Sara Diamond

Moving Out of Bounds: Expanding the Field of Art Education

This chapter asks the question: how might the growing engagement with the sciences and social sciences suggest a different mission for the art school, its pedagogy, its faculty, and its graduates? Before the twentieth century, art and artists from many cultures were inspired by disciplines far beyond the humanities fields of literature, philosophy, or history. These engagements include mathematics, the sciences, and the emerging fields of social sciences. If anything, the post-war era in the West rigidified specialization, creating barriers between disciplines and, with this, a separation of the arts and sciences. It is time to join forces again.

The drive towards collaboration can stem from instrumentalist impulses among artists as much as from engineers or scientists wanting to use artists' representational skills. While some artists are capable of inventing tools and others can create content with existing tools, yet others require interdisciplinary collaboration to develop the technologies that can fit their artistic vision. As Christie Sommerer and Laurie Mignonneau pointed out over a decade ago,[i] collaboration between artists and technologists is a fundamental requirement of many large-scale new media arts or "ArtSci" projects.[ii] "ArtSci" is a term that emerged in the 1990s in the United Kingdom to designate collaborations between artists and scientists.

An example is Blast Theory's (2004) game *Uncle Roy All around You* that offers the public an opportunity to play on the streets of large urban centres using specifically designed mobile devices and mapping interfaces. It has continued to be circulated around the world, with new local expressions since its inception in 2004. Participants search for historical ghosts from the cities' past and collaborate with on-line player teams who direct them (mapping players' movements through the neighbourhood) and live actors who intervene in the play. The development team for this project included social historians, a city planner, graphic artists and programmers, the Blast Theory artists, mobile technology scientists from the University of Nottingham, electronics researchers, local historians from the cities where the work was to be presented, and a commissioning curator. The development of *Uncle Roy All around You* spanned many institutions and venues even before its completion in 2004.

The team used a participatory design approach with end users, designers, and engineers.[iii] Participatory design is a design approach that began in northern Europe with the intention of including workers in designing technologies that could impact their future workplace, and this is now a well-tried means to include end users in the design process with technology inventors. The Blast Theory project included brainstorming and

location-storming, in which developers and players acted out simulations or metaphors of the game on site in order to understand the play dynamics. A wide demography of potential players was involved in imagining the game and testing its iterations. The team culled this knowledge and incorporated it into the creative design, refining the game at each location. The engineering teams in Canada and at the University of Nottingham used the project to build new mobile platform technologies and gaming algorithms, which were applied to scalable new technology applications in the field of mobile computing and wearable technologies. The historians discovered new approaches to social history. Multi-party collaborations, such as those of Blast Theory, can clearly involve engineering and technology research, content creation, social science, and curatorial collaboration from the inception of a project, generating new knowledge at many points.

Blast Theory is just one example of artist-researchers who engage wholeheartedly with science and engineering. "ArtSci" and other forms of investigation of science are international phenomena. Members of Leonardo/The International Society for the Arts, Science, and Technology are currently creating a network (LEF) of faculty teaching in this field at the international level. Red Latinoamericana de Arte, Ciencia y Tecnología (REDCATSUR) was launched in 2008 and is a network of artists, scientists, engineers, theoreticians, and institutions promoting communication and collaboration in art, science, and technology around Latin America (Argentina, Brazil, Columbia, Chile, and Peru are represented) with growing links to an LEF group in Canada and an international network that is truly global.[iv] Leonardo/OLATS[v] remains a long-term player in the field, through publication of its journals, MIT Press books, and support for various face-to-face and online gatherings. At the College Art Association in Los Angeles in 2009, the panel "Shifting Paradigms in Media Art, Science, and Technology Education in a Global Context" provides an overview of the theoretical debates surrounding these areas of practice. Current professor-practitioners who are artists in this field include Maris Bustamente (Mexico); Sean Cubitt (Australia); Nina Czegledy (Hungary/Canada); Diana Domingues (Brazil); Martha Fleming (UK); Lynn Hughes (Canada); Natalie Jeremijenko (USA); Eduardo Kac (Brazil/USA); Ryszard W. Kluszczynski (Poland); Steve Kurtz (USA); Jorge La Ferla (Argentina); Roger Malina (France/USA); Jane Prophet (UK) ; Victoria Vesna (USA); and Mariela Yeregui (Argentina). Some of these artists work in open-ended collaborations with scientists and engineers; some are inspired by scientific theory or ideas; others appropriate, misread, or reposition scientific materials or research; others provide a critique of scientific ethics or methods. Yet others have both scientific and artistic knowledge and methodologies that they intertwine in their practice. Their strategies vary dramatically.

At the same time, science has something to say about artmaking and design. Scientists and mathematicians may look to art or design as a

means of understanding difficult questions or representing the invisible, such as n-dimensionality. They may see artists and designers as grappling with similar philosophical challenges to theirs. They may be curious about approaches to beauty that are parallel to or divergent from their own view. They may share a critique of techno-culture, surveillance, or globalization. In Canada, neural scientists work with musicians at the McGill University Brain, Music and Sound Research Centre. During his appointment in 2002 as scientist in residence at the Institute of Contemporary Art (ICA) London, UK, neuroscientist Daniel Glaser worked closely with artists in order to understand how perception transpires. He is the senior research fellow in imaging neuroscience at the University College of London's prestigious Institute of Cognitive Science. Glaser was so inspired by this experience that he created the ongoing Café Scientique, an opportunity for scientists and artists to share their research, and he continues to research with artists on visual cognition.[vi]

Other science researchers are equally interested in the physiological processes connected to creativity. Colour theorists and colour-theory artists bridge science and art. Cognitive scientists and visual artists collaborate because of a shared interest in memory and emotion, for example at Baycrest, a centre for the aged and an institute for advanced brain research in Toronto, Canada. Judith Doyle and Martha Ladly, Ontario College of Art & Design (OCAD) researchers and their students collaborate with the Memory Link project there, led by Dr. Guy Proulx. Artists already make significant contributions to medical imaging, scientific and data visualization, and the creation of abstract and experimental as well as instrumental imagery.

The visual arts and the sciences contain many rich but often contradictory philosophical threads. Rather than reduce the value of art education to instrumentalism, thereby erasing intrinsic cultural values, the differences and parallels can provide vitality to art as well as to art and design pedagogy and research in a way that is appropriate for contemporary times. There are many sciences (the various fields of theoretical physics, biology, psychology, genetics, for example) that offer theory, methods, and materials to art. Fears that art can be reduced to illustration or instrumentalism if engaged in face-to-face encounters with science fail to recognize both the variability in approach that science itself offers or the multiple positions that artworks can occupy.

What is more, collaborations with the sciences offer artists and designers an opportunity to find common ground with each other and even a common identity. Like art, some movements in contemporary design have an engagement with social theory, intervention, and dialogical aesthetics. The recent *Design and the Elastic Mind* exhibition in 2008, created by curator Paola Antonelli for the Museum of Modern Art in New York City, featured projects that are engaged with new materials and scientific experimentation that are often exhibited in other contexts as art pieces. Art projects, at times, become design works that allow new

perceptions and answers to hard problems to emerge. The works of Ben Fry, a visualization artist and scientist, serves as an excellent example. His visualizations are able to provide insight into new approaches to genomics and are, at the same time, rigorous in formal beauty while engaging in a dialogue about the nature of scientific representation.[vii]

Paola Antonelli proposes that the twentieth-century conversation between design and science has returned to the foreground in this century and has become focused. She argues that this is, in part, a result of technologies that offer scientists the freedom to use their imaginations, particularly in the realm of biosciences, biotechnologies, and nanotechnologies, opening their minds to the views of designers. Design thinkers such as Anthony Dunne argue that given the convergence of design and science, it is time for design to engage with science as a research-methods discipline and to take up a critical and ethical position in relation to science, technology, and invention.[viii] The call for an ethical stance on the part of design aligns with the expressed concerns of artists who engage with science and who feel that humanist or post-human ethics (in which the world is understood from an ecological and network perspective outside the human) need to be taken up more vigorously by science.

Nigel Cross, in *Designerly Ways of Knowing*, warns against the creation of a positivist or wholly rationalist approach to design in relation to science. He argues for "designerly" ways of knowing and thinking that do not conflate design into science. He warns against reductionism in relation to design in which design science is reduced to engineering. Cross argues instead for a science of design that is founded on the skills that designers have in "proposing additions to and changes to the artificial world."[ix] Artificiality in this instance extends to all systems, including natural systems, where there is human intervention. The creative process needs to stay in the foreground. Paul Svenson underscores digital design as a site of interdisciplinary culture where design must be able to import knowledge from multiple domains to problem solving.[x] Problem-solving approaches are a hallmark of some new forms of twenty-first century art and play out in relational aesthetics. Hence, art and design can agree that they have much to offer to science beyond the teleological.

The argument in these pages is to move the current accelerating, collaborative practices of artists, scientists, engineers, and designers away from the margins and into the centre of at least a part of the practice of art and design teaching and research institutions. Engaging and challenging practices in visual arts in league with "big science" are emerging from specialized art and design institutions and from similar faculties within comprehensive universities. Programs have successful track records and can serve as models. For example, the Arts, Computation, and Engineering Graduate Program at the University of California at Irvine is aligned with the CalIT2 at Irvine and UC San Diego, and focuses on contextualization, real-time computational arts, games design, and interactivity. Hexagram in

Montreal and Quebec, Canada, straddles Concordia University and Université de Québec and supports multiple creative researchers. Hexagram's large-scale science initiatives are driven by artists, architects, and designers. For over a decade, Media Lab at the University of Art and Design Helsinki (UIAH) in Finland has included many opportunities for engineers, artists, designers, and social scientists to interact.[xi] Faculty sociology and ethnography researchers study these collaborations in order to understand how new methods that emerge might be generalized into research and industry practices.[xii]

The notion that art, design, and science can and should have a deeper dialogue than in the recent past is embedded in "Leading in the Age of Imagination," the OCAD's Strategic Plan for 2006-12.[xiii] The plan draws on a growing history of successful cross-disciplinary research and pedagogy that engages knowledge in art, design, and many other disciplines.[xiv] The call for engagement is for a significant and fundamental dialogue, not one that simplifies art, design, science, or social science. It does not erase the value of practice outside of the art and science dialogue, although these practices can then be interpreted through a wider range of lenses. The turn to an activist engagement with the sciences (including medicine, earth sciences, physics, and material science) is driven by the desire and need to provide relevancy, cogency, and power to art and design practices. An engagement with the social sciences provides a set of parallel methods and tools for analysis of human factors in creative fields. This in turn places art and design at the centre of contemporary discourses, practices, and concerns—looking out at other disciplines and providing fresh approaches and methods to these. This engagement offers the potential for new forms of knowledge and of practices. The emergent field of "ArtSci" or "SciArt" (depending on where one lives) as well as new media represent edge practices in these domains.

Hybridity or dialogues across differences and within differences are even more powerful, according to Mark Muller, when these occur between groups.[xv] A successful social aesthetic between science and art collaborators or other differentiated groups would then depend on a high level of interactivity, hence creating a bias towards social media. The shift from individual experience to hybrid group experiences is precisely the aesthetic challenge that Warren Sack, (a designer of collaborative spaces for large-scale online conversations) makes to artificial intelligence research and cognitive science in his recent article in *Database Aesthetics*.[xvi] . He argues that contemporary technology systems require an aesthetic that allows the emergence of new common and collectively constructed shared experiences and identities. This statement is relevant to the culture we need to create in art and design institutions, the pedagogy that we need to develop, and it is exemplary of the new perspectives that artist/designers bring to science and engineering.

How did an art and design university arrive at a strategic plan that calls for a much stronger engagement with the contemporary sciences,

whether "big science," computer science, or social science? OCAD created a working group that drew upon its own expertise in art, design, cultural theory, and history, and solicited the views of outside consultants from many different disciplines. OCAD grappled with two significant questions:

- What is the future of art and design?
- What is the future of post-secondary education?

Through this process the group created scenarios in order to understand the key uncertainties affecting art and design.[xvii] The major drivers that the research acknowledged and then analyzed were technological change, globalization, societal values, sustainability, and cultural diversity. These powerful forces would shape the broad context of art and design.[xviii] This analysis led to the identification of two key forces that would impact art and design education. These were a) the extent to which art and design would be valued in future societies and b) diversity and sustainability and the extent to which the resolution of world conflicts would be able to effectively address these.

From these forces came four scenarios. The first scenario was entitled the "Globe Lab,"

> an optimistic, but not impossible scenario in which global creative diversity, art and design imagination and leadership are valued and harnessed to help solve major global problems, from poverty and security to disease and sustainability.

The second scenario was dubbed "Island Living," in which,

> increasing global political instability, inequity and insecurity lead to a growing rejection of globalization, and "local" problem solving that includes non-geographic issues through networked collaboration. A combination of idealism and pragmatism influences and is influenced by art and design. For artists, society is rich in paradox, evolving in its thinking and open to exposure and direction in reshaping society's view of itself. Art is recognized and valued.

The third scenario was named "Legacy Inc.," a time of terrorist activity, pandemics, and economic upheaval, a conservative time of fear in which,

> people search for their roots and cherish the original, the archival and traditional. Art and design are used in the service of the culture, the community and the clan, on preserving and securing the past…. The criterion for

> success in design is not whether it is attractive, unique or groundbreaking, but whether it works.

Finally, there is a scenario entitled "Commercial World" where,

> commercialization and technology drive art and design as well as education. Strong global economic growth, relative political stability and the rapid deployment of technology—notably broadband and wireless—renew globalization in trade, travel and consciousness. Large-scale universal aesthetics are constantly asserted and then re-invented. This is a world of user generated content and "prosumers" as well as constant demand for skilled artists and designers.

In taking into account each of these scenarios, OCAD saw the impact of holistic knowledge, albeit from an art and design perspective. It saw the tremendous impact of technology in the last century and, with this, the often hidden role of science in shaping our lives, the planet, and beyond. The vision of the plan was to contribute to "the fields of art and design, local and global cultural initiatives, and knowledge and invention across a wide range of disciplines." It defined its culture as "a learning environment that integrates studio-based education with historical, critical, and scientific inquiry. OCAD values accessibility, cultural diversity, equitable global citizenship, art and design advocacy, aesthetic and formal excellence, sustainability and entrepreneurship."

What did this understanding mean for pedagogy? OCAD identified five themes that would consolidate and build on existing cross-disciplinary curriculum and research interests within the school that were identified within the analysis of key trends in knowledge that needed art and design engagement. These would shape practices within the institution and in its relationship with others. The themes are:[xix]

Sustainability: An overarching challenge for the twenty-first century, reflected in the use of materials, energy, economic autonomy, and other key concerns.

Diversity: A vibrant, productive arts community, animating and reflecting rich cultural diversity, is a core quality of twenty-first century practice and a requirement for problem solving.

Wellness: Medical discovery, health-care policy, health technologies, service delivery health communication, lifestyle education, art therapy, addiction, and care for the elderly are among the areas of potential collaboration and discovery between art, design, health,

wellness, and lifestyle researchers and promise significant innovation potential in the current century.

Technological innovation: Rapid growth and persistent change in technological platforms are a constant. Digital culture and tools are transforming everyday life, creative practices, business models, and cultural industries. The international trend is towards increasing engagement of art and design with science and engineering. Artists and designers have begun to move beyond using current technologies to imagine and invent new technologies and applications.

Contemporary ethics: Art and design grapple with ethics and social justice, at times embracing divergent strategies such as critique, revelation, intervention, or problem-solving. Community and international engagement surface and require attention to ethics, as do art and design research methodologies.

These new directions emphasized the development of new methodologies that were cross-disciplinary and emergent and moved towards a hybrid culture, one that prized problem solving, requiring nurturing collaboration skills as well as fostering individual talent.

What are the implications for faculty? Faculty at OCAD will continue to be valued in areas of OCAD's historical strengths. Painting, drawing, print-making, illustration, jewelry, sculpture and installation, environmental design and model-making, and industrial design are just some of the practices that continue using traditional media, although content often carries contemporary discourse. Other curriculum areas like advertising, photography, graphic design, aspects of environmental and industrial design, textiles, ceramics, integrated media, and curatorial and critical practice programs at OCAD are clearly inflected by these new fields. Graduate programs are shaped by interdisciplinary exchange as well as disciplinary approaches. In fact, many faculty members have a practice, undertake research, and teach curriculum of relevance to the new themes. OCAD has promised to provide opportunities for faculty to explore these new ways of approaching these fields through research and professional development. The institution is also hiring faculty with art or design and science backgrounds.

OCAD has developed a series of partnerships with science and technology, engineering, medical research, and innovation faculties of other institutions, research institutes, or companies. An implication of these directions has been an intensification of research interests and support. Art and design research is understood as intrinsically valuable in its own right and of value in relation to the thematic fields above. OCAD has undertaken intensive research development in three areas in the last

three years: digital media; design and art; design and medical research (in areas such as universal design, accessibility, and human factors); and sustainability, in particular, in relation to the built environment. As an art and design university, it defines itself as a highly public institution:

> It can occupy the public terrain as a culturally diverse, creative and intellectual centre that links initiatives in culture, public education and discovery to its mandate as a university of art and design. OCAD can function as a hybrid—first as a university, second as a cultural institution, and third as a partner institution able to intervene effectively to meet the needs of diverse communities.

This means intensified support for faculty and students to engage with the larger community and to present their practice and their research beyond OCAD's walls.

In the process of developing the strategic plan, OCAD's working group undertook intensive sketching as well as brainstorming. It created metaphors for the new OCAD, often working in subgroups and teams. It described the institution's intellectual environment as "The New Ecology of Learning." This nomenclature reflected images of an OCAD that was organic, whether biological, plant-like, or cellular: penetrable yet able to absorb and adapt to new growth. Brian Goodwin, in *How the Leopard Got His Spots: the Evolution of Complexity*, captures this image when he states, "organisms…must be understood as dynamical systems with distinctive properties that characterise their living state."[xx] The institution was depicted with intertwined yet semi-autonomous systems that were able to evolve in systematic yet complex ways. It is a strong image.

Back to the present

Despite the segregation that occurred during the last century, we have shown that there is an ongoing but often unrecognized history of collaboration between artists, designers, and scientists that has resulted in a number of past and present innovations. Randolph Packard and Ken Jordan chronicle the relationships of artists and engineers in the exciting era of early digital discovery: the 1960s.[xxi] Scientist Billy Kluver, at Bell Labs, was an early instigator, opening the door for artists to work with scientists. He collaborated with Robert Rauschenberg, creating *Oracle* (1963-1965) and *Soundings* (1968), art that anticipated the power of digital media and encouraged "a participatory role for the audience."[xxii] Kluver and Rauschenberg co-founded EAT (Experiments in Art and Technology), an institution that also exhibited art and technology works.

Kluver did not expect that art and technology projects would immediately result in new technologies. Rather, he hoped to inspire each

field towards relevant creation in its own domain. He clearly believed that artists and engineers together could reveal how technology works and, in the process, discover new expressions: "What I am suggesting is that the use of the engineer by the artist will stimulate new ways of looking at technology and dealing with life in the future."[xxiii] He argued for a willingness to accept failure in order to find ultimate success: "The artist's work is like that of a scientist. Is in an investigation which may or may not yield meaningful results; in many cases we only know many years later."[xxiv] This optimistic modernist view has been tempered by science and technology studies and decades of postmodernism, yet the experimentalist tone and sense of emergent potential offers an exciting opening for cross-disciplinary pedagogy and research. At the same time, in the current economy, Kluver's patient anticipation of outcomes and a tolerance for failure may be eclipsed by a more instrumental set of expectations of art and technology collaboration as these collaborations become institutionalized. Hence, the construction of programs that span open-ended investigation and more instrumental engagement can satisfy the needs of all collaborators.

Contemporary observers of interdisciplinary collaboration have discovered that complex multidisciplinary systems will foster results that are "different" than the sum of their parts, not simply greater. These differences can lead to breakthrough discoveries and new forms of knowledge (as Wendy Kellogg, Thomas Erickson, Kate Mason, Jon Denzinger, and Sheila Carpendale prove),[xxv] tendering thresholds that result in new attitudes, expressions, and roles. Hence the experience that students will gain in intensive collaborations with other disciplinary areas can be remarkable. Lily Diaz-Kommonen notes some of the ingredients she has found successful at the Media Lab, Helsinki. She describes an environment that favours "the acceptance of openness and indeterminacy to acknowledge others' agency."[xxvi] Gerhard Fischer, who designs tools for interdisciplinary teams, stresses the need for a complex and open context where collaborators can learn from their mistakes.[xxvii] Diaz-Kommonen also comments that finding common research goals as a process requires placing the tangible art, design, science, or engineering research product into a social and cultural understanding that focuses on the "contexts in which these objects exist and the communities and practices within which they acquire meaning."[xxviii] Such an exercise requires not only social and cultural theory but empathy and imagination, skills that are part of the repertoire of trained artists and designers.

Role hybridity can be a direct result of ongoing collaboration, eventually requiring a redefinition of "artist" or "designer." The National Research Council of the National Academies notes that effective collaboration appears to create cohesion or "intersubjectivity"[xxix] that transcends "traditional role boundaries to exploit different perspectives and skills and create new ideas and products that are somehow greater than the sum of their parts."[xxx] Artists and designers are self-reflexive as a part of our

practice; such a renegotiation is only apropos to our fields.

Artists as inventors of technologies: not a bad outcome

Michael Century and the National Research Council of the National Academies report on creativity and culture, and each suggests that artists' tools, at times, address problems that require solutions but that science has not prioritized.[xxxi]. Forays into technology creation by artists can therefore have significant impact.[xxxii] Recent tools built by artists can provide alternate ways of understanding or experiencing the social and technological world. Some artists value the double nature of working with visualization—creating imagery and creating actual technologies to enable research science. Jane Prophet's 2002 work *Cell* was created with mathematician Mark d'Inverno, medical scientist Dr. Neil Theise (a New York-based world leader in adult stem cell research), computer scientist Rob Saunders, and curator Peter Ride. It is visually arresting software,[xxxiii] and it facilitated Theise's breakthrough research. He was able to see relationships between phenomena that had been previously invisible.

Here is another example of an artist-created technology. A virtual reality software product provides an example. The MANDALA® Virtual Reality System (now the Vivid group of technologies) used camera tracking of gesture, placing the performer into an animated stage set. It was first created by performance artist Vincent John Vincent in 1984. Vincent used the tool to collaborate with live musicians in many places around the world. He played music, danced and juggled. ."[xxxiv] Vincent provided a different artist-friendly design perspective on a set of mass market emerging technologies.[xxxv] His tools are now embedded within mobile telephones (in Japan and China) to enable gesture-based interactions for gaming, navigation, and communication, moving human and technology interaction away from text-based interfaces to full-body engagement.

Artists and designers must be at the centre of thinking and making the future

Anne Cauquelin, a French sociologist of culture, warns against a turn to *"techo-doxique"* forced in the name of technology onto art, resulting in cold technological aesthetics, a set of practices that could obliterate the aesthetic history and variability of art and its embodied references. She argues for a science and art engagement that is "*kinesthésiques, tactiles ou polysensorielles that can 'permettant d'éprouver le sentiment de la presence de l'autre, et de contrebalancer ainsi la dureté des temps*" and that does not reproduce the separation of nature and culture.[xxxvi] This commitment to this particular approach can be constituted as a call for a much broader need for engagement of art and design with science in its broadest variance. Artists and scientists derive their approaches from different training and ways of working, with much

differentiation within their own disciplines. A goal of collaboration is both cohesion (or intersubjectivity—a capacity to meld different kinds of knowledge) but it is also dissonance—bringing different perspectives, methodologies, and lenses into play. Artists work in relatively speculative ways, drawing from technical methods and experiential, process-based methods as well as on studio critique. Many scientists and social scientists also work speculatively and then add experimental tests of proof, mixing quantitative iteration with qualitative assessment. Contemporary engineering and design are relatively applied forms of practice, where concrete outcomes are imagined, prototyped, tested, and revised, yet have increasingly crossed into complexity and social engagement. The combined power of these ways of understanding the world, of practising, representing, embodying, making, and theorizing are critical if art and design institutions wish to play a role in shaping our future as a species and as a planet.

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[i] See Christie Sommerer and Lauren Mignonneau, eds., *Art @ Science* (Berlin: Springer, 1999).

[ii] SciArt is used in some contexts as an alternative. We use the term with correct alphabetical order.

[iii] See Mark J. Muller, "Participatory Design, the Third Space in Human-Computer-Interaction," *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications*, Julie A. Jacko and Andrew Sears, eds. (Mahway: Erlbaum, 2003) 1051-1068.

[iv] For information on REDCATSUR, see "Página de Informatión de Redcatsur," n.d., Web, 31 Jan. 2009, ≤http://redcatsur.net/mailman/listinfo/redcatsur >.

[v] l'Observatoire Leonardo pour les Arts et les Techno-Sciences

[vi] For an overview of Glaser's initiatives see Daniel Glaser, home page, n.d., Web, 31 Jan. 2009, <http://www.danielglaser.org/index.html>.

[vii] In order to explore the various contexts of Fry's practice, See his Web site at *Ben Fry*, n.d. Web, 31 Jan., 2009, <http://benfry.com/>.

[viii] See Anthony Dunne & Fiona Raby's *Design Noir: the Secret Life of Objects*. (Basil, Boston, Berlin: August/Birkhauser, 2001) and the citation of their work in Peter Hall's essay "Critical Visualisation" in Paola Antonelli's *Design and the Elastic Mind* (New York: Museum of Modern Art, 2008) 120-131.

[ix] Nigel Cross, *Designerly Ways of Knowing* (London: Springer, 2006) 54.

[x] See Paul Svenson, "Interdisciplinary Design Research," *Design Research: Methods and Perspectives*, ed. Brenda Laurel (Cambridge: MIT Press, 2003) 192-196.

[xi] UIAH may be merging with the Finnish technology institute and business universities for better reciprocal collaboration. It continues with excellent laboratories, such as Crucible Laboratory, specializing in new media fiction, mobile phone and television interaction and other research and audience development activities.

[xii] For a case study of one of these collaborative labs see Marjo Maenpaa, John Nykanen, and Philip Dean, *Media Lab Helsinki 10 Years* (Helsinki: University of Art and Design, Media Lab, 2005).

[xiii] The document, "Leading in the Age of Imagination" is available in PDF format at the OCAD Web site. See *Ontario College of Art & Design (OCAD)*, OCAD, Web, 31 Jan. 2009, <http://www.ocad.ca/home.htm>.

[xiv] The power that these crossover practices can have was indicated time and again during many years of leading the Banff New Media Institute—an experiment in new media research and intellectual exploration that depended on dialogues and experiments between the arts and sciences.
[xv] See Muller.
[xvi] Warren Sack, "Network Aesthetics," *Database Aesthetics: Art in the Age of Information Overload*, ed. Victor Vesna (Minneapolis: U of Minnesota P, 2007) 183-210.
[xvii] The development of "Leading in the Age of Imagination" was itself a dynamic process. The core working group included students, faculty, administrators, alumni, staff, and the Board of Governors. It used all manner of participatory design and brainstorming tools. It held extended brainstorms at OCAD beyond its own membership. It met with faculties (Art, Design and Liberal Studies). The plan was passed by Academic Council. The Student Union held a series of fora that resulted in additions to the plan. It was then unanimously adopted by the Board of Governors in 2006.
[xviii] The discussion also included a discussion of more focused forces and factors directly shaping art and design practice and education, such as education funding and delivery, the nature of learners and evolving practices of art and design. These factors are reflected throughout the core strategies that OCAD has embraced.
[xix] This is a highly abbreviated version of the themes. An executive summary of the plan is available at the OCAD Web site.

[xx] Brian Goodwin, *How the Leopard Got His Spots: the Evolution of Complexity* (Princeton: Princeton Science Library, 2001) 3.
[xxi] See Randolph Packer and Ken Jordan, *Multimedia: From Wagner to Virtual Reality* (New York: Norton, 2001).
[xxii] Packer and Jordan xix.
[xxiii] Kluver in Packer and Jordon 33.

[xxiv] Kluver 33.

[xxv] See Thomas Erickson and Wendy Kellogg, "Knowledge Communities: Online Environments for Supporting Knowledge Management and Its Social Context," in Ackerman, M., Volkman, R., & Volker, W., eds. *Sharing Expertise: Beyond Knowledge Management*, (Cambridge: MIT P, 2003) 299-326; and Kate Mason, Jon Denzinger and Sheelagh Carpendale, (2004) "Negotiating Gestalt: Artistic expression and coalition formation in multi-agent systems", in the *Proceedings of AAAMA, July 2004.* New York: ACM, 2004 1350-1351.
[xxvi] Lily Diaz-Kommonen. "Design, Knowledge and Multidisciplinary Collaboration," *Media Lab Helsinki: 10 Years*, eds. Marjo Mawnpaa, Jon Nykanen, and Philip Dean, trans. Susanna Heiskanen (Helsinki: Media Lab, University of Art and Design, 2005) 92-104.
[xxvii]Gerhard Fischer, "Social Creativity: Turning Barriers into Opportunities for Collaborative Design," *Proceedings: Participatory Design Conference*, *2004, Toronto* (New York: ACM, 2004) 152-161.
[xxviii] Diaz-Kommonen 96.
[xxix] Vilém Flusser, *Writings*, ed. Andreas Ströhl (Minneapolis: U of Minnesota P, 2004).
[xxx] See William J. Mitchell, Alan S. Inouye, and Marjory S. Blumenthal, M., eds. *Beyond Productivity: Information Technology, Innovation and Creativity*, a document of the Committee on Information, Technology and Creativity, Computer Science and Telecommunications Board Division on Engineering and Physical Sciences, National Research Council of the National Academies (Washington, DC: National Academies Press, 2003). 56

[xxxi] Michael Century, "Collaboratories," *Proceedings of Banff Bridges II: October 4 - 6, 2002, Banff Centre for the Arts* (The paper is on deposit at Banff: Banff New Media

Institute Archives, 2006) Information about this event and an abstract of Century's keynote and other papers is available online at *Banff Bridges Conference Two Proceedings* <http://www.banffcentre.ca/bnmi/bridges/speakerabstract.html> See also Mitchell, Inouye and Blumenthal.

[xxxii] In the 1970s artists such as Dan Sandin (2007), undertook artistic research that had a tremendous impact on computer graphics and the emergence of virtual reality (BNMI, Smart, Sexy, Healthy, 2001) Sandin created early graphics works and then, working with computer scientists, built simple related tools that were expressive of undiscovered capacities of the technologies that he was exploring.

[xxxiii] More information on *Cell* is available at Jane Prophet's Web site. See "Jane Prophet: Artworks," at *Jane Prophet:Portfolio 2008*, n.d., Web, 31 Jan. 2009, www.janeprophet.com>.

[xxxiv] For more information on Vincent's work, see "Vincent John Vincent: Virtual Reality Pioneer," *Vincent John Vincent*, n.d., Web 31 Jan. 2009, <http://www.vjvincent.com/>.

[xxxv] In addition, Ted Druckery and Hatje Cantz indicate the ways that Ars Electronica's commissions and exhibitions added new features to technologies. Finally, Maenpaa, Nyakaneen and Dean provide case studies of such projects at the Helsinki Media Lab. See Maenpaa, Nykaneen, and Dean; Ted Druckery, *Ars Electronica Facing the Future: A Survey of Ten Decades,*(Cambridge: MIT Press, 1999) print; and Hatje Cantz, *International Compendium : Ars Electronica CyberArts* (Linz: ORF, 2003).

[xxxvi] Anne Cauquelin, *L'Art du Lieu Commun: Du bon usage de la DOXA* (Paris: Editions du Seuil, 1999).