From Rich Media to the Sensorium: How to Understand Pervasive Computing

Intelligence Paper
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Creative Disturbance (http://www.creativedisturtbance.com) offers a unique window to creative ingenuity in Human Computer Interface and Interaction (HCI) for organizations who know the next wave of innovation arises, not by adapting humans to technology, but by adapting technology to humans. We help design better product applications, technologies and user environments by playing a dynamic role in the innovation process as experts, as enablers and as partners. Creative Disturbance creates what traditional organizations cannot manage successfully internally- an open channel for interdisciplinary collaboration between researchers, artists and designers - to evolve new user-centered environments.

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Survey of Projects, Applications & Companies

Sight

Company: Interaction Laboratory, Sony Computer Science Laboratories, Inc.
Application: VisualFlow
Website: http://www.sony.com
Keywords: Rich Media Browser; User Interface.
Sensuality: Sight.

Company: Arts Alliance Labs
Application: TextOrgan
Developers: Jason Lewis & Alex Weyers
Website: http://www.aalab.net/projects/ActiveText/TextOrgan/
Keywords: Text Animation Program, Dynamic text performance tool
Sensuality: Sight, Sound

Company: Shout Interactive
Product: Headpedal
Website: http://www.shoutinteractive.com/index_flash.htm
Keywords: Voice, animated characters, support systems.
Sensuality: Sight, Sound.

Company Dassault Systemes
Product: CATIA & ENOVIA
Website: http://www.dsweb.com
Keywords: 3D Modeling Tools, CAD/CAM
Sensuality: Sight.

Company Credo Interactive Inc.
Product: Life Forms
Website: http://www.charactermotion.com/products/index.html
Keywords: 3D Character Animation.
Sensuality: Sight

Company Enroute
Product: FirstPerson Immersive Video System
Website: http://www.enroute.com
Keywords: 3D Imaging, Video, Gaming, Imaging.
Sensuality: Sight

Company: Viewpoint (Nasdaq: VWPT)
Product: 3D imaging Tool
Website: http://www.viewpoint.com
Keywords: 3D imaging, video.
Sensuality: Sight.

Project:	Mass Hallucinations
Project Lead:	Trevor Darrell & Gaile Gordon
Website:	http://www.thetech.org/press_resources/releases/1998/pr- - /
Keywords:	Motion Tracking; Pattern Recognition; Video
Sensuality:	Sight

Project:	Desert Rain
Project Lead:	Blast Theory, Computer Research Group at Nottingham University. Toynbee Studios, London
Website:	http://www.blasttheory.easynet.co.uk/work_desertrain.html
Keywords:	Mixed Reality; Performance; Monitors
Sensuality:	Sight, Touch, Sound.

Project:	Rapid Fire & Active Vision: Eye Tracking Musical Instrument Interfaces
Project Lead:	Andrea Polli
Website:	http://homepage.interaccess.com/~apolli/avision.html
Keywords:	Eye Tracking; Ocusonics
Sensuality:	Sight, Sound

Project:	Body Movies - Relational Architecture
Project Lead:	Rafael Lozano Hemmer (CDN/MX)
Website:	http://www.telefonica.es/fat/artistas/rlh/eprlh.html http://www.telefonica.es/fat/artistas/rlh/eimagenes.html (Images)
Keywords:	Motion-tracking, interactive entertainment
Sensuality:	Sight, Touch.

Company:	Eyematic
Product:	Realtime character animation; 3D Face Recognition,
Website:	http://www.eyematic.com
Keywords:	Computer vision Technology, Realtime character animation; 3D Face Recognition, Wireless, Gaming.
Sensuality:	Sight, Sound.

Project:	Computational Choreography; Interactive Software for Modelling Dance
Project Lead:	
Martin Colbert,	Digital Imaging Research, Centre, Kingston University
Juan Gutierrez,	Spanish Visiting Researcher
Rebecca Marshall,	The Random Dance Company
Wayne McGregor,	The Random Dance Company
Dr Paolo Remagnino,	Digital Imaging Research Centre, Kingston University
Website:	http://www.sciart.org/site/
Keywords:	Motion tracking,

Sensuality: Sight.

Company: Unified Field
Product: Evolving Screen™
Website: http://www.unifiedfield.com/
Keywords: Visualization, 4D, architecture.
Sensuality: Sight, Time.

Sound

Company: IM Networks
Product: SonicBox, IM Tuner
Website: http://www.imnetworks.com
Keywords: Music player, Internet radio.
Sensuality: Sound, Touch.

Project: Ping
Project Lead: Chris Chafe & Greg Niewmeyer
Website: http://ccrma-www.stanford.edu/~cc/sfmoma/topLevel.html
Keywords: Audio database , network, harmonics.
Sensuality: Sound, Touch.

Project: HUBBUB
Project Lead: Sha Xin Wei, Anne-Maria Korpi, James Yu-Cheng Hsu
Website: http://titanium.lcc.gatech.edu/hubbub/
Keywords: Speech-painting; Public Space; Speech Recognition.
Sensuality: Sound, Sight

Company: Lernhaut & Hauspie
Product: Dragon Systems, Inc.
Speech & Language Products
Website: http://www.dragonsys.com/
http://www.lhsl.com/default2.htm
Keywords: Speech Recognition
Sensuality: Sound

Company: Texas Instruments
Product: Voice Chips
TSP50C04/06 synthesizer
TSP50C13/14/19 synthesizer
Website: http://www.ti.com
Keywords: Voice functionality, semiconductors.
Sensuality: Sound

Company: Motorola

Product: Voice Chip- MC34018 Synthesizer
Website: http://www.motorola.com/
Keywords: Voice functinality, semiconductors.
Sensuality: Sound

Touch

Company: Anoto
Product: Digital Pen
Website: http://www.anoto.com
Keywords: Wireless communication
Sensuality: Touch, Sight.

Project: DataTiles
Project Lead: Jun Rekimoto
Website: http://www.csl.sony.co.jp/person/rekimoto.html
Keywords: Data tiles, media browser.
Sensuality: Touch, Sight, Sound

Project: Boundary Functions
Project Lead: Scott Snibbe
Website: http://www.snibbe.com/scott/bf/
Keywords: Tracking, Motion Capture, Video Projection
Sensuality: Touch, Sight

Project: GeoSCAPE & HandSCAPE
Project Lead: MIT Media Lab, Tangible Media Group
Jay Lee, Hiroshi Ishi, Blair Duun, Victor Su, Sandia Ren

Website:
http://tangible.media.mit.edu/projects/GeoSCAPE/GeoSCAPE.html
Keywords: Hybrid Physical-Digital; Wireless; 3-D Visualization.
Sensuality: Touch, Sight

Project: GeoNotes
Project Lead: HUMLE lab, Swedish Institute of Computer Science
Website: http://www.sics.se/humle/
Keywords: Augmented Reality, GPS systems, Mobile Computing.
Sensuality: Touch, Sight.

Project: Digital Jewelry
Project Lead: IBM Almaden Research Center
Website:
http://www4.ibm.com/software/ebusiness/innovations/digital_middle_no.html

Keywords: Wearable Computing; Wireless; Enhance Environments.
Sensuality: Touch, Sight.

Company: Sony Vaio
Product: Touch Sensitive LCD/Notebook
Website: http://www.sony.com.jp
Keywords: Computer, touchscreen
Sensuality: Touch, Sight.

Project: Sensetable
Project Lead: Tangible Media Group, MIT Media Lab
Website: http://tangible.media.mit.edu/projects/sensetable/sensetable.html
Keywords: Enhanced desk, motion-tracking.
Sensuality: Touch, Sight, Hybrid Physical-digital.

Project: The I/O Bulb, the Luminous Room & Urp
Project Lead: John Underkoffler, Daniel Chak, Gustavo Santos, and Professor Hiroshi Ishii, Tangible Media Group, MIT Media Lab
Website: http://www.tangible.www.media.mit.edu/groupgs/tangible/projects/Luminious_Room/Luminous_Room.html

Keywords: Architects, enhanced reality, simulated lighting.
Sensuality: Touch, Sight.

Company: Sensatex
Product: Smart Shirt
Website: http://www.sensatex.com
Keywords: Wearables, wireless, smart-fabrics, electro-optical textile.
Sensuality: Touch, Sight, Sound.

Company: Wacom
Product: Tablet & pen-based tools
Website: http://www.wacom.com/productinfo/intuos.cfm
Keywords: Tablet technology, pen-based technology, interface.
Sensuality: Touch, Sight.

Company: Charmed Technology
Website: http://www.charmed.com
Product: Wearable technology, wireless.
Keywords: Wearable computing, fashion.
Sensuality: Touch, Sight.

Smell

Project: Chemical Portraiture
Project Lead: Scientist Dr. George Dodd and artist Clara Ursitti
Website: http://webserver1.wellcome.ac.uk/en/old/sciart98/10chemical_port.html
Keywords: Chemical portraits, scent analysis.
Sensuality: Smell

Company: DigiScents
Product: iSmell™
Website: http://www.digiscents.com/
Keywords: Scent technology, Gaming, Entertainment.
Sensuality: Smell.

Company: Aerome, AG.
Website: http://www.aerome.de/
Technology: Scent Technology
Keywords: Scent media, communications.
Sensuality: Smell, Sight

Multi-Modal

Project: Morrocan Memory
Project Lead: Vibeke Sorenson
Website: http://www.olats.org/bureaud/test/newSite/africa/galerie/gal-sorensen.shtml
Keywords: Ubiquitous computing, multi-modal communications.
Sensuality: Sight, Sound, Smell, Touch.

Project: MORI
Project Lead: Ken Goldberg, Randall Packer
Website: http://memento.ieor.berkeley.edu/seismo.html
Keywords: Internetworking, Vibration.
Sensuality: Touch, Sight, Sound, Hybrid Physical-digital.

Project: Brainball
Project Lead: Interactive Institute
Website: http://smart.interactiveinstitute.se/smart/PDFfiler/brainball_eng_press.pdf
Keywords: Bio-sensors, gaming, brain-waves
Sensuality: Sight, Sound, Hybrid Physical-digital

Project: ambient Room
Project Lead: Hiroshi Ishii, Craig Wisneski, Scott Brave, Andrew Dahley, Matt Gorbet, Brygg Ullmer, and Paul Yarin
Website: http://citeseer.nj.nec.com/ishii98ambientroom.html

Keywords:	Awareness, attention, periphery, ambient media, graspable media, physical interface
Sensuality:	Sight, Sound, Touch, Hybrid Physical-digital.

Project:	bump
Project Lead:	association.creation (A)
Website	http://www.bump.at/home.html
Keywords:	Virtual Environments, pneumatics
Sensuality:	Touch, Sight, Sound, Hybrid physical-digital.

Project:	polar
Website:	http://www.canon.co.jp/cast/artlab/artlab10/polarMain.html
Project Lead:	Carsten Nicolai, Mark Peljhan(D/SLO) and artlab.
Keywords:	Networks, database, search.
Sensuality:	Touch, Sight, Sound.

Project:	notime
Project Lead:	Victoria Vesna, Gerald A. de Jong, David Beaudry
Website:	http://notime.arts.ucla.edu/
Keywords:	Social networks, data-bodies, 3D sound, avatars.
Sensuality:	Sight, Sound, Touch, Hybrid Physical-digital.

* Add keywords, hybrid physical digital, gesture, nuance, Extended Senses

Introduction

Sophisticated and rich communication networks that immerse a user in environments that more closely resemble physical experiences have long been the dream of technologists and science fiction writers. In Web terms these aspirations are now being expressed in the catch phrase "rich media." Typically this refers to recent technological advancements in digital video creation, streaming, compression, caching, bandwidth and other content delivery technologies, which bring video, audio and Internet together. 1. According to FAC/Equities analyst John Bowen the rich media market defined in this way will reach $34 billion by 2004 and grow at a compounded annual rate of 53 percent. 2. This kind of explosive growth is expected to arise from revenue generating and cost-saving applications in training, search, visualization, customer interaction, and database management areas while providing new opportunities in creative content and in the enterprise.

We believe these developments can be better understood when conceptualized as part of a more encompassing trajectory of technology development towards what we refer to as "Sensual Media."

Sensual Media is a means of interacting with information through the use of and interconnection between many senses, the extension of the human body across time and space, and the new communication structures and processes that arise from the use of digital technology. Sensual Media provide an important contextual framework for understanding the complex landscape of pervasive computing environments, both technologically and socially. In many cases, very subtle manipulations of digital technology or the metaphor underlying their application can have a dramatic resonance with the human condition. In other cases, hardware, software and material science integrated into physical space stretches the category of rich media to include more extensible forms of interactivity and beyond, increasing the effectiveness of online advertising and direct marketing initiatives. We also find that it provides a more accurate lens for seeing and predicting growth in the acceptability of digital technology in the marketplace.

The purpose of this intelligence paper is to report on new developments in the application of technology in the context of "sensual media." Particular attention is devoted to the use of creative techniques, technologies, and experimental research coming out of leading universities and independent studio-labs, as well as the work of artist/researchers who are rapidly expanding our definition of multi-modal communication. Since communication and knowledge transfer are at the core of new business applications in this arena, we focus on what can be learned from the experience of those working across diverse disciplines to inform our forecast of what will be accepted in the marketplace and the social space.

This paper will be valuable for anyone engaged, or impacted by the rapid development of new media technology; especially corporate executives, R& D managers, media

professionals, artists incorporating new technology into their work, researchers, and academics interested in the trajectory of rich media.

Industries impacted by this information include, mobile, wireless, semiconductor, computer graphics, telecommunications, virtual reality, video, audio, material science, sensor, software and hardware manufacturers.

A. Why Sensual Media is Desirable?

Experience in the world is a combination of multi-sensory impressions. Feelings, thoughts and ideas that form in our minds are the result of interconnections and associations of those impressions. What we are trying to do when we communicate is to describe and transmit them through the media we have available, most of which are MONO-sensory and inadequate.

Sense information is transformed into impressions that are associated. These impressions and their associations are stored in memory, and through a dynamic process of mapping, layering, filtering, and re-association, the mind/brain turns this new sense information from the world into symbols and language for communication. Further, the meaning we give to sense impressions experienced over time, is narrative.

Abstract thought and feeling is non-objective, representing a reality that, once perceived, exists in the mind, beyond the surface qualities of familiar objects. Feelings are real, however they do not resemble photo-realistic images of cars, trees, or airplanes. The human brain negotiates and transforms new information coming in to it from all of the senses in patterns that associate, link and connect them, a *binding* process between them that is always active. It layers and updates the relationships between new and stored sense information, so that the information and the relationships between them are constantly being changed. As a result, the subjective meaning and narrative arising from them is also in continuous flux as the sense-memory context changes.

The mind/brain imprints these complex associations using information gathered from all of our senses. To externalize this process so as to communicate accurately to others requires similarly complex or symmetrical media; that is media that relates to the same senses that generated the impressions that gave rise to the original input.

Sensual Media is “Multimodal.” Multimodal means the use of and interconnection between many senses. New connections that new technology provides, is leading to new communication structures and processes, and new ways of thinking about the human brain and consciousness.

This paper suggests that in order to understand and leverage the trajectory of new technological development in general, and pervasive computing environments in particular, they should be thought of in terms of their relationship to the human senses, the body and its extension across time and space. In other words, the more sensual or

multimodal an experience is, the more likely it is that it will be valued by individuals, communities, and organizations.

Why? Because technology and electronic media tend to disconnect us from our bodies, creating a tension that seeks relief. More often now we find ourselves isolated in cubicles typing onto screens, which transmit information to other individuals isolated in cubicles typing onto screens. Instead of having a conversation in physical space, we disconnect our physicality. As electronic devices have become more ubiquitous, they have tended to emphasize the visual and have disengaged us from our senses of hearing, touch, smell and taste. This imbalance has changed the way we apprehend our physical environments, other people, and our means of communication.

On the other hand, when we use technology ways that reconnect us to our bodies and our natural senses, not only is this tension relieved but our senses are more richly extended. For example, one may argue that the written word has become a focal point in applications like e-mail or chat. Enter speech recognition. Here we are returned to our sense of hearing, which in and of itself is important. But when this same speech is transmitted digitally across the Web, an audience far beyond that in the immediate physical environment is impacted. The same text-based message now carries the nuances of voice, including subtext, personality and so much more depending on the richness of the media being utilized. In addition, this same speech is now a digital pattern, which may be interpreted as wave files that move objects in physical space with the aid of robotics. It may trigger an on or off switch controlling heavy machinery. It may even be used to paint a picture, move an animated character, or create music.

Since the application of rich and sensual media requires an intimate understanding of the human body, the social relations between humans and their relationship to physical time/space are fore-grounded, and the expertise of "social experts" is demanded. This includes the experience and knowledge of humanists and social scientists, anthroplogists, psychologists, and particularly artists who are fluent in the use of science and technology. Diana Domingues of University of Caxias Do Sul, Brazil notes: "I think that what we are experiencing now is an anthropological evolution and not a technological evolution because we have new forms of life, new behaviors that we didn't have before." But fundamentally, it is not just about content, but rather something much deeper. Examples of leading edge work discussed here will draw heavily on diverse bodies of knowledge and experience.

B. aRt&D: A Window into Sensual Media

"The artist studies the distortion of sensory life produced by new environmental programming and tends to create artistic situations that correct the sensory bias and derangement brought about by the new form."

Marshal McLuhan

The computer industry is made up of a mix of scientists and artists, and has what is widely regarded as the most PhDs per capita of any industry. This industry understands the short

distance between research and economic development, and see artists as researchers much like scientists: as people who innovate new applications and, as a by-product of their work, open up new markets. Art is a window to the future, and artists working with technology prototype new civilian uses of it, pioneering new modes of communication. Their activity with computers over the past 30 years has catalyzed technology development broadly in media communication, most recently in networked multimedia and the world-wide-web.

Researchers, artists, and software and hardware developers are exploring new ideas and possibilities unique to the new media environment, and new modes of production and distribution, including interactive visual-music performance, new forms of narrative, such as the *database narrative*, and other forms resulting from increased interconnectivity between diverse and seemingly unrelated fields, including art, architecture, cinema, music, literature, the social and natural sciences, engineering, and others.

Projects in the 1970's such as University of Illinois Chicago's Electronic Visualization Laboratory (EVL) provided early models for initiatives that merged art and computer science departments and research. The EVL emerged at a moment when visualization technologies were on the upswing and provided a basis for common goals. Artists worked to apply their knowledge, communication design and project management skills. Scientists provided the content and design challenge, and the means to raise money for the development of high-end technologies. As a result, the "interdiscipline" of scientific visualization was born. Interestingly, this is where Marc Andreeson first built Mosaic, the precursor of Netscape, and where the first e-mail programs (including Eudora) were begun.

Anne Nigten, of V2 Lab in the Netherlands, has coined the term aRt&D (read "art and D") to highlight the contrast from traditional R&D. aRt&D uses different processes, methodologies and objectives than pure science or technological research in that the content that drives the technological research is provided by art rather than science. Many art-based projects have a performative or production component which demands quite a different working methodology. It is one that extends the research directly into the humanistic fields, including civilian communications and entertainment application areas.

As EVL computer artist and scientist Dan Sandin has stated, "Artist organized projects help visualize data and create media mechanisms; not just the content, but the mechanism for delivering the data…. I view interactive art as a kind of speculative research in the human computer interface."

Art research pioneer Michael Naimark, formerly of Interval Research, lays out a most articulate value proposition for aRt&D, giving six fundamental reasons why artist-led projects can inform research:

1. They provide stimulation and provocation for the research community, adding meaning, entertainment, and emotional resonance to their work.
2. They projects often act as magnets to bring together unconventional combinations of skills and talents.

3. They can also provide content to test tools and sometimes even tools to test content.
4. Some of these projects are means for collecting data, both through explicit query as well as through observation.
5. These projects may lead researchers down unforeseen paths and result in new discoveries and intellectual property
6. External deadlines and public scrutiny serve as a forcing function for decision-making rigor and completion. They keep us screen-smart. Putting on a show is a test of new ideas in a simulation of the real world.

Today, traditional corporate labs are augmented by a rich network of universities with strong interdisciplinary programs that link art, architecture and design departments with computer science and engineering programs. In between the corporate and academic environment are thousands of independent research labs and studio-labs that merge art and science methodologies. The latter fill a gap left by corporate research labs driven by quick turn-around pressures by engaging in "basic research" for human-computer interface and emerging technology design.

C. Fundamental Forces Driving Us Toward Sensual Media

Trends that pave the way for a pervasive computing environment in which sensual media will proliferate including the following:

1. Exploding Bandwidth

According to figures from the Industry Standard, only 10% of American households have high-speed Internet access. Yet 24 million people, almost 60% of U.S. workers, who access the Internet while at work, offer Net access. U.S. satellite subscribers are projected to grow from less than 200,000 today to more than 4 million by 2005, according to the Strategis Group. Jupiter Research predicts that by 2005 broadband at home will grow to 59 million, outpacing the work audience for the first time. Fiber optic networks will take bandwidth potential to new heights. The Wall Street Journal reports that the amount of information that can be transmitted over a strand of glass is doubling every 9-12 months while Lucent said it had recently developed experimental equipment to break light into 1022 colors. Currently each band of light can carry 10 million bits of information.

2. Wireless

The Web is already wireless-enabled with Wireless Access Protocol (WAP), the wireless version of HTML. Wireless data services should grow from a base of 170 million subscribers in 2000 to more than 1.3 billion by 2004 according to Cahners In-Stat Group.

Blue Tooth Technologies and 802.11B, a standard for wireless Ethernet promises to connect virtually any communications device, from laptops to mobile phone players to MP3 players, in seamless, adaptable, mini-networks. They will provide inexpensive broadband communications inside office buildings, in homes, and in developing countries

Walk into a bookstore, use your PDA to find what you are looking for, take the book off the shelf and walk out the door as the virtual credit card transaction occurs automatically.

Until a more robust graphical user interface emerges, text-based wireless services resemble the Internet environment before the Web. But you will not have to wait long: MPEG-4, the new photo/video compression algorithm compresses still pictures and video so small that soon it will be possible to stream MPEG-4 video and still images onto small handheld wireless devices such as cell phones and Internet-enabled PDAs. Software company Adobe Systems now sees “network publishing” as a $64 billion market making images, text, and video available on the exploding number of wireless devices worldwide.

By providing low-cost `voice mail' messaging and Internet connectivity in developing countries, it will be possible to reach more than 2 billion people who currently are not served by telephone or Internet today.

3. Sensors

The explosion in the number of sensor technologies being developed is a testament to this new era of sensual media. There were 163 categories of sensors covered in the “Sensor, Measurement & Instrumentation Conference,” recently held in England. Application domains are extraordinarily wide. GPS systems are now used in the trucking, railroad and airline industries. Transportation management systems are being used in airports not only to manage airplanes but also automobiles. In Los Angeles, sensors are being placed in the streets surrounding the airport to detect and model complex traffic flow patterns. Motion capture systems are recording the complex movement of dancers like Bill T. Jones and Merce Cunningham. These systems are also being used to measure limb movement for medical applications, including sports medicine.

Adaptive algorithms, software models that adapt to change using neural nets, artificial intelligence, and geometric correlation, are enabling machine vision systems that perform quickly, accurately, and robustly without massive programming.

4. Material Science Advances:

A substantial shift is also occurring in the way material science is advancing. Nomenclature like “smart materials” and “rapid prototyping” provide clues about the direction the field is taking. Smartness describes self-adaptability, self-sensing, memory, and multiple functionality of the materials or structures. Professor Gregory B. Olson from Northwestern University suggests that the field of materials science and engineering is beginning to shift into a more systems-based approach to materials innovation and toward materials design in which researchers can predict new materials they would like to have rather than having to discover them. This is accomplished by integrating predictive modeling throughout the full design and development process.

According to Professor Olson, “In this millennium, a new architecture of synthetic thought will continue its symbiosis with modern computational capabilities. And an age of empirical exploration will continue to be superceded by an Age of Design. This will open up powerful pathways by which human creativity, fused with scientific knowledge, will bring new levels of control over the material world widely applicable both to society's problems and its ambitions.”

5. Hybrid Physical-Digital interfaces

Digital media are becoming more integrated into our physical world and are a growing part of our everyday environment. They are even inside our bodies, connecting us in new ways to the physical world. A great body of research and development is now concerned with digital systems that are aware of physical objects in space. Manipulate the physical object and you manipulate its digital counterpart and vice versa. In a growing number of conferences around the world, the emphasis is on simple, meaningful interfaces to drive powerful technologies, especially by large corporate R&D labs.

Sensual media employ hybrid physical-digital interfaces in ubiquitous computing (chips in objects) environments to engage and extend our senses, putting the technology in the background, in service of the desired relationship to the physical object, or experience. They use implicit knowledge of interacting with the world to achieve this.

An important aspect is that in these approaches, human-computer interaction is not achieved through a conventional keyboard-display installation. Instead, the computing environment is more closely integrated with the architectural space, and is surrounding the users. Sounds, images, but also temperature and tangible artifacts [Ishii and Ullmer 1997] are used to create an interface between the physical and digital environments. Here are some examples:

C. Media in Six Senses

The following section looks at new research and development in the context of each of the major senses.

It also discusses the interconnection between the senses and the phenomenon of synaesthesia. : a concomitant sensation; especially : a subjective sensation or image of a sense (as of color) other than the one (as of sound) being stimulated French philosopher Bergson, observed the similarity between products of technology and biological organs (they are both optimal solutions of the same technical problem)

we will send billions of these nanobots to take up positions by every nerve fiber coming from all of our senses. If you want to be in real reality, they sit there and do nothing; if you want to be in virtual reality, they suppress the signals coming from our real senses and replace them with the signals that you would have been receiving if you were in the

virtual environment. And the virtual environment is created courtesy of the graphics profession, which will probably encompass more than half of the computer field by that time, because we're going to be recreating these virtual environments.

In this scenario, we have virtual reality from within and it can recreate all of our senses. And, these will be shared environments, so you can go there with one person or many people, and going to a website will mean entering a virtual reality environment encompassing all of our sense, and not just the five senses but also emotional correlates, reactions we have, emotional reactions, sexual pleasure, humor—there are actually neurological correlates of all of these activities--

1. Sight

Visual media go back to our earliest human remains. Cave paintings intrigue us today, not only because of their great age, but because of their great beauty. This beauty touches us even though we are disconnected from the original creator by thousands of years and miles.

All technical research and development looks at the techniques and concepts of the most advanced expressions of visual language that came before in previous media, and builds on it. Today, we have worldwide access to the contemporary and historical visual languages of many cultures around the world. Moreover, there is an increasing awareness of and participation by people from more and more non-western cultures, and their point of view brings new information, ideas, and insights into the dialog and development of our media.

The trajectory here is wide beginning with rich media browsers like Sony's Visual Flow to 3D and 4D realtime information visualization software that turns 30 years of stock market history into an undulating road, navigable at will from 360 degree vantage points.

One of the biggest design trends is the ubiquity of camera-based motion sensors and trackers, the most popular being boujou (boo-zhoo), (http://www.2d3.com/), a fully-automated camera calibration and tracking system targeted at film and television effects, games development, architectural and industrial design applications. Many in the virtual reality industry are impressed with the goggle-free volumetric displays being shown by companies like Actuality Systems, where you can see three-dimensional characters in space without the aid of special glasses. (http://www.actuality-systems.com/) Viewpoint's and Eyematic's rich media 3D applications also received rave reviews. Viewpoint's technology allows consumers to zoom in or turn products around in 3D, while Eyematic has made a big leap in human facial recognition for authoring, publishing, streaming and wireless.

Retinal displays that project images direcly on to your eye from a simple pair of eye glasses will usher in versatile enhanced reality systems. As you walk down the street, wireless networks will feed data to human interfaces (PDA's wearables, etc.) that allow

you to see for example, the buildings you pass as they existed 100 years ago, practical information like addresses that are enlarged, and maps of the building's interior that can help guide you to your destination.

Artists experimenting in this arena like Andrea Polli, Blast Theory and Rafael Lozano Hemmer are extending social application of technologies like motion tracking and ocusonics in what we view as basic research in human computer interface design and adoption. Polli is conducting music with the movement of her eyes. Blast Theory and Hemmer are extending the physical plane of engagement using projection screens made of fine mists of water and shadows that are cast in large, open public spaces.

The natural progression then, in the age of sensual media, is wetware. Sensors and chips inside the body provide a means to repair and bypass damaged sense organs. The technology serves as a kind of prosthesis for disabled people. For example, individuals with damaged retinas have had chips implanted in their optic nerves that receive signals from video cameras. The video signals replace the retinal signals, and while not as good as a healthy retina, it is better than the damaged one, and the person can see basic shapes.

2. Sound

The addition of sound to overall experience is immediately striking. We know from experiments in film, for example, that sound substantially enhances the viewer experience. Yet there is much to be learned in terms of the social life of sound data or information.

"Voice chips" may be viewed as one clue to the next stage of pervasive, embedded, use of sound. Defined by the North American Patent literature as "speech synthesis chips… that can be configured by the manufacturer to produce sound patterns simulating certain words, music or other effects." Artist/engineer Natalie Jeremejenko, recognizing the deep seated nature of sound in social relations, takes the unusual tactic of archiving a long term collection of "product voices" for the examination of changing socio-technical relations. Her methodology is literally to listen to what hardware has to say noting that "the short product life cycle of the consumer electronic devices they inhabit position these products as the E.coli of socio technical relations and can demonstrate the formation of product identities, products voices, in the shifting understandings of machine interaction. We believe these kinds of non-traditional anthropological approaches are important in understanding the social life of technologies.

Other interesting research at Stanford University is investigating the usefulness of audio for internetworking and, reciprocally, ways in which the Internet can abet audio. It is "precisely this dialectic that illustrates the increasingly common intersection of art and technical advancements, an interdisciplinary breeding ground where computer-based technology functions both as a stunning artistic medium and as a research tool."

The Market is beginning to take notice of speech-enabled information systems [http://www.instat.com/abstracts/ct/2001/va0101sr_abs.htm], but the domains of

application, for good information processing reasons, have been restricted to special contexts like telephone call centers with extremely restricted vocabulary, or a single user at a desk who has the incentive to spend a lot of time training his or her personal speech recognizer's user model.

Recognizing this social flaw Sha Xin Wei, a mathemetician in the Linguistics Department of Georgia Tech, has begun to explore new avenues of design when we set aside the constraint of speech as a medium of information processing, and think of speech as an architectural medium for coordinating play in public space.

In the project HubBub he explores “speech-painting” as an alternative development path for speech recognition systems, investigating ways to hang speech in the air like graffiti, that eventually dissapate and disappear.

By taking the limitations of existing technology and investigating alternative approaches to its use, new forms of communication can be invented from the substrate of a sense-based media.

3. Touch

Unlike film, or photography, television is primarily an extension of touch rather than of sight, and it is the tactile sense that demands the greatest interplay of all the senses.”
Marshal McLuhan, Playboy 1971

Tactile media dramatically changes the way we experience pervasive computing environments. It will likely be the one sense that, when digitally extended, really makes us feel as if we have moved into a new era. Touch sensitive screens in kiosks and laptops, wireless pens, digital tape measures, digital jewlery, smart shirts- these are some of the projects and applications already hitting the marketplace. In research and studio-labs around the world new development paradigms are being explored that greatly expand on these intitial efforts.

One area receiving a great deal of attention in research and studio-labs around the world is the desktop. Buxton looked in the rearview mirror for examples, noting that no new technology has matched the utility of the age-old blackboard. At the 2001 SIGGRAPH conference, however, there was no shortage of experiments attempting to do so. In fact, the Emerging Technologies Exhibit was filled with prototype research related to enhanced
blackboard and tabletop systems -- as well as a number of other offerings.

Xerox PARC has created the “Tilty-table”, a three-foot-by-three-foot white square resting on a metal podium. The table is attached in such a way as to allow it to be tilted in all directions; when users tilt the table, images spill off, revealing other images.

Hiroshi Ishi from MIT's Media Lab has developed URP, an urban planning workbench in which simple architectural models cast accurate shadows, and inter-structure distances are automatically calculated and displayed around the models.

A system called "Riding the Net," created by veteran ATR researchers Christa Sommerer and Laurent Mignonneau, is a speech-based image browser with an interactive window that displays a collection of constantly updated images derived from the Internet. As users speak into voice input devices, keywords generate downloads of corresponding images. Users can then interact with the images on the window's surface by touching them and holding them.

Tactile Media-skin/topography
If you look at computer games you will see the addition of some tactile media for input (joysticks being the primary form), and while these are still limited at this time, they show the trend in this direction.

Touch, movement displays, Bear thing from siggraph

4. Smell

(Brief summary of research, companies, applications etc. in this category)
"We've lost touch, as a species, with our sense of smell," Digiscents founder Joel Lloyd Bellenson made this observation in the interview: "our noses are not on the ground anymore, because we don't have to hunt for food. Scent became an art perpetuated by the big fragrance houses in Europe, and the average person was not empowered. You cannot create a new smell, communicate about it, talk about it. But now we can change that! Our mission is to make scent accessible to everyone! We're giving back to humanity our ability to communicate using scent!"

5. Taste

If we could have scratch and taste, well then lipstick! Wine! You name it, people will go for it. It doesn't exist yet though. Taste is a challenge, but it will come.

D. Technological Extensions of Human Senses

"Pre-historic, or tribal man existed in a harmonious balance of the senses, perceiving the world equally through hearing, smell, touch, sight and taste. But technological innovations are extensions of human abilities and senses that alter this sensory balance- an alteration that, in turn, inexorably reshapes the society that created the technology."
Marshall McLuhan

In order to contextualize the full implication of technologically extended senses, it is informative to consider the field of astronomy. Astronomy is currently in its golden age. Many discoveries have been made, especially due to the introduction of new types of telescopes. The use of new technologies, such as computers, robots, and spacecrafts has caused a huge impact and revealed a new universe to us, the existence of which we would not be able even to imagine if not for them. We will be able to study everything with these instruments, even that which we cannot behold, since we only see part of the light spectrum with the naked eye. These advances bring us new sensations and insights. Rockets can go where most of us cannot, and bring us images we could not see otherwise. The probability of incidental discoveries is very large.

As space scientist Roger Malina notes: “We need technology to improve and extend our senses. Our five senses, in their natural state, are limited in their ability to perceive things that are very small or very large, existing beyond the surface of the visual world apparent to the unaided eye. They are not sufficient for us to understand everything around us.”

Fluid or Dynamic Synaesthesia

Now we can connect all of our senses using digitizing devices and transfer that data through computer media to other people, and transform that data so that elements of one sensory modality become those of another. This data can then be presented to various senses of our body beyond vision and sound, including smell, touch, and taste, and to groups of people spread out around the world. This is a kind of fluid or dynamic synaesthesia.

This is not "post symbolic communication," as media theorist, Jarron Lanier [20] has discussed, where symbols are not needed as one interacts with data going directly to the senses such as in a VR world. Nor is this meant to suggest that we feed raw sense information into each modality. Rather, this means that organic, playful, and collaborative interaction with sense information can allow us to create new symbols to express and communicate in a more complete way. Symbolic thinking is inherent to the way the human brain works. Therefore, when we obtain the means to express ourselves and communicate with others in a rich media world, we will naturally do so with symbols. The new symbols are multimodal. New media are developing in this way because it reflects how we actually think, associatively, multi-sensorily, and symbolically. Symbols are strategies for associating and storing complex sense information in meaningful ways. They will develop naturally, and in time, the connection patterns between media will become apparent. Research into what multimodal symbols, or connection/association patterns, will accelerate the development of multimodal technology and its dissemination.

Multimodal symbols are formed not just by reduction of sense experience into simpler representations for encoding efficiency, but by recombining full bandwidth information from all of the senses, using visual and other strategies to link and associate them. We can encode the associative strategy or transformation motif as a symbol. These symbols convey a great deal of information about the senses and how they function together. Further, the communication or 2-way transmission of multiple multimodal symbols provides us with dialogic narrative about human experience in a more complete way than

any other existing medium. This is one of the challenges, and inevitable approaches, for rich media research and development. It will continue along the trajectory of emulating and extending our bodies, and connecting us with others in powerfully deep and empathetic ways. Rich media reaches into our brains far beyond other media, accessing our deepest instincts and processes. It is therefore more affective, memorable and appealing, and ultimately irresistible. Two powerful initiatives make this case explicit:

Example 1: The Digital Human
The Digital Human is an Open Source Software Consortium using 21st century information technology tools to represent the body's processes from DNA molecules and proteins, to cells, tissues, organs, and gross anatomy. The Digital human can be a powerful research tool, allowing scientists to tie together the explosion of information available about biological systems. Now that the human genome has been sequenced, the rate of discovery is likely to increase. These simulations provide a powerful tool for understanding the connection between thousands of simultaneous processes that occur when a cell is attacked by a virus or bacteria, and the way drugs might help counter the attack. They could help understand how performance of the heart is affected by defects in its blood supply and anticipate the benefits of different interventions. By providing clear, visual representations of the body's processes, and allowing open opportunities for explorations, these simulations can also provide a key learning tool useful for students at many different levels, including training for professionals already in the field. Thus, simulation can be used to train physicians and healthcare personnel as it has been used in flight training. It would allow, for instance, surgeons and surgical teams to develop and practice procedures using data from individual patients prior to an actual operation on the patient. It can also help designers of automobiles, aircraft – even spacecraft – design safer vehicles using simulated human surrogates. Chips in the body and brain.
http://www.fas.org/dh/

Example 2. ECAI
The Electronic Cultural Atlas Initiative (ECAI,) is creating an infrastructure for data discovery by time and location. The paradigm of the historical atlas, showing spatial and temporal relationships among cultural data, and the digital library model of networked distributed resources, together define within ECAI a new approach to collaborative scholarly research. Using time-enabled Geographic Information Systems (GIS), ECAI-affiliated research projects are creating interoperable data layers that can be retrieved from globally distributed servers for display on a map-based interface. Data layers can be further linked to text, images, audio, video, or other resources. http://www.ecai.org

E. New Social Structures & Processes

"Pre-historic, or tribal man existed in a harmonious balance of the senses, perceiving the world equally through hearing, smell, touch, sight and taste. But technological innovations are extensions of human abilities and senses that alter this sensory balance- an alteration that, in turn, inexorably reshapes the society that created the technology."
Marshall McLuhan

1. Memory- Conscious vs. Unconscious (or Database) Communication.

Artificial intelligence has sought for many years to bring the intelligence of the human brain to computers. But it is clear that our synthetic brains are not nearly as complex as our wetware, and will not be so for many years. This is one reason why interfacing to the brain and the body directly, and engaging its innate intelligence makes so much more sense as a major direction for technology development. In the 1980's, human computer interface researcher and pioneer, Dr. Fred Brooks, of the University of North Carolina, Chapel Hill, spoke of the computer as a "brain amplifier".[footnote Virtual Reality, Howard Rheingold, 19XX, pp.] He was on the right track. Today, we know that the organs of the body have local genetic intelligence and memory. Our sense organs do also. We can consider our technological extensions as 'body amplifiers,' or 'sense amplifiers.' We connect with data coming from near and afar, through some kind of interface and network. Signals enter our bodies and go to our brains and minds from a new virtual and physical environment. They interface to neurological and mental structures that pre-exist. We use patterns and strategies inherent in them, in analyzing the data, both consciously and unconsciously. The same structures that exist in the memory of our bodies, brains, and minds, appear in simpler forms in our digital and computer structures. They are models transferred to our artificial brains.

What commonalities exist between our real and synthetic brains that are useful in to communication between humans and machines, humans to humans, and humans to the environment, with the invention of the machines?

There are some basic concepts and structures offered to us from neuroscience and psychology that are useful. From neuroscience, we learn that interaction with the physical world is essential for increased connectivity in the brain, an important measure of intelligence. We know from numerous clinical experiments with animals, and observation of children, that a stimulus rich environment leads to greater physical involvement and interaction with it, and to greater intelligence. It is physical interaction with the world, using all of the senses, that fosters these connections that lead to increased intelligence. This is an important consideration, a model, for the development of intelligent new forms of interactive computing.

We now commonly have neural nets in computer systems that 'learn' from increased interaction by users and adapt to them. We have hardware interfaces to the physical world that allow users to engage it directly, and transmit signals in real-time to the computer. The patterns of connections that arise, of associations between them, are fundamental elements of the resulting intelligence. While interpretation must still take place in the mind of the person using it, these pieces of the puzzle are available to us today to analyze. The hybrid physical-virtual world is certainly a stimulus rich environment, and we just need to 'map' it to understand it, and to know how to use it in a responsible and meaningful way.

The terms *pre-conscious, conscious, unconscious, collective unconscious, ego, id, superego, archetype,* and others were derived from psychoanalysis, most notably the psychoanalytic theories of Sigmund Freud and Carl G. Jung developed over the past 100 years. They shed light on how the brain and mind engage the senses, and 'make sense' out of them, sorting and narrating to us what it means and how to function. When building a computer, interacting with media, or engaging the natural world, mental strategies that pre-exist are employed, and are used over and over again. Therefore, it is useful to look at them, to see the similarities between them, and understand their potentials and limitations.

For example, the *Conscious* mind, according to Freud, is active when we talk and think, and deals with awareness of present perceptions, feelings, thoughts, reflections and memories, and fantasies at any given moment. It is an active, dynamic process in the brain. The parallel in a computer system is RAM, or the program running in Random Access Memory, operating on data stored on the disk or coming in from real-time sensors or other processes. The *Pre-conscious* relates to data stored in the brain that can easily be brought to the conscious mind. The parallel in our digital systems is the data stored on CDROMs or local hard drives, with clear and easy access by the user. The *Unconscious* relates to data stored in the brain that is not easily available to the conscious. In computer systems, this would be similar to the data stored on local or networked hard drives, of which we are mostly unaware. The *Ego* is the part of the mind that has will, actively engages the conscious mind and memory, and instructs our bodies. In our computers, this would be akin to a program running to perform a task. The *Id* is the part of our minds that has desires and wishes, often physical and sexual, and demands immediate satisfaction. This would be similar to a program processing real-time data coming into the computer from external devices, drivers. The *Superego* is the censor, the part of the mind that prevents us from behaving in anti-social ways. This would be similar to a program that filters data from the sensors, or prevents children from gaining access to specific adult content websites. *Dreamwork,* according to Freud, is a subterfuge process where the mind creates disguises for the wishes and desires of the Id, thus making the desires acceptable to the *Superego.*

To Jung, the conscious mind is made up of 2 parts, the *Personal* and the *Collective.* The *Personal Unconscious* is comprised of suppressed and forgotten memories, either because they are too weak to reach consciousness or because they are actively suppressed. The *Collective Unconscious* is universal and predates the individual. It is inherited, and reflects the structure of our brains and the tendency for people in diverse and otherwise isolated cultures to have similar dreams and develop similar symbols. It is the memory of all of the religious, spiritual, and mythological symbols and experiences of the world. Jung termed its primary structures that exist deep in the psyche *Archetypes.* To Jung, dreams and dream symbols are not disguises for unacceptable thoughts and urges, but rather they are the basis of all symbols and religions, prophetic, help solve problems, and aid in restoring a healthy relationship between man and the world. He also coined the term *Synchronicity,* a principle explaining "meaningful coincidences."

Web browsers can be considered interfaces to the Collective Unconscious, accessing shared memory available to everyone over the network. In a virtual, conceptual space free of gravity, with input from our senses, we can dream collectively, and become conscious of our unconscious. We can communicate consciously with the contents of the unconscious mind. The parallel in computing is real-time interaction with multimedia/multimodal data while associating and transforming it freely, so as to extend beyond the limitations of our conscious minds, allowing us to make new connections, thoughts, and dreams, between people and cultures, in ways previously not possible.

There are many other concepts and processes affecting the interaction between rich media and psychology and consciousness. They are useful to study as a paradigm for thinking with a computer, the mind, and the body.

2. Social Organization

a. Multiculturism as Rich Media

The digital network, including the world-wide-web, catalyzes connections, thus amplifying and accelerating the crossover of cultural information on the web. There is an international audience accessing the web, and it is increasingly multicultural and diverse. People in Vietnam, Brazil, Mexico, Europe, India, China, Australia, Africa, the Phillipines, Indonesia, almost every country in the world now has telephones and web connections. People who never would have met in the physical world, can now meet on-line. People from cultures previously isolated by physical location are now just a click away from the central park of the web. New social forms of interaction are developing that could lead to new structures and organizations. The richness and complexity of culture is seen its art, and the mixing or fusion of cultures will lead to new cultural forms. These forms will be increasingly multicultural. Cultural identity will be an even greater issue in the near future than it is today, as globalization and the forces of monoculturalism, supported by technologies of exclusion are challenged by the movement toward self-representation and inclusion inherent in digital multimedia. The demands on the resolution and bandwidth will increase dramatically as traditional media forms transfer to digital, and mix in a multicultural context. Rich media are a necessary foundation in order for multiculturalism to become an active and creative agent.

Already there are experiments taking place between Brazil, England, and Finland where artists who have never met before interact in a digital space, and collaborate and create artworks by mixing the local cultural forms. [Lucia Pimental, UFMG, Brazil] Sheldon Brown of UCSD has experimented with a shared virtual reality space connecting the USA and Mexico, in Mi Casa, Su Casa. The motivation for such projects is clear. We want to meet those we do not know, and find out how we are alike and different. We are curious. Curiosity about people is healthy, and helps us develop understanding that ultimately contribute to the solving of common problems of survival.

The west, and western technology, needs the eyes, ears, and minds of the third world to see its impact on it, and to benefit from the wisdom and experience of people who have a wider experience than most of those in the west. This includes learning from people who

have lived in harmony with their environment for hundreds or thousands of years, such as the Indians of the Amazon. It is also important to recognize the suffering of people who live in tyranny or disaster zones, and assist them. Sometimes their problems can be addressed through access to information. For many profound reasons, we need to include those who have been excluded, and ask ourselves why they have been excluded, and change it. Everyone counts, and everyone should be included if they want to be, and have a voice in the discussion that shapes their lives.

It is also the only way to have access to the best possible ideas for creating the best possible ways of connecting the world. Only the third world knows how best to integrate itself into the dialog, and how to bring its special knowledge, insights, ideas, and art into it. When this happens, we see ourselves as others see us, and the world new ways, from other points of view. The unexpected stimulates and stretches the mind, makes us smarter and more tolerant. It expands our consciousness, and this is good for all of us.

b. Cultural Content

"*It is the cultural frame, (how we structure our ideas), that projects the universe of man into the future."* G2M

Civilian technology is used primarily to enhance communication, and what people most often discuss with each other, is their memories and dreams, or culture and art. Multicultural art opens windows of understanding and exchange between people all over the world. Given the convergence of entertainment and e-commerce, cultural content or art, is the currency of the new digital economy.

As computation becomes more ubiquitous and available in small, low power, networked and distributed form factors, computers are entering our shared social space. We carry them with us and use them to verify entry to places, to prepare us for our next meeting, to send each other messages during lunch. A shift is occurring in when and why we access information and in how we use computation.

3) Time/Space: Metamorphosis, Montage, and Transformation

Visual transformation from one shape to another is called metamorphosis, and is central to the language of animation, and rich media. Normally in nature, we see metamorphosis as taking place over a very long period of time, such as in the aging of the human body or the growth of a plant or animal. We use technology to speed it up, as in "time lapse" where one image per minute, hour or day, is recorded instead of continuously at the normal rate of 24 (film) or 30 (video) frames per second. The entire sequence is then played at normal rates, and the result is one of a nearly magical change in perception, and as a consequence our understanding of the world and universe.

Our computers are also non-linear, and they allow for spontaneous and improvisational changes as new information from users and devices, including sensory data, passes

through them. The computer is thus a dynamic instrument with the ability to change relationships, contexts, associations and meanings in real time.

With a real-time process, images, sound and/or text can change at an instant, and if part of a networked process, they can respond immediately to a live event such as an on-line discussion or improvised musical performance. By freeing animation from linear media and fixed relationships, it becomes a part of a new and larger language of communication that provides countless opportunities for solo and collaborative creative expression. We can create on-line events that incorporate physical performances with live people and instruments at various sites, and employ algorithmic transformations of data, projected and interacted with simultaneously by audiences in numerous locations around the world. For example, installations with multiple screens of animation based on seismic, solar or ozone data can be embedded in a sculpture or architectural structure that respond to local and remote audiences/interactors. This author's recent research and creative work, *Morocco Memory II* explored some of this territory**.** [28] Conceptual web events that exist only on the network, but respond to input from thousands of people through the input of text, sound, touch and smell data, and images, can be created.

It is possible to change the voices, faces, or gestures of avatars, or other synthetic identities, in virtual communities and prototype new social structures and evolve hybrid physical-digital, virtual creatures. One can interact with the physical environment, where a wide range of natural and physical objects are input to virtual environments, where the interface between the virtual and physical worlds are, for example, familiar objects, thus literally keeping one foot in the natural world and one in the virtual. We can extend our brains and limbs to others through the network, making a distributed collective body connected directly with a collective brain. In this way, we become part of a collective body-mind continuum, with a kind of collective memory. Given synthetic life made up of many pieces of many people, a new kind of immortality can arise, as data in computer memory will outlive most of us. Connected to brain monitoring equipment, it is possible for psychologists to study the human brain as it contemplates itself in a new form.

4) Architecture & Ambient Intelligence

MP3 players began with virtual interfaces resembling physical stereo systems, and then quickly leapt off the desktop to physical palmtop “Walkman” devices. Anoto now offers pens with scanning devices that record printed surface in digital format. As we write notes on paper, they are transferred to the computer and our own personalized filtering systems. (http://www.anoto.com/). We will soon read books with connections to this same filtering system, complete with digital research archives. New interfaces for channeling data increasingly resemble something we already know from the non-technological environment. They imply an implicit mode of interaction, meaning that explicit step by step instructions, or conceptually or physically difficult devices, are no longer necessary. No more scroll bars and mice. Instead, we are increasingly using our own familiar hands and gestures, but with powerful enhancements and playful new twists. For example, you might open a perfume bottle and music will emanate from its confines.(http://tangible.www.media.mit.edu/groups/tangible/projects/musicBottles/musicBottles.html).

These examples and others suggest the architecture and design of our physical and virtual spaces will have to be re-thought. The merger of physical and digital forces new social paradigms for pervasive computing. One of these new paradigms can be called ambient intelligence.

Natalie Jeremijenko characterizes the utility of physical objects as “persistence, peripheral presence, priority and particularity.” Physical objects - in contrast to digital objects – are persistent; they do not ‘disappear’ when they are not in use. An aspect of such persistence is peripheral accessibility; physical objects continue to be where you left them and are therefore readily accessible for just-in-time reference. In addition, their visibility does not map completely to the attention given them, unlike digital counterparts. They can be thought to have an independence from their users’ attention scheme because they do not appear and disappear according to whether they are in use. They are therefore attention-directing devices. As such, physical devices exploit peripheral information cues - sound and movement - to indicate state change, thereby unobtrusively redirecting attention when needed.

Ambient systems Ambient Intelligence: 010101

Exploratory User Study of Haptic & Auditory DIsplay- Sig CHI!!!!!
Srrata/ICC: Physical Models as Computatinl Interfaces

ambient user interfaces

(more here)

A focus on interfaces

"Interfaces to the digital world are exploding in terms of access points and bandwidth, yet the ease of interaction by human users is hardly advancing. We'd like to make computers more natural and easy to use, by allowing them to use the same visual interface modalities that humans take for granted. Simple things, like presence, posture, and gaze, are extremely important cues in communication between people, and they should be with computers as well. Bandwidth symmetry is also a priority: users should have the same bandwidth into an interface as they experience from the interface: they can be inundated with sound and graphics, so why can't they shout and gesture back? We're exploiting machine perception techniques and the rapidly increasing computational power of common workstations to build vision-based perceptual user interfaces, and integrate them with speech interfaces and user-interface technologies. Making computers interact with people using natural human interface modalities, and not vice versa, is the ultimate goal of our work." Trevor Darrell MIT AI Lab

video conferencing (Placeware)

E. Emerging Technologies Applications and Companies

While the underlying technologies being used to create sensual media cross a wide chasm of fields and industries, what unifies them is the degree to which they enhance or extend our command of sensory communication. The first application areas benefitting from this trend include training, search, customer interaction, and database management. However, other fields are making even greater overall strides toward the sensorium. They include the convergence of TV, the Internet & Virtual Reality (visualization and simulation), the digital home and wearable technologies.

1. Convergence: TV , Internet & Virtual Reality

People have shown an immediate attraction to, and adoption of, media which are increasingly multisensory, or multimodal. They include all of our audio-visual media (eg. the consumer market for audiovisual equipment is huge, including integrated stereo systems with television screens, and the video camcorder). The public has also adopted media that are interactive (eg. the telephone, video games, and the world-wide-web and internet). There are trajectories of these two kinds of media, and they are converging. We are now seeing networked interactive multimedia on a larger scale, and in this arena, the quality and availability will improve quickly as Internet 2 (I2) begins to deliver higher resolution, temporally and spatially, media over it to the general population.

Interactive television, however, has been slow to develop and adapt to the new digital paradigm. Television has the problem of not having a history of being interactive, whereas the Internet has been interactive since its inception. But this will change, and the two will increasingly come together (TV and internet). There will soon be networked digital delivery of TV coming in a high bandwidth form, as in I2, or better. Already, I2 experiments in multimedia production are taking place between labs and studios around the world, sharing live high-bandwidth audio-video files, and 3-D graphics, in a 2 way process. Soon, this will be standard practice.

Industry interest in this convergence is evidenced by new standards like Open ML™. OpenML™ is complementary to the ubiquitous OpenGL® standard, and allows digital content authoring application developers to more easily integrate video, audio and graphics capabilities into their application suites, and makes these applications more portable over multiple operating systems, CPU architectures and add-in hardware devices. These are intended to bring dynamic media capabilities to a wide variety of appliances and embedded devices such as advanced digital TVs, set top boxes and game consoles. Current “Promoting” member level companies supporting the group’s activities are 3Dlabs, ATI, Discreet, Evans & Sutherland, Intel, NVIDIA, SGI and Sun Microsystems.
http://www.3dlabs.com/khronos/EmbeddedAPIs.htm

a. Moving Images: 5 Levels, 5 Industries

Projection and immersive virtual environment expert Michael Naimark, (and Creative Disturbance Advisory Board Member), outlines the state of convergence using moving images as a frame of reference:

I believe there are five distinct levels, each with its own distinct industry. The hottest one right now is the lowest-resolution one, the "streaming video" level, since everyone wants video over the thin pipe of the current Internet. Streaming video often has to pass through a 56 kilabit per second modem, and is rarely more than 1 megabit per second (mb/sec). But streaming video never looks as good as the movies we rent on vhs.

VHS quality, and home video in general, is the next level. VHS resolution is approximately what the MPEG-1 standard is, with a bandwidth or bitstream of 1-3 mb/sec. It's noteworthy that moving from streaming video to home video crosses an industry line from computing and networks (Apple and Akamai) to consumer video (Sony and Blockbuster). These people drink in different bars.

The next level is broadcast-quality video. MPEG-2 was made for this, with a bitstream range from 2 to 12 mb/sec. Everyone agrees that broadcast video looks much better than vhs, and high-end broadcast equipment typically costs ten times more than consumer video equipment. Uncompressed broadcast video often travels around production studios at 45 mb/sec.

Then there's cinema. The silver screen of the local movie theater appears much bigger than the television in the home, and requires that much more bandwidth. We just crossed another industry line from video to filmmaking, from CNN to Panavision. Typically, movies are shot with 35mm motion picture film, but the quest to replace film with high-definition digital video has its roots almost 20 years ago. Today, various digital HDTV bitstreams range from 20 mb/sec for highly compressed HDTV to as high as 1,000 mb/sec, 1gigabit/sec!

But we're not done. "Special venue" cinema, the sort of immersive movies seen in theme parks and world's fairs, are typically 10 times the bandwidth of theatrical 35mm film. This is yet another industry, with formats like Imax (wide 70mm film), Showscan (70mm film at 60 frames per second rather than 24), Stereo-70 (twin 70mm film for 3D), and CircleVision (nine 35mm screens in a panorama), each presenting different offerings of what's "really real."

So the range of current versions of moving images is from roughly 0.1 mb/sec to 10,000 mb/sec. It's both true and ironic that the Reel.com folks and the Imax folks, or the QuickTime VR folks and the CircleVision folks, have very little to talk about.

But when one looks at the continuum, the drive at each end becomes clear. At one end is sensory verisimilitude. Some might say "looking real." But others might say "dead," in that it's never live and at best barely interactive. At the other end is "live," telematic, participatory, and interactive, even if the cost is sacrificing a four-storey high 3D screen for a postage stamp screen. Again, realness means different things to different people.

There's a noteworthy other phenomena, dealing with the politics of access, best summarized by French art theorist and UNESCO Webworld Director Philippe Queau: "Maximum hits per bits." It's extreme interpretation is that there's something unfair about concentrating a large number of bits for a small number of people. Immersive theaters and art installations are out, websites accessible to all are in.

Incredibly, this polarized situation is temporary. Add Moore's Law and fiber in the home, easily capable of over a million mb/sec (!), and the conflict disappears. It's inevitable, with the only questions being when and how? The lever is large because the status is embryonic.

b. Immersive Virtual Reality

It is inevitable that people will engage all of their senses in new media, as examples from other media show. The Exploratorium in San Francisco is a good example of this. So are museums, many of which have "touch" displays - mostly for children, but adults like them too. Educational institutions know about this and provide multi-sensory ways of learning. Learning is a form of communication, and these days, entertainment (edutainment). What we are really trying to do is communicate the entire experience of something that includes all of the sense information involved. One way to do that is to immerse the entire body in a simulation, or a copy of the real thing with a mixture of real and virtual stimulation. That's why theme parks are so attractive and popular, and they are becoming increasingly digital in their media. Virtual Design & Training is the first area of Virtual Reality to yield commercially viable applications.

Linda Jacobson, former VR Evangelist for SGI and current CEO of Glass House Studio outlined the state of the art in Virtual Reality in a recent issue of Creative Disturbance newsletter EMERGEncy:

Today’s lucrative, productive VR work involves high-brightness projectors displaying 1:1 scale, 3D imagery on large, custom screens. Instead of one head strapped into one 3-pound helmet, a group of people gather in a room, where they’re surrounded by wall-sized screens and can take turns “driving” or otherwise controlling a simulation (e.g., simulated tractor, visual financial database, seismic geological model). The screens are wide and high enough to occupy most of your field of view, thereby enabling the sense of immersion.

The jury’s still out on which 3D input controllers will mature and survive. Right now the industry is wielding keyboard and mouse, joysticks, and in the case of CAVEs and power walls, non-robust hand- and head-mounted trackers. Eventually we’ll have the whole-body user interface paradigm: unencumbered full body interaction. The ultimate VR user interface would allow kinesthetic sense and whole body motion to control the simulation, for reasonable cost, without requiring rocket science—and applications would be widely useful and practical. Hollywood-based motion-capture expert Ron Fischer imagines a potential setup comprised of a lightweight, vibrating/scanning bar-type headset, flexible

resistance-sensor body tracker, smart camera-based image processing tracker, and inertial sensors. Such an effort would, Ron says, “require a large cooperative effort among patent holders to achieve a market price under $500-$1,000.” I’d like to see voice recognition, high-resolution tactile and force feedback, an olfactory simulator, and, on the software side, standardized, application-dependent GUIs.

The challenge right now is how to make the most out of the relatively expensive large-screen setups: curved walls, flat screens, CAVEs, domes, and drafting tables with projection surfaces. About 500 systems operate today. Automotive, aerospace, and heavy equipment manufacturers, building constructors, and even big TV set makers use them regularly. So do physicists, geologists, petroleum engineers, chemists, architects, astronauts, air traffic controllers and surgeons. Oh, yes, sure, soldiers love VR, too; but you knew that already. Here’s a new one for you: a major consumer products company now uses immersive computational fluid dynamics (emphasis on fluid) to build a better diaper.

The display hardware is well understood. The games industry is driving graphics hardware development and reducing costs. Many smart people are building the next-generation Internet with enough bandwidth to spew monster real-time 3D graphics datasets.

Finally, advances in applied 3D design and prototyping in the architectural field (as distinct from 3D CAD and CAE), are coming fast. These applications range from image-based modeling and rendering, to 3D scanning, applications of Web3D in architectural design and training and virtual design.

c. Strategies

Given the complexity of the converging landscape, we asked projection and immersive virtual environment expert Michael Naimark, to offer some examples of interim strategies for leveraging technology today:

One strategy is simply to continue doing what we can with the narrow pipe of the Internet. It's relatively cheap, easy, and uncharted (particularly when one ponders the World Wide part of the Web). And the pipe is quickly getting wider via DSL, cable modems, and broadband.

Another strategy involves hybrid investigation. For example there's are lots of stereoscopic and panoramic images on the web, even if they're small. "Interactive films" have existed since 1967 and have managed to present at least the illusion of control. For example, the world's first interactive movie, at Expo '67, involved red/green pushbuttons for everyone and two projectors running in sync, where the operator swapped the lens cap depending on the vote. Its director, Raduz Cincerra, alive and living in Prague, told me "I did it as a joke but everyone believed it."

A related strategy is based on simulation: making web video more cinematic in style and making motion pictures more webcam like, for example. There's evidence of this happening today.

Another hybrid strategy exploits high-octane cheap computers at each end of the narrow pipe. We're beginning to see examples of the Sony Playstation II, whose power is similar to the SGI Reality Engines that drove first-wave VR, being used for live networked gaming and beyond.

A most intriguing strategy turns the access argument into a feature. One can use such democratization ideology to justify piping 100 times home bandwidth into a large space designed for 100 co-present people: public space as public spectacle as public research as community experience. Such media-rich public experiments have a lively history, most notably 100 years ago around the birth of cinema. An enormous opportunity exists for museums, libraries, alternative art spaces, and other public places to collaborate with scientists and researchers.

2. Enhanced Environments

Enhanced environments, (also referred to as augmented and/or mixed reality), are picking up where virtual reality leaves off and are rapidly emerging as a major multidisciplinary research, development, and deployment area. Wireless technologies , small and easily deployable sensor technologies, networked off-the-shelf 2 and 3D cameras, pattern recognition algorithms, smart mobile phones, RFID tags, GPS and location trackers, etc. are being deployed in ways that powerfully enhance experience in physical space.

Projects like Desert Rain, ambient Room, Morrocan Memory and notime are breaking barriers in human-computer interface design by merging senses in virtual environments, social networks, and hybrid physical-digital applications.

3. Emerging Virtual Entertainment

With entertainment/game consoles rivaling the power of flight simulators, and game engines taking over 3D standards, entertainment is playing an increasingly strategic role in the Virtual and 3D worlds.

Projects like Brainball, Boundary Functions, Eyematic and Body Movies stretch the limits of what is possible in the Virtual Entertainment field and are inspiring a whole new group of game developers. Will Wright, lead designer of the hugely successful SimCity and Sims game series, recently told a SF MOMA crowd that game designers need to think outside the box and stop trying to reproduce reality down to the last detail. He said that designers should create alternative worlds, and that in that sense the game industry had much to learn from the art world.

4. The Digital Home

Human beings inhabit physical spaces in the home that are optimized to their bodies. As digital devices become smaller and migrate to objects in the home, people will use the ease and comfort of objects in the environment to communicate with the virtual, computer world. And that in turn, will allow them to communicate with their physical world, and its devices (appliances, lights, doors, windows, entertainment system, etc) in more efficient and imaginative ways. High bandwidth connections between them will offer higher quality video, audio, connections to food, which is multi sensory, and increasingly hybrid digital-analog. Connections between home, body, and movies is fertile ground and inevitable.

While these obvious connections are being exploited, another promising area of research involves much more passive interface design. When using any computer device, your full attention is demanded. This requires extraordinary engagement on the part of the user and in many cases increases isolation. In traditional human interaction, there are many other ways of exchanging information - body language, glance, gesture, etc. The important thing is that they do not have to do any effort to interact with each other: sharing the same physical space is sufficient. This has been called “affective” or “perepheral” awareness.” Olivier Liechti of Information Systems Laboratory in Japan elucidates:

“These interfaces should also enable processes where the user can remain passive, and does not have to give an input to the system (e.g. watching TV as opposed to browsing the Web). Whenever possible, these interfaces should be integrated in the architectural space of the home: in furniture, on walls, etc. Indeed, the home is already populated with a wide range of displays. These include televisions, computer displays, but also screen phones, wall-mounted panels, etc. In the future, information will be displayed on digital wallpaper, mirrors and windows.”

Liechti’s studies led to the development of an affective computing prototype called KAN-G which is best defined as an interpersonal communication framework supporting affective awareness through home photography. It has been named after the Japanese word kanji, meaning impression or feeling. This suggests that the goal of the framework is not to support the exchange of explicit messages, but rather to convey a general sense of being "in touch" among users. This goal is achieved through the exchange of i) photographs and ii) reactions of watchers on these photographs. The capture, distribution and observation of snapshots are performed with a number of digital imaging devices, distributed across the Internet. (See Project Summary in Appendix I).

5. Wearable Interfaces and Technologies

Another qualitative change to the Internet and computing will be the move to wireless wearable devices. With this move the Internet will spread from desktops to all aspects of daily life, opening thousands of new commerce opportunities. Wireless Internet will also reach billions of people who are not yet connected, because of its less expensive

infrastructure requirements. We will see telephony, health care, games, post-it notes, diaries and photography (to name but a few businesses) all based on wireless wearable Internet communications; we expect that the opportunities created by this new generation of mobile Internet devices will dwarf, and to a substantial extent replace, current business-to-consumer e-services.

Advanced Interfaces, include hands-free recognition of speech commands, context-sensitive or `smart' interfaces, and new types of keyed interfaces that can replace standard keyboards. New fabrics embedded with sensors for health monitoring such as those used in SmartShirt by Sensatex offer many possibilities. In each case devices have already been designed, tested, and in some cases are beginning to be deployed in niche applications.

6. Health & Medicine

Application areas here include telemedicine and telesurgery, virtual surgery, virtual patients (and the importance of training delivery using task abstraction vs. physiological fidelity) VR and micro- and nanotechnology for biomedical applications, surgical robotics using VR or other advanced human-system interfaces, virtual hospitals and operating theaters (for training), case studies (transfer of skills, especially), Web-based surgical training.

E. Conclusion

Sense based media are increasingly converging as the digital foundation common among them makes transfer of data from one to another more fluid. Chips are now routinely placed inside and outside our bodies, and throughout our environment. They are connected to each other through high bandwidth technology, both wireless and wired, making hybrid new forms resulting from their interconnectivity and synergy. Communication between the organs of the body and the physical environment has taken a dramatic step forward, contributing not only to medical advances, but improved environmental awareness, social and political understanding, and new forms of education and entertainment.

There is now a fundamental change in how we relate to the world. Technology has become a dynamic prosthesis that extends our body's ability to perceive and engage it. Through networking, it allows multiple people to share this, allowing greater sensitivity to, for example, doctors performing complex medical procedures, or scientists studying a model of a dynamic molecular process, or musicians performing an improvised visual-musical piece from 6 locations around the world. This technology can give some blind people sight, and deaf people hearing, and make sound visible and images sonic. It also allows us to transmit a multisensory experience of an event over thousands of miles, between 2 people or many more. Instead of privileging a single sense, usually vision, and limiting touch to the movement of a few fingers on a keyboard or clicking on a mouse, users now engage their entire bodies in otherwise familiar ways within a ubiquitous computing environment, made up of smart appliances, books, cars, and roads. Even

within a completely natural environment, non-invasive sensing technology allows us to communicate in new ways with its elements and inhabitants.

Our understanding of the world exists in the mind, and now this understanding is increasingly shared between the mind in the brain, and the mind in the computer. We can analyze and understand both in new ways. As a result, a new relationship between the body and the mind, and the body and the computer, is developing. It portends great advances and discoveries that can have short and long term consequences for humanity.

The potentials and limitations of a new relationship between man and nature, activated by technology, are great. The technology can be used humanistically, to make mankind better, more free, ethical, empathetic, and responsible. But it can also be misused, to enslave, destroy, and deceive. It is a conscious choice on the part of people developing and applying the technology. It is important that decisions made about it be guided first and foremost by ethics and empathy. Otherwise, it will not be useful, and ultimately will be discarded as regressive.

One of the primary concerns of the art technology community is ethics, and one of the main reasons why their work is so important to the field. Not only are they visionaries, but they are practically minded developers of technology and its most advanced, humanistic applications. As more and more technology involves the human body and the senses, the degree to which it can penetrate it is dramatically increased, a major concern of this community. The benefits of rich media in this regard are enormous, and so are the risks. So it is not only that artists are the most demanding users, sensually, of whatever media they use, and therefore make it far more responsive and useful to others. But artists understand the limits, where to stop, criticize, and create alternatives. They offer solutions to problems, through functioning real-world applications that directly address the public, its needs, fears, hopes, and desires. Their work can be seen as a compressed, humanistic, research and development process, where the commercialization process is following closely, afterwards. Artists are the conscience of the culture, and their concerns about technology should be heeded. They are essential to understand for the applications to be useful and meaningful, and ultimately have longevity in the civilian sector and marketplace.

It is not the commercial return, however richly rewarding it might be, that is of primary importance of rich media. Rather it is what it offers to humanity in its role of helping to solve common problems of survival, and live in harmony with nature and the world around us, especially the protection of bio- and cultural diversity. We are the creatures that have the fate of the earth in their hands. To survive, we must understand our world and protect it. Rich media will help us to perceive it in new ways that will surprise us. We will see the scale of our destruction, but also that of our creativity and imagination. We should use our knowledge and intelligence, our resources and know-how, our technology and increased abilities to engage each other and the world, intelligently and idealistically, to protect rather than destroy, to empower rather than enslave. We should use it to enhance our ability to live in harmony with each other, and the world around us. People like it, want it, and it is also good business.

F. Recommendations: A Plan of Action

Companies that incorporate art + science and art + technology research into their R&D methodologies will gain an extraordinary advantage in the coming years as we move into the age of sensual media. Economic cycles like the current one remind us that changes must be made in the way technology is utilized. Human adaptation to technological advances requires new approaches, which place the technology in the background and the person in the foreground. This can be done without downsizing the potential of various technologies. Rather this approach can measurably extend the impact of the technology and its application because the overall experience will be so much more powerful. Concrete steps can be taken to incorporate the trajectories described in this paper including the following:

- Attend Conferences and Events where sensual media is presented and discussed. (See Appendix)
- Subscribe to hubs of intelligence in this arena (i.e. Creative Disturbance).
- Invite diversity into your research plan by hiring researchers who bridge the corporate and aRt&D worlds.
- Hire these individuals as consultants on targeted projects at an early stage in your development process.
- Reserve budgetary resources for incorporating a sensory rich approach and initiate projects where sensory rich approaches and perspectives guide your research and development process.
- Investigate the research trajectories at academic and cultural institutions that have interdisciplinary programs (i.e. where computer science, engineering , and other science departments have direct links to art and design,, humanities and social sciences departments). This is the subject of another Creative Disturbance intelligence paper to be released Fall, 2001.

Footnotes

Emerging Trends in Machine Vision; Sensors, August 2001
Steve Geraghty, Coreco Imaging, Inc.

Invencao, Sao Paulo
Astronomy: an old science, a new science; notes on the roles of new technologies in art and science. Roger Malina

Natalie jeremijenko
Tangible Interfaces to Computation

Linda Jacobson, Better Reality Through Virtual Reality, EMERGEncy Volume 2, Issue 3, 2001.

[Wisneski, et al. 1998], and calm technologies
[Weiser and Brown July 1996] are all related to
this idea and have been an inspiration for our
work.

About The Authors

Mark Beam

Mark is CEO and Founder of Creative Disturbance, the only global network dedicated to serving the human-computer interface (HCI) market. Prior to founding Creative Disturbance, Mark Beam directed beaming, llc. (1995), a new media venture consulting firm in San Francisco, advising public and private organizations, from start-ups to major telecommunications companies. beaming also produced "New Minds," a widely acclaimed lecture and performance series that focused on the cultural impact of new media (www.newminds.org). From 1983 to1994, Mark was a financial securities executive, investment banker and portfolio manager for three of the largest banks in the world, most recently as Senior Vice President for Sanwa Securities. Mark serves as a Board Member of Leonardo and an Advisory Board Member of Media Arts at SF MOMA and WITI (Women in Technology International). He received a Bachelors Degree in Business, a JD and MBA from Creighton University.

Vibeke Sorenson

Vibeke Sorensen is an artist working in experimental new media, including computer graphics and animation. From her early work with hybrid video synthesizers over twenty years ago, through her long engagement with three-dimensional computer graphics, to her present internet based pieces, she has created a series of prints, installations, films, and interactive works while also experimenting with and contributing to the development of new systems and methods. Her work has received many honors and awards, and has been shown internationally on broadcast and cable television, in galleries, in museums, and in live performance.

Sorensen created programs and developed facilities for computer art at Virginia Commonwealth University (Assistant Prof. 1980-83), Art Center College of Design (Director of Computer Graphics Program 1983-85), and California Institute of the Arts (Director of the Computer Animation Laboratory , School of Film and Video, 1984-94). She also worked with Prof. David Dobkin of the Princeton University Computer Science Department. to create an interdisciplinary laboratory, and a course for art and computer science students which they team-taught in 1990, 91, and 93. She is currently Professor and Fouding Chair of the Division of Animation and Digital Arts in the School of Cinema-Television at the University of Southern California.

Appendix A:

Survey of Projects, Research, Applications & Companies in Sensual Media

The technologies, software, applications, etc. discussed in this paper include sensors, tracking devices/motion capture and image recognition systems. They involve PDA's, phones, voice chips, wearables and MP3 players. Software ranges from speech recognition to XML to streaming to MPEG-4, the next generation video compression codec, and much more.

While the underlying technologies being used to create sensual media cross a wide chasm of fields and industries, what unifies them is the degree to which they enhance or extend our command of sensory communication. The following Projects, Applications and Companies are surveyed as both practical guide and insight into the future of sensual media.

Project: DataTiles
Project Lead: Jun Rekimoto
Website: http://www.csl.sony.co.jp/person/rekimoto.html
Keywords: Data tiles, media browser.
Sensuality: Touch, Sight, Sound

Project Abstract:
The DataTiles system integrates the benefits of two major interaction paradigms: graphical and physical user interfaces. Tagged transparent tiles are used as modular construction units. These tiles are augmented by dynamic graphical information when they are place on a sensor-enhanced flat-panel display. They can be used independently or can be combined into more complex configurations, similar to the way language can express complex concepts through a sequence of simple words.

Using this system it is possible to realize various functions with the placement of a combination of different tiles. Each tile is an independent Web-enabled GUI capable of displaying real-time video, music and data files arranged to your choosing. Once a JAVA-enabled tile is placed, it checks nearby tiles for the possibility of "inter-tile communication." A tile running a clock placed next to a video clip can now act as a dial for playing the video. Placed next to a weather map the clock tile can be used to retrieve meteorological data from the previous day.

Key Company: Sony

Key Technology: A liquid crystal display integrated to an internal electromagnetic pen tablet (Sony VAIO PCV-LX80), as well as an array of coil antennas mounted on the

display's surface. The pen tablet is capable of sensing pen positions when the pen is sufficiently close. Tiles are 75x75 mm.in size, each embedded with an RFID tag made by Texas Instruments. Inductor coils under the LCD act as a tag reader antenna. A microcontroller informs the DataTiles software about ths presensnce/absencs of RFID tags through an RS232 serial connection.

Key Application: System for controlling home and office appliances as a "digital dashboard"; Media editing environments; Education platforms; Gaming.

References:

Contact/E-mail: rekimoto@acm.org
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Sony Computer Science Laboratories, Inc.
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Tokyo 141-0022 Japan (Map)

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Project: Boundary Functions
Project Lead: Scott Snibbe
Website: http://www.snibbe.com/scott/bf/
Keywords: Tracking, Motion Capture, Video Projection
Sensuality: Touch, Sight

Project Abstract:
Boundary Functions makes visible the often-invisible spatial relationships between people. The lines projected onto the floor from overhead isolate each visitor into a geometric region. With one person in the gallery there is no response. When two are present, there is a single line drawn halfway between them segmenting the room into two regions. With more than two people, the floor becomes divided into cellular regions. These geometric regions are collectively referred to as a Voronoi diagram. Anthropology, chemistry, astronomy and marketing use Voronoi Diagrams to explain natural patterns of settlement and natural divisions of space. A projector and video camera mounted in the ceiling are networked with a computer that runs custom software designed to sense the people on the floor and to generate the diagram. As visitors move within the space, the diagram updates to reflect the people's continuously changing spatial relationships.

Key Company: Interval Research
Key Technology: The installation consists of an overhead camera and projector aimed at the floor through an intermediate mirror. The camera and projector are connected to a PC computer, which performs tracking of the moving people on the floor below using custom software. The software generates the Voronoi diagram, which is projected back onto the floor.

Application: Gaming.

References:
Contact/E-mail: scott@snibbe.com

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Project: Mass Hallucinations
Project Lead: Trevor Darrell & Gaile Gordon
Website: http://www.thetech.org/press_resources/releases/1998/pr- - /
Keywords: Motion Tracking; Pattern Recognition; Video
Sensuality: Sight

Project Abstract:
Mass Hallucinations is an interactive display that senses and reacts to visitor's faces. It combines video cameras and a computer display to make a digital mirror. Computer-vision algorithms developed at Interval detect and track faces in front of the screen. Special effects and distortions are applied to the detected faces. These effects follow visitors as they move and interact with the display.

Key Technology:
There are three different tracking modules: a stereo-vision module that separates people from the background, a color-module that detects regions of skin hue, and a pattern-module that recognizes contrast patterns that appear to be faces. Stereo vision uses the relationship between two camera views to find the distance of objects from the mirror. Mass Hallucinations performs this computation in real-time using special computer hardware created at Interval. In regions of the image that have been labeled as being part of a human face, we implement graphical effects by applying distortions to the live video signal. These distortions stay with the visitor and continue to change as the visitor moves with respect to the mirror, as well as to other faces in the mirror.

Key Company: Interval Research

Key Application: Entertainment; Controllers.
This project demonstrates how computers can observe and analyze visual information quickly enough for use in interactive systems, allowing the user to control a display directly without a mouse or keyboard.

References:
Contact/E-mail: trevor @ ai.mit.edu

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MIT AI Laboratory

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Project:	Desert Rain
Project Lead:	Blast Theory, Computer Research Group at Nottingham University. Toynbee Studios, London
Website:	http://www.blasttheory.easynet.co.uk/work_desertrain.html
Keywords:	Mixed Reality; Performance; Monitors
Sensuality:	Sight, Touch, Sound.

Project Abstract:
A "mixed reality performance and interactive game for six players who journey through an extended physical and virtual stage set. Pods with sensors track each players movement in a virtual world projected onto a 'curtain of rain"- a projection screen made from a fine water spray. Upon finding the final clue, the players literally walk through the screen into "the real world."

Key Company: Blast Theory, Toynbee Studios, London

Key Technology: The virtual environement is developed in the MASSIVE-2 system, Footpad sensor; projectors; PC's.

Application: Gaming. Monitoring systems for kiosks and touch screen devices in public spaces.

References:
Contact/E-mail: info@blasttheory.co.uk

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Project: Rapid Fire & Active Vision: Eye Tracking Musical Instrument Interfaces
Project Lead: Andrea Polli
Website: http://homepage.interaccess.com/~apolli/avision.html
Keywords: Eye Tracking; Ocusonics
Sensuality: Sight, Sound

Project Abstract:
Rapid Fire is a collaborative project focusing on the exploration and implementation of Intuitive Ocusonics, a process in which voluntary and involuntary eye movements create a visual and aural landscape. Intuitive Ocusonics melds visual and aural information through high end data transfer and eye-tracking technology. It concretizes the thought process, invading and amplifying subtle movements of the eye in real time through sound and image, examining the search for meaning through a biological lens.

Key Technnology: Eye tracking software: BigEye designed by Tom Demeyer at STEIM; Sound processing software: Opcode's Max and MSP.

Application: Universal Access; Controllers.

Key Company: Blast Theory, Toynbee Studios, London

References:
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Project: Chemical Portraiture
Project Lead: Scientist Dr. George Dodd and artist Clara Ursitti
Website: http://webserver1.wellcome.ac.uk/en/old/sciart98/10chemical_port.html
Keywords: Chemical portraits, scent analysis.
Sensuality: Smell

Abstract
Scientist Dr. George Dodd and artist Clara Ursitti are both unusual in their respective fields as they both explore scent. Five years ago, Clara approached Dr. George Dodd with regard to a project involving an Olfactory Self-Portrait. Since then, they have been collaborating on a numerous projects involving smell for exhibitions across Europe, Canada and Australia. With the assistance of the Wellcome Trust SCI-ART Grant, Dr. George Dodd and Clara Ursitti were able to take their previous work further and create Chemical Portraits of people and places using sophisticated scent analysis equipment.

Having the opportunity to use the ATD-2D-GLC-MS has allowed them to experiment with re-creating the scent of people and places in a much more precise manner than was previously possible. The world of olfaction is a rich environment for the exploration of the inter-relationship between science and art.

Project:	Computational Choreography; Interactive Software for Modelling Dance
Project Lead:	
Martin Colbert,	Digital Imaging Research, Centre, Kingston University
Juan Gutierrez,	Spanish Visiting Researcher
Rebecca Marshall,	The Random Dance Company
Wayne McGregor,	The Random Dance Company
Dr Paolo Remagnino,	Digital Imaging Research Centre, Kingston University

Website:	http://www.sciart.org/site/
Keywords:	Motion tracking,
Sensuality:	Sight.

Abstract
Computer vision meets dance choreography to develop software that models the shapes created by your movements. If you don't like your shape, change it in an editor. To understand your shape, display it in various ways. To use our tool, upload your images to our web site.

The system will comprise a Modelling module and a Supervision module. The Modelling module will acquire whole human body movements and generate compact mathematical models. The Supervision module will enable the choreographer to directly manipulate computer modelling, and to visualise both the shape and behaviour of the dancer. Supervision is an interactive and incremental process. Supervision takes place when choosing dance video data, when manipulating the mathematical model and when assigning meaning to the dancer's shapes and behaviours.

The modeling will take place in two separate phases. At first the body of the dancer will be extracted from the uniform background, and a deformable shape, spline curve, will be used to accommodate the profile of the body silhouette. The spline will be controlled by a number of points along the curve, which will allow the mathematical approximation of the
body profile. A video sequence is systematically analysed, by extracting the body from the background and fitting a spline to its profile. The user will be able to modify selected aspects of the generation of the model. The work spans three areas of research. These are human and computer interaction (visualisation work), dance creation (shape and behaviour) and computer vision (algorithmic development of interactive tools for movement tracking).

Company: Aerome, AG.
Website: http://www.aerome.de/
Technology: Scent Technology
Keywords: Scent media, communications.
Sensuality: Smell, Sight

Abstract:
Dusseldorf and New York based company develops brand specific online scent applications for consumer, retail and manufacturing industries. The Company views their products as a new information channel in the communications business. “In sync with seeing and hearing, scents extend the myriad of multimedia possibilities towards a new level.”

The Original aerome¨ ScentCartridge consists of several glass tubes. These are filled with a special granulate that stores the scent molecules. They can be retrieved from the cartridge without undergoing any changes. The cartridge is robust and capable of being stored for long periods, providing the Original aerome¨ ScentController with six exactly defined scents for at least one week. The cartridge looks like a video cassette which is placed in the ScentController. Once in the ScentController, the Cartridge is automatically opened. aerome can create many scents. Each rendition can be achieved in accordance with a detailed product briefing, developed in close cooperation between aerome and the customer.

aerome has developed a multimedia-kiosk that presents aerome¨ Scent Technology in a user-friendly way. The multimedia system is directly controlled by audio and visual sources, e.g. from a CD-interactive (CD-i), or by means of PC technology. User-friendly menus lead the consumer through the program which they control by means of a touch-screen. Multimedia applications are developed by aerome in cooperation with software partners. Existing customer applications include, e.g. advertising spots, Internet pages, product information and service performances. They also have a mini system for sales counters, on shelves, for external sales purposes as well as for training and educational purposes.The MiniScenter consists of a flat screen with an integrated touchscreen, PC technology and aerome Scent Technology. The system is Windows compatible and can be operated with other systems as well.

aerome claims they are the first company in the world to create a totally reliable storage module for aromas as a communication medium. They recently demonstrated the technology at SIGGRAPH.

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Project: Ping
Project Lead: Chris Chafe & Greg Niewmeyer
Website: http://ccrma-www.stanford.edu/~cc/sfmoma/topLevel.html
Keywords: Audio database , network, harmonics.
Sensuality: Sound, Touch.

Abstract:
Ping is a site-specific sound installation that is an outgrowth of audio networking research at Stanford University's Center for Computer Research in Music and Acoustics and interactive and graphic design experiments originating from the Stanford University Digital Art Center. Ping is a sonic adaptation of a network tool commonly used for timing data transmission over the Internet. As installed in the outdoor atrium of SFMOMA, Ping functions as a sonar-like detector whose echoes sound out the paths traversed by data flowing on the Internet. At any given moment, several sites are concurrently active, and the tones that are heard in Ping make audible the time lag that occurs while moving information from one site to another between networked computers.

Within the Ping environment, one can navigate through the network soundscape while overlooking San Francisco, a cityscape itself linked by the same networks that constitute the medium. Visitors to the installation can expand or change the list of available sites as well as influence the types of sound produced, choosing different projections of the instruments, musical scales, and speaker configurations in the surround-sound environment.

Current explorations pertaining to sound synthesis and Internet engineering are the foundation of the Ping installation. The research that led to this installation is, however, just one part of a larger effort to investigate the usefulness of audio for internetworking and, reciprocally, ways in which the Internet can abet audio. It is precisely this dialectic surrounding Ping that illustrates the increasingly common intersection of art and technical advancements, an interdisciplinary breeding ground where computer-based technology functions both as a stunning artistic medium and as a research tool."

Key Technnology:

Mapping Pings to Musical Events- the “ping” comes from network calls to websites which triggers a return message to a server in varying time intervals. These intervals are fit to music intervals like harmonics (1/3, 1/4, 2/5. Etc.,) The eight columns of speakers are four pairs of strings whose harmonic roots are tuned to fifths like a violin. The ping time determines the length of a given string at that instant.

Application: Explores the usefulness of audio for internetworking and, reciprocally, ways in which the Internet can abet audio

References:
Contact/E-mail: Greg.niemeyer@stanford.edu

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Project: HUBBUB
Project Lead: Sha Xin Wei, Anne-Maria Korpi, James Yu-Cheng Hsu
Website: http://titanium.lcc.gatech.edu/hubbub/
Keywords: Speech-painting; Public Space; Speech Recognition.
Sensuality: Sound, Sight.

Abstract
Hubbub is an investigation of accidental and non-accidental conversations that can be catalyzed in urban spaces by means of speech that appears as glyphs projected onto public surfaces. Hubbub installations may be built into a bench, in a bus stop, a bar, a cafe, a school courtyard, a plaza, a park. As you walk by a Hubbub installation, some of the words you speak will dance in projection across the surfaces according to the energy and prosody of your voice. In this way, new forms of conversation are born in that space. We capitalize on imperfect transcription and incorporate technical errors into the presentation of the HUBBUB system as an amusingly daft and occasionally deaf listener. Success will be measured by the extent to which strangers who revisit a hubbub space begin to interact with one another socially in ways they otherwise would not. Hubbub is a part of a larger cycle called URBAN EARS, which explores how cities conduct conversations via the architecture of physical and computational matter.

Key Technology: 2 PC’s, Dragon speech recognizer, TextOrgan text animation program by Jason Lewis and Alex Weyers of ArtsAlliance; Itís Alive!, custom-written application in C++ with MIDI interface; Data projector
2000 Lumens; Mac G4 with MIDI interface; 88-key MIDI keyboard; Portable generator for AC.

Key Company: Dragon Systems, Inc. (http://www.dragonsys.com/)
Lernhaut & Hauspie (http://www.lhsl.com/default2.htm)

Application: Ambient speech recognition systems, Kiosks,

References:
Contact/E-mail: xinwei@lcc.gatech.edu

Sha Xin Wei
Professor, Georgia Tech

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Project: GeoSCAPE & HandSCAPE
Project Lead: MIT Media Lab, Tangible Media Group
Jay Lee, Hiroshi Ishi, Blair Duun, Victor Su, Sandia Ren

Website: http://tangible.media.mit.edu/projects/GeoSCAPE/GeoSCAPE.html
Keywords: Hybrid Physical-Digital; Wireless; 3-D Visualization.
Sensuality: Touch, Sight

Project Abstract:
GeoSCAPE is a reconstructive tool for capturing measurement data in field archaeology and facilitating a 3-D visualization of an excavation rendered in computer graphics. This project is carried out by extending a recently developed orientation-aware digital measuring tape. Using embedded orientation-sensing hardware, it captures relevant vector information and transmits this data wirelessly to a remote computer in realtime. As the user measures artifacts in real space the GeoSCAPE application transfers the representation of the artifacts to the computer screen. Thus the user is allowed to navigate the archaeological excavation site virtually with immediate access to excavation information on-site. This will improve collaboration between on-site and laboratory archaeological research.

Key Technology: Orientation Sensors.

Application: Archaelogical Reconstructive Tool.

References:
Contact/E-mail: jaylee@media.mit.edu

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Cambridge, MA 02139

Project: GeoNotes
Project Lead: HUMLE lab, Swedish Institute of Computer Science
Website: http://www.sics.se/humle/
Keywords: Augmented Reality, GPS systems, Mobile Computing.
Sensuality: Touch, Sight.

Project Abstract:
GeoNotes is based on positioning technology and allows people to attach virtual notes to real world locations. Allows users on a mass-scale to annotate geographical places with virtual notes via their mobile devices (such as mobile phones and PDAs). When other people pass the location, they will be notified about the note and will be able to read it. It allows mass-annotations with no or little restrictions on accessing others' GeoNotes. Includes social filtering technologies to sort our unwanted GeoNotes.

Key Technology: GPS System; PDA's.

Application: Social Computing, Real Estate.

References:
Contact/E-mail: perp@sics.se

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164 29 Kista, Sweden

Project: Digital Jewelry
Project Lead: IBM Almaden Research Center
Website: http://www-4.ibm.com/software/ebusiness/innovations/digital_middle_no.html
Keywords: Wearable Computing; Wireless; Enhance Environments.
Sensuality: Touch, Sight.

Project Abstract:
Pervasive technology devices must not only meet our functinal requirements, but also our social, emotional, and aesthetic needs. PDA's and cell phones are portable, but not wearable, yet they still elicit strong consumer demand for intuitive interfaces and well-designed forms. Digital Jewelry suggests that using a non-technology aesthetic can

postitvely influence user acceptance. The technologies have been place in appropriate places in the jewelry and on the body: a speaker by the ear in an earing or an earpiece, microphone by the mouth in a necklace or pin, display in glasses, watch or bracelet, input and control in a TrackPoint ring. The full realization of Digital Jewelry awaits the development of technologies like Bluetooth and adequate battery power.

Key Applications: E-mail, affective communication.
Key Technology: Wireless; Tracking.

References:
Contact/E-mail: csm@us.ibm.com

Cameron S. Miner
IBM Almaden Research Center
USER Group, Design Lab
650 Harry Road
San Jose, CA 95118

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Project: Morrocan Memory
Project Lead: Vibeke Sorenson
Website: http://www.olats.org/bureaud/test/newSite/africa/galerie/gal-sorensen.shtml
Keywords: Ubiquitous computing, multi-modal communications.
Sensuality: Sight, Sound, Smell, Touch.

Abstract
Morocco Memory II includes a small house or tent made of wood and satin where a 6' x 8' back wall serves as a rear projection screen for a data projector. In front of the screen are Moroccan rugs, pillows, and a wooden table with stools for people to sit on. On the table are 6 Moroccan wooden boxes with Moroccan spices in them that people can open and close. Each time one is opened, not only are aromas released, but signals are sent to 2 computers (one for audio and one for graphics) that control colored lights in the space, and the mixing of sound, text and real-time moving images that are displayed on the rear projection screen. In this way, people can interactively explore and associate memory fragments in real-time, layering them in a way similar to what happens when a particular combination of smells triggers a string of linked and layered memory fragments in the mind.

People can also feel the spices - primarily seeds, leaves, and bark, and other coarse plant materials - with their hands and fingers. It is a "ubiquitous computing" environment where almost all of the technology used is concealed or placed inside objects made of natural materials. None of the boxes have any wires or computer mice to physically

connect them to the computers. Instead, there are custom chips in them that send radio waves to a receiver at a distance, which keeps track of the boxes and sends MIDI signals corresponding to their state on to the computers placed outside the tent where they cannot be seen. As a result, people can walk about freely inside the tent while holding, touching and smelling the boxes and their contents while dynamically altering the layers of images, texts, movies and sounds as they do so. It is a complete sensory experience that engages the entire body. It is also a social experience, as several people can interact with the 6 boxes and memories at the same time.

Key Applications: Entertainment, commmunications.
Key Technology: Technical: Dell Computers provided by Intel Corporation; custom peripheral interfaces by James Snook of the Neurosciences Institute, La Jolla, California. Software includes Pure Data (Pd) by Miller Puckette of the U. C. San Diego Department of Music; Graphics Environment for Multimedia (GEM) by Mark Danks of Stormfront Studios; and custom neural net software by Phillip Mercurio of the Neurosciences Institute, La Jolla, California. Additional assistance from Rand Steiger of the U. C. San Diego Department of Music; William Galloway of the Sweeney Art Gallery of U. C. Riverside; and Laurel Almerinda of the USC School of Cinema-Television.

References:
Contact/E-mail: vibeke@usc.edu

Project: Body Movies - Relational Architecture
Project Lead: Rafael Lozano Hemmer (CDN/MX)
Website: http://www.telefonica.es/fat/artistas/rlh/eprlh.html
http://www.telefonica.es/fat/artistas/rlh/eimagenes.html (Images)
Keywords: Motion-tracking, interactive entertainment
Sensuality: Sight, Touch.

Abstract:
As part of its 2001 program grounding, V2_Organisation presents in collaboration with Las Palmas - International Centre for Art, Image and Media Technology: Body Movies. From the 31st of August till the 23rd of September the Schouwburgplein (a square in the centre of Rotterdam, Cultural Capital of Europe) will be transformed by the projection of huge interactive portraits on the façade of the Pathé Cinema building. Over one thousand portraits - which were taken on the streets of Rotterdam, Madrid, Mexico and Montreal – will be shown, using roboticlly controlled projectors located around the square. However, the portraits will only appear inside the projected shadows of local passers-by, whose silhouettes will measure between 2 to 22 metres high, depending on how far people are from the powerful light sources placed on the floor of the square.

As soon as someone walks on the square, his or her shadow is projected and the portraits

are revealed within it. A camera-based tracking system will monitor the location of the shadows in real time, and when the shadows match all the portraits in a given scene, the control computer will issue an automatic command to change the scene to the next set of portraits. This way the people on the square will be invited to embody different representational narratives. Up to 80 people can take part at any given time, controlling 1,200 square metres of projections and creating a collective experience that nonetheless allows discreet individual participation.

Key Applications: Sculpture, compuer networks, architecture, public space.

References
Contact: 75337.1453@compuserve.com

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Project: Sensetable
Project Lead: Tangible Media Group, MIT Media Lab
Website: http://tangible.media.mit.edu/projects/sensetable/sensetable.html
Keywords: Enhanced desk, motion-tracking
Sensuality: Touch, Sight, Hybrid Physical-digital.

Project Abstract:
Sensetable is a system that wirelessly tracks the positions of multiple objects on a flat display surface quickly and accurately. The tracked objects have a digital state, which can be controlled by physically modifying them using dials or tokens. The attempt here is to embody data in controllable, manipuable objects which sit on a table. Movement of the objects inititate interaction with the represented data.

Key Technology: Commercially available Wacom Intuous™ sensing that are placed next to each other to form a 52cm x 77cm sensing surface; Two dual processor 866MHz Intel® Pentium® III Xeon™, sensing coils, capacitance sensors, video projector.

Key Applications: Business supply chain visualization, system dynamics simulations; chemistry demonstrations.

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Project: The I/O Bulb, the Luminous Room & Urp
Project Lead: John Underkoffler, Daniel Chak, Gustavo Santos, and Professor Hiroshi Ishii, Tangible Media Group, MIT Media Lab
Website:
http://www.tangible.www.media.mit.edu/groupgs/tangible/projects/Luminious_Room/Luminous_Room.html

Keywords: Architects, enhanced reality, simulated lighting.
Sensuality: Touch, Sight.

The I/O Bulb and the Luminous Room are the two central ideas in a project whose goal is the pervasive transformation of architectural space, so that every surface is rendered capable of displaying and collecting visual information.

An I/O Bulb is the conceptual evolution of the ordinary lightbulb: one which not only projects high resolution information but also simultaneously collects live video of the region it's projecting onto. A Luminous Room is the structure that results from seeding an enclosed space with a multiplicity of coordinated I/O Bulbs÷enough, specifically, so that every location is treated by at least one I/O Bulb.

"Urp" is an urban planning workbench in which simple architectural models cast accurate shadows, pedestrian-level wind patterns can be observed and tested for different arrangements of buildings, inter-structure distances are automatically calculated and displayed around the models, reflections off the surfaces of glass buildings onto surrounding terrain made visible.

Contact
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Project: MORI
Project Lead: Ken Goldberg, Randall Packer
Website: http://memento.ieor.berkeley.edu/seismo.html
Keywords: Internetworking, Vibration.
Sensuality: Touch, Sight, Sound, Hybrid Physical-digital.

Project Abstract:
Randal Packer's and Ken Goldberg's MORI extends this aesthetic in an installation now being shown at a San Francisco Art Institute show called Telematic Connections, curated by Steven Dietz. Here, real-time seismic recordings from the Hayward Fault are sent via the Internet which generate ground vibrations and music in the installations space. The Internet is alive. We will visualize it this way.

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Professor
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Department of Industrial Engineering and Operations Research
University of California, Berkeley

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Project: Brainball
Project Lead: Interactive Institute
Website: http://smart.interactiveinstitute.se/smart/PDFfiler/brainball_eng_press.pdf
Keywords: Bio-sensors, gaming, brain-waves
Sensuality: Light, Sound, Hybrid Physical-digital

Abstract
Brainball is a game, an art- and research project about new methods of interaction between human and machine using bio-sensors. The rules are simple: the player with the least brain activity wins, the stressed, thinking opponent loses. Biosensors connected to the brains of the players read alpha and theta waves which guide a ball bearing over a playing board towards the opposing goal. Brainball came about as part of a project involving co-operation between artists, engineers and designers at the Interactive Institute.

Brainball is an inverted way to play - as far as the activity-oriented people of today are concerned-where inactivity leads to activity. However, it is also the result of an experiment whereby researchers from a number of disciplines have come up with a product which sheds new light on how IT technology, design, psychology and medical equipment can be used in new configurations. Brainball was developed by Smart studio, which is one of the Interactive Institute’s six research groups.

In Brainball, players put themselves into a meditative frame of mind to take control of the ball and score goals over their opponent. The only way the opponent is able to counter the attack is to reduce his or her stress levels and relax even more. Players react to developments by not reacting.This game is built on a platform which also stimulates

players' light and sound impressions. The biosensors linked to the players' brains measure various body functions. The brainwaves are analysed via a computer and displayed to the public on a screen behind the table. The computer then guides the ball bearing over a playing board towards the opposing goal. The Interactive Institute is active in the borderland between enterprise and art, technology and science.

Contact
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Project:	ambient Room
Project Lead:	Hiroshi Ishii, Craig Wisneski, Scott Brave, Andrew Dahley, Matt Gorbet, Brygg Ullmer, and Paul Yarin
Website:	http://citeseer.nj.nec.com/ishii98ambientroom.html
Keywords:	Awareness, attention, periphery, ambient media, graspable media, physical interface.
Sensuality:	Sight, Sound, Touch, Hybrid Physical-digital.

Abstract
We envision that the physical architectural space we inhabit will be a new form of interface between humans and digital information. This paper and video present the design of the ambientROOM, an interface to information for processing in the background of awareness. This information is displayed through various subtle displays of light, sound, and movement. Physical objects are also employed as controls for these "ambient media."

Contact
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Matt Gorbet, Brygg Ullmer, and Paul Yarin
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{ishii, wiz, andyd, mgorbet, brave, ullmer, yarin}@media.mit.edu

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Project:	bump
Project Lead:	association.creation (A)

Website http://www.bump.at/home.html
Keywords: Virtual Environments, pneumatics
Sensuality: Touch, Sight, Sound, Hybrid physical-digital.

In two cities, wooden footbridges have been set up as tactile interfaces for public communication. When someone walks upon one of these footbridges, the person triggers an impulse that is transmitted to the other city. bump produces a gap in the urban interface, a site at which one no longer has firm ground under ones feet. If a person steps onto this catwalk his/her weight triggers an impulse which is transferred into the other city by means of a data-line. There a pneumatic piston raises the corresponding board by a few centimetres.

Created by association creations, an artist collective that works on networks and their transitions into a sensuous capacity for being experienced. The 'virtual world' is given a new field of action and the sensuous perception of impulses from previously unimaginable networks.

Contact:
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Project: polar
Website: http://www.canon.co.jp/cast/artlab/artlab10/polarMain.html
Project Lead: Carsten Nicolai, Mark Peljhan(D/SLO) and artlab.
Keywords: Networks, database, search.
Sensuality: Touch, Sight, Sound.

Abstract
Polar enables the data stream in global and local networks to be experienced both sensorially and cognitively—an effort to materialize the immaterial. It is an intelligent information search system in a space-integrated installation

In "polar," the whole space functions and is integrated as the artwork. Participants-visitors, two persons in a pair, enter the space, each with an interface device named "pol" developed for this project, and they collect sensory information (images, sounds, temperature, and acceleration/gravity in the surroundings) for a precisely set amount of time. When the collection is finished, information from each pol is analyzed, and seven keywords (concepts) corresponding to the qualities of information through an algorithmic

calculation are displayed on each of two monitor-interfaces placed in the room. when one of the keywords is chosen, a specially developed intelligent information search system begins to operate, and newly linked concepts of the keyword are collected from various databases and websites on the internet.

Through simple, natural movements the visitor changes and influences situations and processes and is himself the co-creator of the new reality. In the installation there are real time projections of wave-shaped movements which are calculated corresponding to sound data and visualised trace routes and various other reflected and processed analogue-digital information and images as well as natural elements residing in the space (a microorganism culture, which is cultivated in concordance with the temperature and light conditions of the space.) the whole room space responds in the combination of sensory outputs, to the characteristics of information and data collected by two pairs of participants and their constructed and discovered conceptual system.

Contact:

Project:	notime
Project Lead:	Victoria Vesna, Gerald A. de Jong, David Beaudry
Website:	http://notime.arts.ucla.edu/
Keywords:	Social networks, data-bodies, 3D sound, avatars.
Sensuality:	Sight, Sound, Touch, Hybrid Physical-digital.

Abstract

By exploring innovative ways of visualizing the trajectories of evolving human networks in relation to information, access and navigation, notime explores our relationship to time and the meaning of community in networked public space.

"Notime" develops ways in which visualization of social networks can be used to create new types of communication patterns, revealing an aesthetic space that is based on time spent communicating with others and the attention span the audience gives to people represented as meme fabrics. The installation allows the audience to navigate the networked environment with their bodies and through their interaction affect the constructed geometries representing information data-bodies of people connected to the "Telematic Connections" exhibition. Experience of time is heightened not only by the conceptual framework but also by the very architecture that is built using elastic interval geometry and navigable 3D sound environment. Time spent on different people, memes embedded in the geometry, as well as total time spent in the space is measured throughout the experience.

The physical installation of notime allows the audience to navigate these structures with their bodies via sensors. The experience of time and no time is heightened in the physical

structure whose base is shaped as a spiral and creates an enclosed atmospheric space with projections and a reactive 3D sound environment working in conjunction with the elastic interval geometry. By spending time navigating, participants add intervals that replicate from the initial tetrahedron shape.

Participants are invited to spend a few minutes to create their initial minimum structure, a tetrahedron, by determining the length of the six intervals that have a base color and meaning attached to them: red represents family, orange: finances; yellow: creativity; green: love; blue: communication; violet: spirituality. The time a person spends on deciding the length of a particular interval is registered and has an effect on the speed of replication. After determining the length, they input four memes in the nexus of the lines and then, as a last step, attach sounds from a library created by David Beaudry. When the structures are in motion, the combination of the chosen sounds with the determined lengths of intervals creates a unique composition for each person.

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Project: KAN-G
Project Lead: Olivier Liechti & Tadao Ichikawa, Information Systems Laboratory
Website: http://citeseer.nj.nec.com/liechti00digital.html
Keywords: Affective awareness, ambient media, Computer Mediated, digital camera, home photography.
Sensuality: Sight, Sound, Touch.

Abstract
KAN-G is best defined as an interpersonal communication framework supporting affective awareness through home photography. It has been named after the Japanese word kanji, meaning impression or feeling. This suggests that the goal of the framework is not to support the exchange of explicit messages, but rather to convey a general sense of being "in touch" among users. This goal is achieved through the exchange of i) photographs and ii) reactions of watchers on these photographs. The capture distribution

and observation of snapshots are performed with a number of digital imaging devices, distributed across the Internet.

Many of the current technologies support explicit social interaction, by creating a new medium for conversations. also support implicit social interaction is also important. The KAN-G system also recognizes the importance of social interaction and affective awareness, defined as a general sense of feeling in touch with relatives and friends. The need for tools supporting implicit interaction between users, in more natural and effortless ways, is at the center of this system. For details of the system including diagrams and paper, see http://citeseer.nj.nec.com/liechti00digital.html

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Appendix B.

Sensual Media Companies, Products & Applications

Company: Anoto
Product: Digital Pen
Website: http://www.anoto.com
Keywords: Wireless communication
Sensuality: Touch, Sight.

Abstract
Anoto has developed a concept that allows you to send anything you write on paper or another surface to any computer in the world.The pen acts as your wireless communication gateway to digital destinations such as personal computers, databases, the Internet and e-commerce.

Special paper is printed with the Anoto pattern, consisting of very small dots slightly displaced from a grid structure. A minute section of the pattern will give you your exact location on the full pattern. As you write or draw on the paper with your digital pen, the pen creates a digital trace of whatever you do. This information is stored in the pen until you tick the Magic box. The information is then forwarded from your digital pen directly to your nearby personal computer, or by a Bluetooth[a] device - such as a Bluetooth enabled mobile phone - to any computer, mobile phone, PDA, palm device or a fax via the Internet.

The Company seeks to drive the convergence of paper-based and wireless digital Communications, as well as to make paper once again the preferred user interface. They also seek to create a global standard for paper-based digital communication. The first pens and applications based on Anoto functionality will be available in the fourth quarter of 2001. Proprietary patterns, advanced image processing, Bluetooth wireless technology and an information infrastructure enables Anoto's system.

Anoto AB
Lund, Sweden.
Offices in Stockholm, Boston, Tokyo and Hong Kong.
Anoto AB

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Company: Interaction Laboratory,

Sony Computer Science Laboratories, Inc.

Application: VisualFlow
Website: http://www.sony.com
Keywords: Rich Media Browser; User Interface.
Sensuality: Sight.

Abstract:
A media browsing application designed for Sony's Memory Stick and VAIO Computers. Launched through the OS or from inserting a Memory Stick, it allows a user to browse digital pictures, sound files and movies on their computer as well as navigate a users file system. Inspired by Dr. Rekimoto's notion of Time Machine Computing where you can time-travel to the day a particular file was created. VisualFlow is also sensitive to "semantic scaling" where the representation of the data might change accordingly with its

scale, rather than clutter up the screen with detailed file information. Media fills the screen except for a small navigation bar at the bottom of the screen. A jog wheel can also move files across the screen.

References:
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Eduardo Sciammarella
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Tokyo, Japan

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Company: Lernhaut & Hauspie
Product: Dragon Systems, Inc.
Speech & Language Products
Website: http://www.dragonsys.com/
http://www.lhsl.com/default2.htm
Keywords: Speech Recognition
Sensuality: Sound

Using speech and language technologies, combined with human linguistic expertise, the Company enables people to talk to their cars, automatically translate foreign language e-mail, and navigate the Internet without touching a keyboard. It is also developing technology for automatic real-time translations of multiple languages as well as using the spoken word can control any device or computer application. The Company produces consumer, business, and industry offerings in automatic dictation, translation, sound compression, voice synthesis, and industrial documentation.

L&H's products and services originate from four core technologies: automatic speech recognition (ASR), text-to-speech (TTS), digital speech and music compression (SMC), and text-to-text (translation). With these technologies, we enable original equipment manufacturers (OEMs) to harness the power of spoken language as an interface between people and machines.

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Company:	Sony Vaio
Product:	Touch Sensitive LCD/Notebook
Website:	http://www.sony.com.jp
Keywords:	Computer, touchscreen.
Sensuality:	Touch, Sight.

Abstract
Sony revealed a Vaio Touch Screen computer at Comdex last November with a crystal-clear LCD that folds down over the keyboard at any desired angle. The Tablet, running an onboard paint program, allows users to draw and paint (and erase) directly on the LCD's surface with a wireless stylus.

Key Technology: The system has an Internet keyboard, a mouse and wireless stylus, and a 15-inch display that incorporates Wacom input technology. Targeted toward consumers and graphic designers could. The CPU has an 866-MHz Pentium III with 128MB of RAM, a 37GB hard drive, and a Sis630 graphics chip that complements the 1024x768 display. Opening the CPU's front panel exposes a CD-RW drive, slots for a PC

card and memory stick and iLink (1394) and USB ports. The ergonomic display can either stand straight up or fold down over the keyboard for easy access.

Company: Texas Instruments
Product: Voice Chips
TSP50C04/06 synthesizer
TSP50C13/14/19 synthesizer
Website: http://www.ti.com
Keywords: Voice functionality, semiconductors.
Sensuality: Sound

Abstract
Speech synthesis reproduces various kinds of voices and sound patterns simulating certain words, music or other effects.

Voice chips refers colloquially to: Texas Instrument TSP50C04/06 and TSP50C13/14/19 synthesizers; Motorola MC34018 or any other “speech synthesis chip implemented in C-MOS to reproduce various kinds of voices, and includes a digital/analog (D/A) converter, an ADPCM synthesizer, an ADPCM ROM that can be configured by the manufacturer to produce sound patterns simulating certain words, music or other effects.”

Voice chips provide the opportunity to add ‘voice functionality’ to the whole consumer based electronics industry. They are the integrated circuits that can record, play and store sounds, and more importantly voice. They are the patented chips that play Jingle Bells [11] in the Hallmark greeting card. They are the voice in the car that reminds you “Your lights are on”[12] . They are the technology that makes dolls that say “Meet me at the Mall”[13] , and give products ranging from picture frames to pens [14] , voices. The well sung virtues of integrated circuits (chips) is that theyare cheap, tiny and require little power. Smaller than a baby's fingernail, they have the force of a global industry of behind them and an entire economic sector invested in expanding their application. Technically, they can be incorporated into any product without significant changes in their housing, their circuit design, power supply, or price.

Company: Motorola
Product: Voice Chip- MC34018 Synthesizer
Website: http://www.motorola.com/

Keywords: Voice functinality, semiconductors.
Sensuality: Sound

Abstract
Speech synthesis reproduces various kinds of voices and sound patterns simulating certain words, music or other effects.

Voice chips refers colloquially to: Texas Instrument TSP50C04/06 and TSP50C13/14/19 synthesizers; Motorola MC34018 or any other “speech synthesis chip implemented in C-MOS to reproduce various kinds of voices, and includes a digital/analog (D/A) converter, an ADPCM synthesizer, an ADPCM ROM that can be configured by the manufacturer to produce sound patterns simulating certain words, music or other effects.”

Voice chips provide the opportunity to add ‘voice functionality’ to the whole consumer based electronics industry. They are the integrated circuits that can record, play and store sounds, and more importantly voice. They are the patented chips that play Jingle Bells [11] in the Hallmark greeting card. They are the voice in the car that reminds you “Your lights are on”[12] . They are the technology that makes dolls that say “Meet me at the Mall”[13] , and give products ranging from picture frames to pens [14] , voices. The well sung virtues of integrated circuits (chips) is that theyare cheap, tiny and require little power. Smaller than a baby's fingernail, they have the force of a global industry of behind them and an entire economic sector invested in expanding their application. Technically, they can be incorporated into any product without significant changes in their housing, their circuit design, power supply, or price.

Company: Charmed Technology
Website: http://www.charmed.com
Product: Wearable technology, wireless.
Keywords: Wearable computing, fashion.
Sensuality: Touch, Sight.

Abstract
Los Angeles-based Charmed Technology is an MIT Media Lab spin-off and is poised to be a leader in affordable, wearable Internet products, services and technologies. The company has established strategic partnerships with Penton Media/InternetWorld, Red Herring, MIT's Media Lab, the University of Rochester Center for Future Health, Motorola and others." Charmed Technology’s vision is to incorporate the unwired Internet into fashion, lifestyle and health applications by creating inexpensive wireless mobile devices that will allow individuals to access the World Wide Web anywhere and anytime through wireless technology.

Key Technology: In its quest to bring the Internet to small wireless devices, Charmed Technology has developed an operating system called NANIX that be configured to function on small embedded computing devices. This Linux-based OS supports the 802.11, IRDA, and Bluetooth standards, as well as I/O connections for handheld keyboards, voice-recognition, head mounted displays, and palm-sized LCD monitors. In addition, support is provided for cameras, GPS receivers, MP3 music files, and broadband streaming audio/video.

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Telephone: 310-458-3233
Fax: 310-458-2844
info@charmed.com
Promotional materials contact:
Alex Lightman
E-mail: alightman@charmed.com

Company:	IM Networks
Product:	SonicBox, IM Tuner
Website:	http://www.imnetworks.com
Keywords:	Music player, Internet radio.
Sensuality:	Touch, Sound.

Abstract
IM Networks has bridged the physical/virtual divide first by creating software for navigating global Internet radio stations via broadband networks using an interface that resembles a physical radio. It then created a cordless physical player with knobs, buttons and dials that creates a wireless connection between your pc and your stereo. (RF Remote Tuner works through walls). In a coup for the Company, it signed a software licensing agreement with Phillips to add an “IM” button next to FM and AM bringing it one step closer to becoming the standard dial for global Internet Radio.

Key Technology: iM Band™ stations (software), Sonicbox K.O. which uses a wire connection from PC to stereo. Remote tuner, base-unit, 25 ft. stereo cable, USB cable and software CD.

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Company:	Wacom
Product:	Tablet & pen-based tools
Website:	http://www.wacom.com/productinfo/intuos.cfm
Keywords:	Tablet technology, pen-based technology, interface.
Sensuality:	Touch, Sight.

Abstract
The Intuos graphics tablet system is a set of tablet based tools for the creative professional. It's 1,024 levels of pressure sensitive control and 2450 lpi (or dpi) of resolution gives you control in graphic applications. It's pressure sensitivity and resolution gives Photoshop users much more accuracy. Painter artists experience brushes that behave exactly like natural media. Web designers, video editors and 3D artists can
use
pressure sensitive applications such as Flash, Commotion and Deep Paint 3D. QuickPoint. Also provides ergonomic alternative for navigating your screen. Wacom has also developed 4D Mouse, the first true computer airbrush, QuickPoint active areas and ToolID.

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Subsidiary of Wacom Co., Ltd., in Japan
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1-800-922-6613 x151

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Company:	DigiScents
Product:	iSmell™
Website:	http://www.digiscents.com/
Keywords:	Scent technology, Gaming, Entertainment.
Sensuality:	Smell.

Abstract

DigiScents has developed an end-to-end hardware and software platform for incorporating scent into all forms of media, including movies, interactive games, advertising, e-commerce, and educational software. The end-user can experience scents at home, using a PC peripheral device, the iSmell™ personal scent synthesizer. (The code activates a fragrance created with a set of oils stored within the box). This plug-and-play device connects to the USB port of the user's PC. The emotional impact of smell will make the gaming and entertainment experience lifelike and immersive. At the same time, digital scent technology affords packaged goods companies a revolutionary tool to communicate a key feature of their foods, beverages, perfumes, cosmetics, soaps and candles.

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Company:	Arts Alliance Labs
Application:	TextOrgan
Developers:	Jason Lewis & Alex Weyers
Website:	http://www.aalab.net/projects/ActiveText/TextOrgan/
Keywords:	Text Animation Program, Dynamic text performance tool
Sensuality:	Sound, Sight.

Abstract:
Equal parts digital graffiti and digital concrete poetry, TextOrgan is the rave cousin of It's Alive! TextOrgan takes the It's Alive! environment, adds a MIDI keyboard for quick access to all the functionality, and allows the user to either input text directly or to select among a set of prepared texts that are then streamed onto the screen. She can quickly build up immensely rich collages of performance-specific poetry and found texts.

TextOrgan was developed for use in conjunction with a DJ at musical events. By collaborating beforehand, the DJ and the TextOrganist can choose a selection of texts and discuss what sort of mood or themes they want develop in the set. When the set begins, the two embark on a improvisational duet, each reacting to what the other is throwing into the media environment. The DJ plays his decks, and the TextOrganist uses the MIDI keyboard and a mouse to play the text. The output of the TextOrgan, projected above the crowd, oscillates between text as pure text, text as image, and pure image, creating an experience that is at times reading, at times watching and at times both. The TextOrganist can also extract simple signal information such as pitch and intensity from either the ambient environment or directly from the DJ's decks. This provides a mean of automating some of the text dynamics to be in synch with the beat, or to ebb and swell as the intensity of the music decreases and increases.

Contact/E-mail:
Jason Lewis
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Company:	Eyematic
Product:	Realtime character animation; 3D Face Recognition,
Website:	http://www.eyematic.com
Keywords:	Computer vision Technology, Realtime character animation; 3D Face Recognition, Wireless, Gaming.
Sensuality:	Sight, Sound.

Abstract
Eyematic is a technology innovator poised to revolutionize the way people across the globe use the Internet to communicate. Eyematic is emerging as the leader of interactive rich media authoring, playback and communication software, and the supporting infrastructure solutions necessary to enable them.

The Eyematic family of products enable real-time character animation and communication within shared virtual spaces. Eyematic's turnkey suite of rich media offerings, differentiated by our proprietary computer vision technology, represents the next important step in the evolution of rich media for entertainment, advertising and communications over Internet, wireless and broadband networks.

Applications:

6. Creation of syndicatable content with output to Web and wireless spaces.
7. Customer service: enables real time communication between custioimers and customer service representatives, who can appear in live video or as digital characters.
8. Games and toys including real time 3D experiences between multiple players of Web and wireless.
9. Film and television.

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Company:	Shout Interactive
Product:	Headpedal
Website:	http://www.shoutinteractive.com/index_flash.htm
Keywords:	Voice, animated characters, support systems.
Sensuality:	Sound, Sight.

Abstract
Headpedal brings a new interaction paradigm to the world of digital information: Voice-enabled interactive animated characters. Headpedal's customer friendly characters provide corporations with real-time support systems for web-based transactions. Headpedal characters provide the first tier of support to customers needing assistance to complete on-line transactions. At the same time, our characters can reduce customer support costs and improve purchase transaction completion rates.

Headpedal licenses software for producing interactive, voice-enabled animated characters that provide scalable, real-time support for web-based transactions. Our products and services are ideal for corporations focused on building one-to-one relationships with their customers, facilitating customer transactions, building consumer trust, and increasing the likelihood of repeat visits--all while reducing sales and support costs.

Incorporating Headpedal characters into your website allows your customers to engage in face-to-face interactions with virtual sales and support agents, putting information literally on the tip of the tongue. Headpedal characters reply with spoken responses, facial expressions and gestures, all calculated on the fly using Headpedal's patented character technology. Click on the links above for more information on our products and services.

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Company	Dassault Systemes
Product:	CATIA & ENOVIA
Website:	http://www.dsweb.com
Keywords:	3D Modeling Tools, CAD/CAM

Sensuality: Sight.

Abstract

CATIA is the flagship 3D modeling solution of Dassault Systemes' mechanical engineering tools. Dassault Systèmes is one of the premier global software developers for the CAD/CAM/CAE/PLM market, providing companies with e-business solutions to implement their digital enterprise, thus creating and simulating the entire product life cycle from initial concept to product in service.

SolidWorks and SmartTeam, Dassault Systemes companies, offer respectively 3D design-centric and TeamPDM software solutions based on Windows. Spatial, also part of Dassault Systemes family, is a market-leading provider of world-class 3D software components and services (for 3D modelling, visualization, and interoperability) to meet the requirements of 3D in Internet-based e-commerce and B2B applications.

CATIA, ENOVIA and DELMIA solutions support industry-specific business processes to help unleash creativity and innovation, reduce development cycle time, improve quality, competitiveness and shareholder value: CATIA supports the digital product definition and simulation, DELMIA provides solutions to define and simulate lean digital manufacturing processes and ENOVIA delivers enterprise solutions that manage collaborative and distributed models of the digital product, processes and resources.

CATIA and Enovia are marketed, sold and supported by IBM and it's worldwide network of business partners. (Nasdaq: DASTY; Euronext Paris: #13065, DSY.PA)

Contact

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Company:
Application: It ís Alive!
Developers:
Website:

Abstract:
Custom-written application in C++ with MIDI interface;

Company Credo Interactive Inc.
Product: Life Forms
Website: http://www.charactermotion.com/products/index.html
Keywords: 3D Character Animation.
Sensuality: Sight

Abstract
Credo, based in Vancouver, is a leader in creating innovative content, products and solutions for 3D character animation applications.

Life Forms, Credo's flagship product, is a 3D motion creation and editing software program. As a professional animation tool, it currently has wide and diverse applications in entertainment, education, choreography, architecture, and the arts. Life Forms is a key tool in constructing avatars for internet communities and environments. It was used for pre-visualization work in BarbWire, Batman and Robin, Jurassic Park and Terminator II. Many companies such as, SingleTrac and InterPlay are also using the software for game production of their hit titles.

Company: Enroute
Product: FirstPerson Immersive Video System
Website: http://www.enroute.com
Keywords: 3D Imaging, Video, Gaming, Imaging.
Sensuality: Sight

Abstract
Enroute Imaging is a leading provider of professional and consumer immersive imaging products, FirstPerson is the only 360 degree system on the market today to offer professional-quality video and full-motion navigation. FirstPerson Immersive Video is the
first to apply this concept to high-resolution full-motion video. By combining multiple video streams captured from multiple outward-facing cameras into a single cylindrical or spherical video. Enroute's camera is equipped with several lenses for capturing surroundings on video without panning. Imagine being able to pan and rotate a video camera's point of view so you experience everything that's happening in the scene.
"We take various streams; we actually process it together into one seamless first-person

video."

The FirstPerson Immersive Video System is a complete solution, providing production services for capturing and processing immersive footage, and viewing products for
playing
back immersive movies. Customers have the choice of specifying the immersive movie format (either spherical or cylindrical), resolution and frame rate, and playback platform.

Enroute recently announced it will develop and offer a toolkit to authorized PlayStation 2 software developers that will enable them to bring Enroute's FirstPerson Immersive Video technology to PlayStation 2 applications. Enroute is developing immersive video to be played over a variety of platforms and formats, including DVD. Enroute is currently working on immersive video for the music industry, and hopes to roll outconsumer applications of FirstPerson Immersive Video later this year.Industry applications include:

Entertainment, Music Videos, Concerts, DVD Movies, Video games, Advertising
Tourism, Real Estate, Training, Simulation, Sports, Media Events, Documentaries

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Company:	Viewpoint
Product:	3D imaging Tool
Website:	http://www.viewpoint.com
Keywords:	3D imaging, video.
Sensuality:	Sight.

Abstract
Viewpoint is a leading provider of digital marketing technologies and services.
Viewpoint
licenses its proprietary technologies for e-commerce initiatives and provides a full range of professional services for implementing enhanced digital rich media marketing solutions that integrate online advertising, promotions and e-mail strategies. With

Viewpoint Rich Media Solutions, marketers and e-merchants can effectively streamline their online business applications - from e-CRM to e-commerce.

Event planners, for example, can take a rich media tour of the center; which includes an expanded view of the building layoutand take a virtual "fly-through" of each floor separately for viewing the location of the facilities. It supports a cross-channel campaign; first by distributing a CD-ROM to event planners, and then by broadcasting on their rich media focused Web site, both of which will be powered by Viewpoint Experience Technology. The technology allows companies to develop content for the Web and leverage it offline, whether that be through in-store kiosks, direct marketing vehicles like CD-ROMs or branding efforts through broadcast.
(Nasdaq: VWPT)

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Company:	Sensatex
Product:	Smart Shirt
Website:	http://www.sensatex.com
Keywords:	Wearables, wireless, smart-fabrics, electro-optical textile.
Sensuality:	Touch, Sight, Sound.

Abstract
The Smart Shirt System utilizes an electro-optical textile, the Wearable Motherboard™, to seamlessly incorporate sensory capabilities with radio and computing devices, representing a highly effective and unobtrusive means of integrating broad-based sensors with the human body.

By supporting voice and data communications from multiple sensory locations through one wireless backbone, the Smart Shirt System provides a framework for a host of health monitoring and personal information processing applications. The System's principal advantage is its ability to collect and wirelessly transmit data, biomedical or otherwise, to remote locations in an unobtrusive fashion.

The first component of this integrated System is the Wearable Motherboard™, a novel electro-optical fabric that permits information transfer and exchange between a wearer and a garment. The second component is a wireless communications and data management infrastructure that consists of a proprietary Application Programming Interface (API) and numerous open architecture hardware and software elements designed to relay information from the garment to a wireless environment.

Markets include: Infant/Toddler/Active Child Monitoring, Geriatric Monitor, Amateur/Individual Sports, Team Athletic Training, Cardiovascular Monitoring, Infant Vital Signs Monitoring, Sleep Studies Monitoring and Hazardous Occupations Monitoring.

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FAX: (212) 334-2324

Company:	Unified Field
Product:	Evolving Screen™
Website:	http://www.unifiedfield.com/
Keywords:	Visualization, 4D, architecture.
Sensuality:	Sight, Time.

Abstract
The Evolving Screen is a high tech media installation developed by Unified Field for lobbies and other public spaces.

The Evolving Screen is a sophisticated communication tool that engages the viewer in a visual conversation. High performance computers generate self-transforming environments that unite multiple media forms into a seamless, ever changing vision of your company.

Meta-information design: Flexible templates and macro-level rules generate combinations of multi-media content and 4D models. Each screen shows a different perspective on the information and different blends of ideas.

Environment design: Information is displayed in a series of virtual worlds (environments) that change based on live data streams. The environments add depth, motion, and a sense

of immediacy to the information display. Sophisticated graphic design ties all of the screen elements together into a seamless whole. It is a new art form that transforms public spaces into living architecture.

Multi-media elements for the Evolving Screen™ may include movies, text, images, real time news and data feeds, and data-driven 4D models. Evolving Screen™ can be shown on displays ranging from a single plasma screen to large-scale rear projection systems or LCD arrays.

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Project:	Tilty Tables
Project Lead:	Xerox PARC RED
Website:	http://www.parc.xerox.com/red/projects/xfr/tilty_tables.html
Keyworkds:	Table
Sensuality:	Touch, Sight.

Abstract
The tables sit on pneumatic shock absorbers, much like the ones used in cars to smooth out the ride. Also under each table is a digital device called "an accelerometer" which measures how quickly something is getting faster or slower. (Acceleration means rate of change. For example, a car going from 0 to 60 is accelerating. A car moving at a steady 60 miles per hour is not accelerating at all.) As it turns out, an accelerometer can also measure tilt, much the same way that the bubble in a carpenter's level can measure tilt. This is because gravity is really acceleration (as Newton discovered 400 years ago). The tilt information from the accelerometers is sent to computers that use this information to determine the correct image to send to the video projectors. These projectors are mounted in the ceiling and are precisely aligned with the tables beneath them so that the images fill the white surface of the tables.

Table #1: The Reading Table allows the visitor to move through a large document that, if it were to be printed out, would be over thirty feet on a side. The Reading Table is a small window onto this large document such that when the table is tilted, the window slides across the large document (or, another way to look at it, is that the large document is sliding under the window). The result is that the visitor feels as if he or she is surfing or gliding across the image.

RED is interested in exploring how to read extremely large documents in new ways. This technique, for instance, could also be used in reading blueprints or large maps; how words and images work together to form meaning; and lastly, The Reading Table examines how we use our bodies when we read and how that might effect the meaning of the words.

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Project:	Riding the Net
Project Lead:	Christa SOMMERER, Laurent MIGNONNEAU, Roberto Lopez-Gulliver; Interface design support: Stephen Jones ATR Media Integration and Communications Research Lab, Kyoto
Website:	http://www.mic.atr.co.jp/~christa/WORKS/
Keywords:	Browser, 3D, interactive TV.
Sensuality:	Sight, Sound Touch

Abstract
Riding the Net presents a novel approach to browsing the Internet in a more intuitive, playful and entertaining fashion. While two users talk and communicate with each other, the keywords of their communication are being picked up by the system's speech recognition engine. These keywords are then used to search and download the corresponding images from the Internet. When users for example speak about "houses" or "flowers," different images of "houses" or "flowers" are downloaded. As there is usually a vast amount of images available for each keyword, users see new image icons constantly being retrieved from the Internet. All images are then collectively displayed in 3-D in the system's interactive window and streamed from the respective side of each user. As images come from either the left or right side of the screen, they all stream toward each other before leaving the screen and being replaced by new images derived from new keywords spoken by the two users. The entire image scenario on the window surface constantly changes, since it is a direct interpretation of the users' dialogue and communication with each other.

Both users can also touch the image icons on the screen: this halts the images temporarily so users can look at specific image icons in more detail. By doing this, the exact web

address (URL) for this specific image icon can be downloaded onto a separate computer screen so users find out where this image came from and what it refers to.

Riding the Net thus provides an entertaining and playful way to browse the Internet and, somewhat similar to watching TV, users become intensively engaged in the vast amount of visual information available and presented by the system. However Riding the Net is obviously more interactive than watching TV, and users can control the content of what they are watching through their own decisions, dialogue and interaction.

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Company:	LivePerson.com
Product:	LivePerson
Wesite:	http://www.liveperson.com
Keywords:	Communication, chat, customer support
Sensuality:	Sight, Touch.

Abstract
LivePerson is a provider of online sales and customer service solutions. Over 1500 Web sites currently use theri solutions to answer customer questions, satisfy customers, build relationships and deliver results. LivePerson Exchange enables your operators to interact online with their customers at critical moments during their visit. LivePerson offers Web sites a timely and cost-effective means of providing customers with a number of options to communicate with them online. Combining the interactive nature of the Internet with the dependability of traditional customer service. Software individualized for industry type: Travel, Financial , B2C and Technology.

Live persons have full sensory capability, so even where these senses are not directly engaged, they are conveyed nonetheless in realtime conversations. This is especially effective at the point that you really want to talk to someone about a particular need. When this happens, an overall sense of “touch “ is conveyed. Among the features:

Chat and Site Monitoring Capability
Push Pages, HTML and Preformatted Response Capability
Support Multiple Languages for User Interface
Interactive FAQ / Knowledgebase for Customer Self Service

LivePerson (NASD: LPSN)

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ZevNet and AutoNet
http://www.calit2.net/transportation/10-19_meeting.html

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Company: Fakespace Systems

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e-Touch Software by Novint technologies
http://www.novint.com/etouch.htm

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Renja from Renja.com, what they’re doing. They’re the people who exchange image and imagination over the network, and the two people have been doing that for nearly ten years. And recently they are working with an artist, a visual artist who [WORD]. So what they’re doing is how to exchange visual image with tactile image using all kind of possible variable technology. I think this is a very interesting model of collaboration. So those artists who can see, they came to realize what is this to see words through tactile sense, through the imagination or the world of the blind person. The blind person try to find out how artist who can see visualize the work and how it can be conveyed to him through many different ways. I think maybe if you check it, you will get many interesting ideas.

http://www.digitalearth.org/newmat/cussans.htm

http://www.codezebra.net/

Appendix C.

Conferences Covering Sense-based Media

Conference: Interaction 2001 Conference
Website: http://www.ipsj.or.jp/
http://www.shift.jp.org/053/interaction2001/index2.shtml

Abstract
The fifth symposium 'Interaction2001' was held March 4 and 5 at Waseda University Tokyo. "Interaction" is the symposium which Information Processing Soc. of Japan sponsors. The symposium's focus is the cooperation of the real organic world and "information technology".

Conference: Subtle Technologies Conference
Website: http://www.subtletechnologies.com/

Abstract
The 4th Annual Subtle Technologies Conference is an opportunity for scientists and artists to come together and share each others language in those areas which are still searching for definitions, explanations and meaning. This conference blurs the boundaries between art and science.

Conference: International Conference on Virtual Systems and MultiMedia
Website: http://www.vsmm.org/vsmm2001

Abstract
The International Society on Virtual Systems and MultiMedia and the Center for Design Visualization, University of California the 7th International Conference on Virtual Systems and MultiMedia in Berkeley California, USA, 25-27 October 2001. This year's conference theme is "ENHANCED REALITIES: Augmented and Unplugged."

At the crossroads of rapidly evolving wireless technologies and rich 3D authoring tools, this conference explores the technologies and applications of Enhanced Environments, with a focus on the specific areas of: Virtual Heritage, Immersive Art and Creative Technology, and Virtual Design (Industrial, Architectural and Medical), plus a Special Session on Emerging Virtual Entertainment Directions.

More information can be found on the official conference website:
http://www.vsmm.org/vsmm2001

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Conference: SIGGRAPH
Website: http://www.siggraph.org/

Abstract

While many conferences are being cancelled or postponed, SIGGRAPH continues to experience steady growth in its 28th year. 34,000 people attended this year's event including an estimated 6,000 people in 75 countries. SIGGRAPH continues to be one of the most well organized, large-scale conferences anywhere. There are big, clear signs everywhere, a great information booth, well-informed volunteers and short taxi lines. Having already chosen next years program chairs, organizers are able to take the pulse of the event, solicit advice and rally support and enthusiasm for next year. Even the technology worked!

Michael Schrage from the MIT Media Lab has noted that “increasingly innovation is the by-product of the way people behave around the prototype.” If you have a vested interest in the successful implementation of interactive technologies, especially around human-computer interface development, then head to this event for a day or two and pay careful attention to audience behavior around the prototypes exhibited there. You are likely to learn a great deal that will inform your own development plans and/or help save you a bundle in research dollars by avoiding the costly mistakes of others. SIGGRAPH is an unusually fertile environment for this kind of intelligence due to the interesting overlap between academic research, artist led experimentation and commerce. Add the large international and local draw and you find a rare cross-cultural sampling for assessing product viability.

SIGGRAPH’s longevity also provides firm footing for experimental sessions that complement its tried and true core program. Over the years the conference has adapted to the evolving digital landscape by producing new events like Web 3d Roundup (a digital gong show), the Animation Festival (a curated collection of state of the art animated shorts), and Sensapalooza (A TV style presentation of new human sense-based media- from touch to smell.) New to the 2002 agenda is a core program in Web Graphics.

The exhibition hall is the main business domain where Sun and SGI have held court for years.

Conference: Sig CHI
Website: http://www.acm.org/sigchi/chi2002/indexcopy.html

Abstract
The annual CHI (Computer Human Interface) conference is the leading international forum for the exchange of ideas and information about human-computer interaction (HCI).3000 attendees and 55 members of the press attended the event and a record number of newcomers in 2001. The conference draws a good number of international attendees. If you carefully map out the agenda, then this conference can be really valuable.

There were a plethora of sensor-based technologies represented here and applications using motion-tracking, eye tracking and sophisticated pattern recognition algorithms. Augmented and mixed reality displays were prevalent, as were wireless, mobile communications, pen and notebook based products and haptics.

CHI 2002 will highlight specific areas of interest that relate to the conference theme: Changing the World, Changing Ourselves, drawing attention to the profound changes interactive technologies have made and will continue to make in the way we work, play, communicate, and think. Areas of interest include:

- Radical visions of computing in the future, from nanotechnology to spiritual computing
- How such new visions will change the way we work, play, and think
- How HCI as a body of knowledge and practice will change
- Retrospectives on how technology has transformed individuals and society in the past
- Reflection on how HCI research and practice have changed as new technologies have emerged and been adopted
- Case studies of design and usability in practice
- New, integrative, or forward-looking perspectives on HCI
- HCI and its social and economic implications

Conference: Uncommon Senses: An International Conference On the Senses in Art and Culture"
Website: http://alcor.concordia.ca/~senses/

Abstract

An Interdisciplinary Conference on the Senses in Art and Culture at Concordia University, features artworks which address the subtle but powerful links between the senses, lived experience and æsthetic meaning.

Drawing inspiration from recent research on the senses in the social sciences, literature and art, Uncommon Senses will pose a series of questions: What lies beyond the scope of the aesthetic gaze? How do artworks involving taste, touch and smell transgress and reconceive definitions of art? What models of sensory aesthetics exist in non-Western cultures? How is technology reinventing the senses? What are the historical roots of contemporary sensory paradigms? How are the senses engaged (or manipulated) in popular culture? In what manners can difference - whether based on culture, class, gender or sexuality - be mobilized to counter and reconfigure hegemonic understandings of the senses?

The following are some of the panel topics for the conference:

- Innovative and non-traditional uses of the senses in visual art, architecture, music, performance, film and other media
- The cultural history of the senses
- Cybersenses: technology and the future of perception
- Synaesthesia/anaesthesia: shock, mixing, numbing and disruption of the senses
- Popular entertainments: affect and sensationalism of the senses
- Cultural difference/sensory difference
- Design and the senses

Concordia University, Montreal.

Conference: ARS Electronica
Website: http://www.aec.at/festival2001/

Abstract

Art as a Test-Drive of the Future Ars Electronica 2001 sets out on the trajectory of this burst of creativity to track the scenes, sites and protagonists of the art of tomorrow. Experimental arrays by these protagonists are being developed further in order to provide these models and motifs of artistic activity with compatible forms of presentation that are capable of also stimulating suitable situations in which to encounter them. The scientific method of some projects plays just as integral a part in the whole as the proximity of

others to experimental entertainment. The festival as an art institution functions as a transfer node, as a marketplace of ideas, processes and ways of working.

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Conference: Doors of Perception
Website: http://www.doorsofperception.com

Abstract
Doors of Perception (Doors) is an international conference and knowledge network which
sets new agendas for design – in particular, the design agenda for information and communication technologies (ICTs). Six conferences have been organised since 1993, with an average attendance of about one thousand people; they come from a total – so far – of 52 countries, the mixture being roughly 50:50 Dutch and foreign attendees.

The results of Doors are published on our website (you're in it now) which is visited by more than 500,000 people a year; the site won a People's Voice Award at the Webbies – the so-called "Oscars of the Internet" – in 1999. The conference also features live 'webcasts', and an interaction design bazaar for graduate design students from around the world to present projects. In addition to five Doors conferences, there have been Open Doors public events, two Doors On Tour roadshows (to the USA and India), two CD-Roms, and a book.

The result, six years on, is a worldwide community at the front of new thinking on design. In the words of Wired, Doors is where "top conceptual thinkers ruminate on sticky new media subjects"; for Scientific American, Doors "examines new paths to development . . . a place where key questions are raised"; NRC Handelsblad recognised that Doors "brings together the international avant-garde in new media and computer networks"; for Süddeutsche Zeitung, Doors is "an international focal point for new thinking on design and innovation"; the Independent found Doors "a great place to find out about the future of design".

Until 1999, Doors was organised by The Netherlands Design Institute. Beginning in January 2000, Doors of Perception became an independent foundation [and we are looking for sponsorship]. John Thackara, formerly director of the Netherlands Design Institute, and Kristi van Riet are the directors of the new foundation.

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Conference: The first IEEE international conference on sensors
Website: http://www.ewh.ieee.org/tc/sensors/Sensors2002_announcement.htm

Abstract

The aim of the conference is to bring together scientists and engineers who work on sensor science and technology. The topics of interest include (but are not limited to)

1. Sensor phenomena & characterization
2. Sensor systems: multiple-sensor systems, intelligent sensing, sensor arrays, "electronic nose" technology, sensor buses, sensor networks, voting systems, telemetering
3. Mechanical and thermal sensors
4. Optoelectronic/photonic sensors
5. Ionizing radiation sensors
6. Integrated and combined sensor devices: fiber optics, photometry, fluorimetry, interfermetry, electrical + mechanical, etc.
7. Microwave/millimeter wave sensors
8. Magnetic sensors
9. Chemical and biological sensors
10. Mass-sensitive devices
11. Sensor-actuators
12. Sensor applications: automotive, medical, environmental monitoring, consumer, alarm and security, military, nautical, aeronautical and space sensor systems, robotics, automation, etc.
13. Intelligent sensors for on-line monitoring and process control; test kits
14. Internet based and other remote data acquisition and control of sensors
15. Packaging and interconnections
16. Sensor signal processing and array sensor fusion
17. Sensor materials
18. CAD modeling and testing of sensors

Conference: Tech-u-wear
Website: http://www.tech-u-wear.com/

Abstract

tech-u-wear 2001 will focus on the technologies behind wearable computing and the latest business applications driving the market forward. This is where display manufacturers, wireless technology companies, chip manufacturers, battery producers, "smart fabric" makers and speech-recognition companies will meet to forge the future of the industry and make crucial strategic partnerships.

Expert panel sessions will focus on key technical issues, such as minimizing weight and energy consumption, improving reliability and ruggedness, creating scalable systems and ergonomics. Fully interactive case studies will look at current business uses of wearable

computers in the field, including warehouse management systems, medical and fitness monitoring, and repair and maintenance staff support.

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Penton's announcement WiFi local wireless event, First Conferences says that it's kicking off the

802.11 Conference and Exhibition Dec. 3-4 in Austin, as well as an "industry portal" for 802.11 issues. The FirstConf folks are also working on

DistributedWorld, focused on peer-to-peer and other distributed computing technologies, scheduled for Austin on Oct. 23-24,

tech-u-wear, covering wearable technology, and planned for the end of October in New York...

And just to prove that it doesn't have to be all bad news out there, the folks at CTIA Wireless IT & Internet 2001 show are crowing about the event's growth, which they claim is doubling in terms of show floor space from last year. Now to get those attendees to come...

(Insert History of Sensory-Based Media Graph Here?)

Pda’s phones to sensors/ smart notification systems/ambient notification/ to gesture based interactions/ to brain induced modifications to telepathy.