design process for software, hardware and artifact design. See chapters seven through nine for additional information about the parallel development method for designing network systems with tangible components.

10.6 Team Self Report Assessment Questionnaire

A self-assessment questionnaire, designed to assess the effectiveness of team management and the collaborative development processes, was administered after the first four months of the project development. The short answer questionnaire was designed to gather feedback on each team member's process, project contributions, and suggestions for improvement. Below are a few of the questions asked and responded to in a short paragraph format.

> Were the team meetings effective?
> Did you participate in team programming and/or design sessions?
> Did you find the preparation of reports beneficial to the process of understanding new technologies, processes, and concepts?
> How would you rate your learning curve?
> What was challenging?

Three out of four team members, from the summer of 2002, completed and returned the questionnaire. The fourth team member completed the questionnaire; however it was lost in the shuffle of graduation.

Responses from all team members indicated that the report process was beneficial in helping them organize their ideas and keep track of details that would have been lost in the brainstorming process. The reports also helped team members keep focused on their individual tasks while giving them an intermittent sense of accomplishment in the weekly oral summaries.

In answering the question "Did you find the team meeting process to be effective?" one student involved in the artifact design responded, "Yes – because we were given an overview of what other people were working on, but not clobbered with technical details that would have alienated a non-tech audience. Same for the non-art audience – they weren't overloaded with the details of art discussion but got enough to know in what direction that part of the project was going."

In response to the work process, the same student responded, "I found it motivational to have the team deadlines to meet for the team meetings. Also making the reports helped get my work done, and feel a sense of accomplishment. The risk with such an ambitious and complex project is to become paralyzed by all the stuff you need to do or do many things and forget them. I found the team meeting and reporting to work very well."

Student programmer #1 responded: "There was significantly more brainstorming and design concept work that was entailed in the work load than I had expected. This was quite challenging to me." The same student remarked that he would have preferred more focus group meetings rather than full team meetings.

In response to the question about participating in extreme programming and/or design activities, the student designer responded: "I guess that I was working on a real multidisciplinary team. People knew about what others were working on but there wasn't an expert understanding of what the other was doing. I say this because no team member had the same background. I've worked on teams where people have the same background and sometimes there seems to be less respect for other people's work. On this team I felt that there always was that respect for other people's work." Software programmer number 1 found extreme programming to be an effective work approach "since each [programmer] could rely on the other on areas which were not familiar. And each could bring up design

issues which were possibly overlooked individually," whereas student programmer #2 preferred to approach his tasks as a solo activity. Software programmer #2 left the project to be replaced by a more skilled programmer who worked very well in an extreme programming environment.

In addressing challenges and learning curves, Software Programmer #2 stated, "[My learning curve] is what I expected. I got in knowing well that I would be writing lots of nitty-gritty aspects of the networking protocol. The learning curve didn't surprise me considering what I had to create was a robust system for communication between blocks."

Challenges for the student designer were eloquently stated in his response: "I'm an Interaction Designer, and previously worked as an Architect. I was applying my skills in a different context and projects. I have designed buildings and built scale models. I had never done industrial design work before that went beyond sketching. I chose to work on this project because it would be a challenge for me. The opportunity was to be able to apply previously acquired knowledge to a different context. I know how to design buildings and interactive products so the project was an opportunity to join the two. That was what I thought going into the project. Once in the project it turned out that I had underestimated the complexity of the task at hand, especially what I would need to learn to get my work done. But once you are on a team and things need to be done one just needs to rise to the occasion.... All in all the learning curve was manageable—this is simply because of the process that we used as a team. The fact of breaking it into a series of reports and steps makes it easier to face even the greatest learning curve. The other thing is that as a designer I am accustomed to learning new things on each project, it just comes with the trade."

10.7 Conclusion

The sample size for the self-assessment report was small and unique to the *Constructed Narratives* project yet it served to illustrate some of the cultural differences across disciplines as well as how those differences can be integrated into effective methods for supporting interdisciplinary research teams. The student designer was accustomed to using brainstorming and work methods for finding solutions to complex problems. The software programmers were fully engaged in the brainstorming sessions and yet articulated a desire for less brainstorming. The programmers demonstrated a tendency to work separately on solving complex problems. This may have been a result of not having previous experience with team-based programming, personality differences, and/or the intensity of individual tasks. In reflection, I realize that the team programmers worked best when they possessed complementary skills level, or were able to transcend their own knowledge deficits to seek assistance from other members on the team. The team members involved in artifact and user experience design had a very effective collaborative work process. Although their primary tasks were very different they were able to quickly understand how their tasks influenced each other.

Chapter 11 Exhibition and Future Plans

11. 1 Exhibition and Presentations of the Constructed Narratives Project

My theoretical and practical work completed for this dissertation has been presented, discussed, reviewed, influenced by and served as an influencer of complementary research agendas and projects in international forums thanks to my participation in the Center for Advanced Inquiry in the Integrative Arts (CAiiA) Ph.D. program at the University of Plymouth. This research has been peer reviewed and published and exhibited in venues outside of the CAiiA program including: the Association for Computer Machinery (ACM) Computer Human Interaction; ACM Cognition and Creativity and ACM Multimedia conferences; National Science Foundation Workshop on Creativity Support Tools; Inter-Society for Electronic Arts (ISEA) 1999, 2000, and 2004, etc.... A list of public presentations, peer reviewed conference papers and journal publications can be found in beginning of this text.

Constructed Narratives and the theoretical framework for critical creative technology has received an overwhelmingly enthusiastic response for the theoretical social cartography I am mapping and the method of aesthetic experimental project-based research. I have received a few less than enthusiastic responses from researchers who question the relevance of extending contemporary philosophy and critical theory into human computer interaction research methodologies. In one particular case, a senior colleague who is involved in traditional cognitive modeling research methodologies, in my respected institution, berated me about the integration of 20th century theoretical thought as a supplement to HCI methods and practice. This response I find extremely troublesome given the great influence philosophy and critical theory have played across nearly all disciplines in the Arts and Humanities and public policy. This however, has been a rare response. Conference audiences spanning the continuum of Human Computer Interaction

Consortium to the Inter-Society for Electronic Arts (ISEA) have generously given both enthusiastic and inquisitive responses to the work and its supporting theoretical framework. (HCIC, 2005; ISEA, 2004) This indicates to me that the project is addressing the need for new transdisciplinary research agendas and integrated art experiences that transcend cultures and disciplines.

At the time of writing this text, I have had two opportunities to demonstrate and exhibit the Constructed Narratives project at the Interact 2003 Human Computer Interaction Conference held at Eigenössische Technische Hochschule (ETH) Zurich, Switzerland and 2004 at the Kiasma Museum for Contemporary Art as part of the ISEA2004 conference in Helsinki, Finland. I had hoped to have a complete functional prototype for Interact2003, however the software development was further along than the block artifact and hardware design. As an alternative to an interactive demo, I presented video capture from the Virtual Build application along with a poster describing the interdisciplinary team work process. The low fidelity presentation was very helpful with general feedback on my overall concept and design plans.

Preparation for the ISEA2004 exhibition required speeding up the pace of development and included a few compromises on the block design, but was well worth a summer of soldering and assembling blocks under a glass ceiling studio during the unrelenting Pittsburgh summer heat. I had an extremely dedicated group of students and other colleagues who helped prepare for the exhibition. We literally worked twenty-four hour days, in the month of August 2004, and assembled four working block prototypes and enough circuit boards for a complete set of blocks. The live demonstration of the project was up for the opening night of the ISEA2004 exhibition titled Koodattu Kokemus (Wireless Experience) (fi. 109). (ISEA, 2004) A software simulation of a block construction in the Virtual Build application was displayed for the remainder of the month-

long show. Hundreds of people watched, played, and asked questions about the project, its goals and ideas for further project development. A few programmers suggested that I make the software open source to enable an international community of programmers to contribute to its development. Others suggested that I patent the idea and package it as a product. Needless to say, I have heard from several people that there may be intellectual property with the project.

Fig. 109

Fig. 110

Fig. 109 Constructed Narratives at the Kiasma Museum for Contemporary Art installation, Helsinki, Finland 2004.

Fig. 110: People curiously manipulating the Constructed Narratives blocks at Kiasma.

Despite standing on pins and needles as the blocks were manipulated for the first time by people outside of the development team, I was able to observe a deep enthusiasm and curiosity for the game that kept individual groups of people at the game table for extended amounts of time. They were fascinated by the devices, the technology, and the potentials for the game. The Kiasma experience, though exhausting beyond what one may be able to comprehend, instilled in me the confidence that the project has the potential not only to be successful, but touch the hands and lives of many individuals who could encounter it in a public spaces, a home coffee table, or online.

11.2 Observations Made during the Kiasma Exhibition

Three core observations were made as I watched and facilitated builders' interaction with the prototypes: (Figures 110 & 111)

11.2.1 Block Size

The block size was determined by the shape grammar scheme and the internal hardware components. Even with the great reduction of the circuit board in the current version of the hardware, the block was approaching a size that was difficult to manipulate and connect by one person. This could be seen as a problem since the block size was cumbersome. However, the very nature of its awkwardness forced cooperation and collaboration among builders in order to stabilize the structure.

Fig. 111: People curiously manipulating the Constructed Narratives blocks at Kiasma.

11.2.2. Location of Virtual Build Projection

The Virtual Build projection was placed on a wall behind the round game table. This location enabled onlookers to watch the physical construction and see its semantic transformation on the wall. The projection on the wall forced builders into an awkward position with their bodies. Turning around to view the screen was not a comfortable position, or a way to keep the structure from toppling. This meant that the builders missed out on a major component of the game play, if not the most important component, that is the constructed semantic world.

11.2.3. Connector Technology

One of the hardest development areas for the block is the electrical and mechanical connector solution. The live demonstration gave me the opportunity to test, in a more realistic setting, technical solutions that work well in planning, design, and studio testing, but falter in real user testing. Whereas, the current solution is well on its way to being optimal, it is still far from perfect given external factors to the connectors such as balance of the connected blocks and properties of the physical blocks, and manipulation by many hands.

11.3 Future Design Plans

Access to various design facilities at Carnegie Mellon University has been extremely resourceful in the development of this project. However, continued design optimization will require resources that are not readily available at my institution. This includes reasonably-priced and accessible rapid prototyping facilities and machine-automated circuit assembly processes. The following are functional and aesthetic requirements and improvements I plan to implement in future prototypes of the Constructed Narratives project.

- Reduce the overall block size to comfortably fit into the average adult-sized hand.
- Redesign the block form factor to better facilitate the assembly of the block parts.
- Optimize the mechanical and electrical connection solutions to guarantee integrity in the physical and electrical block connections blocks.
- Explore the color and texture of the plastic cast block. A softer plastic with a lower durometer value (lower value gives a softer surface) may encourage builders to manipulate the blocks with a "gentler" touch.
- Reduce the overall size of the main circuit board by using machine-soldered sub-miniature electronic components.
- Update the main circuit board with connectors to enable future block updates such as a connector for small LCD screens to be embedded in the block and touch sensors.
- Reduce component cost by replacing the current OEM RFID reader with a smaller component with printed circuit board etched antenna.
- Completion and implementation of the Builder's Profile Application and the Semantic Engine lexicon search.

11.4 Additional Scenarios for Critical Creative Technologies

My primary audience and target environment is the public space where concepts of the public sphere are molded into existence. My primary focus has been to produce an interactive "transforming mirror" (Rokeby, 1996) that reflects and refracts the contextual situation and dialogical potentials inherent in a physically co-located space. The emphasis was on the design of collaborative social interfaces that support: context awareness and enable collaboration between people as a means to locate and visualize familiar and hidden social networks within and between spaces; make accessible knowledge networks that enhance collaborative experiences of a space; and produce tangible social interfaces that provide a common-ground to support dialogue between individuals who typically would not engage each other in a public space.

There are several other alternative methods for the dissemination of the project. The first involves converting the software architecture into an online game that can be played with or without the physical artifacts. The second would be the "commercialization" of the project into a boutique parlor game – a cross between Jenga and magnetic poetry. Here the concept of discourse wrangler could continue to be explored, but in a private or semi-private space as opposed to a space where serendipitous connections between people is

possible. The third is the development of other critical creative technology research projects that continue to address issues discussed thus far in this text.

The four scenarios below, *AirExperience, ConnectSpaces, ConnectUs* and *ConnectInfo,* explore possible design spaces that are based on the theoretical framework of *critical creative technology* and/or the *Constructed Narratives* project.

11.4.1 Scenario 1:
Airperience: In-flight Dynamic Global Mapping Collaborative System

(This scenario is a continuation of the Constructed Narratives scenario in chapter six)

Sara and Thomas, who met in the Auckland International Airport while playing the Constructed Narratives game, discovered that they can continue to build their Constructed Narratives world on the airplane using the in-flight entertainment consoles embedded in the head rests of the seats in front of them. They can also explore the worlds constructed by other players in other airports and public spaces scattered around the world. They continue to play for a short time, until Thomas sends a message to Sara via the LCD console that he needs to spend time preparing for his meeting in Los Angeles and he signs off of the system. The flight lands safely in Los Angeles and they catch a glimpse of each other across the baggage claim carousel and wave goodbye. Although they did not exchange contact information, their collaborative experience will be permanently etched in their memories.

Sara is now on the final leg of her trip to the Pittsburgh International Airport. The flight has been in the air for an hour. An announcement is made over the loud speaker announcement system for passengers to close their window shades in preparation for the in-flight movie - the classic 1956 Disney film, "Around the World in 80 Days." A blue glow from hundreds of small LCD screens on the 767 jetliner permeates the cabin and passengers begin to plug their headphones into the seat audio connectors – as they voluntarily tune-out their immediate surroundings. Sara has seen the film many times and

is not interested in watching it again. She fumbles with the remote control device attached by cable to her arm rest. It's a bit difficult to get the cord uncoiled. But once this task is accomplished, she proceeds in searching through the entertainment system for something else to occupy her time. Sara is intrigued by the live video feed coming from cameras mounted to the nose and belly of the plane. "Wow," she exclaims to herself. "This is what it really looks like outside, right now! The clouds are so beautiful, like soft swabs of cotton gently suspended on a cushion of air." A break in the clouds reveals a rugged landscape below with a few enclaves of buildings and streets separated by a large patchwork of green and yellow fields. "Where are we? Are there any people below? How far away are those little towns from each other?" she thinks to herself. She continues to fumble with the remote control to see if she can find any answers to her questions. She comes across a GPS map with very low resolution graphics and an icon of an airplane with alternating screens that give logistical, time, altitude, and speed data every 20 seconds. She reads on the map the location "Jackson, Wyoming." Okay, she thinks to herself. What if this interface were truly informative and dynamic? She would love to be able to use her game console remote to actually fly through a visualization of the land below using GeoVRML software protocols from the Web3D consortium and Google Earth (GeoVRML, 2006; Google Earth, 2006) combined with local knowledge databases including GIS information, state, county, and tourist attraction web sites. She could sail down low to touch the mountain peaks of the Yellowstone National Park and then jump lightly to the Grand Teton National Park, and navigate through the cannons etched by great rivers. She could see a visual representation of communities and stop for a virtual bite to eat or conversation with a local who tells her about the communities, wildlife, geography, and other local items of interest. She would learn about the Wind River Indian Reservation and the Eastern Shoshone and Northern Arapahoe Indian Tribes. Perhaps, she could share her expedition of the world below with another passenger on the plane. Together, they could go virtual sky diving, spelunking and navigating the world below. Sara's fantasy of an improved in-flight edutainment

application using many information technologies that are already available along with the data-structures and database that would allow this application to be truly dynamic and collaborative. Sara grows bored with the alternating 4-bit graphics and data screens giving her updated information about the velocity of the airplane and she flips back to the live video feed of the clouds.

11.4.2 Scenario 2: ConnectSpaces Bridging the Demographic Gap between Diverse Constituencies

Sara is enrolled in an interdisciplinary Ph.D. program at Carnegie Mellon University that brings together faculty and researchers working in digital arts, interaction design, architecture and human computer interaction. The mission of the group is to research and design computer-based collaborative systems, interfaces and experiences that promote human-to-human collaboration and sharing of information in public spaces. She has been working in a project with her advisor called *ConnectSpaces* in collaboration with cultural arts and informal learning institutions in the Pittsburgh region. The research project is based on the premise that the urban space can be a segregated environment where people tend to interact socially with others who are more similar than different then themselves. This common act of social engagement leads to missed opportunities to exchange ideas and learn from people who do not fit the profile of one's immediate familial or social network. There is a need for increased social interaction and a way to make public or semi-public spaces more inviting, interactive, informative and engaging experiences.

Among the features Sara is researching and developing for the ConnectSpaces project is a method to visualize the interaction and movement history through two demographically-unique urban locations as a means to increase the awareness of social networks among individuals in ConnectSpaces locations. ConnectSpaces pairs two or more institutions with very different patron demographics as networked Constructed Narratives sites to

provide a means for broader community engagement, knowledge sharing and learning across logistical sites and social networks. Part of Sara's job is to research and analyze the visitor demographics at cultural and informal learning institutions partnering with her Critical Creative Technology research center. She is considering institutions such as: the Andy Warhol Museum and African American Cultural Center; or the Wood Street Gallery (which focuses on contemporary visual arts practice) and the Heinz Auditorium (home of the Pittsburgh Symphony Orchestra); or the Carnegie Science Center and the Pittsburgh International Airport.

Many conceptual ideas have been generated about how to accomplish this task in the Critical Interaction Design class where Sara is a teaching assistant. One very popular idea was to build a computer vision system for tracking and analyzing movement patterns in the institutional spaces. The interactive experience would be an enriching experience for people whose presence is caught by the surveying system. Sara and her advisor have decided to develop a project based on the robust system architecture and network capabilities that are already built into the Constructed Narratives project. The transition of the Constructed Narratives into a ConnectSpaces project involves the implementation of Internet networking components to the software that facilitate the transportation of structural data about the physical construction to a new physical location. Real-time reconstruction of the structural data would result in a 3D replication of the physical construction at the original site that can be rotated and navigated in the new site. Sara remarks to her advisor that it would be wonderful to be able to reconstruct the actual physical construction at a new site. They both agree that doing such is a task of much larger magnitude requiring additional professional team members in robotics and mechatronics not to mention funding. They laugh and resolve that the physical re-build idea will remain a concept for the next William Gibson novel.

Sara is designing interface and interaction design methods that would enable a participant at a companion institution to manipulate a virtual rendition of a physical structure made elsewhere. This provides a rich arena for development, research and assessment of synchronous collaborative spaces across physical locations. The interface would provide a 3D navigable reference to the construction made at the companion institution and a scratch-pad area for cross-site collaboration. The results of the manipulation would be viewable in a screen projection. Sara and her advisor are very keen on incorporating the basic rules of rhetorical action that include addition, suppression, substitution and exchange as a method to provoke and support dialogical exchanges between participants located at different institutional sites. These rhetorical tropes are already used by the semantic engine rules matrix used by the Constructed Narratives project to initiate word searches in the WordNet application programming interface.

11.4.3 Scenario 3: ConnectUs: Intelligent Spaces: Social Network Visualization

Among the collaborative applications Sara is researching and developing is a method to visualize the interaction and movement history through two demographically-unique urban locations as a means to increase the awareness of social networks among individuals in those spaces. This project is called ConnectUs. To maintain the anonymity of the person who is tracked by the system, the visualization of movement through the space is represented with abstract visual forms, colors, shapes. If a person traced by the system chooses, he can attach personal data to his representation in the visualization so that the underlying computer database system can connect him with others in the visualization system with similar interests. Sara plans to incorporate several methods for attaching personal data to a user's presence icon in the visualization. The first method she is programming involves tapping into the social network the profile information, voluntarily provided by ConnectUs participants, through online social network applications and recommendation engines such as Friendster, 2006, The Facebook, 2006, and Orkut, 2006.

Although online social network applications provide a good resource of data for the ConnectUs system, Sara noted the limitations of these tools. They tend to support networking between active primary relationships and not buried relationships that exist beyond the limited levels of network branching algorithm used by the online systems. The ConnectUs visualization application she is designing will incorporate methods and recursive search algorithms that will data mine the user's primary relationships for buried social network connections between people that would not have been evident or revealed, such as a friend of a friend three or four times removed from the primary relationship that also has similar profile interests. The ConnectUs application will automatically determine and capture primary or buried social networks across the two physical spaces using a spatial RFID tracking system that can locate a unique ID in a three-dimensional space and map it to the overall traces of movement in that space. The unique RFID number is matched to the online social network database profile. The traced individual maintains his anonymity when a match is found. He can choose to send a video to the matched individual in the other urban space using a video kiosk station set for recording and transmitting messages in real time. A goal for the ConnectUs application is to increase the chance that new primary social networks will be developed from previously buried social networks. People who were once strangers to each other will find a common-ground for interaction.

Similar to the ConnectSpaces concept the ConnectUs visualization screens will be placed in two Pittsburgh cultural institutions. Sara envisions that the technology will provide a means for broader cultural and location specific knowledge exchange and collaboration. Both ConnectSpaces and ConnectUs will be transformed from a tool for finding unlikely matches between people in different locations to a tool used to transform traditional cultural institutions into vibrant and dynamic spaces for engaging in the recursive process

of negotiation, reorganization, and building of ideas inherent in the constructivist and situated cognition theories of learning.

11.4.4 Scenario 4: ConnectInfo: Knowledge Sharing System

The learning experience in informal learning environments often occurs within a social context. People come with other people – friends family, fellow students. Visitors browse with their feet and set individual courses of learning based on their movement through the physical information space. In a museum, opportunities naturally arise for people to relate to each other and one can overhear delightful discussions between visitors about the nature of exhibits. (Semper, 1990) Sara and members of her university research team are designing a cultural information application version of ConnectUs called ConnectInfo. The goal of the ConnectInfo cultural interface application is to challenge boundaries of distance from the objects of interest, as well as boundaries between visitors that is typically present in such environments, by enabling visitors to learn from each other, as well as the museum artifacts and docents. They are designing principles for transforming a static space into an adaptive structure that will encourage visitors to take advantage of the learning opportunities through deeper levels of interaction with each other and context-sensitive feedback from the space. ConnectInfo is a networked information system that unleashes the powers of software agents across handheld devices to interact, inform and inspire visitors at a cultural institution.

The visitor profile will be built out of information supplied to the software agent directly by the user or through the ConnectInfo system and also by what the agents observe as they interacts with the user. The dedicated agents will be responsible for tracking both the user's current physical context and dialogue exchanges with others in the space and her social network. Combined, these components would be used to dynamically build a profile of a user's interests and dispositions. For example, a visitor with a handheld comes in front

of Frida Kahlo's painting "My Beloved Husband." The visitor is unfamiliar with the history of Frida Kahlo and interprets the painting of a depiction of a "happy couple." The visitor may want to express her feelings, interests and curiosities about the painting. Possible media could include voice, text, drawings, which, through the person's handheld are stored in a server to be browsed and retrieved by visitors on their handhelds as they stand in front of the Kahlo painting. Using collaborative filtering techniques the agent technology might be able to recommend to its user either on-going conversation that the user might not be a aware of, or other exhibits the user might find interesting. For instance, if the system detects that a visitor is interested in Frida Kahlo, it can act as a compass and lead the visitor to other paintings by Frida Kahlo or Diego Riviera, the writings of Leon Trotsky, or suggest contextual information, e.g.a biography of Frida Kahlo that highlights her many infamous affairs.

Intelligent brokering system architecture would mediate communications between users who wish to receive messages from each other who are or who have experienced the same event or exhibition, or wish to share their own thoughts and impressions with others who might be interested in engaging in some level of dialogue. The system would be expected to support many separate discussions following different threads simultaneously. The system might also allow past exhibition visitors to participate in discussions with current visitors. The system could also facilitate more personal interactions amongst users sharing the space contemporaneously, e.g., arranging meeting places to interact face-to-face, if so desired. To make things interesting, the agent system might allow for a degree of "planned randomness" in message delivery, to allow for possible serendipitous meetings of minds between users.

11. 5 Conclusion

The scenarios, in the previous section, extend the possible applications for *critical creative technologies* for social mediation that support real-time intersubjective collaborative experiences. They describe the design of information technologies that identify, visualize, and mediate the harmonious counterpoints that influence the quality and quantity of interaction among people in the public spaces. The *Airperience* in-flight mapping system makes geographical, logistical and cultural information available to flight passengers. *ConnectSpaces* connects disparate public spaces, such as cultural institutions that attract different demographic patrons, via networked *Constructed Narratives* games. *ConnectUs* takes this idea one step further to map in real-time, much like Hillier's Space Syntax, the rhizome-like movement of people in a public space by making visible their logistical relationships. *ConnectInfo*, similar to *Airexperience*, assists in revealing dynamic levels of relevant information in the gallery or museum space. In addition, the software and hardware system architecture, for *Constructed Narratives*, has been designed to be an extendable platform for alternative applications in education and/or healthcare research. The blocks could be transformed into components for teaching engineering students about bridge building or used for therapeutic activities for people suffering cognitive disorders such as dementia.

Throughout this text a social cartography has been developed to support the design of technology-based applications in public spaces that promote dialogue, connections between people, awareness and change. Starting with the manifesto of the liberal ironist, polemic theories of communication from Habermas to Bakhtin were explored in light of concepts of empathy, intentionality and intersubjectivity. This was followed by an examination of three definitions of the public sphere from Dewey, Broeckmann and Habermas and lead to discussions of the role of technology in society. Concretization, vocation, aesthetics and collegiality, the four principles of Feenberg's *dialectics of technology* were imbued with

contemporary theoretical and design practices from the New London Group's theory of multiliteracies and Fischer's metadesign, to tactical practices from digital media arts such as the European based R.A.M. (Re-Appropriating Media) collective and the United States based StoryCorps project. Three principles for the design of critical creative technologies evolved from this social cartography: (1) place as connected space; (2) empathetic intersubjective experience; and (3) discourse facilitated through deep play.

The *Constructed Narratives* project is a first experimental application in the design of critical creative technology and tangible social interfaces, interfaces that respond uniquely based on data from the individual who is manipulating the device. Up to this point, the focus has been on the design and development of the block artifact and underlying software and hardware system. As mentioned earlier this chapter, the project had its public debut at the Kiasma Museum for Contemporary Art in Helsinki in 2004. This was an opportunity to watch builder's manipulating the objects. Further evaluation of the project was not possible at that time. The next design phase will focus on making the blocks robust enough for prolonged manipulation by public audiences. At that time more extensive evaluation activities will be done to further test the premises of the tangible social interface as a mediator for communication between people. The Exploratorium Museum of science, technology and art in San Francisco, California has expressed interest in assisting with formal evaluation of the project. This would include pre and post questionnaires and interviews as well as observation and video analysis of real-time usage. The results will be used to form general principles for the design of tangible social interfaces to support the development of critical creative technologies.

Appendix A Narrative, Interactivity, Storytelling, and Intelligence

The concept of narrative in the western literary and theatrical works is generally equated with the linear structure for character and plot progression of Aristotle's *Poetics.* Narrative, particularly from non-western and early western cultures, finds its roots in many techniques of storytelling that are strongly rooted in orality and memesis as described in the strategies of pre-rational play. (See chapter six for further elaboration on the theories of play) Several alternative structures for narrative were addressed in my paper *Narrative Structures for New Media.* (Jennings, 1996) Many new theories on the implication of interactivity on narrative structures have been developed as a result of the digital media art practices over the past three to four decades. (Rokeby, 1996; Ascott, 1966) The pursuit, by cognitive psychologist and computer scientist, to understand human information processing and models for the design of artificial intelligent machines has supported new theories on narrative, storytelling and intelligence. (Schank, 1990) The Constructed Narratives project has been influenced by some of the alternative models to the linear structure of the *Poetics* discussed below.

A. 1 Narrative as a Model for Interactive Computer-based Applications

Brenda Laurel's book, *Computers as Theater*, proposes Aristotle's *Poetics* to be a viable model for the development of human-centric computer applications.[1] The linear structure of the *Poetics* was viewed by Laurel as a "liberating" system that would challenge

[1] The concept of narrative is frequently equated with the linear progression as supported by Aristotle's *Poetics.* The Poetics is based upon a relationship of rising and falling complications over a finite time. There are seven unique and essential components to the Poetics. The *exposition* reveals the context for the action that is about to unfold. During this stage narrative potentials and possibilities for the characters, environments and situations are formulated. As the action in the narrative progresses the exposition diminishes. The *inciting incident* is a small segment following the *exposition.* Possible causes for the events of the narrative are introduced. The central action and component that drives the remainder of the narrative is formed. Characters pursue their central goals, formulate, implement, and revisit actions that promote plot progression during the rising action. Critical events occur and characters must make major decisions and take conclusive actions in the pursuit of their goals. *Crisis* is a period of heightened activity and commitment that generally proceeds at a faster pace. It is at this point of *crisis* that clarity about causal relationships in the narrative begins to appear. The moment at which one of the lines of probability becomes necessity is the moment of *climax.* This is the turning point of action and characters either succeed or fail to achieve their goals. The consequences of the *climax* are reflected through the characters and situation during the *falling action.* Elements of the narrative fall quickly into place, at this stage of the narrative, and return toward normalcy or *denouement.* And the curtain is closed.

common methods used in the development of interactive computer applications in the 1980's and early 1990's. Laurel did not believe that contemporary semiotic and post-structural theories were viable alternative models for the burgeoning industry of computer-mediated applications and declared the *Poetics* to be a platform for reassessing of the role of computers, interaction and design in human computer systems. Introducing this metaphor into the computer industry was radical, revolutionary paradigm shift in understanding and building human centric computer applications based on a methodology borrowed from the arts. However, Aristotle's *Poetics*, as a dramatic theory, is too prescriptive and rigid a system of rules to describe the rich and complex web of interactivity between people and people and computers.

A.2 Behaviorist Art and the Cybernetic Feed-back Loop and the Open Work

Roy Ascott's 1967 paper, "Behaviorist Art and Cybernetic Vision" predicted the great influence of new information technologies would have on artistic expression and production. Ascott challenged artists of the time to acknowledge and embrace these new technologies as the most significant and powerful tools for creative expression. The power of these tools lies not only in the seemingly infinite combinatorial methods by which they can be applied in the artistic practice but also in their potential to serve as the very foundation of contemporary culture, communication, economics, and globalization. Ascott emphasized that it is the artists' obligation to adopt and adapt these tools into their practice. This view of the new arts practice situated by the use of computer-based tools and processes is a means by which to empower and broaden the spectator's experience of the artists' concepts, processes, and experiential objects. Ascott notes that modern art borrowed from a Deweyian approach to aesthetic experience by shifting from a focus on the object to the creative process as the aesthetic act. Function is explored, manipulated, and molded by means of visual, tangible, postural (physical), and aural attributes of the

creative process. From this observation Ascott introduces the term Behaviourist Art as a more inclusive means to describe this burgeoning art practice.[2]

The term behaviorist art was a precursor for the many labels currently given to computer-based art including: interactive art; generative art; new media art and computational design, digital media, etc.... Behaviorist art is defined by techniques used to: support an interactive experience; the artists' role in production; and the definition of boundaries between the art experience and the participant(s). The behaviorist context celebrates and encourages formal ambiguity and instability. Its context can be polemic by playing with techniques and topics that challenge the creator and participants to physically and cognitively engage with the works for the greatest integrative experience with the works.

"If the cybernetic spirit constitutes the predominant attitude of the modern era, the computer is the supreme tool that its technology has produced. Used in conjunction with synthetic materials it can be expected to

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[2] The behaviorist tendency in modern art, exemplified by artistic practices in the late 1960's, observed that the production of modern art shifted from the making of objects, (e.g. painting, drawing, sculpture, installation) to the molding of behavior – in particular manipulating, orchestrating, encouraging and challenging the behavior of the spectator. Ascott's use of the term behaviorist reflects the era of the theory when behaviorist psychology and the observations of the impact of environmental cues on animal and human behavior was being developed. It is doubtful that Ascot was rallying support for the incorporation of behavioral psychology methodologies into the artistic practice. Rather, he was making an observation of a particular zeitgeist that extended across the domains of science and art.

Understanding, measuring, and augmenting human behavior became a major drive for research, innovation, and creative expression across many disciplines during the later half of the 20th century. Examples include: Skinner's theories on behaviorism; Kohlberg's stages of moral development that range from pre-conventional obedience and punishment to post-conventional principled consciousness as means for influencing ones beliefs and actions; Milgram's controversial studies on conflicts between an individual's moral beliefs and the tendency to obey authority despite a moral conflict regarding the act which is to be performed; to the burgeoning new field of computer science and information technology ushered forth by Englebart's H-LAM/T – Human using Language, Artifacts and Methodologies in which he is Trained research initiative. (Milgram, 1963; Englebart, 1962; Skinner ,1953; Kohlberg. & Turiel, 1971)

Although the driving force behind the influx of behavioral studies and humanity was centered on psychology, sociology and later the influence of new information technologies, traditional arts practices from the modernist tradition were not excluded from this *zeitgeist* of theoretical quest to understand the impact of the modern world on humanity. Ascott points out that traditional art practices positioned the artists in the role as controller of the spectator's experience.

The final relationship is also compounded by the rules and restrictions of access set forth by any presenting institution. The role of the modern artists was to dominate the aesthetic arena – to set the rules and win the game. The artist controlled the subtle and tenuous connections between his intent as an artist and the prescribed relationship of the spectator to his art. The work was often a window into the tormented life of the painter, as typical of the abstract expressionist. But the painter was not looking for a dialogue with his audience, only his canvas and its intimidating stance when hung on the gallery wall.

The work of the Action Painters from the Abstract Expressionist movement produced authentic imagery that utilized the artists physiological placement in space in relation to his canvas by a painterly process of manipulation, scratching, erasing and layering. The process embodied the artists' relationship to himself, his canvas and his subject. It was often about power and submission to the medium. Slashing violent gestures imbued with a sexual energy became the masculine method by which to carve and drip paint onto the canvas – a most private experience crying for empathetic ties to its finished framed product.

open up paths of radical change and invention in art... The interaction of man and computer in some creative endeavor, involving the heightening of imaginative thought, is to be expected." (Ascott, 1966)

The feedback loop, as described in Weiner's theory of cybernetics is Ascott's structural framework for behaviorist art. The creation of flexible, moldable, adaptable, malleable structures becomes a new medium for creative expression. Ascott introduces the Artifact/Observer model of interaction as the engine and product of the behaviorist art experience. This model furnishes its own self-referential feedback loop. The feedback loop is comprised of an input and output mechanism manipulated by the artist, the artifact and the participant. The participant's interaction with the system provides an input that the system manipulates based on instructions programmed by the artist. The result is a system output that influences the participant's subsequent interactions with the system. The behaviorist game of art making remains in a perpetual state of play and is never won. Rather, the art "is now a more strident agent of change, affecting a jolt to the whole human organism, a catalyst which sets up patterns of behavior of thought and emotion, which are unpredictable in any fine sense." (Ascott, 1966) Boundaries between the making of art, the artifact and the experience of the work are no longer clearly defined because of the infinite unique interventions that occur between the participant and their unique experiences.

> *... If I draw a square around a crack in a wall with a piece of chalk, I automatically imply that I have chosen the crack over others and now propose it as a particularly suggestive form. In other words, I have turned it into an artifact, a form of communication, simply by isolating it, by calling attention to it in a rather mechanical fashion. ... The direction I insert into the figure may retain a high degree of indeterminacy and yet steer the viewer toward a particular field of possibilities, automatically excluding other ones. (Eco, 1989)*

Polemics, ambiguity, instability, uncertainty are not behaviorist art attributes that are meant to obscure the intentions of the work or to hide poor production methods. Rather the work is left open to invite the participant to be creator of his experience by giving him physical, emotional and conceptual access to the artifact. Eco describes the "open work" as the work in movement of tentative and hazardous acts of inference. There is no single point of view and there is the possibility of numerous different personal interventions. (Eco, 1989)

Fig. 112

Fig. 113

Fig. 114

Fig. 112: Still image from Char Davies' "Osmose" virtual environment

Fig. 113: Breath navigation apparatus designed for the project.

Fig. 114: Jeffrey Shaw's "Legible City" participant navigating a virtual world using a bicycle.

While every performance offers a complete and satisfying version of the work at the same time it remains incomplete because it cannot simultaneously give all possible performances. The densest amount of information is also the hardest to mine. Eco suggests framing structures that serve to isolate and draw out the unique attributes of an information rich work. The "work in movement" is "not an amorphous invitation to indiscriminate participation." (Eco, 1989) The open work must maintain its structure as a work of art else it resolves into noise.

A.3 Rokeby's Models of Interactivity

David Rokeby's theory of interactivity as a transforming mirror is addressed in chapter five as it relates to Andrew Feenberg's *Dialectics of Technology* presents a framing structure based upon observation of contemporary interactive art works. Rokeby defines four models of interactivity that include: (1) navigable spaces; (2) invention of media; (3) transforming mirrors; and (4) automata. Together they define a broad spectrum of approaches and practices that challenge the linear structure of the *Poetics* and contribute alternative narrative structures for computer-mediated works.

A.3.1. Navigable Spaces

Navigable virtual environments are an articulation of a real or conceptual space in which the boundaries are typically defined and limited by the surrounding structures. Typically this space is defined by architectural constructs, walls, corridors, passageways, horizons and gravity. Visionary work by artists including Char Davies, defy the status quo architectural framework with alternative imaginary spaces that are defined by and represented with images from nature and other semiotic constructs. (Davies, 1995) Davies work is internationally recognized not only for its visionary approach to the aesthetics of virtual environments, but also the breath vest worn by the participant that maps breathing patterns to directional movement in the virtual world.

Fig. 115

Fig. 116

Fig. 115: Screen image from Bill Seaman's "World generator/ the Engine of Desire," 1996 – 1997.

Fig 116 : Screen image from Toni Dove's "Spectropia," evening length interactive performance, 1999 – 2002

Jeffrey Shaw's work, *Legible City* incorporates a sensor laden bicycle as the control for navigating through a city of text. (Shaw, 1989) Hypertext-based works provide a branching structure of linked words and images for the participant to generate a personalized mise-en-scene in a linear story structure by permitting the participant to select a path of text and/or images to explore. (Amerika, 2006) Artists Toni Dove likens her navigable virtual environments to "wandering accretions," and Bill Seaman's installations are referred to as "recombinant poetics." (Jennings, 1995; Seaman, 2006)

In each of these examples the artist maintains expressive power by emphasizing particular interactive possibilities and discouraging others. The artist allows the participant to experience the virtual world. In return, the participant's actions have a reciprocal

"enriching" impact on the interactive system. This enriching impact on the system triggers systematic changes in the very structure of the technology.

A.3.2 Invention of Media

Interactive art works in the category if invention of media blur or rather defy the boundaries between that of artist – the giver and the audience – the takers. The audience is empowered to express itself creatively with tools developed by the artist. Works developed from the framework of creative critical technology may incorporate properties from all four of Rokeby's models of interactivity. They are, however, specifically aligned with the *invention of media* model as it relates to the theory of multiliteracies concept of redesign, the development of tools that empower participants to re-invent and develop new perspectives on a given experience, task or problem.

A.3.3 Transforming Mirrors

Myron Krueger's telepresence projects in the 1970's such as Video Place set the stage for artists' exploration and integration of video technology as a means to develop interactive interfaces that reflect, mimic, and/or augment a visual or auditory representation of collaborating participants. Rokeby's well known *Very Nervous System* is also an example of the interactive computer application as a transforming mirror. The work incorporates advanced computer vision technology to analyze human movement in a restricted space. That visual analysis is transformed into sounds mapped to many dynamic properties of the movement (e.g. direction, speed, magnitude, etc...) and transformed into sound which is played in the environment in real time. Creating an instantaneous and playful feedback loop that instigates the participant to transform her gestures to manipulate the auditory stimulus. (Krueger, 1977; Rokeby, 1986)

Fig. 117: Myron Krueger's 1970 "Videoplace", early remote video collaboration project.

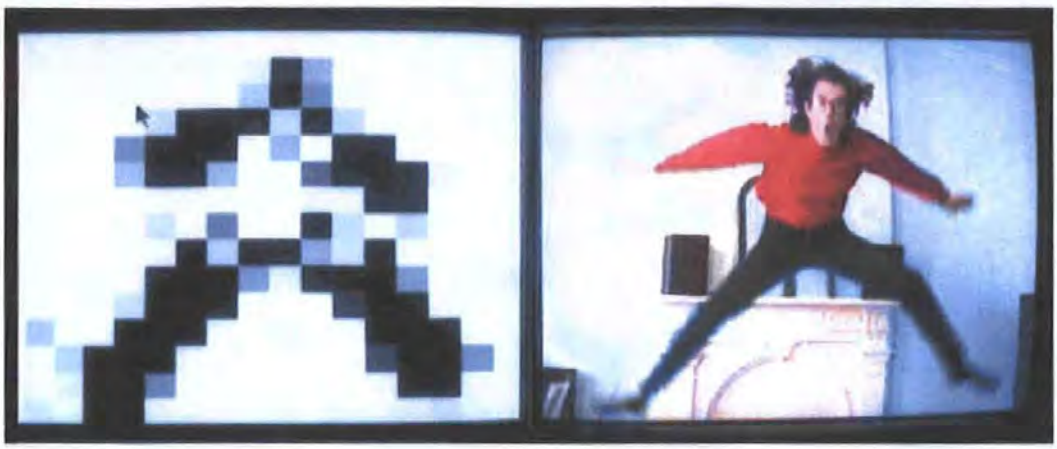

Fig. 118 : David Rokeby's 1990 "Very Nervous System" interactive computer vision system.

A.3.4 Automata

The automata model of interactivity is related to computer science research and developments in artificial intelligence and artificial life. Rather than attempting to replicate the functions of the brain -hard AI, or simply create tools to assist researchers in understanding and augmenting the function of the brain – soft AI, the artists' use and invent algorithms to create generative, adaptive and responsive interactive experiences based on a variety of disciplines including complexity theory, social behavior economics and biology. Darwinism is a very strong theoretical and philosophical construct that drives this model of interactivity.

Fig. 119

Fig. 120

Fig. 119: Christa Sommerer and Laurant Mignonneau Avolve project, 1994.
Fig. 120: Christa Sommerer and Laurant Mignonneau Life Spacies II, 1999.

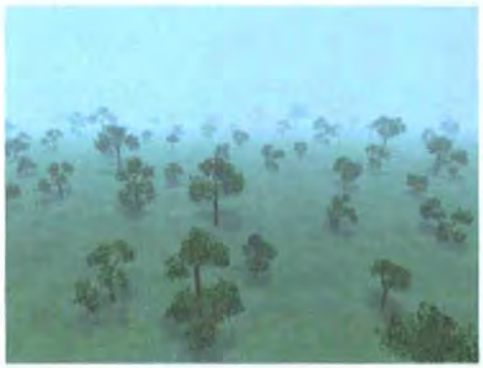

Fig. 121 *Fig. 122*
Fig. 121 & 122: Jane Prophet's "Technosphere" project, 1995.

Fig. 123 *Fig. 124*

Fig. 123 & 124: Karl Sims, Evolved virtual Creatures, Hopping and Competing, 1995.

Interactive works based on the automata model are exemplified with Christa Sommerer and Laurant Mignanou digital media projects. Starting with the *Avolve* project, their collaborative work has grown in sophistication and is exemplary of an arts practice that defies the boundaries of seemingly disparate disciplines to invent novel, entertaining complex system installations that have impact on both the art and computer science communities. (Sommerer & Mignanou, 2006)

Jane Prophet's *Technosphere*, project is another example of the generative fictitious interactive environment based upon complexity theory and social behavior. The project launched on the Internet and was accessible by a broad international community. Participants created fictitious creatures in a Darwinian environment and received email updates regarding the fate of their creature – whether they were dead or alive, procreating or starving. Later versions of this project took the form of a visual graphic navigable world that could be viewed on the Internet and in gallery installations. (Prophet, 1995) Karl Sims, *Evolved Virtual Creature*, (Sims, 1994) is a video animation of several hundred creatures with odd primitive shaped appendages. The creatures were programmed with instructions to learn how to move from one position to another by learning how to walk, swim, run, or fly based on the affordances and handicaps made evident by their design features. Successfully locomotive creatures were copied (or mated) into new complex fictitious creatures that were also programmed for optimum locomotion.

A.4 Refractive Transforming Mirrors and the Chinese Room

The theory of transforming mirrors states that a technology is interactive if it provides a means by which the participants can communicate with themselves such as a mirror. This in turn requires that the technology reflects back to the participant the consequences of his actions with the technology. (Rokeby, 1996) Now suppose that the mirror has a perfect surface with no flaws. That mirror, or technology, simply becomes a device of mimicry and not interactivity. The mirror could be a type of magnifying glass, which simply replicates and amplifies the participant's interactions, making them larger, faster, bigger, and louder. Then this interactive work is just a mechanism supporting the delusion of domination, power and control over one's environment.

This interactive work is most like an Xbox type video game of car races or gang warfare (e.g. Grand Theft Auto.) The mirror must have imperfections embedded into its surface to refract, bend, invert, and add dimensionality to what it reflects to transcend mimicry and truly become a vehicle for interactivity with its subject. These imperfections can be triggered through the participants' input, the system manipulation of that input by a set of rules created by the artists, or by the method by which a systemic response is relayed to the participant. Interactive technology as refractive mirror is a Searlian black box that uses methodologies to manipulate a participant's input. (Searle, 1980) These methodologies can include obliqueness and irony, transformation, and causal effects of variables input into the system. In return, the black box output delivers an image of self that is both processed and transformed. If the refracted self is recognizable, and not overly processed, that image of the self will communicate to the participant an enriched sense of the relationship of themselves to their immediate environment. This analogy is similar to Will Wright's notion of "engineered failure" as a generating seed in the SIMS games. Here Wright introduces cognitive and systemic instabilities in the player generated worlds that to the player appear to be errors that need to be corrected. The player is provoked to engage in a deeper exploration to discover alternative solutions for the game play problem at hand. (New Paradigms for Using Computers, 1997)

A.5 Storytelling and Intelligence

Roger Schank claims that intelligence is the ability for people to tell the right story at the right time; to reply to a question, statement, and account of an event -a story – by the narration of another story. (Schank, 1990) Schank proposes that a person is likely to respond to the statements of another by telling a story based on his or her understanding of the other persons words. In dialogue, the listener's reactions may differ from what one expects. Therefore, one constantly makes adjustments, each adjustment involves a choice among possibilities, and each choice may suggest others, not thought of before. At each point, words selected to convey a given event may themselves suggest a different

continuation. Every choice may provoke unanticipated responses from a listener, which may, in turn, affect future adjustments as a means to construct everyday narratives. (Schank, 1990, p. xxxii)

Schank's definition of intelligence and intelligent responses in discourse is the ability to store, index in memory and retrieve one's explanatory narratives. We typically respond to a story by isolating an element of the story being told and searching through our index of experiences and personal stories for an actual or metaphorical referent. We retell our own stories, to verify our experiences, and challenge or validate our assumptions, and update the index of materials and explanations we use to understand the world around us. Schank notes that intelligence is also engrained in the content of what one says and not based on a lack or abundance of specific cognitive properties. Innovation of ideas, new content, and inventive stories are marked as a sign of intelligence. This is true, even when the delivery of the story is bad.

An intelligent being has storytelling abilities that exploit seven essential properties: (a) data mining; (b) data manipulation; (c) comprehension; (d) explanation; (e) planning; (f) communication; and (g) integration. The more stories a person has to tell, the more information they have indexed, and the more intelligent they will appear. The intelligent being is aware that the mode in which a story is told greatly effects the reception of the story by the listener. By making her story interesting, memorable, and useful to the listener she will be able to elicit responses from her listener(s) in a mode that she commands.

In essence, we construct narratives based upon the uniqueness and richness of our individual life experiences. We reflect on the narrative, assign it meaning(s) of significance and through our memory attach labels that provide a method for easy access for when the need arises to retrieve that material for discourse with other people. Only the

most mundane of communicative exchanges do not use stories as a vehicle to exchange information. For example, asking another person for the time. Beyond the most basic exchanges of information every communicative act involves the process of search, retrieval, and adaptation of stories held in memory.

People are great repositories of stories, stories that can only come from what we know, what we have experienced and the process of imagination to fill in our experiential gaps. It is this combination of the experienced and the imaginative filler – which is based on our experiences, that determines our view of the world and characterizes our beliefs. (Schank, 1990) The premise that communication is an oral storytelling process that is limited by the experiences of the teller parallels Richard Rorty's theory of *final vocabularies* and *passing theories*. Schank and Rorty both emphasis that the ability to interpret and apply meaning in one's world is limited by the breadth and depth of one's final vocabularies or index of stories. As a matter of fact, there are times when we are not completely clear about our views of the world until we reach into our index of stories and final vocabularies to find supporting materials to react to communication with others.

A.5.1 Schank's Taxonomy of Story Categories and Storytelling Goals

Ironically, the process of interpretation and cyclical story telling often leads to an "exchange of monologues," rather than a true dialogue and conversation turns to an act of "mutual reminding" Schank identifies five story categories that center around three main goals including: (a) me-goals; (b) you-goals; and (c) conversational-goals. The five story categories include: (1) official stories; (2) invented stories; (3) firsthand experiential; (4) secondhand; and (5) culturally common stories.

Me Goals	You Goals	Conversational Goals
• to achieve catharsis • to get attention • to win approval • to seek advice • to describe oneself	• to illustrate a point • to effect the way the listener feels • to tell a story that transports the listener • to transfer some piece of information in our head into the head of the listener • to summarize significant events • to help the listener achieve a their goals	• to keep being able to speak • to get the general topic of the story on the floor for discussion • to open discussion about a particular topic or problem • to open a new topic in order to close off or avoid another topic • to generate a responsive story as argument • to distract and obfuscate a conversation away from a specific topic • to revive a conversation

Table 15: Summary list of me, you, and conversational goals from Roger Schank's "Tell Me a Story".

A.5.1.1 Me-Goals

Telling stories satisfies both our need to communicate with others and fulfill personal goals to support our self-identity. When we tell stories to others, we are usually self-focused on our own goals to direct the affect by which the listener listens and responds. The telling of self-descriptive stories is complicated by the negotiation between the goals of oneself in respect to others in the conversation. These goals are sometimes complementary and sometimes contradictory. We tell stories to be understood by others, but also to help us understand ourselves. To develop and maintain a sense of self, we tend to tell the same self-focused stories repeatedly to establish an identity that makes us unique and separate yet hopefully cultivates empathy from others in discourse. By telling personal stories we access, adapt, augment and manipulate our own personal mythologies, acquired from our parents, teachers, friends, enemies and anyone else who tells us stories about ourselves, that help to define who we are and our opinions hopes, dreams and problems in the world. It is almost impossible to deny these personal stories, whether generated from the self or outside of the self. And thus we tell stories to test our sense of reality on the world, to escape reality, and to try to influence our interpretation of the world's reality. In other words, we can paint new pictures of the world with our stories - our words in discourse - to construct a world like one that we would like to inhabit.

A.5.1.2 You-Goals

The "you-goals" story is designed to relay specific information, for example when a parent wants a child to behave in a specific manner. You-goals can be used to transfer knowledge to the listener as a means to manipulate the listener's affect, causing them to redirect their emotions toward the goals of the storyteller. They can also be used to tell transportive stories that steer the listener towards a vicarious experience of sensations, feelings or attitudes. The successful transportive story is delivered with descriptive qualities that motivate the way in which the listeners experience the story. The griot, the evangelist, and the circus ringmaster are all masters of the transportive story.

A.5.1.3 Conversational Goals

The relationship between storytellers and listeners is an essential structural part of conversation. Conversational politeness, as culturally understood, is expected. This may lead to the storyteller/listener relationship to be filled with responsiveness based on cultural discourse norms rather than substantive interjections. Conversational tendencies can sometimes serve to be argumentative or evasive. The argument should not be construed to be non-productive or aggressive. An assertion can be made that unintentionally engages an argumentative or aggressive response. Mutual storytelling in an argumentative mode can also serve as a bridge between storytellers as long as each understands the unspoken boundaries protecting each other from harm from each other's words. Conversational stories can be used to defend one's position. And they can be used to distract the listener from conversational topics. Rather the story is used to avoid certain stories that the storyteller/listener is not prepared to process. This is often done by giving listeners a range of distracting statements to think about. The goal of this type of story is to avoid telling another story through distraction and obfuscation. Simply done, distraction and obfuscation can be achieved by maintaining "conversational sociability" to avoid argument or emotional distress. It is interesting to note parallels between Schank's conversational

goals and Habermas's analysis of pathological communication techniques as discussed in chapter two.

A.5.1.4 Official Stories

These are stories we learn from official institutions of authority in our culture including school, religious institutions, business, the government, and our parents. Examples of official stories may be the creation of the universe – the big bang theory and other stories about the origination of the universe and humanity. Official stories are usually put into place when we lack our own story to explain a particular phenomenon. They are carefully constructed by one or more people to regulate and "sanitize" information about an event. They are often taken as a given or truth regardless of the facts and put into place to simplify the understanding of a complex situation. The history of origination for an official story is rarely questioned. Official social institutions often have scripts for inventing these stories. We tend to ignore the official story only after adopting a new story to replace it.

A.5.1.5 Invented Stories

Invented stories are used to hide something, express a fantasy, or make a statement. They are typically filled with hyperbole that becomes more elaborate as the story is told. Invented stories are generated using several processes. They can expand upon and adapt an actual experience by distorting the story such that the original experience is no longer recognizable. They can also be created from scratch to illustrate a hypothetical case to strengthen one's argument. Regardless of the method used to construct them, invented stories are often adaptations of other stories by creatively disguising or hiding the original source material.

A.5.1.6 Firsthand Experiential Stories

Firsthand stories are autobiographical and represent the storyteller's personal experiences. This type of story is most commonly used during communication. Firsthand stories relay what is thought to be uncommon information that is not reflected in experiences of other's in the conversation and can be very creative and inventive. Inventiveness or hyperbole can be used to eliminate insignificant parts of the story or emphasis story components by stretching or re-interpreting the facts. Often the firsthand story is a non sequitur - an attempt to latch onto a conversational topic when the storyteller's indexed experiences lack an appropriate story that does not involve the self. They are generally used to by an individual to secure a position of inclusion in a conversation. However, they are often comprised of random associations that have no intended point other than reinforcing the storyteller's presence in the conversation.

A.5.1.7 Secondhand Stories

Secondhand stories are usually categorized and retrieved from memory based upon the attributes that are needed to support a statement. These stories have typically been acquired and play the role of message delivery to the listener. Secondhand stories are based upon the recollection of facts as they were interpreted and tend to be delivered in a manner that is blunter than firsthand stories. They can however, have invented elements as a means to preserve coherence particularly when the storyteller has difficulty in recalling the facts. In this case, the storyteller is not intentionally manipulating data and may not be aware of the fact that they are inventing or bending the truth.

A.5.1.8 Culturally Common Stories

Culturally common stories are pervasive in our environment. They are not directly told and there is no claim of original authorship and are understood to be part of the fabric of a culture of people. Culturally common stories often take the form of allusion, proverbs and

puns. These are forms of "ossified distilled stories," that do not require original references for comprehension by members of a given culture. The listener's index of culturally coded stories is key for the comprehension of culturally common stories. The skeleton story, another form of culturally common stories, assumes that the speaker and listener are knowledgeable about the story reference and story details are not required for comprehension.

A.6 Storytelling, Intelligence and the Future of Intelligent Machines

Schank developed his theory of storytelling, scripts, narrative and intelligence to build a model for artificial intelligent machines that were based on human communication patterns. His taxonomy of storytelling goals and categories presents an adequate model for understanding how people communicate and parallels, compliments and challenges other communication theories explored in this text from Bakhtin to Habermas. Similar to Laurel, Schank falls into the trap of looking for a model of communication and interactivity that could be transcribed into the common computer programming practices prevalent at the time of his writing *Storytelling and Intelligence*. His overall goal of developing a model for designing artificial intelligent machines forces him to reduce the rich attributes of his storytelling taxonomy to scripts which are better suited for replication through computer programming. The script is a rigid model of discourse that is based on the pursuit to define a formulaic set of rules for writing natural language processing computer programs as an attempt to understand cognitive sequences involved in a conversational situation. Schank's scripts were originated in the mid-1970s at Yale University as part of the artificial intelligence research to design natural language processing software programs that could understand English. Schank's premise is that conversation is like reading the roles of a play, an interesting correlation to Laurel's thespian metaphor for the development of computer programs. The attributes of the scripts theory of dialogue are that they clearly indicate what is "suppose" to happen and what the

acts of others are "suppose" to indicate. The concept of the script as a discourse mediator was thought to make mental processing easier "by allowing us to think less." Schank claims that scripts aid us in understanding the actions of others, as long as we are reading and acting from the same script. The formulaic properties of scripts allow computers to "understand stories about stereotypical situations." (Schank, p. 8) Schank's script theory infers that rather than think, people simply apply a script and follow its rules for conversation. The more scripts an individual has indexed in their memory the broader their perspective on the world and ability to engage in diverse discourse situations. Strangely, Schank's notion of scripts parallel's Rorty's premise of final vocabularies.

Schank concludes his thesis on storytelling, narrative and intelligence with the proclamation that future intelligent machines will have to be good storytellers. If they are not good storytellers, they will be forgotten and not used. He makes a distinction between the common media vehicles for storytelling such as books and cinema as passive forms of storytelling. He longs for the day when interactive storytelling will become pervasive through interactive storytelling machines. Schank notes that the biggest challenge for the digital storytelling machine is whether humans will have enough interesting stories to tell.

Appendix B: Construction Toys and Electronic Construction Kits

In preparation for the design of the Constructed Narratives project a literature search was undertaken to understand various techniques, properties and goals in the design of traditional construction kit toys and electronic construction kit research. I was particularly interested in the methods used to establish both physical and electrical connections between devices, as well as the affordances of construction options as assisted or hindered by the form factor of the connectable component.

B.1 Construction Toys

Fig. 125: Children's construction toys descriptions categorized on art studio wall.

To broaden my exploration of form factor options the historical evolution of building blocks and children's construction games was explored. The questions posed were simple: how many shapes are needed to allow people to build interesting constructions? What types of mechanical connections are used? What shapes allow for interesting constructions? What type of materials are used? Unlike many other component networked blocks projects in the literature that used simple cubes, I wanted to introduce shapes that would encourage users to design structures that could expand beyond simple two dimensional stacking techniques as is typical of basic primitive shaped blocks. More information about the design of the Constructed Narratives block can be found in chapter seven. Section B1.1 includes examples of non-electronic construction toys. Section B.2.1 includes my taxonomy of electronic construction kits with examples.

B.1.1 Construction Toys Index

Fig.126: Rainbow Blocks

Rainbow Blocks
http://www.hammett.com/s
Smooth hardwood blocks, sized to complement classic block sets, feature transparent windows of strong plexi-glass in red, yellow, blue and green to give a colorful stainless look to a child's design.

Fig. 127: Block n' Roll

Block n' Roll
http://www.taurustoy.com/indexx.html
A horizontal marble maze toy based on the LEGO block connector system.

Fig. 128: Fridgits

Fridgits
http://www.fatbraintoys.com/toy_companies/think_of_it/frigits_deluxe.cfm
A magnetic marble maze toy that can be constructed on the refrigerator door. The components are not physically connected however the carefully crafted marble shoots provide a fluid adjustable system to accommodate the movement of the marble.

Fig. 129: Fridgits

Fig. 130: Magz Magnetic Construction Toy

Magz Magnetic Construction Toy
http://www.magz.com/
MAGZ is a magnetic construction toy that consists of bars and balls. That can be used to create pyramids, balls, blocks, wheels and numerous other shapes. The magnetic connector was of particular interest in the development of the Constructed Narratives block.

Fig. 131: ZOOB

ZOOB
http://www.infinitoy.com/
ZOOB is a unique building system with interlocking and moving parts. It's five basic pieces snap, click, and pop together in more than 20 different ways and can rotate and lock in more than 100 different positions. Its shape is inspired by the nucleotides (the basic structural units of nucleic acids) that make up DNA. Based on the way things connect, move and transform in nature, ZOOB captures dynamic movement, unlike traditional "stacking" or "hub & spoke" construction sets. This is the ultimate non-linear nodal construction toy. It would be an interesting future research project to turn this form factor into an electronic construction kit.

Fig. 132: LEGO Blocks

LEGO Blocks
http://www.lego.com

Although hard to find in toy stores in the United States, the classic LEGO block originated in 1932 by master carpenter Ole Kirk Christiansen of Denmark. The name LEGO comes from the Danish words "Leg Godt" meaning "play well." The LEGO connector is the golden standard for mechanical block connectors.

Fig. 133: TinkerToys

TinkerToys
http://www.hasbro.com/tinkertoy/
http://www.rci.rutgers.edu/~cfs/472_html/Intro/TinkertoyComputer/TinkerToy.html

Charles H. Pajeau and Robert Pettit met while commuting by train from Evanston to Chicago for work. Charles, a stone mason, and Richard, a trader at the Board of Trade, were drawn to each other by their mutual dislike of their chosen professions. Determined to make a change, they soon formed a partnership that would last almost 30 years.

The inspiration for the TINKERTOY construction set came to Pajeau while he was watching children play with pencils and empty spools of thread. He noticed that children would play for long periods of time by mixing simple household items with lots of creativity. Charles also observed that children had a natural curiosity about the world around them and enjoyed taking things apart to see how they work. Most importantly, he noticed that they enjoyed disassembling and re-assembling the same parts to create from their imagination. With these fundamental principals in mind, Charles and Robert set out to create a toy construction set made out of sticks and spools that would inspire the imagination of children everywhere.

Fig. 134: Danny Hillis' Tinkertoy computer that plays tic-tac-toe, Computer Museum, Boston.

Fig. 135: Erector Sets

Erector Sets
http://www.erectorsets.com/

ERECTOR SET is the trade name of a construction toy that was wildly popular in the United States during much of the 20th century. It is similar to Meccano, a slightly older British toy, and Märklin, a later, sturdier German version. All consist of collections of small metal beams with regular holes for nuts, bolts, screws, and other connectors that can be assembled into a variety of devices using pulleys, gears, and small electric motors. The second image to the left is of the 1931 #10 ERECTOR SETS titled the "The Climax of Erector Glory."

Fig. 136: Erector Sets

Fig. 137: Richter's Anchor Blocks

Richter's Anchor Blocks
http://www.chem.sunysb.edu/msl/LEGO/anchor.html
http://www.ankerstein.org/

Marketed first in the 1880's as Dr. F. Richter's ANCHOR BLOCKS, (Anker in German). These blocks were termed the "Practical Architect's Aid." They were made of a composite of powdered stone held together by a resin. The blocks were quite heavy and came in three colors, tan, reddish brown and a blue gray.

This construction kit bears analogous resemblance to the intentions and goals of the tangible interaction research undertaken at MERL described below. That being a construction kit that attempts to closely replicates architectural constructions given the available technologies at the time of research and production.

Fig. 138: STANLO Building Sets

STANLO Building Sets
http://www.chem.sunysb.edu/msl/lego/stanlo.htm

STANLO building sets were metal construction toys manufactured by the Stanley Tool Company of Bridgeport, Connecticut. The sets were built on a different principle than Erector or MECCANO sets. Instead of a girder system, the STANLO building sets used a series of panels that were joined at the edges by wire inserts. The sets came in several sizes.

Fig. 139: Steel Builder Construction Toys

Steel Builder Company, Inc.
SteelBuilder
http://www.chem.sunysb.edu/msl/lego/steel.htm

STEELBUILDER construction toys were manufactured by the Steel Builder Company of Newark, New Jersey, a division of Acme Metal Goods Mfg. Co. In addition to girder system, the STEELBUILDER sets used a series of panels. The panels and girders slid together via a series of grooves and slide fasteners with a few key screws holding everything together. The parts were colored blue and yellow with a matching instruction booklet also in color. The set illustrated below is from 1934.

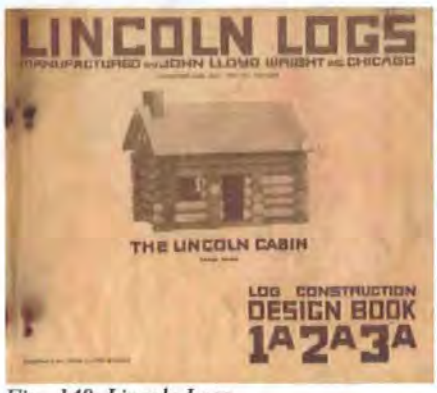

Fig. 140: Lincoln Logs

Lincoln Logs
http://www.chem.sunysb.edu/msl/LEGO/logs.html

LINCOLN LOGS were first marketed in the early 1920's by John Lloyd Wright Inc., of Chicago. The simple sets could be used for building log cabins that were indeed similar to one Lincoln might have occupied in. Later sets became more elaborate and could be used to build forts and other more elaborate structures. Although the conventional LINCOLN LOGS was round, square logs and even bricks were also sold.

Fig. 141: The American Mechanical Toy Company

The American Mechanical Toy Company
American Model Builder
http://www.chem.sunysb.edu/msl/lego/amb.htm

AMERICAN MODEL BUILDER was a builder of metal construction sets and an early competitor of Erector. They were manufactured by the American Mechanical Toy Co. of Dayton, Ohio. Like Erector sets, the AMERICAN MODEL BUILDER sets were progressive sets with each successive numbered set containing the parts of each lowered numbered set plus additional parts for larger models.

Fig. 142: Elgo, American Plastic Bricks

Elgo Plastic, Inc.
American Plastic Bricks
http://www.chem.sunysb.edu/msl/lego/apb.htm

AMERICAN PLASTIC BRICKS were manufactured by the Elgo Plastics Co. of Chicago in the 1950s. The plastic bricks were based upon the wooden American Bricks sold by Halsam for many years earlier. Halsam also sold American Logs, which were similar to Lincoln Logs, but square instead of round.

The AMERICAN PLASTIC BRICKS were bright red in color with white plastic doors, windows and trim pieces as well as green cardboard roofing. The plastic bricks did not hold together as well as the earlier wood bricks, but the plastic doors and windows were an improvement over the cardboard doors and windows used in the wooden sets. Interesting to note that girls were pictured in the advertisements for this typically boy-oriented toy.

B.2 Electronic Construction Kits Influence by Architect Jonathan Frazer

The *Constructed Narratives* project is part of a lineage of projects based on the early work of Architect Jonathon Frazer's *Universal Constructor* generative system. (Frazer, 1995) Most of the projects influenced from Frazer's work have focused on developing three-dimensional screen-based interfaces that replicate and/or augment the physical construction made by networked tangible user interfaces (TUI). Representation of physical objects and digital media are coupled together in the design of the TUI. Hiroshi Ishii defined three metaphors that help categorize TUI's developed in his MIT Media Tangible

Bits Lab. The spatial metaphor emphasizes the spatial configuration of the objects in their environment of use. The relational metaphor emphasizes the sequences, adjacencies and patterns found in the tangible objects. The constructed metaphor emphasizes the mode of assembly of the objects. (Ullmer & Ishii, 2000; Ishii & Ullmer, 1997)

The TUI generally facilitates a connection between a physical object and application specific data. (Ishii & Ullmer, 1997) The Constructed Narratives block differ in that it is a tangible social interface (TSI) – a physical interface designed to enable users to collaboratively construct and negotiate their social and knowledge networks based upon their preferences and user profiles. (Jennings, 2005)

Electronic construction kits reviewed in the design of the Constructed Narratives project fall into four categories; (1) historical electronic construction kits; (2) sensorial interfaces; (3) information navigation; and (4) shape analysis systems. They each fulfill various properties of Ishii's TUI group of metaphors.

B.2.1 Historical Electronic Construction Kits

Fig.143: John Frazer's Mat Project and Universal Constructor.

The Mat Project 1980
The Universal Constructor: The Intelligent Modeler Project
John Frazer

The Hong Kong Polytechnic University, Industrial Centre
http://www.ic.polyu.edu.hk/projects/R&D/modeller.htm

An Evolutionary Architecture
http://www.aaschool.ac.uk/publications/ea/intro.html

John Frazer's 1980 Mat Project was a precursor to the Universal Constructor project. Two dimensional relationships between individual square mats were established with a polling communication protocol for passing messages between neighboring mats. (Frazer, 1995)

The mat project was adapted to work using cubes as the connecting objects and titled the UNIVERSAL CONSTRUCTOR project. The UNIVERSAL CONSTRUCTOR consisted of a base plug-board, called the "landscape", on top of which "smart" blocks, or cells, could be stacked vertically. The cells were individually identified and could communicate with neighbors above and below. Each block cell contained a bank of LEDs that displayed the state of the cell. The structure was connected to a host computer that interpreted

the states of the cells as either color or geometrical transformations allowing a wide range of possible interpretations. The user interacted with the computer display through direct manipulation of the cells. The computer could communicate and even direct the actions of the user through feedback with the cells to display various states. The direct manipulation of the cells encouraged experimentation by the user and demonstrated basic concepts of the system.

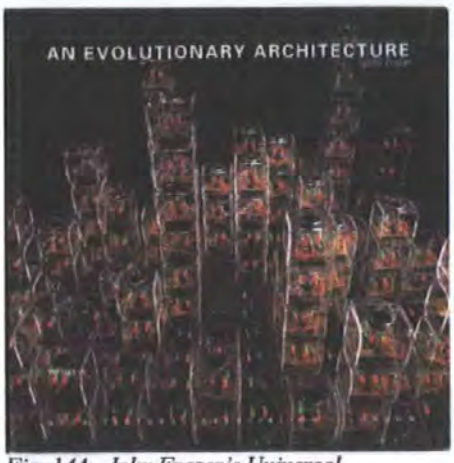

Fig. 144: John Frazer's Universal Constructor.

Fig. 145: MIT Media Lab "Stackables".

Stackables
Rick Borovoy and Kwindla Kramer 1997
http://lcs.www.media.mit.edu/groups/el/projects/stackables/

The researchers of the STACKABLE BLOCKS project hoped to develop simpler ways to understand communication between computational artifacts. Each block was a processor unto itself, a string of blocks was a one-dimensional network of information paths.

A stack of blocks could be programmed to display data from the "outside world," such as stock prices or network traffic. A stack could also generate a display on its own, through the interaction of individual blocks. One could program a stack to follow cellular-automata-like patterns, or to pass pieces of code around with light trails following in the programmatic wake.

This project was obviously influenced by Frazer's UNIVERSAL CONSTRUCTOR and appeared to have followed a similar linear two-dimensional vertical construction method.

Fig. 146: Negroponte's "Seek" cubes and mice project. (Photo from Cynthia Goodmans Digital Visions: Computers and Art. Harry N. Abrams, Inc., NYC 1987.)

Seek 1969-70
Nicholas Negroponte and the Architecture Machine Group
Massachusetts Institute of Technology

First displayed in 1970 *SEEK* was a Plexiglas-encased, computer-controlled environment inhabited by gerbils, whose primary activity consisted of rearranging a group of small blocks. A computer-controlled robotic arm rebuilt the block configurations in a manner its programmers believed followed the gerbil's objectives. The designers, however, did not successfully anticipate the animal's ability to create total disarray.

B.2.2 Sensorial Interfaces

Sensorial interfaces are typically augmented with light, sound, or color mapped onto the digital media component of the TUI, or directly on the physical objects. Peano Cubes from MIT Media Lab are a set of blocks whose physical construction is replicated on screen. The screen interface provides interface widgets to change the color patterns of multi-colored LEDs embedded inside the physical blocks. (Heaton, 2000) BlockJam, from the Sony CSL Interaction Lab, is a set of twenty-five blocks that can be arranged on a flat surface to compose musical phrases. (Newton-Dunn et al., 2000) Instant City, designed by Rosen & Spaderman Enterprise in Basil, Switzerland, is a collaborative sound generating game table. The rectangular blocks of frosted Plexiglas allow various levels of light to pass through to sensors embedded in the table that trigger various sounds once all players have stepped away from the table. (Hauert & Reichmuth, 2003)

Fig. 147: MIT Media Lab Peano Cubes.

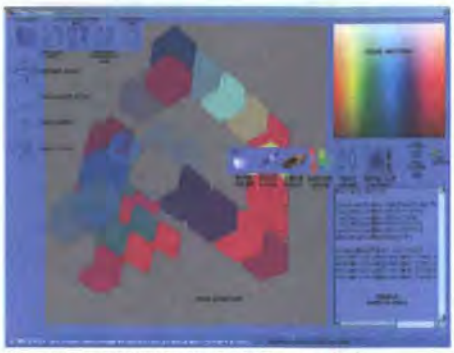

Fig. 148: MIT Media Lab Peano Cube control software interface.

Peano Cube, 2000
Kelly Heaton, Steve Gray, Paul Pham, Alex Jacobs, Michael Hawley
Personal Information Architecture Group & Toys of Tomorrow
MIT Media Laboratory
http://web.media.mit.edu/~kelly/physPix/Peano.htm

Peano is a three-dimensional, modular display system comprised of one-hundred and twenty-eight one-inch Cubes made from a colorless, diffusive plastic material. A path can be drawn on a digital image, which can then be animated, with color, across the Peano cubes. The Peano software interface is designed to allow the user the controller the display of the Peano network from a monitor. The software serves as a display system and does not generate a real-time model of the Peano cube construction. Most of the data transfer is from the host computer to the cube network. As opposed to Constructed Narratives where much of the data transfer is from the block network to the host computer.

Fig. 149: ActiveCube from Osaka University, Japan

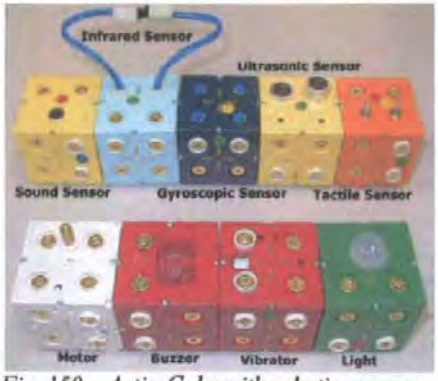

Fig. 150: ActiveCube with robotic sensors from Osaka University, Japan

ActiveCube: A Bi-directional User Interface Using Cubes 2000
Yoshifumi Kitamura, Yuichi Itoh, Toshihiro Masaki, Fumio Kishino
Osaka University, Japan
http://www-human.ist.osaka-u.ac.jp/ActiveCube/

ActiveCube is a device that allows a user to construct and interact with a 3D environment by using physical cubes with a bi-directional user interface. A computer recognizes the 3D structure of connected cubes in real time by utilizing the real-time communication network among cubes. Consistency is always maintained between the real object and its corresponding representation in the computer in terms of shape and functionalities.

The ActiveCube is a monument to connectivity. Four prominent ground sensors are on each face and twelve pinholes are placed to track the orientation of the cubes as they are joined. Looking at the video posted on the active cube site there are two male and two female connectors on each face of the cube dedicated to ground. Intuitively this seems to limit the amount of possible connections between cubes.

There are two male and two female snaps for each face that transmit the ground connectivity. The placement of male and female ground connectors limits the possible connection options. However, the cubes are identical, thus the connectable surfaces limitation does not have great impact on the breadth of design

Fig.151: ActiveCube with screen-based software, from Osaka University, Japan

choices available with a simple cube primitive.

Related Links:

- ActiveCube: A Bi-directional User Interface using Cubes
  http://www-human.ist.osaka-u.ac.jp/ActiveCube/KES2000ActiveCube.pdf
- Real-time Interaction with ActiveCube
  http://www-human.ist.osaka-u.ac.jp/ActiveCube/ACCHI2001short.pdf
- Cognitive Cubes: A Tangible User Interface For Cognitive Assessment
  http://www-human.ist.osaka-u.ac.jp/ActiveCube/AC-CHI2002.pdf
- RoboCube:
  http://arti.vub.ac.be/~thomas/robocube/overview.html
- System Watt Co., Ltd.
  http://www.watt.co.jp/English/index2.html

Fig. 152: BlockJam blocks from Sony CSL Interaction Lab.

Fig. 153: Single BlockJam block showing connectors.

Fig. 154: Illustration of the tangible interface for setting LED and sound patterns.

BlockJam, 2000
Henry Newton-Dunn, Hiroaki Nakano, James Gibson
Sony CSL Interaction Lab and Sony Design Center, Japan
http://www.csl.sony.co.jp/IL/projects/blockjam/contents.html

Block Jam is a musical interface controlled by the arrangement of twenty-five tangible blocks. By arranging the blocks musical phrases and sequences are created, allowing multiple users to play and collaborate. The system takes advantage of both graphical and tangible user interfaces. Each block has a visual display to select sound groups. The display is controlled by button controls and connectivity with other blocks. Thus, musically complex and engaging configurations can be rapidly assembled. The tangible nature of the blocks and the intuitive interface promotes face-to-face collaboration, and the presence of the GUI allows for remote collaboration across a network. The goals for the development of BlockJam are:

- To create a collaborative musical interface.
- To explore the idea that simple interface elements such as a block, can allow an inexperienced user to create a complex musical experience that is engaging for both the musical novice and the musically adept.
- Exploration and creativity where music is not first composed and then listened to, but interactively arranged and re-arranged from the elements at hand to blur the boundaries between the performer, composer and audience.

Block Jam uses the same interactive "block" metaphor for both the tangible interface and the on-screen interface. When the tangible blocks are manipulated, the activity is mirrored on the on-screen interface. The screen interface provides a level of modularity that enables the user to load in new Song Packs to interact with other users across a network, and to enable the users to interact with the system without having to use the tangible blocks. By having an on screen version of the interface, the system can be represented on many platforms, and networked into one group experience.

Fig. 155: Instant City installation at Ars Electronica, 2003.

Fig. 156: Instant City installation

Fig. 157: Instant City installation.

Instant City, Ein elektronischer musik bau spiel automat, 2003
Sibylle Hauert and Daniel Reichmuth
Rosen & Spademan Enterprise Basil, Switzerland
http://www.instantcity.ch/

Instant City is an electronic automat or gaming table for making music. Eight musicians produced special compositions which serve as the game's basic music-making engine. Each semi-transparent building block placed on the table establishes a filter that alters the intensity of the overhead light that is hitting an array of sensors under the glass table top. The result is an analog spectrum of light intensities that are programmed to correspond to a particular parameter of the selected "instant city" music composition. Exactly what is heard, however, depends upon where the building blocks are placed, how high they are, how many are on the table, and the sequence in which they are used.

Players select a composition by choosing from among various respective tower-shaped "keys". Once the selected key has been inserted into the corresponding slot in the frame of the playing board, the game can begin. Using up to 140 semi-transparent building blocks stored within the game board framework, the game can be played alone or as a group by building on top of the illuminated game board. The selected composition becomes audible based on the block selection and placement. It only becomes audible after all of the players remove their hands from the array of photo sensors under the glass plate table.

B.2.3 Information Navigation Interfaces

Information navigation interfaces, such as Navigation Blocks from the University of Washington, used a single tethered tangible block to navigate pre-formatted web pages. (Camarata, 2001) Media Blocks uses the physical blocks as phicons. Tagged blocks are used to link to information in the computer system. (Ullmer, Ishii & Glass, 1998) On the other hand the MIT Media Lab Triangles project is a set of identical flat plastic triangles that organize media elements to form a narrative. (Gorbet & Orth, 1997) The Strata ICC

project uses transparent tiles as a means to replicate various systems, such as energy consumption, in an architectural structure. (Ullmer et al, 2001)

Fig. 158: MIT Media Lab Tangible Bits Triangles Project

Triangles, 1999
Ali Mazalek, Tim Lu, Will Arora, Professor Hiroshi Ishii
MIT Media LabTangible Media Group
http://tangible.media.mit.edu/projects/Tangible_Bits/projects.htm

The Triangles project is a digital/physical construction kit of identical, flat, plastic triangular pieces. The pieces connect together both physically and digitally with magnetic and conductive connectors and trigger digital events. The Triangles project attempted to create a tangible interface where meaning is derived from the topological structure of the information relative to the prescribed content. These events influenced the progress of a non-linear story, and enabled users to organize media elements in order to create their own story space. In creating narratives, users can first capture audio, video and still images and store them in the Triangles digital media software. This media is arranged into a "story" by manipulating the Triangles. The story was retrieved in a non-linear fashion, given that the three-sided nature of the Triangles allowed users to follow different paths as they navigate through the story space.

The digital media story is displayed on a separate display. In essence, Triangles is a physical hyperscript tool that cleverly facilitates the manipulation of pre-determined narrative paths with a tangible user interface.

Fig. 159: MIT Media Lab Tangible Bits Media Blocks Project

MediaBlocks, 1999
Brygg Ullmer, Dylan Glas, Paul Grayson, John Alex
Tangible Media Group MIT Media Lab
http://xenia.media.mit.edu/~ullmer/projects/mediablocks/

The MediaBlocks project is a tangible user interface based upon small, electronically tagged wooden blocks. MediaBlocks act as physical "controls" in tangible interfaces for tasks such as sequencing collections of media elements. The blocks serve as physical icons ("phicons") for the containment, transport, and manipulation of online media. MediaBlocks interface with media input and output devices such as video cameras and projectors. They enable digital media to be rapidly "copied" from a media source and "pasted" into a media display. MediaBlocks were also compatible with traditional GUIs, and provided seamless gateways between tangible and graphical interfaces.

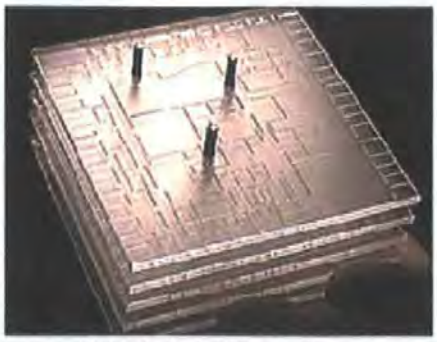

Fig. 160: MIT Media Lab Strata Project.

Strata/ICC Physical Models as Computational Interfaces 2001
Brygg Ullmer, Elizabeth Kim, Axel Kilian, Steve Gray, and Hiroshi Ishii
Tangible Media Group, MIT Media Laboratory

The Strata project explored the design of layered, electronically-augmented physical models that served as tangible interfaces to specific data spaces. Strata's first application was an interface that embodied the physical structure of the Media Lab's home building. It took the form of a five-layer, translucent acrylic model woven with embedded lights, sensors, and computation that created a dynamic visualization of the building's energy grid system.

The Strata/ICC project was a computationally-augmented

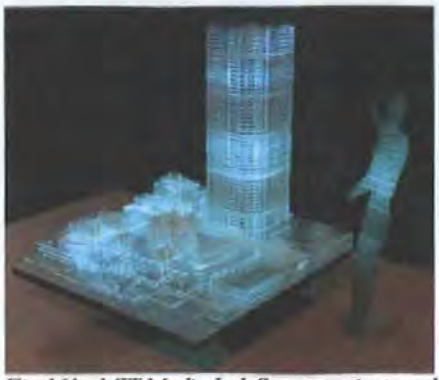

Fig.161: MIT Media Lab Strata project at the ICC, Japan.

physical model of a 54-story skyscraper. It served as an interactive display of electricity consumption, water consumption, network utilization, and other kinds of infrastructure. The goal of the project was to push information visualizations into the physical world, with a vision of transforming large-scale physical models into new kinds of interaction workspaces.

Fig. 162: Navigation Blocks, University of Washington

Navigation Blocks 2001
Tangible Navigation of Digital Information
Ken Camarata, Ellen Yi-Luen Do, Mark D. Gross, Brian R, Johnson
Design Machine Group / Dept. of Architecture / University of Washington
http://faculty.washington.edu/kcamarat/pub.html

"The Navigational Blocks is a tangible computing interface that was designed to provide a way to explore the history of Seattle Pioneer Square. The interface was composed of four individual blocks that represent portions of the history of Pioneer Square: who (the people), what (the events), where (the locations), and when (1850's-1890's). Information was made to the user with web pages. Orienting the block such that the requested topic was facing upwards was the web page selection mechanism. Navigation Blocks incorporates an infrared communication system along with the MIT Cricket microcontroller and an AppleScript control program.

Fig. 163: Navigational Blocks Internal Circuit.

B.2.4 Shape Analysis Systems

Shape analysis systems interpret the shape of a physical construction with pattern finding algorithms. A three-dimensional texture map is applied to the screen replication of the construction recognized images and icons that roughly mirror the TUI physical construction.. The screen interface for a later version of ActiveCubes can recognize basic symbols such as the shape of a toy airplane. (Watanabe et al., 2004) Recognizing a pre-selected group of symbolic shapes, as the MERL project attempts, can be an intractable problem but one that sets a very interesting mathematical and complex programming problems to solve. (Anderson et al, 2000)

Fig. 164: Bottom view of the MERL circuit board.

Fig. 165: Close-up of the MERL tangible blocks.

Tangible Interaction + Graphical Interpretation: a new Approach to 3D Modeling

David Anderson, James L. Frankel, Joe Marks, Aseem Agarwala, Paul Beardsley, Jessica Hodgins, Darren Leigh, Kathy Ryall, Eddie Sullivan, Jonathan S. Yedidia
Mitsubishi Electric Research Laboratories

The Tangible Interaction project uses LEGO like building blocks to build physical constructions which are replicated in a 3D virtual model in two formats, literal replication and interpreted rendering. The blocks are used to build a geometric model which the host computer analyzes and compares to an internal archive of previously determined models. The system is designed to accommodate up to 500 blocks using a simple bi-directional communication protocol. The trade-off of using the simple communication protocol is a fairly complex parallel processing procedure. This process requires an exorbitant amount of processing power to crunch and interpret the block construction data. It takes fifty-three minutes to crunch the data for five-hundred and sixty blocks… and in the end, everything is a castle.

Fig. 166: MERL project physical block construction.

Fig. 167: MERL project shape analysis and virtual interpretation of the physical structure.

Fig. 166

Fig. 167

Appendix C Semantic Engine Documents

This keyword data structure is currently used to seed the WordNET search in the Semantic Engine software application. (WordNet, 2006) As the development of the Semantic Engine continues, aspects of Jacque Durand's second rhetorical matrix table, shown in section C.2 will be implemented as the core algorithmic component of the Semantic Engine. Further discussion about the Semantic Engine can be found in chapter eight.

C.1 Keywords Look-up Table for Current Version of the Semantic Engine (table 16)

CATEGORY	KEYWORDS				
FaceID	M0	M1	M2	M3	M4
Orientation 0: Self Definition					
F5	Age (n,v) Aged (n,v,adj)	Human (n,adj) Humanly (adv)	Gender 2 (n) Male (n, adj) Female (n,adj)	Identity 1,2,4 (n)	Adult (n)
F6	Emotions (n) Emotional (adj)	Experience (n,v) Experiencing (v)	Shame (n,v) Shameful (adj)	Well-being (n) Welfare (n)	Solitary(n, adj)
F7	Health (n) Healthy (adj)	Live (v, adj) Life (n)	Interact (v) Interaction (n)	Celebration (n) Celebrate (v)	Death (n) Deadly (adj)
F8	Mind (n,v) Mindful (adj)	Soul (n) Soulful (adj) Soulfully (adv)	Knowledge (n) Knowing (n,v,adj) Knowingly (adv)	Consciousness (n) Conscientious (adj) Conscientiously (adv)	Intellect (n)
F9	Body (n,v) Bodily (adj, adv)	Touch (n,v) Touchingly (adv.)	Sexuality (n) Sexual (adj) Sexed (v, adj) Sexually (adv)	Love (n,v) Lovely (adj) Desire (n,v) Desirable (adj)	Sensuality (n) Sensual (adj)
Orientation 1: Origins					
F5	Nationality (n) Nationalize (v) Nationally (adv)	Immigration (n) Immigrant (n) Nomadic (adj) Indigenous (adj)	Assimilation (n) Assimilate (v)	Segregation (n) Segregate (v) Separate (n,v,adj)	Residence (m) Residency (adj)
F6	Subculture (n)	Clan (n) Clandestine (adj)	Social group (n) Group (n 1,v 2) Guild (n)	Labor (n,v) Work (n,v)	Occupation (n)
F7	Language (n)	Dialect (n) Accent (n,v)	Slang (n,v)	Talk (n,v)	Dialogue
F8	Culture (n) Social Class (n) Sociocultural (adj)	Ethnicity (n) Ethnic (adj) Ethnically (adv)	Race (n-2,5)	Breed (n,v)	Pedigree (n, adj)

F9	Family (n) Extended Family (n)	Roots (n,v)	Heritage (n)	Ancestry (n) Relative (n, adj) Relation (n)	Parents (n)
Orientation 2: Environment					
F5	Environment (n) Environmentally (adv) Environ (v)	Nature (n) Natural (n, adj)	Earth (n,v)	Space (n,v)	Building
F6	Frugal (adj) Frugality (n) Frugally (adv)	Possession (n) Possess (v) Possessor (n) Possessed (v, adj)	Wealth (n) Wealthy (adj) Wealthily	Capitalism (n) Capital (n 1,2, adj 1,2,3) Capitalist (n, adj) Capitalistic (adj)	Miserly
F7	Society (n) Societal (adj)	Neighborhood (n) Neighborly (adj) Neighbor (n,v,adj)	Community (n)	Home (n, v, adj, adv)	Urban (adj) Rural (adj)
F8	Aesthetics (n) Beauty (n) Beautiful (adj) Beautifully (avd)	Pleasure (n) Pleasurable (adj) Pleasurably (adv) Pleasing (n, v, adj)	Discourse (n,v)	Poetic (adj) Poetically (adv) Prosaic (adj) Prosaically (adv)	Style (n) Stylistic (adj)
F9	Cosmopolitan (n, adj)	Nomad (n) Nomadic (adj)	Worldly (adj)	Civilized (v,adj) Civilian (n, adj)	Provincial (n, adj)
Orientation 3: Values					
F5	Religion (n) Religious (n, adj)	Fundamentalist (n, adj) Evangelist (n) Evangelical (adj) Orthodox (adj)	Agnostic (n, adj)	Nihilism (n) Nihilistic (adj)	God (n) Spirit (n)
F6	Human rights (n) Democracy (n)	Chaos (n) Chaotic (adj) Chaotically (adv)	Common sense (n, adj)	Belief (n) Believe (v) Believer (n)	Morals(n)
F7	Pacifist (n,adj) Peacefully (adv)	Activist (n, adj)	Tolerance (n) Tolerate (v) Diversity (n) Diverse (adj) prejudice (n,v)	Discourse (n,v)	Conflict (n)
F8	Communism (n) Communistic (adj) Socialism (n) Socialistic (adj) Leftist (n, adj)	Anarchism (n) Anarchistic (adj) Anarchist (n)	liberalism (n) Pragmatist (n) Pragmatic (adj) Pragmatism (n)	Authoritarian (n,adj) Fascist (n, adj)	Government (n) Govern (v)
F9	Slave (n,v,adj) Slaver (n, v) Slavery (n)	Murder (n, v)	War (n,v)	Power (n,v) Powerful (adj, adv)	Genocide (n)

C.2 Jacques Durand's Rhetorical Rules Matrix for the Semantic Engine (table 17)

	ADDITION (orientation_0)	SUPPRESSION (orientation_1)	SUBSTITUTION (orientation_2)	EXCHANGE (orientation_3)
IDENTITY mx & mx	**Rule 1 : Repetition** The use of repeated words or phrases.	**Rule 2 : Ellipsis** The omission of one or more words in a sentence which would be neede to express the sentence completely.	**Rule 3 : Hyperbole** A figure of speech consisting in exaggerated statement used to express strong feelings or produce a strong impression and not intended to be taken literally.	**Rule 4 : Inversion** Repetition of words in inverse order
SIMILARITY OF FORM mx & my	**Rule 5: Rhyme** Agreement in the terminal sounds of two or more worlds or metrical lines.	**Rule 6:** *(rhyme, allusion or hendiadys fades to black)*	**Rule 7: Allusion** A covert or implied reference.	**Rule 8: Hendiadys** One idea is expressed by two ideas which are given identical grammatical form ; e.g. « the vastness and the space' for 'the vast space'
SIMILARITY OF CONTENT mx & nx	**Rule 9: Simile** The act of comparing one thing to another	**Rule 10: Circumlocution** The use of several words instead of one, or many instead of few. A roundabout expression.	**Rule 11: Metaphor** The figure of speech in which a name or descriptive term is transferred to some object to which it is not properly applicable.	**Rule 12: Homology** A figure which constitutes a correspondence between the ideas and the way these ideas are expressed.

DIFFERENCE mx & ny	**Rule 13: Accumulation** Unordered collection of words or other grammatical units, all expressing a similar content.	**Rule 14: Suspension** The figure of keeping the listener or reader in a state of uncertainty.	**Rule 15: Metonomy** A figure in which the name of an attribute or adjunct is substituted for that of the thing meant. (e.g. 'sceptre' for 'authority')	**Rule16: Asyndeton** A figure which omits the conjunctions.

OPPOSITION OF FORM mx & ny & ny & mx	**Rule 17: Zuegma** The use of a word to modify or govern tow or more words usually in such a manner that it applies to each in a differnect sense or makes sense with only one.	**Rule 18: Dubitation** The expression of doubt	**Rule 19: Periphrasis** The use of several words instead of one, or many instead of few. A roundable expression . (circumlocution)	**Rule 20: Anacoluthon** The use of a world or other grammatical unit of which the referent dates from a different period than those of the remainder of the text.
OPPOSITION OF CONTENT mx & ny & nx & mx	**Rule 21: Antithesis** An opposition or contrast of ideas expressed by using, in contiguous sentences or clauses, words which are strongly contrasted with each other	**Rule 22: Reticence** The figure of reserve, of saying little or remaining silent on a subject.	**Rule 23: Euphemism** A figure by which a less distateful word or expression is substituted for one more exactly descriptive of what is intended.	**Rule 24: Chiasmus** A figure by which the order of words in one clause is inverted tin a second clause.
FALSE HOMOLOGOUS AMBIGITY mx & my & my & mx	**Rule 25: Antanaclasis** Repeating a word in a differenct or even contrary sense.	**Rule 26: Tautology** A figure which consists of repreating in the immediate context the same word or phrase or the same idea or statement.	**Rule 27: Pun** The use of a word in such a way as to suggest two or more meanings, or the use of two or more words of the same sound with different meaning so as to procude a humourous effect.	**Rule 28: Antimetabola** Repetition of words or ideas in reverse order
FALSE HOMOLOGOUS PARADOX mx & nx & nx & mx	**Rule 29: Paradox** A statement seemingly self-contradictory or absurd, though possibly well-founded and essentially true.	**Rule 30: Preterition** A figure by which summary mention is made of a thing in professing to omit it.	**Rule 31: Antiphrasis** Use of words in a sense opposite to their proper meaning	**Rule 32: Antilogy** A contradition

Appendix D: Design Prototypes Version 1.0 to 3.0

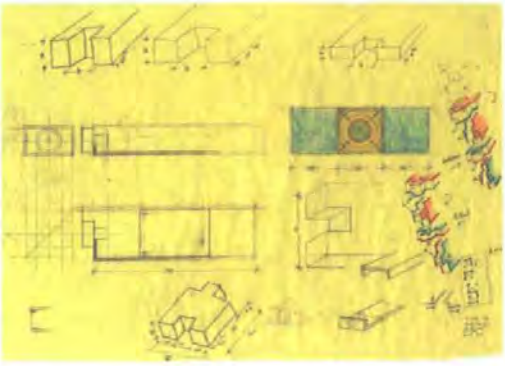

Fig 168: Block Design Version 1.0 The sketches on top show the geometric constraints that result if one desires to have a connection that is valid in different orientations: rotated 90,180, 270 and 360 degrees. The sketches also demonstrate how to determine the orientation of the faces.

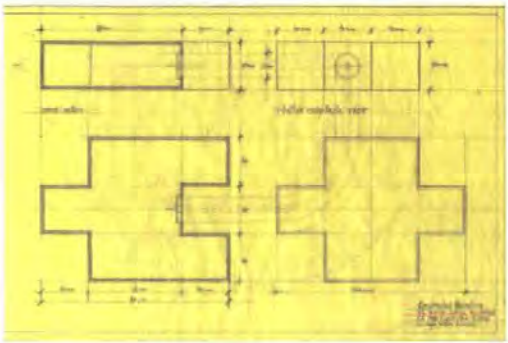

Fig. 169: Building Block Version 2.0: Theme and Repetition

The "H" shape block was inspired by a plastic block game researched in the construction kit literature search in appendix B. Early in the process of exploring possible block forms, this particular shape appeared to fit the following design criteria:

- Design a shape that would enable orthogonal construction at each juncture of connection, as opposed to simple vertical and horizontal stacking.
- Design a neutral shape that did not suggest a particular type of object or entity. (Although eventually the "H" shape was considered to be too anthropomorphic in its possible representation of the human figure.)
- Design for internal placement of electronic components.

Early hardware solutions had large footprints (overall component size) which forced the block size to increase. Subsequent block designs sought to solve the footprint issue by stacking boards, selecting alternative, hardware devices, and exchanging some of the OEM hardware solutions for proprietary circuits.

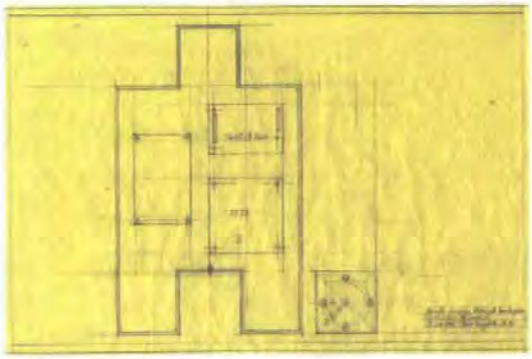

Fig. 170: Building Block Version 3.0: First Internal Design Explorations, the internal layout of the components trying to optimize the paths of the wires from the appendages to the basic board, and Neuron chip.

Fig. 171: First Cardboard prototype of the early block design ideas.

The modularity of interconnected blocks with the "H" shape was explored in design version 2.0. A major concern was the advantages and limitations of concave/convex interconnecting surfaces. Particularly as these surfaces limited the number of protruding electronic connection points, given the electrical connection solution that was considered at the time (I-buttons, stereo and DC plugs).

Emphasis on the optimum placement of internal electronic components was a focus of design version 3.0. Each block was to house a RFID reader and antenna that required a 60 x 90 mm space for installation. As a result, the block size increased to its largest acceptable size, which was slightly too large for an average adult sized hand.

All in all, the excitement around the "H" shaped block dissipated as the limitations of its shape given the hardware requirements overpowered its abstract form and affordances for building complex orthogonal structures.

Appendix E: Constructed Narratives Software API

Available upon request

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