Many of the MIT Media Lab research projects described in the following pages are conducted under the auspices of sponsor-supported, interdisciplinary Media Lab centers, consortia, joint research programs, and initiatives. They are:

**Autism & Communication Technology Initiative**
The Autism & Communication Technology Initiative utilizes the unique features of the Media Lab to foster the development of innovative technologies that can enhance and accelerate the pace of autism research and therapy. Researchers are especially invested in creating technologies that promote communication and independent living by enabling non-autistic people to understand the ways autistic people are trying to communicate; improving autistic people’s ability to use receptive and expressive language along with other means of functional, non-verbal expression; and providing telemetric support that reduces reliance on caregivers’ physical proximity, yet still enables enriching and natural connectivity as wanted and needed.

**CE 2.0**
Most of us are awash in consumer electronics (CE) devices: from cell phones, to TVs, to dishwashers. They provide us with information, entertainment, and communications, and assist us in accomplishing our daily tasks. Unfortunately, most are not as helpful as they could and should be; for the most part, they are dumb, unaware of us or our situations, and often difficult to use. In addition, most CE devices cannot communicate with our other devices, even when such communication and collaboration would be of great help. The Consumer Electronics 2.0 initiative (CE 2.0) is a collaboration between the Media Lab and its sponsor companies to formulate the principles for a new generation of consumer electronics that are highly connected, seamlessly interoperable, situation-aware, and radically simpler to use. Our goal is to show that as computing and communication capability seep into more of our everyday devices, these devices do not have to become more confusing and complex, but rather can become more intelligent in a cooperative and user-friendly way.

**Center for Future Civic Media**
A joint effort between MIT’s Media Lab and Comparative Media Studies Program, the Center for Future Civic Media creates technical and social systems for sharing, prioritizing, organizing, and acting on information. The Center uses the term civic media, rather than citizen journalism: civic media is any form of communication that strengthens the social bonds within a community or creates a strong sense of civic engagement among its residents. Civic media goes beyond news gathering and reporting: it ensures the diversity of inputs and mutual respect necessary for democratic deliberation. The Center for Future Civic Media is funded by a four-year grant from the Knight Foundation.

**Center for Future Storytelling**
Storytelling is fundamental to being human: it’s how we share our experiences, learn from our past, and imagine our future. With the establishment of the Center for Future Storytelling, the Media Lab is rethinking what "storytelling" will be in the 21st century. The Center will take a dynamic new approach to storytelling, developing new creative methods, technologies, and learning programs that recognize and respond to the changing communications landscape. The Center will examine ways for transforming storytelling into social experiences, creating expressive tools for the audience and enabling people from all walks of life to embellish and integrate stories into their lives, making tomorrow's stories more interactive, creative, democratized, and improvisational. It will seek to bridge the real and the virtual, creating tools for both adults and children that allow stories to incorporate synthetic characters and actors, such as robots. It will also pioneer innovative imaging technologies, from new systems for movement capture, to "morphable" movie studios that allow one physical space to represent a variety of settings.

The most current information about our research is available on the MIT Media Lab Web site, at http://www.media.mit.edu/research/.
Communications Futures Program
The Communications Futures Program conducts research on industry dynamics, technology opportunities, and regulatory issues that form the basis for communications endeavors of all kinds, from telephony to RFID tags. The program operates through a series of working groups led jointly by MIT researchers and industry collaborators. It is highly participatory, and its agenda reflects the interests of member companies that include both traditional stakeholders and innovators. It is jointly directed by Dave Clark (CSAIL), Charles Fine (Sloan School of Management), Andrew Lippman (Media Lab), and David P. Reed (Media Lab).

Consumer Electronics Laboratory
The Consumer Electronics Laboratory provides a unique research environment to explore ideas, make things, and innovate in new directions for consumer products and services. Research projects, which span the entire Media Lab and beyond, focus on: innovative materials and design/fabrication methods for them; new power technologies; new sensors, actuators, and displays; self-managing, incrementally and limitlessly scalable ecosystems of smart devices; cooperative wireless communications; co-evolution of devices and content; and user experience. An overarching theme that runs through all the work is the co-evolution of design principles and technological discoveries, resulting in simple, ubiquitous, easy- and delightful-to-use devices that know a great deal about one another, the world, and the people in their proximity.

Digital Life
Digital Life consortium activities engage virtually the entire faculty of the Media Lab around the theme of "open innovation." Researchers divide the topic into three areas: open communications, open knowledge, and open everything. The first explores the design and scalability of agile, grassroots communications systems that incorporate a growing understanding of emergent social behaviors in a digital world; the second considers a cognitive architecture that can support many features of "human intelligent thinking" and its expressive and economic use; and the third extends the idea of inclusive design to immersive, affective, and biological interfaces and actions.

Social Health Living Laboratory
Instead of building on a reactive health-care system centered around treating disease rather than preventing it, the Lab's Social Health Living Laboratory is focused on developing a proactive, social health system: a network of organizations and tools to give people the knowledge and support they need to maintain health, vitality, and happiness throughout their entire lives. This involves developing devices such as mobile phones that record our daily patterns, and smart exercise equipment that knows our personal patterns and life-style goals. This initiative integrates persuasive technologies, to help us make better decisions and adopt better behaviors; personal sensing, to increase our awareness of our bodies; personal collective intelligence, to collect knowledge from our peers; and socially aware computation and communication systems that are aware of us as social beings.

Things That Think
Things That Think, the Lab's largest consortium, is inventing the future of digitally augmented objects and environments. Toward this end, Things That Think researchers are developing sophisticated sensing and computational architectures for networks of everyday things; designing seamless interfaces that bridge the digital and physical worlds while meeting the human need for creative expression; and creating an understanding of context and affect that helps things "think" at a much deeper level. Things That Think projects under way at the Lab range from inventing the city car of the future to designing a prosthesis with the ability to help a person or machine read social-emotional cues—research that will create the technologies and tools to redefine the products and services of tomorrow.
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**Frank Moss—New Media Medicine**

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**Neri Oxman—Mediated Matter**

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**Joseph Paradiso—Responsive Environments**

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**Alex (Sandy) Pentland—Human Dynamics**

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V. Michael Bove Jr.—Object-Based Media
How to create communication systems that gain an understanding of the content they carry and use it to make richer connections among users.

1. Consumer Holo-Video
   V. Michael Bove Jr., James D. Barabas, Sundeep Jolly and Daniel E. Smalley
   The goal of this project, building upon work begun by Stephen Benton and the Spatial Imaging group, is to create an inexpensive desktop monitor for a PC or game console that displays holographic video images in real time, suitable for entertainment, engineering, or medical imaging. To date, we have demonstrated the fast rendering of holo-video images (including stereographic images that unlike ordinary stereograms have focusing consistent with depth information) from OpenGL databases on off-the-shelf PC graphics cards; current research addresses new optoelectronic architectures to reduce the size and manufacturing cost of the display system.
   Alumni Contributor: Quinn Y J Smithwick

2. Everything Tells a Story
   V. Michael Bove Jr., David Cranor and Edwina Portocarrero
   Following upon work begun in the Graspables project, we are exploring what happens when a wide range of everyday consumer products can sense, interpret into human terms (using pattern recognition methods), and retain memories, such that users can construct a narrative with the aid of the recollections of the "diaries" of their sporting equipment, luggage, furniture, toys, and other items with which they interact.

3. Guided-Wave Light Modulator
   V. Michael Bove Jr., Daniel Smalley and Quinn Smithwick
   We are developing inexpensive, efficient, high-bandwidth light modulators based on lithium niobate guided-wave technology. These modulators are suitable for demanding, specialized applications such as holographic video displays, as well as other light modulation uses such as compact video projectors.

4. Magic Hands: Multitouch Interfaces to Everyday Objects
   V. Michael Bove Jr. and David Cranor
   An assortment of everyday objects is given the ability to understand multitouch gestures of the sort used in mobile-device user interfaces, enabling people to use such increasingly familiar gestures to control a variety of objects and to "copy" and "paste" configurations and other information among them.
5. **NeverEnding Drawing**

*Cynthia Breazeal, V. Michael Bove Jr., Glorianna Davenport, David Robert, Edwina Portocarrero, Sean Follmer and Michelle Chung*

Inspired by the Surrealists' Exquisite Corpse art game, the NeverEnding Drawing project is one of several applications developed on a scalable architecture and platform for collaborative creativity. Users co-create and edit each other's augmented sketchbooks in real time. By tracking individual pages of each live sketchbook, the system loads the appropriate background audiovisual content and enables users to add to it using a variety of real materials and means of mark-making. Users take pictures and record sounds to be sent back and forth between collaborators on the network. Additionally, the live sketchbooks facilitate non-linear, asynchronous access to the evolving, co-created content through their physical editing interface. By using crayons, colored pens, and various tactile and light-diffusing materials, the analog/digital hybrid model of content creation requires no expertise and creates a safe environment for sharing unfinished work with others.

6. **ShakeOnIt**

*V. Michael Bove Jr. and David Cranor*

We are exploring ways to encode information exchange into preexisting natural interaction patterns, both between people and between a single user and objects with which he or she interacts on a regular basis. Two devices are presented to provoke thoughts regarding these information interchange modalities: a pair of gloves that requires two users to complete a "secret handshake" in order to gain shared access to restricted information, and a doorknob that recognizes the grasp of a user and becomes operational if the person attempting to use it is authorized to do so.

7. **SurroundVision**

*V. Michael Bove Jr. and Santiago Alfaro*

Adding augmented reality to the living room TV, we are exploring the technical and creative implications of using a mobile phone or tablet (and possibly also dedicated devices like toys) as a controllable "second screen" for enhancing television viewing. Thus, a viewer could use the phone to look beyond the edges of the television to see the audience for a studio-based program, to pan around a sporting event, to take snapshots for a scavenger hunt, or to simulate binoculars to zoom in on a part of the scene. Recent developments include the creation of a mobile device app for Apple products and user studies involving several genres of broadcast television programming.

8. **The "Bar of Soap": Grasp-Based Interfaces**

*V. Michael Bove Jr. and Brandon Taylor*

We have built several handheld devices that combine grasp and orientation sensing with pattern recognition in order to provide highly intelligent user interfaces. The Bar of Soap is a handheld device that senses the pattern of touch and orientation when it is held, and reconfigures to become one of a variety of devices, such as phone, camera, remote control, PDA, or game machine. Pattern-recognition techniques allow the device to infer the user's intention based on grasp. Another example is a baseball that determines a user's pitching style as an input to a video game.
9. Vision-Based Interfaces for Mobile Devices

V. Michael Bove Jr. and Santiago Alfaro

Mobile devices with cameras have enough processing power to do simple machine-vision tasks, and we are exploring how this capability can enable new user interfaces to applications. Examples include dialing someone by pointing the camera at the person's photograph, or using the camera as an input to allow navigating virtual spaces larger than the device's screen.

Ed Boyden—Synthetic Neurobiology

How to engineer intelligent neurotechnologies to repair pathology, augment cognition, and reveal insights into the human condition.

10. Cell-Type-Specific Optical Neuromodulation Interfaces

Ed Boyden, Brian Allen, Rachel Bandler, Jacob Bernstein, Giovanni Talei Franzesi, Mike Henninger, Justin Kinney, Emily Y Ko, Suhasa Kodandaramaiah, Caroline Moore-Kochlacs, Jorg Scholvin, Annabelle Singer, Ashley Kristin Turza, Christian Wentz and Anthony Zorzos

Neural stimulation hardware has traditionally been either electrical or magnetic in nature. Our lab has recently developed optogenetic molecular methods for making neurons able to be activated or silenced by multiple colors of light. We are engineering optical hardware systems for targetedly stimulating and inactivating neurons precisely, from one to many at a time, with complex spatiotemporal patterns, even in dense tissue in the living brain. We are also integrating electrophysiological readout of brain activity, so that closed-loop and real-time causal analyses of neural computation become possible. Our goal is to discover fundamental circuit-level principles for treating intractable psychiatric and neurological disorders.

11. Gene Therapy Devices

Ed Boyden, Jacob Bernstein and Stephanie Chan

Devices to facilitate gene therapy will be of increasing importance in years to come. We are developing fluidic systems to facilitate viral delivery in complex tissues.

12. Molecular Sensitizers for Optical Manipulation of Biological Systems

Ed Boyden, Yongku Cho, Brian Chow, Amy Chuong, Alison Dobry, Mike Henninger, Nathan Klapoetke, Tania Morimoto, Daniel Schmidt and Aimei Yang

We have engineered molecular sensitizers that make genetically specified neurons that can be activated and silenced by differently-colored pulses of light. This revolutionary technology enables us to reprogram neural networks at the millisecond timescale, opening up the systematic analysis and engineering of the brain, as well as completely novel methods of therapy. We are now developing new and improved molecules that transform energy into signals appropriate to control brain computations, and pursuing principles of use, as well as pre-clinical translational testing.
13. **Non-Invasive, Focal, and Portable Brain Stimulators**

*Ed Boyden, Leah Acker, Amy Chuong, Mike Henninger, Nathan Klapoetke and Fumi Yoshida*

Despite use in treating depression, and promise in treating stroke, Parkinson's, tinnitus, and other disorders, non-invasive brain stimulation technology is bulky, power-hungry, non-focal, and requires precision alignment with neural structures. We are applying modern engineering techniques to create a portable, focal, non-invasive brain stimulator that will enable a new platform for therapeutic neuromodulation.

14. **Principles of Controlling Neural Circuits**

*Ed Boyden, Leah Acker, Claire Ahn, Brian Allen, Rachel Bandler, Michael Baratta, Jacob Bernstein, Huayu Ding, Giovanni Talei Franzesi, Mike Heninger, Emily Y Ko, Albert Kwon, Pei-Ann Lin, Sonya Makhni, Patrick Monahan, Masaaki Ogawa, Alex Rodriguez, Annabelle Singer, Jenna Sternberg, Victoria Wang and Fumi Yoshida*

Neurological and psychiatric disorders afflict over one billion people worldwide, presenting annual costs exceeding $1 trillion. What are the principles of controlling neural circuits, in order to improve their functions and overcome intractable neurological and psychiatric disorders? We have invented cell-type-specific optical neural control technologies, and with them we are seeking to parse out the methods with which to fix activity in aberrant neural circuits, correcting the computational dynamics within, in order to discover new principles of treating neural disease.

15. **Real-Time Data Mining and Perturbation**

*Ed Boyden, Brian Allen, Doug Fritz, Justin Kinney, Caroline Moore-Kochlacs and Christian Wentz*

Complex data—such as neurophysiological recordings, or measures of human behavior, Internet, and general network data—are extremely difficult to analyze because of the dynamic nature of the high-dimensional set of interacting processes that generates the data. Accordingly, traditional statistical and data analysis methods—clustering, correlation, and so forth—can rarely create models sophisticated enough to explain the data without trying to explain noise, demanding astronomically sized datasets, or requiring enormous amounts of hand-tuning by insightful labor. We propose to design and develop a system that continuously generates novel data-modeling hypotheses and evaluates them in real time, testing models of ever-increasing complexity on data as it comes in.

**Cynthia Breazeal—Personal Robots**

How to build social robots that interact, collaborate, and learn with people as partners.

16. **3DprintedClock**

*Cynthia Breazeal, Peter Schmitt and Robert Swartz*

The 3DprintedClock project is the result of ready-assembled 3-D printed computational mechanisms, and is related to research in the fields of rapid prototyping and digital fabrication. The clock was modeled in CAD software after an existing clock, and uses a weight and a pendulum to keep track of time. The CAD model was created according to the specifications of the 3-D printer,
assuring sufficient gaps and clearances for the different parts. In addition, support material, drainage, and perforations were added to allow for excess support material being removed after printing. The 3DprintedClock is intended to demonstrate the superior capabilities of 3-D printing as a fabrication process. It should contribute toward the future use of 3-D printers to replace injection molding and expensive tooling processes, and allow for on demand, customized, and “greener” consumer products.

Alumni Contributor: William J. Mitchell

17. Crowdsourcing Human-Robot Interaction: Online Game to Study Collaborative Human Behavior

*Cynthia Breazeal, Jason Alonso and Sonia Chernova*

Many new applications for robots require them to work alongside people as capable members of human-robot teams. We have developed Mars Escape, a two-player online game designed to study how humans engage in teamwork, coordination, and interaction. Data gathered from hundreds of online games is being used to develop computational models of human collaborative behavior in order to create an autonomous robot capable of acting as a reliable human teammate. In the summer of 2010, we will recreate the Mars Escape game in real life at the Boston Museum of Science and invite museum visitors to perform collaborative tasks together with the autonomous MDS robot Nexi.

18. Dynamics of Initial Trust and Cooperation

*Cynthia Breazeal and Jin Joo Lee in conjunction with Northeastern University and Cornell University*

When meeting someone for the first time, we can walk away with an intuitive sense of how much we can trust that person. This intuition to evaluate trustworthiness possibly stems from non-verbal cues. We are investigating non-conscious mimicry as a powerful cue that can reveal information about trustworthiness not only between humans but also between robots and humans. In using robots, we can investigate whether this behavior can translate and replicate onto humanoid robots. Also, by using a robotic system, we can take advantage of its controlled behavior to advance our understanding of mimicry and its role in trust. In order to achieve natural social interactions between a robot and a person, we have developed an easy user interface to teleoperate our humanoid robot. The current demonstration will show our robot Nexi interacting with people in its environment through the use of this teleoperation interface.

19. I/O Stickers

*Natalie Anne Freed, Cynthia Breazeal, Leah Buechley, Jie Qi and Adam Michael Setapen*

I/O Stickers is an electronics construction kit made up of adhesive sensors and actuators. Users can place these special electronic stickers onto contact points in pre-wired and pre-programmed pages, and the pages will transmit the state of the input (sensor) sticker to a corresponding output (actuator) sticker. Building the electronics is a simple matter of matching the sticker to the correct footprint. Users can design the interaction by choosing the sensor and actuator stickers, and then personalize the interface by decorating over the flat, electronic stickers with their choice of craft materials. I/O Stickers is designed to empower users to create electronics while also leveraging existing skills in craft, resulting in works that are creatively expressive as well as technically sophisticated.
20. **Le Fonduephone**  
*Cynthia Breazeal, Natalie Anne Freed, David Robert and Emma Freed*

Young children learn language not through listening alone, but through active communication with a social actor. Cultural immersion and context are also key in long-term language development. We are developing a robotic conversational partner and a hybrid physical/digital environment for second language learning. In "Le Fonduephone," a young child learns French by sitting down at a cafe table with a plush robotic character and ordering food together. The table is situated within a projected virtual environment that provides an animated backdrop. The character models how to order food and as the child practices the new vocabulary, the food is delivered via projections onto the table's surface. Meanwhile, a teacher observes the interaction remotely via a virtual representation of the cafe and can adjust the robot's conversation and behavior to support the learner.

21. **Modeling the Dynamics of Social Interactions to Design for More Effective Human-Robot Interactions**  
*Cynthia Breazeal, Sigurdur Orn Adalgeirsson, Jason Alonso, Nicholas DePalma, Julian Hernandez, Jin Joo Lee, Adam Setapen and Kenton Williams*

As robots began to interact with us in our daily lives, they will need to be capable of perceiving and understanding our social nuances to effectively communicate with us. We are exploring nonverbal cues to design robots capable of “socially synching.” Research in human social psychology has found that mimicry and synchronous movement behavior are building blocks in fostering trust and rapport between people. To model such behaviors, we need a full-body perception of how people move in a social interaction. Using motion-capture technology like the Xbox Kinect, we can track the body movements of people, and through this head-to-toe representation, model the dynamics of social interactions between people in order to design for more effective human-robot interactions. The current demonstration will show steps towards this goal. Maddox, our humanoid robot, will try to learn how to perform different non-verbal gestures by mirroring/mimicking people.

22. **NeverEnding Drawing**  
*Cynthia Breazeal, V. Michael Bove Jr., Glorianna Davenport, David Robert, Edwina Portocarrero, Sean Follmer and Michelle Chung*

Inspired by the Surrealists' Exquisite Corpse art game, the NeverEnding Drawing project is one of several applications developed on a scalable architecture and platform for collaborative creativity. Users co-create and edit each other's augmented sketchbooks in real time. By tracking individual pages of each live sketchbook, the system loads the appropriate background audiovisual content and enables users to add to it using a variety of real materials and means of mark-making. Users take pictures and record sounds to be sent back and forth between collaborators on the network. Additionally, the live sketchbooks facilitate non-linear, asynchronous access to the evolving, co-created content through their physical editing interface. By using crayons, colored pens, and various tactile and light-diffusing materials, the analog/digital hybrid model of content creation requires no expertise and creates a safe environment for sharing unfinished work with others.
23. New Object Studio  
Peter Schmitt, Susanne Seitinger and Amit Zoran

New Object Studio challenges traditional design paradigms by approaching old and new design questions with innovative digital tools and fabrication processes. Using this approach, [N][O] Studio focuses on creating new artifacts. These new products combine mechanical and electronic components to challenge traditional notions of manufactured objects through their integrated functional, visual, and narrative qualities.

Alumni Contributor: William J. Mitchell

24. originalMachines  
Cynthia Breazeal and Peter Schmitt

The digital revolution has fundamentally changed our lives. Multimedia content-creation tools allow us to instantiate and share ideas easily, but most outcomes only exist on-screen and online--the physical world and everyday objects are largely excluded from a parallel explosion of mechatronic object creation. Services like Ponoko and Shapeways allow professionals and non-professionals to access computer-aided manufacturing (CAM) tools like 3D-printing and laser-cutting, but there are few (if any) design tools for creating complex mechanical assemblies that take full advantage of CAM systems. Creating unique mechatronic artifacts--Original Machines--thus requires more specific and sophisticated design tools than exist today. Object-oriented mechatronics is a parametric design approach that connects knowledge about mechanical assemblies and electronics with the requirements of digital manufacturing processes. The approach addresses the missing link between accessible rapid-manufacturing services and currently available design tools, creating new opportunities for self-expression through mechatronic objects and machines.

Alumni Contributor: William J. Mitchell

25. plywoodServo  
Cynthia Breazeal, Peter Schmitt and Susanne Seitinger

Animated artifacts require many different electronic and mechanical components, as well as appropriate drive software. This complexity has led to a kit-of-parts thinking in designing robotic assemblies, enabling more people to engage with animated devices. However, these robotics kits provide designers with a series of given constraints; the resulting black box becomes a form factor around which design is created rather than an integral part of the completed artifact, and these devices lack the specificity and material diversity of traditionally crafted artifacts. Many rapid prototyping tools propagate the same logic; for example, laser cutters are more frequently used to build casings that hide embedded mechanics and electronics than components that celebrate them. PlywoodServo considers a holistic approach to the design of animated artifacts in order to recapture the magic of engaging with their mechanical and electronic components together.

Alumni Contributor: William J. Mitchell

26. Robotic Textiles  
Cynthia Breazeal and Adam Whiton

We are investigating e-textiles and fiber-electronics to develop unique soft-architecture robotic components. We have been developing large area force sensors utilizing quantum tunneling composites integrated into textiles creating fabrics that can cover the body/surface of the robot and sense touch. By using e-textiles we shift from the metaphor of a sensing skin, often used in robotics, to
one of sensing clothing. We incorporated apparel design and construction
techniques to develop modular e-textile surfaces that can be easily attached to a
robot and integrated into a robotic system. Adding new abilities to a robot system
can become as simple as changing their clothes. Our goal is to study social touch
interaction and communication between people and robots while exploring the
benefits of textiles and the textile aesthetic.

27. Scruffy Planning

_Cynthia Breazeal, Henry Lieberman, Jason Alonso, Kenneth C. Arnold and Catherine Havasi_

Scruffy Planning is an effort to use dimensionality reduction to model learning,
memory, recall, and planning as all part of the same imprecise process. This
approach would allow robots and other artificial agents to learn from experience,
even superstitions. We aim to use this to train artificial agents, including synthetic
characters, using corpora of human-human interactions recorded with crowd-sourcing tools.

28. Storytelling in the Preschool of Future

_Ryan Wistort_

Using the Preschool of the Future environment, children can create stories that
come to life in the real world. We are developing interfaces that enable children to
author stories in the physical environment—stories where robots are the
characters and children are not only the observers, but also the choreographers and actors in the stories. To do this, children author stories and robot behaviors
using a simple digital painting interface. By combining the physical affordances of
painting with digital media and robotic characters, stories can come to life in the
real world. Programming in this environment becomes a group activity when
multiple children use these tangible interfaces to program advanced robot
behaviors.

29. TeleScrapbook and TelePostcard

_Cynthia Breazeal, Leah Buechley, Natalie Anne Freed, Jie Qi and Adam Michael Setapen_

TeleScrapbook and TelePostcard are pairs of wirelessly connected electronic
scrapbooks and electronic greeting cards, respectively. These electronic pages
use I/O Stickers—adhesive electronic sensors and actuators—to allow users to
design their own interfaces for remote communication. This project combines the
creative affordances of traditional paper craft with electronic interactivity and
long-distance communication. The simple, low-bandwidth connections made from
these sensors and actuators leave room for users to design not only the look and
function of the pages, but also the signification of the connections. By attaching
I/O Stickers to these special books and greeting cards, users can invent ways to
communicate with long-distance loved ones with personalized messages that are
also connected in real time.

30. The Alphabots

_Cynthia Breazeal, Natalie Anne Freed, David Robert and Adam Michael Setapen_

The Alphabots are trans-fictional(xF) mobile and modular semi-autonomous
robotic symbol set characters designed to play with preschool aged children
(three to six years old). In support of early development goals (literacy, numeracy
and shape recognition) educators and parents can take an active role in
co-designing playful learning interactions both on and off-screen.
Leah Buechley—High-Low Tech

How to engage diverse audiences in creating their own technology by situating computation in new contexts and building tools to democratize engineering.

31. A Kit-of-No-Parts

Leah Buechley and Hannah Perner-Wilson

The Kit-of-No-Parts is an approach to crafting electronics rather than designing discrete components. The collection of recipes and ingredients on the Kit-of-No-Parts website describes how to build electronics from a wide variety of conductive and non-conductive materials using a range of traditional and contemporary craft techniques.

32. Getting Hands-On with Soft Circuits

Leah Buechley and Emily Marie Lovell

Getting Hands-On with Soft Circuits is a set of instructional materials which seeks to expose middle and high school students to the creative, expressive, and computationally engaging domain of e-textiles. Engaging in hands-on activities, such as creating soft, electronic textile (e-textile) circuits, is one promising path to building self-efficacy and scientific understanding – both of which can have a dramatic impact on diversity in the field of computing. The instructional materials include a workshop activity guide and an accompanying kit of low-cost craft and electronic components.

33. I/O Stickers

Natalie Anne Freed, Cynthia Breazeal, Leah Buechley, Jie Qi and Adam Michael Setapen

I/O Stickers is an electronics construction kit made up of adhesive sensors and actuators. Users can place these special electronic stickers onto contact points in pre-wired and pre-programmed pages, and the pages will transmit the state of the input (sensor) sticker to a corresponding output (actuator) sticker. Building the electronics is a simple matter of matching the sticker to the correct footprint. Users can design the interaction by choosing the sensor and actuator stickers, and then personalize the interface by decorating over the flat, electronic stickers with their choice of craft materials. I/O Stickers is designed to empower users to create electronics while also leveraging existing skills in craft, resulting in works that are creatively expressive as well as technically sophisticated.

34. LilyPad Arduino

Leah Buechley

The LilyPad Arduino is a set of tools that empowers people to build soft, flexible, fabric-based computers. A set of sewable electronic modules enables users to blend textile craft, electrical engineering, and programming in surprising, beautiful, and novel ways. A series of workshops that employed the LilyPad have demonstrated that tools such as these, which introduce engineering from new perspectives, are capable of involving unusual and diverse groups in technology development. Ongoing research will explore how the LilyPad and similar devices can engage under-represented groups in engineering, change popular assumptions about the look and feel of technology, and spark hybrid communities that combine rich crafting traditions with high-tech materials and processes.
35. **LilyPond**
   
   *Emily Lovell, Leah Buechley, Kanjun Qiu and Linda Delafuente*
   
   LilyPond is a budding e-textile Web community that fosters creative collaboration through the sharing of personal projects. Home to a growing repository of skill- and project-based tutorials, LilyPond provides support for young adults who want to design and create soft, interactive circuits with the LilyPad Arduino toolkit.

36. **Living Wall**
   
   *Leah Buechley, Emily Lovell, David Mellis and Hannah Perner-Wilson*
   
   Run your hand across this wallpaper to turn on a lamp, play music, or control your toaster. This project experiments with interactive wallpaper that can be programmed to monitor its environment, control lighting and sound, and generally serve as a beautiful and unobtrusive way to enrich environments with computational capabilities. The wallpaper itself is flat, constructed entirely from paper and paint. The paper is paired with magnetic electronic modules that serve as sensors, lamps, network interfaces, and interactive decorations.

37. **Novel Architecture**
   
   *Leah Buechley, Jie Qi and Adrian Melia*
   
   This project is an experiment in material and scale: a life-sized pop-up book that you can open up and step into, made using only cardboard, an X-acto knife, tape, and glue. Inside the book is a kinetic mural of breathing pleated flowers. As you tug on a string of beads leading from one flower, the rest come to life, moving like puppets using a series of strings attached to motors. The mural itself is drawn using conductive fabric and copper tape, which serve as both expressive and functioning traces within the circuit. Electronic components are also openly displayed and emphasized to explain the electronic workings behind the mural.

38. **Open Source Consumer Electronics**
   
   *David A. Mellis and Leah Buechley*
   
   We offer case studies in the ways that digital fabrication allows us to treat the designs of products as a kind of source code: files that can be freely shared, modified, and produced. In particular, the case studies combine traditional electronic circuit boards and components (a mature digital fabrication process) with laser-cut or 3D printed materials. They demonstrate numerous possibilities for individual customizations both pre- and post-fabrication, as well as a variety of potential production and distribution processes and scales.

39. **Self-Folding Origami Paper**
   
   *Leah Buechley and Jie Qi*
   
   A first-step toward origami robotics, I/O paper is a pair of origami papers in which the red (controller) paper senses how it is being folded and the white (output) paper follows. When the white paper is flipped over, blintz folding allows the paper to get up, wobble around, and even flip itself over. The microcontroller and circuitry is on the body of the red paper and the white paper is actuated by shape memory alloy.

40. **TeleScrapbook and TelePostcard**
   
   *Cynthia Breazeal, Leah Buechley, Natalie Anne Freed, Jie Qi and Adam Michael Setapen*
   
   TeleScrapbook and TelePostcard are pairs of wirelessly connected electronic scrapbooks and electronic greeting cards, respectively. These electronic pages use I/O Stickers—adhesive electronic sensors and actuators—to allow users to design their own interfaces for remote communication. This project combines the
creative affordances of traditional paper craft with electronic interactivity and long-distance communication. The simple, low-bandwidth connections made from these sensors and actuators leave room for users to design not only the look and function of the pages, but also the signification of the connections. By attaching I/O Stickers to these special books and greeting cards, users can invent ways to communicate with long-distance loved ones with personalized messages that are also connected in real time.

41. **Textile Sensors**  
*Leah Buechley and Hannah Perner-Wilson*

We are exploring ways to build sensors using a variety of crafting and needlework techniques, using affordable and available materials such as conductive threads, yarns, fabrics, and paints. These materials are used to sew, knit, crochet, embroider, and laminate, creating a range of textile-based sensors.

42. **Tilt-Sensing Quilt**  
*Leah Buechley and Hannah Perner-Wilson*

This shape-sensing quilt consists of a communicating grid of textile tilt sensors. It showcases the wide variety of techniques we have developed for constructing fabric-based sensors and circuits.

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**Chris Csikszentmihályi—Civic Media**

How to create technical and social systems for sharing, prioritizing, organizing, and acting on information.

43. **BrownBag Toolkit**  
*Chris Csikszentmihályi, Rick Borovoy and Matthew Hockenberry*

We are building a set of free, open-source Web and mobile tools to support informal face-to-face meetings and organizing. The first of these tools we’ve developed provides a lightweight solution for group brainstorming and decision making.

44. **Department of Play**  
*Chris Csikszentmihályi and Leo Burd*

NEW LISTING

The Department of Play (DoP) is a working group of researchers, students, and community practitioners who share a common passion: the design of appropriate technology and methods to empower youth and their communities. In particular, the Department of Play initiative aims to develop an easy-to-use, open-source digital toolkit to foster youth participation, social inclusion and local civic engagement. Among other things, we are currently developing a multimedia neighborhood mapping editor that uses kites with cameras to collect community images. We are also implementing a multi-channel neighborhood communication system that combines email, SMS and regular phones to help young people organize and promote block parties, games, performances and other events in the places where they live.
45. **ExtrACT**

*Chris Csikszentmihályi, Matthew Gordon, Matthew Hockenberry and Sara Wylie*

ExtrACT, a set of Internet-based databasing, mapping, and communications technologies for communities impacted by natural gas development, is a novel platform for community education and civic action. Its objective is to create and distribute open-source, Web-based tools for mapping, analyzing, and intervening in this industry based on supplementing data obtained from state and federal agencies with user-generated reports, complaints, and experiences. All of these tools, though accessible individually, will share information through a unified database. Because these tools will serve both urban and rural populations, we are also developing innovative paper and phone interfaces to the Web services. To develop these tools we are working with a network of lawyers, citizen’s alliances, national activist organizations, and environmental health experts in Colorado, New Mexico, Ohio, New York, Pennsylvania, West Virginia, and Texas.

Alumni Contributors: Daniel F Ring and Ke Xu

46. **Homeless Neighbors**

*Chris Csikszentmihályi, Rick Borovoy, Matthew Hockenberry and Spare Change News*

By working in the same public spot over a long period of time, street vendors and panhandlers often amass a large amount of social capital. We are building tools for street vendors to reify their social networks online. These tools will help them leverage this social capital for upward mobility, and enhanced community building.

47. **Junkyard Jumbotron**

*Chris Csikszentmihályi, Andy Lippman, Rahul Bhargava, Rick Borovoy and Brian Kneb*

The Junkyard Jumbotron (JJ) lets one take a collection of random screens and instantly stitch them into one large virtual display simply by taking a picture or their arrangement. The software works with laptops, smartphones, tablets—anything that runs a web browser. It shows a new way of using mobile devices to create a feeling of community: ganging mobile devices together to create a shared experience. And the JJ is designed from the ground up to make the process of connecting heterogeneous user devices together "in the wild" easy and fun, with no anti-social wireless configuration, app installation, or device compatibility anxiety.

48. **Landman Report Card**

*Chris Csikszentmihályi, Matthew Gordon, Matthew Hockenberry and Sara Wylie*

Landman Report Card is the first in a suite of applications designed to help communities affected by extractive industries to recognize, report, and act on their interests. LRC allows landowners to document, discuss, and rate their experiences with landmen, the professional negotiators who work for oil and gas companies. We are currently deploying the application in communities in several states in the US.

Alumni Contributors: Daniel F Ring and Ke Xu
49. **LostInBoston.org**  
*Chris Csikszentmihályi, Rahul Bhargava and Rick Borovoy*

LostInBoston.org is about helping Bostonians work together to make their neighborhoods more visitor-friendly. Community groups are partnering with local businesses and institutions to design signs that call out the key spots in their area. Signs are placed on private land in public places.

Alumni Contributor: Ke Xu

50. **News Positioning System**  
*Chris Csikszentmihályi, Matthew Gordon, Matthew Hockenberry and Sara Wylie*

NPS is a way to archive and share your news geographically. Through NPS you can create a shared archive of news, as well as represent that archive on a searchable map. You can choose to share your news only with your group, or with the public in general. Location matters when sharing news, and NPS can be used to find out about news in your area.

Alumni Contributors: Daniel F Ring and Ke Xu

51. **Red Ink**  
*Chris Csikszentmihályi and Ryan O'Toole*

Red Ink is an open-source web service for ad hoc groups to share and interpret their collective financial data. It includes interfaces for defining transactions upon which to aggregate, methods of visualization, and public and private web publishing.

52. **VoIP Drupal**  
*Chris Csikszentmihályi and Leo Burd*

VoIP Drupal is an innovative framework that brings the power of voice and Internet-telephony to Drupal sites. It can be used to build hybrid applications that combine regular touchtone phones, web, SMS, Twitter, IM and other communication tools in a variety of ways, facilitating community outreach and providing an online presence to those who are illiterate or do not have regular access to computers. VoIP Drupal will change the way you interact with Drupal, your phone and the web. Feel free to contact us at any time!
Hugh Herr—Biomechatronics
How technology can be used to enhance human physical capability.

53. Artificial Gastrocnemius

Hugh Herr and Ken Endo

Human walking neuromechanical models show how each muscle works during normal, level-ground walking. They are mainly modeled with clutches and linear springs, and are able to capture dominant normal walking behavior. This suggests to us to use a series-elastic clutch at the knee joint for below-knee amputees. We have developed the powered ankle prosthesis, which generates enough force to enable a user to walk "normally." However, amputees still have problems at the knee joint due to the lack of gastrocnemius, which works as an ankle-knee flexor and a plantar flexor. We hypothesize that metabolic cost and EMG patterns of an amputee with our powered ankle and virtual gastrocnemius will dramatically improve.

54. Biomimetic Active Prosthesis for Above-Knee Amputees

Ernesto C. Martinez-Villalpando and Hugh Herr

We propose a novel biomimetic active prosthesis for above-knee amputees. The clinical impact of this technology focuses on improving an amputee’s gait symmetry, walking speed, and metabolic energy consumption on variant terrain conditions. The electromechanical design of this robotic device mimics the body’s own musculoskeletal design, using actuator technologies that have muscle-like behaviors and can integrate control methodologies that exploit the principles of human locomotion. This work seeks to advance the field of biomechatronics by contributing to the development of intelligent assistive technologies that adapt to the needs of the physically challenged.

55. Command of Powered Ankle Angle using Electromyography

Hugh Herr and Matthew Robert Williams

While the current powered ankle under development can readily adapt to constant surfaces while walking (including slopes and stairs), it is unable to predict slope transitions; particularly when the walking surface changes from a positive to a negative slope (or vice versa) within one step. This project explores to effect of using voluntary electromyography (EMG) signal from muscles in the residual limb to adjust ankle angle for better accommodation of slope transitions. Unilateral, trans-femoral amputees will walk across a course consisting of a series of changing slopes while using either a conventional prosthesis or the powered ankle with EMG commanded ankle position. It is thought that by giving the user a simple, effective, and rapid means of adjusting ankle angle, the safety and comfort of gait during rapid slope transitions can be improved.
56. **Control of Muscle-Actuated Systems via Electrical Stimulation**

*Waleed Farahat and Hugh Herr*

Motivated by applications in rehabilitation and robotics, we are developing methodologies to control muscle-actuated systems via electrical stimulation. As a demonstration of such potential, we are developing centimeter-scale robotic systems that utilize muscle for actuation and glucose as a primary source of fuel. This is an interesting control problem because muscles: a) are mechanical state-dependent actuators; b) exhibit strong nonlinearities; and c) have slow time-varying properties due to fatigue-recuperation, growth-atrophy, and damage-healing cycles. We are investigating a variety of adaptive and robust control techniques to enable us to achieve trajectory tracking, as well as mechanical power-output control under sustained oscillatory conditions. To implement and test our algorithms, we developed an experimental capability that allows us to characterize and control muscle in real time, while imposing a wide variety of dynamical boundary conditions.

57. **Effect of a Powered Ankle on Shock Absorption and Interfacial Pressure**

*Hugh Herr and David Hill*

Lower-extremity amputees face a series of potentially serious post-operative complications. Among these are increased risk of further amputations, excessive stress on the unaffected and residual limbs, and discomfort at the human-prosthesis interface. Currently, conventional, passive prostheses have made strides towards alleviating the risk of experiencing complications, but we believe that the limit of “dumb” elastic prostheses has been reached; in order to make further strides we must integrate “smart” technology in the form of sensors and actuators into lower-limb prostheses. This project compares the elements of shock absorption and socket pressure between passive and active ankle-foot prostheses. It is an attempt to quantitatively evaluate the patient’s comfort.

58. **Human Walking Model Predicts Joint Mechanics, Electromyography, and Mechanical Economy**

*Hugh Herr and Ken Endo*

We are studying the mechanical behavior of leg muscles and tendons during human walking in order to motivate the design of economical robotic legs. We hypothesize that quasi-passive, series-elastic clutch units spanning the knee joint in a musculoskeletal arrangement can capture the dominant mechanical behaviors of the human knee in level-ground walking. Biarticular elements necessarily need to transfer energy from the knee joint to hip and/or ankle joints, and this mechanism would reduce the necessary muscle work and improve the mechanical economy of a human-like walking robot.

59. **Human Walking Neuromechanical Models**

*Hugh Herr, Ken Endo and Jared Markowitz*

This research aims to extract a potentially small set of underlying principles that govern human movement and to apply that set of principles to biomimetic control systems. Using a morphologically realistic human model and kinematic gait data, we find that spin angular momentum in human walking is highly regulated, and that there exists a nonlinear coupling between center of mass transverse forces, center of mass position, and center of pressure location. Using an open loop optimization strategy, we show that biologically realistic leg joint kinematics emerge through the minimization of spin angular momentum and the sum of the joint torques squared. This suggests that both angular momentum and energetic factors are important considerations for biomimetic controllers.
60. Load-Bearing Exoskeleton for Augmentation of Human Running

Hugh Herr, Grant Elliott and Andrew Marecki

Augmentation of human locomotion has proved an elusive goal. Natural human walking is extremely efficient and the complex articulation of the human leg poses significant engineering difficulties. We present a wearable exoskeleton designed to reduce the metabolic cost of jogging. The exoskeleton places a stiff fiberglass spring in parallel with the complete leg during stance phase, then removes it so that the knee may bend during leg swing. The result is a bouncing gait with reduced reliance on the musculature of the knee and ankle.

61. Metabolic and Biomechanical Effects of Using a Powered Prosthetic Knee

Hugh Herr and Matthew Robert Williams

Gait research on trans-femoral prosthesis users has shown that the metabolic costs for these individuals are significantly higher than those of able-bodied individuals for level-ground walking. Additionally, trans-femoral amputees exhibit a much higher degree of gait asymmetry between the affected and non-affected sides, leading to reduced walking speeds and increased hip and back pain compared to non-amputees. This project consists of a clinical study of five to ten unilateral trans-femoral amputees using either a conventional or a powered knee prosthesis and height-weight matched able-bodied individuals. This work will compare the metabolic cost of transport and biomechanics of conventional standard of care prosthetic knees with a novel powered knee. Amputee performance with each prosthetic will also be compared to the performance of able-bodied individuals. It is hypothesized by using a powered prosthetic knee both the metabolic and biomechanical aspects of amputee gait can be improved.

62. Powered Ankle-Foot Prosthesis

Samuel Au and Hugh Herr

The human ankle provides a significant amount of net positive work during the stance period of walking, especially at moderate to fast walking speeds. Conversely, conventional ankle-foot prostheses are completely passive during stance, and consequently, cannot provide net positive work. Clinical studies indicate that transtibial amputees using conventional prostheses experience many problems during locomotion, including a high gait metabolism, a low gait speed, and gait asymmetry. Researchers believe the main cause for the observed locomotion is due to the inability of conventional prostheses to provide net positive work during stance. The objective of this project is to develop a powered ankle-foot prosthesis that is capable of providing net positive work during the stance period of walking. To this end, we are investigating the mechanical design and control system architectures for the prosthesis. We also conduct a clinical evaluation of the proposed prosthesis on different amputee participants.

63. Sensor-Fusions for an EMG Controlled Robotic Prosthesis

Matthew Todd Farrell, Hugh Herr

Current un-motorized prosthesis do not provide adequate energy return during late stance to improve level-ground locomotion. Robotic prosthesis can provide power during late-stance to improve metabolic economy in an amputee during level-ground walking. This project seeks to improve the types of terrain a robotic ankle and successfully navigate by using command signals taken from the intact and residual limbs of an amputee. By combining these commands signals with sensors attached to the robotic ankle it might be possible to further understand the role of physiological signals in the terrain adaptation of robotic ankles.
Cesar Hidalgo—Macro Connections
How to transform data into knowledge.

64. Complexity
Phil Salesses and César A. Hidalgo
In his famous work "The Image of the City," Kevin Lynch established how people perceive and create mental models of the cities in which they live. Since then, an important focus of both architecture and urban planning has been the study of urban perception, analyzing everything from the macro scale of a city to the micro details of a building. Technology, however, has limited the throughput of studies in urban perception by constraining these to a small number of images and subjects. Complexity is an online tool that can be used to simultaneously run a large number of evaluative urban studies using readily available data from Google Streetview. It can be used to collect and analyze information on the perception of cities, held by citizens from all around the globe.

65. Preference Networks
Phil Salesses and César A. Hidalgo
In recent years, collaborative filtering has become ubiquitous. Amazon, iTunes, and other services have popularized recommendation services based on the idea that similar users have overlapping preferences. These links, based mainly on co-purchasing, do not carry information on human preferences. This is because co-purchasing links are symmetric, undirected links and human preferences are asymmetric, directed links. This lack of preference information limits both the power of our current recommendation systems and our ability to use them for more forward-looking predictions. Preferences do exist. They vary among people and they affect decisions. Preference Networks aims to create tools for extracting preferences out of populations. By combining crowdsourcing techniques and large datasets, the value of hard to measure features, such as appeal of a product design or the aesthetic value of a building, can begin to be quantified.

66. The Economic Complexity Observatory
Alex Simoes, Dany Bahar, Ricardo Hausmann and César A. Hidalgo
With more than six billion people and 15 billion products, the world economy is anything but simple. The Economic Complexity Observatory is an online tool that helps people explore this complexity by providing tools that can allow decision makers to understand the connections that exist between countries and the myriad of products they produce and/or export. The Economic Complexity Observatory puts at everyone’s fingertips the latest analytical tools developed to visualize and quantify the productive structure of countries and their evolution.

67. The Economic Diversity Lab
Dany Bahar, Charles Gomez, Coco Krumme, Ricardo Hausmann and César A. Hidalgo
The geographical range of modern elephants is sub-Saharan Africa, parts of India, and Southeast Asia. But what is the geographical range of motorcycle-engine factories, or leather tanneries? Evolution and natural history can help us understand the geographical range of modern elephants, but can they also help us understand why some industries occur at some places and not others? The Economic Diversity Lab studies the geographical patterns defined by
economic activities and the connections of these patterns to prosperity and human well being. A joint effort with Harvard’s Center for International Development, the Economic Diversity Lab leads the development of tools that can help elucidate the origins of the geographical patterns defined by different economic activities and the coarsenss of global prosperity.

68. **The Notable Network and The Connected History**

*César A. Hidalgo*

James Watt (1736-1819), the Scottish engineer that perfected the steam engine, was a good friend of Adam Smith (1723-1790), the Scottish moral philosopher who wrote *The Wealth of Nations*. While both are notable historical characters, the link between them is practically unknown. Scottish philosopher David Hume (1711-1776) was also Smith’s friend, and some sources presume that he also knew Watt. These connections between notable historical characters motivate us to wonder how much their contributions were influenced by the richness of their intellectual environments and also whether intellectual enlightenments tend in general to have particular social signatures. The Notable Network project looks to map and document the connections between notable historical characters, both old and new to help develop a relational view of history to complement the atomized view.

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**Henry Holtzman—Information Ecology**

*How to create seamless and pervasive connections between our physical environments and information resources.*

69. **BiDi Screen**

*Henry Holtzman, Matt Hirsch, Douglas Lanman and Ramesh Raskar*

The BiDi Screen is an example of a new type of thin I/O device that possesses the ability both to capture images and display them. Scene depth can be derived from BiDi Screen imagery, allowing for 3D gestural and 2D multi-touch interfaces. This bidirectional screen extends the latest trend in LCD devices, which has seen the incorporation of photo-transistors into every display pixel. Using a novel optical masking technique developed at the Media Lab, the BiDi Screen can capture light field-like quantities, unlocking a wide array of applications from 3D gesture and touch interaction with CE devices, to seamless video communication.

70. **Bird's-Eye-View**

*Henry Holtzman, Polychronis Ypodimatopoulos and Boris Kizelshteyn*

A collage of face pictures provides a bird's-eye-view over the Media Lab community, displayed on a public touch-screen. Contrary to hierarchical directories, this collage provides one-click access to personal information for anyone in the community, lending itself more towards browsing than specific searching. We connect to individual Twitter accounts and mobile phone numbers, allowing the visitor to view a person's status and place a call to them. We also highlight the people that happened to walk by the screen up to five minutes ago by detecting their RFID tags.
71. CAMIT

**Henry Holtzman, Greg Elliott, David Carr, and David Cranor**

CAMIT is a web-based front-end to milling machines like the Model-A and for our own in-house $75 milling machine, the Mantis Machine. It allows drag-and-drop "printing" of circuit boards in seconds. It also captures all uploaded designs and allows anyone to optimize, modularize, change, or simply re-print them. CAMIT is a circuit-board design anyone can use.

72. DepthJS

**Pattie Maes, Henry Holtzman, Aaron Zinman, Doug Fritz, Greg Elliott and Roy Shilkrot**

DepthJS is framework that allows any web page to interact with Microsoft Kinect via Javascript. Navigating the web is only one application of the framework—we envision all sorts of applications that run in the browser, from games to specific utilities for specific sites. The great part is that now web developers who specialize in Javascript can work with Kinect without having to learn any special languages or code. We hope this will allow a new set of interactions beyond what we first developed.

73. Dual-Space Drawing

**Jee Yeon Hwang, Henry Holtzman, Mitchel Resnick and Sherry Turkle**

Dual-Space Drawing supports creative drawing and reflective learning experiences using dual layers: a screen display and a transparent display. Dual-Space Drawing users can reflect themselves and embody their ideas while designing scenes and drawing objects.

74. E-MotionInfo

**Jee Yeon Hwang and Henry Holtzman**

e-MotionInfo enables users to explore the harmonization of their movements, digital information, and responsive objects. e-MotionInfo creates links between motions, digital content, and associated objects to improve upon expressive and natural user interactions.

75. Ego

**Henry Holtzman, Andy Lippman and Polychronis Ypodimatopoulos**

Ego presents an agent-based, user-centered architecture for storing, discovering, and sharing information about an expandable set of applications, such as location, reviews, or buying and selling goods. Users can fluidly create agents that hold information relevant to their intentions. For example, for buying or selling, users could announce a product they are interested in, then the system creates a group of users interested in the same product, allowing direct discovery and analysis. Tradeoffs between factors such as reputation and physical location are considered. We demonstrate an interactive, tabletop visualization of different urban scenarios involving 1,000 agents that discover each other in the context of some personal interest.

Alumni Contributor: Charles Amick

76. Ghosts of the Past

**Henry Holtzman, Andy Lippman, Julia Shuhong Ma and Daniel Edward Schultz**

NEW LISTING

What if you could see what the past looked like from where you are standing? What if you could relive any event that happened at your current location? Ghosts of the Past allows you to create, save, and geotag panoramic canopies. Anyone
who subsequently visits that space can see what you have seen, joining with you to create time-lapsed socialization. Since each canopy is time-stamped and geotagged, it gives the user an anchor in space while they explore history. Any event, special or mundane, can be captured for anyone in the same location to view. QR codes are posted in building locations with an active canopy.

77. **Home Fabratory**

   *Henry Holtzman and David Carr*

   Using your personal fabratory, explore a world in which 3D printers cost as little as today's inkjets and are found in every home. We've developed several sub-$100 machines that demonstrate the practicality of this future, and greatly expand the range of items that can be created on your desktop. These new capabilities have far-reaching implications for personalization of products, direct-to-consumer production, and the creation of "information objects."

78. **HR3D: Glasses-Free 3DTV**

   *Ramesh Raskar, Douglas Lanman, Matt Hirsch and Yunhee Kim*

   For 3D displays to be successful, they must be bright enough to compete with 2D displays and not diminish display resolution. To date, stacked-LCD displays have employed parallax barriers, which use pinhole or bar patterns to provide view-dependent imagery. We show a prototype that adapts the imagery on both layers to multi-view 3D content, increasing brightness while maintaining display resolution. This promises a future of devices with sharp 2D screens and 3D displays with full horizontal and vertical parallax.

79. **If These Walls Could Tweet**

   *Henry Holtzman and Daniel Schultz*

   What if a building could sense what was happening inside of it, and tell the world? This project explores the concept of automated micro blogging—automatically generating and triggering short messages about what is going on in a particular context. The current platform is built around a modular sensor network which combines proximity, temperature, light, and sound values to make guesses about an environment and put those guesses to words.

80. **Konbit**

   *Greg Elliott, Aaron Zinman, Henry Holtzman and Pattie Maes*

   Konbit is a service that helps communities rebuild themselves after a crisis by indexing the skillsets of local residents, allowing NGOs to find and employ them. Haitians, their diaspora, and the international community can volunteer their skills via phone, SMS, or Web. Skills can then be searched in real time and location by NGOs such as the American Red Cross and Partners-in-Health. Konbit is language and medium neutral, where Kreyol voice and text messages may be translated into other languages through the Konbit phone, text, or Web interface.

81. **Make.Preview**

   *Henry Holtzman and David Carr*

   Make.Preview adds three-dimensional input and output devices to traditional 3D printers and fabrication machines. These enhanced capabilities enable users to "print preview" 3D objects before actually creating them.
82. **NeXtream: Social Television**

*Henry Holtzman, Reed Martin and Mike Shafran*

Functionally, television content delivery has remained largely unchanged since the introduction of television networks. NeXtream explores an experience where the role of the corporate network is replaced by a social network. User interests, communities, and peers are leveraged to determine television content, combining sequences of short videos to create a set of channels customized to each user. This project creates an interface to explore television socially, connecting a user with a community through content, with varying levels of interactivity: from passively consuming a series, to actively crafting one's own television and social experience.

Alumni Contributor: Ana Luisa Santos

83. **PalimPost**

*Li Bian, Roy Shilkrot, Pattie Maes and Henry Holtzman*

PalimPost is a converged system for storing, searching, and sharing digital and physical world information using sticky notes and mobile devices. PalimPost extracts contextual cues from a user's physical environment and activities, connects them to the user's digital world research, and subsequently presents to the user systematically categorized, relevant, and JIT information. Whether a user is writing down a shopping list on a sticky note after surfing the internet at home, or checking out hundreds of products at hand in a physical store, whether a user is preparing a list of dinner ingredients in the kitchen or buying food outside in the market, PalimPost integrates information from different time and location to form a seamlessly connected experiences for the user.

84. **Protocol**

*Greg Elliott, Hugo Van Vuuren and Henry Holtzman*

The quality of communication, in all its various forms, is heavily dependent on the appropriate medium, timing, and level of trust between parties. Protocol is a tool that helps you, and society at large, understand and share preferences—personal or professional protocol—to communicate more effectively. Protocol is a dynamic and syndicated contact sheet, seen most often as an email signature or status update; it also functions as an independent site. More specifically, we see it as a preference page to share how and where you want to be contacted. Soon you will be able to embed your protocol in your site of choice (hey about.me, flavours.me, linkedin.com and wordpress.com).

85. **Proverbial Wallets**

*Henry Holtzman, John Kestner, Daniel Leithinger, Danny Bankman, Emily Tow and Jaekyung Jung*

We have trouble controlling our consumer impulses, and there's a gap between our decisions and the consequences. When we pull a product off the shelf, do we know our bank-account balance, or whether we're over budget for the month? Our existing senses are inadequate to warn us. The Proverbial Wallet fosters a financial sense at the point of purchase by embodying our electronically tracked assets. We provide tactile feedback reflecting account balances, spending goals, and transactions as a visceral aid to responsible decision-making.
86. Qooqle  
*Li Bian and Henry Holtzman*

Qooqle allows people to reshape their interactions with computing and reorganize the world’s information through their casual conversations and habitual gestures. Qooqle combines mobile, cloud, and social media to draw people closer to computing and make computers more invisible. The multi-modal user interface of Qooqle allows people to engage with one another and the information world more naturally.

87. QRtcullis  
*Henry Holtzman, Andy Lippman, Boris Kizelshteyn, Julia Ma and Daniel Schultz*

Online games bring geographically separated people together in a virtual world. Board games bring people together in the physical world. QRtcullis is a game that does both. It is a place-based, multi-player, social game that can be played on any smartphone, tablet, or computer. It is a remix of the fort-explorer genre, updated to have a connection to the physical world through QR code-based markers. Play can be affected by real-world environment factors. Each fort can be populated with various objects that either help or hinder other players. Completing the fort may require solving a maze or other puzzles, answering riddles, or finding answers to questions about the real world. The goal is to find and complete as many forts as possible. QR codes will be placed throughout the Media Lab and on a screen in the Viral Spaces area where you can see and interact with all the players.

88. Queen’s New Clothes  
*Li Bian, Matt Hirsch, Lining Yao, Henry Holtzman and Hiroshi Ishii*

Inspired by the Danish fairy tale “The Emperor’s New Clothes” and Lady Gaga’s Orbit dress, we have designed and implemented a costume, The Queen’s New Clothes, which appears plain to the naked eye but exhibits changing patterns on photos taken at different times and locations. The process of making this costume has taken us on a journey of exploring the digital aspect and dual status of fashion, fashion as a dynamically changing and embodied visual communication tool, and the relationship between the fashion trendsetter and the audience.

89. Soundaround  
*Henry Holtzman, Ramesh Raskar, Matt Hirsch, Alex Olwal and Thomas A. Baran*

Recently, multi-view display hardware has made compelling progress in graphics. Soundaround is a multi-viewer interactive audio system, designed to be integrated into unencumbered multi-view display systems, presenting localized audio/video channels with no need for glasses or headphones. Our technical work describes a framework for the design of multi-viewer interactive audio systems that is general and supports optimization of the system for multiple observation planes and room responses.

90. Tableau  
*Henry Holtzman and John Kestner*

Remember when we made a connection by handing someone a photo? Now we fiddle with too many cables, menus, and communication channels, and those individual connections get drowned out. Can we return to physical experiences while retaining the collective intelligence of the network? Tableau is a side table that stores and retrieves memories. It may put friends’ photo postcards in the drawer, or post mementos to your online scrapbook. This is an example of
task-centric computing, where the interface is distributed across connected physical objects. Apps that run in the cloud can weave available objects into environmental I/O, giving users computing experiences that fit into the flow of life.

91. Takeover TV

*Henry Holtzman, Greg Elliott and David Carr*

Takeover TV heralds a new era of bar patronage where you and your like-minded friends are in charge of the screens. When you check in at a location, your likes and dislikes automatically influence what is being shown on local displays. If you want more control, start a vote to pick a new show using your beer glass—or your iPhone. Create season-premiere nights for your favorite shows, or work with friends to define the types of shows that play at your local bars. Sick of watching sports? Assemble enough fans of your favorite show at the local pub and take over the TV.

92. Tastes Like Rain

*Henry Holtzman, David Carr and David Zafrilla*

What if the taste of your toothpaste told you the weather? Leave your smartphone weather app in your pocket. Tastes Like Rain dynamically alters the flavor and color of your morning toothpaste to give you today's temperature and weather. No LCD required.

93. The Glass Infrastructure

*Henry Holtzman, Andy Lippman, Matthew Blackshaw, Rick Borovoy, Greg Elliott, Jon Ferguson, Catherine Havasi, Boris G Kizelshteyn, Julia Shuhong Ma, Daniel Edward Schultz and Polychronis Ypodimatopoulos*

This project builds a social, place-based information window into the Media Lab using 30 touch-sensitive screens strategically placed throughout the physical complex and at sponsor sites. The idea is get people to talk among themselves about the work that they jointly explore in a public place. We present Lab projects as dynamically connected sets of "charms" that visitors can save, trade, and explore. The GI demonstrates a framework for an open, integrated IT system and shows new uses for it.

94. Twitter Weather

*Henry Holtzman, John Kestner and Stephanie Bian*

The vast amounts of user-generated content on the Web produce information overload as frequently as they provide enlightenment. Twitter Weather reduces large quantities of text into meaningful data by gauging its emotional content. This Website visualizes the prevailing mood about top Twitter topics by rendering a weather-report-style display. Comment Weather is its counterpart for article comments, allowing you to gauge sentiment without leaving the page. Supporting Twitter Weather is a user-trained Web service that aggregates and visualizes attitudes on a topic.

95. Wall Paper

*Henry Holtzman and Daniel Schultz*

Wall Paper explores the ability to selectively display information in specific physical spaces. By intelligently rendering content based on people's proximity, the wall avoids being the cause of information overload despite the vast amount of information it provides. The project also explores the themes of personalized information and group interaction surrounding common content.
Hiroshi Ishii—Tangible Media
How to design seamless interfaces between humans, digital information, and the physical environment.

96. **Beyond: A Collapsible Input Device for 3D Direct Manipulation**

*Jinha Lee and Hiroshi Ishii*

Beyond is a collapsible input device for direct 3D manipulation. When pressed against a screen, Beyond collapses in the physical world and extends into the digital space of the screen, so that users have an illusion that they are inserting the tool into the virtual space. Beyond allows users to interact directly with 3D media without having to wear special glasses, avoiding inconsistencies of input and output. Users can select, draw, and sculpt in 3D virtual space, and seamlessly transition between 2D and 3D manipulation.

97. **IdeaGarden**

*Hiroshi Ishii, David Lakatos, and Lining Yao*

The IdeaGarden allows participants of creative activities to collectively capture, select, and share (CCSS) the stories, sketches, and ideas they produce in physical and digital spaces. The iGarden attempts to optimize the CCSS loop and to bring it from hours to seconds in order to turn asynchronous collaborative thought processes into synchronous real-time cognitive flows. The iGarden system is composed of a tangible capturing system including recording devices always "at-hand", of a selection workflow that allows the group to reflect and reduce the complexity of captured data in real-time and of a sharing module that connects socially selected information to the cloud.

Alumni Contributor: Jean-Baptiste Labrune

98. **Kinected Conference**

*Anthony DeVincenzi, Lining Yao, Hiroshi Ishii, and Ramesh Raskar*

NEW LISTING

How could we enhance the experience of video-conference by adding utilizing an interactive display? With a Kinect camera and sound sensors, We explore how expanding a system's understanding of spatially calibrated depth and audio alongside a live video stream can generate semantically rich three-dimensional pixels containing information regarding their material properties and location. Four features have been implemented, which are "Talking to Focus", "Freezing Former Frames", "Privacy Zone" and "Spacial Augmenting Reality".

99. **MirrorFugue**

*Xiao Xiao and Hiroshi Ishii*

While modern technologies such as CDs, MP3s, and digital media players make listening to music a portable activity, vital aspects of music such as learning, rehearsing, and performing are still constrained by location. MirrorFugue is an interface for the piano that bridges the gap of location in music playing by connecting pianists in a virtual shared space reflected on the piano.
100. **NeverEnding Drawing**  
*Cynthia Breazeal, V. Michael Bove Jr., Glorianna Davenport, David Robert, Edwina Portocarrero, Sean Follmer and Michelle Chung*

Inspired by the Surrealists' Exquisite Corpse art game, the NeverEnding Drawing project is one of several applications developed on a scalable architecture and platform for collaborative creativity. Users co-create and edit each other's augmented sketchbooks in real time. By tracking individual pages of each live sketchbook, the system loads the appropriate background audiovisual content and enables users to add to it using a variety of real materials and means of mark-making. Users take pictures and record sounds to be sent back and forth between collaborators on the network. Additionally, the live sketchbooks facilitate non-linear, asynchronous access to the evolving, co-created content through their physical editing interface. By using crayons, colored pens, and various tactile and light-diffusing materials, the analog/digital hybrid model of content creation requires no expertise and creates a safe environment for sharing unfinished work with others.

101. **PingPongPlusPlus**  
*Hiroshi Ishii, Xiao Xiao, Michael Bernstein, Lining Yao, Dávid Lakatos, Kojo Acquah, Jeff Chan, Sean Follmer and Daniel Leithinger*

PingPong++ (PingPongPlusPlus) builds on PingPongPlus (1998), a ping pong table that could sense ball hits, and reuse that data to control visualizations projected on the table. We have redesigned the system using open-source hardware and software platforms so that anyone in the world can build their own reactive table. We are exploring ways that people can customize their ping pong game experience. This kiosk allows players to create their own visualizations based on a set of templates. For more control of custom visualizations, we have released a software API based on the popular Processing language to enable users to write their own visualizations. We are always looking for collaborators! Visit pppp.media.mit.edu to learn more.

102. **Radical Atoms**  
*Hiroshi Ishii, Leonardo Bonanni, Keywon Chung, Sean Follmer, Jinha Lee, Daniel Leithinger and Xiao Xiao*

Radical Atoms is our vision of interactions with future material.

Alumni Contributors: Keywon Chung, Adam Kumpf, Amanda Parkes, Hayes Raffle and Jamie B Zigelbaum

103. **Recompose**  
*Hiroshi Ishii, Matthew Blackshaw, Anthony DeVincenzi and David Lakatos*

Human beings have long shaped the physical environment to reflect designs of form and function. As an instrument of control, the human hand remains the most fundamental interface for affecting the material world. In the wake of the digital revolution, this is changing, bringing us to reexamine tangible interfaces. What if we could now dynamically reshape, redesign, and restructure our environment using the functional nature of digital tools? To address this, we present Recompose, a framework allowing direct and gestural manipulation of our physical environment. Recompose complements the highly precise, yet concentrated affordance of direct manipulation with a set of gestures, allowing functional manipulation of an actuated surface.
104. Relief

Hiroshi Ishii and Daniel Leithinger

Relief is an actuated tabletop display, able to render and animate 3D shapes with a malleable surface. It allows users to experience and form digital models such as geographical terrain in an intuitive manner. The tabletop surface is actuated by an array of motorized pins, which can be addressed individually and sense user input like pulling and pushing. Our current research focuses on utilizing freehand gestures for interacting with content on Relief.

Alumni Contributor: Adam Kumpf

105. RopePlus

Jason Spingarn-Koff (MIT), Hiroshi Ishii, Sayamindu Dasgupta, Lining Yao, Nadia Cheng (MIT Mechanical Engineering) and Ostap Rudakevych (Harvard University Graduate School of Design)

Rope-based games such as jump rope, tug-of-war, and kite-flying promote physical activity and social interaction among people of all ages, and especially in children during the development of their coordination skills and physical fitness. Our RopePlus system builds on those traditional games by enabling players to participate remotely, interacting with ropes that connect physical and virtual spaces. The RopePlus platform is centered around the rope as a tangible interface, with various hardware extensions to allow for multiple playing modes. We present two games that have been implemented in detail: a kite-flying game called Multi-Fly and a jump-rope game called Multi-Jump. Our work aims to expand tangible interface gaming to real-time social playing environments.

106. SandScape

Carlo Ratti, Assaf Biderman and Hiroshi Ishii

SandScape is a tangible interface for designing and understanding landscapes through a variety of computational simulations using sand. The simulations are projected on the surface of a sand model representing the terrain; users can choose from a variety of different simulations highlighting height, slope, contours, shadows, drainage, or aspect of the landscape model, and alter its form by manipulating sand while seeing the resulting effects of computational analysis generated and projected on the surface of sand in real time. SandScape demonstrates an alternative form of computer interface (tangible user interface) that takes advantage of our natural abilities to understand and manipulate physical forms while still harnessing the power of computational simulation to help in our understanding of a model representation.

Alumni Contributors: Yao Wang, Jason Alonso and Ben Piper

107. Sensetable

Hiroshi Ishii

Sensetable is a system that wirelessly, quickly, and accurately tracks the positions of multiple objects on a flat display surface. The tracked objects have a digital state, which can be controlled by physically modifying them using dials or tokens. We have developed several new interaction techniques and applications on top of this platform. Our current work focuses on business supply-chain visualization using system-dynamics simulation.

Alumni Contributors: Jason Alonso, Dan Chak, Gian Antonio Pangaro, James Patten and Matt Reynolds
108. Sourcemap

Hiroshi Ishii, Leonardo Bonanni, Matthew Hockenberry, David Zwarg, Reed Underwood, Bianca Sayan and Smita Deshpande

Sourcemap is a crowd-sourced directory of product supply chains and carbon footprints. The free and open-source website offers a suite of tools to visualize where products come from, to calculate their social and environmental impact, and to share this information across social media. Since 2009, the website has gathered thousands of user-generated sourcemaps of foods, furniture, clothing, electronics and more. The Sourcemap team partners with for- and non-profit organizations to bring visibility into their supply chains and to connect consumers with the source of products. Sourcemap has been featured by the BBC, NPR, the Globe and Mail and the Huffington Post and received awards from Scientific American, Ars Electronica and ID magazine.

109. t(ether)

Hiroshi Ishii, Andy Lippman, Matthew Blackshaw and David Lakatos

What if you could draw anywhere, on the objects around you, or simply in the air? What if you could walk through digital volumetric data, exploring these as you would real objects in physical space? t(ether) explores this possibility. By using tablets as views into a virtual world we are able to create a shared space for exploration and expression. Altering your viewpoint in t(ether) is as simple as changing the position and orientation of a tablet. Volumetric data are viewed at human scale, a 1:1 coordinate mapping between the virtual and the real, allowing intuitive navigation of space. Unlike Augmented Reality applications, which often separate us from the physical world, t(ether) grounds our experiences by allowing objects to be viewed, explored, annotated and manipulated as if they were in real space.

110. Tangible Bits

Hiroshi Ishii, Sean Follmer, Jinha Lee, Daniel Leithinger and Xiao Xiao

People have developed sophisticated skills for sensing and manipulating our physical environments, but traditional GUIs (Graphical User Interfaces) do not employ most of them. Tangible Bits builds upon these skills by giving physical form to digital information, seamlessly coupling the worlds of bits and atoms. We are designing "tangible user interfaces" that employ physical objects, surfaces, and spaces as tangible embodiments of digital information. These include foreground interactions with graspable objects and augmented surfaces, exploiting the human senses of touch and kinesthesia. We also explore background information displays that use "ambient media"—light, sound, airflow, and water movement—to communicate digitally mediated senses of activity and presence at the periphery of human awareness. We aim to change the "painted bits" of GUIs to "tangible bits," taking advantage of the richness of multimodal human senses and skills developed through our lifetimes of interaction with the physical world.

111. Topobo  
*Hayes Raffle, Amanda Parkes and Hiroshi Ishii*

Topobo is a 3-D constructive assembly system embedded with kinetic memory—the ability to record and play back physical motion. Unique among modeling systems is Topobo’s coincident physical input and output behaviors. By snapping together a combination of passive (static) and active (motorized) components, users can quickly assemble dynamic, biomorphic forms such as animals and skeletons, animate those forms by pushing, pulling, and twisting them, and observe the system repeatedly playing back those motions. For example, a dog can be constructed and then taught to gesture and walk by twisting its body and legs. The dog will then repeat those movements.

112. Video Play  
*Sean Follmer, Hayes Raffle and Hiroshi Ishii*

Long-distance families are increasingly staying connected with free video conferencing tools. However, the tools themselves are not designed to accommodate children’s or families’ needs. We explore how play can be a means for communication at a distance. Our Video Play prototypes are simple video-conferencing applications built with play in mind, creating opportunities for silliness and open-ended play between adults and young children. They include simple games, such as Find It, but also shared activities like book reading, where users’ videos are displayed as characters in a story book.

Alumni Contributor: Hayes Raffle

113. VisualizeMe  
*Hiroshi Ishii, Andy Lippman, Matthew Blackshaw, Anthony DeVincenzi and David Lakatos*

VisualizeMe provides a new perspective on your social life. By presenting your social graph as a moving picture, VisualizeMe breaks free from the text-centric interfaces of today’s social networks, offering a fresh, holistic perspective. Unseen trends, before lost in mountains of text, can be better understood, providing an organic and evolving view of your relationships. VisualizeMe is a semi-finalist in the MIT 100k Entrepreneurship Competition.

114. Wetpaint  
*Leonardo Bonanni, Xiao Xiao, Bianca Costanzo, Andrew Shum, Matthew Hockenberry, Maurizio Seracini and Hiroshi Ishii*

The Wetpaint project investigates new interfaces for exploring the history of a work of visual art. We are seeking intuitive metaphors for touch-screen interaction, including virtually scraping through the multispectral scans of an ancient painting, and pulling, stretching, and tearing through a virtual canvas. The interaction techniques refined through Wetpaint are being built into a Web-based tool for leveraging collective intelligence toward the pursuit of art diagnostics.
Joseph M. Jacobson—Molecular Machines
How to engineer at the limits of complexity with molecular-scale parts.

115. GeneFab
Bram Sterling, Kelly Chang, Joseph M. Jacobson, Peter Carr, Brian Chow, David Sun Kong, Michael Oh and Sam Hwang

What would you like to "build with biology"? The goal of the GeneFab projects is to develop technology for the rapid fabrication of large DNA molecules, with composition specified directly by the user. Our intent is to facilitate the field of genetic engineering as it moves from a focus on single genes to designing complete biochemical pathways, genetic networks, and more complex systems. Sub-projects include: DNA error correction, microfluidics for high throughput gene synthesis, and genome-scale engineering (rE. coli).

Alumni Contributor: Chris Emig

116. NanoFab
Jaebum Joo and Joseph M. Jacobson

We are developing techniques to fabricate nanostructures and logic devices using nanoparticulate colloids of metals and semi-conductors as building blocks.

Kent Larson—Changing Places
How new strategies for architectural design, mobility systems, and networked intelligence can make possible dynamic, evolving places that respond to the complexities of life.

117. A Market Economy of Trips
Dimitris Papanikolaou and Kent Larson

We are developing a new strategy to create autonomous self-organizing vehicle sharing systems that uses incentive mechanisms (dynamic pricing) to smooth demand imbalances, and an interactive graphical user interface to effectively communicate location-based price information. Prices adjust dynamically to parking needs, incentivizing users to drive vehicles to stations with too few vehicles, while discouraging arrivals to stations with excess vehicles. This research explains how users make decisions in dynamically priced mobility systems, under which circumstances their actions may make up a self-regulating economy, and how this economy dynamically performs in different demand patterns. To address these issues we develop a computational framework using System Dynamics, Urban Economics, and Game Theory that models system behavior which will be used to determine optimum pricing policy, fleet size, and density of parking stations for having a stable yet profitable system.

Alumni Contributor: William J. Mitchell
118. Autonomous Facades for Zero-Energy Urban Housing

Ronan Lonergan and Kent Larson

We are developing self-powered responsive building envelope components that efficiently integrate solar shading and heating, ventilation, privacy control, and ambient lighting. Dynamic facade modules integrate sensing systems to respond to both environmental conditions and the activities of people.

119. CityCar

Ryan C.C. Chin, William Lark, Jr., Raul-David Poblano, Nicholas Pennycooke, Praveen Subramani, Charles Guan, and Kent Larson

The CityCar is a foldable, electric, sharable, two-passenger vehicle for crowded cities. Wheel Robots—fully modular in-wheel electric motors—integrate drive motors, suspension, braking, and steering inside the hub-space of the wheel. This drive-by-wire system requires only data, power, and mechanical connection to the chassis. With over 80 degrees of steering freedom, Wheel Robots enable a zero-turn radius; they also enable the CityCar to fold by eliminating the gasoline-powered engine and drive-train. We are working with Denokinn on an integrated, modular system for assembly and distribution of the CityCar. This project, based in the Basque region of Spain, will be called the "Hiriko" Project, which stands for Urban Car. The Hiriko project aims to create a new, distributed manufacturing system for the CityCar which will enable automotive suppliers to provide “core” components made of integrated modules such as in-wheel motor units, battery systems, interiors, vehicle control systems, vehicle chassis/exoskeleton, and glazing. (Continuing the vision of William J. Mitchell.)

Alumni Contributors: Patrik Kunzler, Philip Liang and William J. Mitchell

120. CityCar Driving Simulator

Kent Larson, Chris Post and Praveen Subramani

In next-generation electric vehicles, drive-by-wire technology will allow us to replace mechanical linkages for steering, throttle, and braking with electronic controls. This enables a wealth of possibilities for controlling electric vehicles; we can make almost any physical interface send appropriate electronic messages to the wheels. The CityCar Driving Simulator uses the CityCar’s physical parameters to model the car’s driving behavior, allowing users to drive a virtual CityCar with a variety of alternative controls. While the steering wheel has been a ubiquitous and important driving interface, there is vast potential for alternative interfaces. With the driving simulator, we can prototype and test these interfaces with a virtual vehicle to develop design rules and principles that will shape next-generation driving interfaces.
121. CityCar Folding Chassis  

William Lark, Jr., Nicholas Pennycooke, Raul-David Poblano, Charles Guan, Ryan C.C. Chin and Kent Larson

The CityCar folding chassis is a half-scale working prototype that consists of four independently controlled in-wheel electric motors, four-bar linkage mechanism for folding, aluminum exoskeleton, operable front ingress/egress doors, lithium-nanophosphate battery packs, vehicle controls, and a storage compartment. The folding chassis can demonstrate compact folding (3:1 ratio compared to conventional vehicles), omni-directional driving, and wireless remote controls. The half-scale mock-up explores the material character and potential manufacturing strategies that will scale to a future full-scale build. (Continuing the vision of William J. Mitchell.)

Alumni Contributor: William J. Mitchell

122. CityCar Testing Platform  

Raul-David Poblano, William Lark, Jr., Charles Guan, Nicholas Pennycooke, Ryan C.C. Chin and Kent Larson

The CityCar Testing Platform is a full-scale and modular vehicle that consists of four independently controlled Wheel Robots, an extruded aluminum frame, battery pack, driver's interface, and seating for two. Each Wheel Robot is capable of over 120 degrees of steering freedom, thus giving the CityCar chassis omni-directional driving ability such as sideways parking, zero-radius turning, torque steering, and variable velocity (in each wheel) steering. This four-wheeler is an experimental platform for by-wire controls (non-mechanically coupled controls) for the Wheel Robots, thus allowing for the platform to be controlled by wireless joysticks. The four-wheeler also allows the CityCar design team to experiment with highly personalized body/cabin designs. (Continuing the vision of William J. Mitchell.)

Alumni Contributor: William J. Mitchell

123. CityHome  

Kent Larson and Daniel Smithwick

NEW LISTING

We demonstrate how the CityHome, which has a very small footprint (840 square feet), can function as an apartment two to three times that size. This is achieved through a transformable wall system which integrates furniture, storage, exercise equipment, lighting, office equipment, and entertainment systems. One potential scenario for the CityHome is where the bedroom transforms to a home gym, the living room to a dinner party space for 14 people, a suite for four guests, two separate office spaces plus a meeting space, or an open loft space for a large party. Finally, the kitchen can either be open to the living space, or closed off to be used as a catering kitchen. Each occupant engages in a process to personalize the precise design of the wall units according to his or her unique activities and requirements.

124. Context-Aware Dynamic Lighting  

Maria Thompson and Kent Larson

Buildings consume about three-quarters of US electricity, and lighting accounts for about one-third of typical office-building energy use. Much of this is wasted by illuminating unoccupied spaces or those with sufficient natural light. We are deploying tiny, low-cost, easily installed wireless sensors to control tunable LED luminaires. The control system will turn off, dim, or tune the lighting to more energy-efficient spectra in response to the location, activities, and paths of the occupants. It will also respond to the daylight entering the space. An interface will
allow occupants to define activities and preferences for their personal lighting. Energy savings may approach 40% without the occupants being aware of, or disturbed by, changes in lighting. (A House_n Research Consortium project funded by Siemens and the MIT Energy Initiative)

125. **Distinguish: Home Activity Recognition**

*Kent Larson*

We propose a recognition system with a user-centric point of view, designed to make the activity detection processes intelligible to the end-user of the home, and to permit these users to improve recognition and customize activity models based on their particular habits and behaviors. Our system, named Distinguish, relies on high-level, common sense information to create activity models used in recognition. These models are understandable by end-users and transferable between homes. Distinguish consists of a common-sense recognition engine that can be modified by end-users using a novel phone interface.

126. **Environmental Impacts of Utilizing Mass Customization**

*Ryan C. C. Chin, Daniel Smithwick, and Kent Larson*

Sanders Consulting’s 2005 ground-breaking research, “Why Mass Customization is the Ultimate Lean Manufacturing System” showed that the best standard mass-production practices when framed from the point of view of the entire product lifecycle—from raw material production to point of purchase—was actually very inefficient and indeed wasteful in terms of energy, material use, and time. Our research examines the environmental impacts when applying mass customization methodologies to men's custom dress shirts. This study traces the production, distribution, sale, and customer-use of the product, in order to discover key areas of waste and opportunities for improvement.

127. **Home Genome: Mass-Personalized Housing**

*Daniel Smithwick and Kent Larson*

The home is becoming a center for preventative health care, energy production, distributed work, and new forms of learning, entertainment, and communication. We are developing techniques for capturing and encoding concepts related to human needs, activities, values, and practices. We are investigating solutions built from an expanding set of building blocks, or “genes,” which can be combined and recombined in various ways to create a unique assembly of spaces and systems. We are developing algorithms to match individuals to design solutions in a process analogous to that used to match customer profiles to music, movies, and books, as well as new fabrication and supply-chain technologies for efficient production. We are exploring how to tap the collective intelligence of distributed groups of people and companies to create an expanding set of solutions.
128. Intelligent Autonomous Parking Environment

Chris Post, Raul-David Poblano, Ryan C.C. Chin, and Kent Larson

In an urban environment, space is a valuable commodity. Current parking structures must allow each driver to independently navigate the parking structure to find a space. As next-generation vehicles turn more and more to drive-by-wire systems, though, direct human interaction will not be necessary for vehicle movement. An intelligent parking environment can use drive-by-wire technology to take the burden of parking away from the driver, allowing for more efficient allocation of parking resources to make urban parking less expensive. With central vehicle control, cars can block each other while parked since the parking environment can move other vehicles to enabled a blocked vehicle to leave. The parking environment can also monitor the vehicle charge, allowing intelligent and efficient utilization of charge stations by moving vehicles to and from charge stations as necessary.

129. Media Lab Electric Charging Station

Praveen Subramani, Raul-David Poblano, Ryan C.C. Chin, Kent Larson and Schneider Electric

We are working with Media Lab sponsor Schneider Electric to develop a rapid, high-power charging station in the new Media Lab facility for rapid charging of the CityCar and other electric vehicles. Research experiments include the exploration of DC battery banks for intermediate energy storage between the grid and vehicles, re-purposing the lead acid batteries in UPS systems with lithium-ion cells, exploration of level III charging connectors, wireless charging, and user-interface design for connecting the vehicles to physical infrastructure.

Alumni Contributor: William J. Mitchell

130. MITes+: Portable Wireless Sensors for Studying Behavior in Natural Settings

Kent Larson and Stephen Intille

MITes (MIT environmental sensors) are low-cost, wireless devices for collecting data about human behavior and the state of the environment. Nine versions of MITes have now been developed, including MITes for people movement (3-axis accelerometers), object movement (2-axis accelerometers), temperature, light levels, indoor location, ultra-violet light exposure, heart rate, haptic output, and electrical current flow. MITes are being deployed to study human behavior in natural setting. We are also developing activity recognition algorithms using MITes data for health and energy applications. (a House_n Research Consortium Initiative funded by the National Science Foundation)

Alumni Contributors: Randy Rockinson and Emmanuel Munguia Tapia

131. Mobility on Demand Systems

Ryan C.C. Chin, Chih-Chao Chuang, William Lark, Jr., Raul-David Poblano, Nicholas Pennycooke, Praveen Subramani and Dimitris Papanikolaou and Kent Larson

Mobility on Demand (MoD) systems are fleets of lightweight electric vehicles at strategically distributed electrical charging stations throughout a city. MoD systems solve the “first and last mile” problem of public transit, providing mobility between transit station and home or workplace. Users swipe a membership card at the MoD station to access vehicles, which can be driven to any other station (one-way rental). The Vélib' system of 20,000+ shared bicycles in Paris is the largest and most popular one-way rental system in the world. MoD systems incorporate intelligent fleet management through sensor networks, pattern
recognition, and dynamic pricing, as well as the benefits of Smart Grid technologies including intelligent electrical charging (including rapid charging), vehicle-to-grid (V2G), and surplus energy storage for renewable power generation and peak shaving for the local utility. We have designed three MoD vehicles: CityCar, RoboScooter, and GreenWheel bicycle. (Continuing the vision of William J. Mitchell.)

Alumni Contributors: Philip Liang and William J. Mitchell

132. Open-Source Furniture

Kent Larson

We are exploring the use of parametric design tools and CNC fabrication technology to enable lay people to navigate through a complex furniture and cabinetry design process for office and residential applications. We are also exploring the integration of sensors, lighting, and actuators into furniture to create objects that are responsive to human activity.

133. PlaceLab and BoxLab

Jason Nawyn, Stephen Intille and Kent Larson

The PlaceLab was a highly instrumented, apartment-scale, shared research facility where new technologies and design concepts were tested and evaluated in the context of everyday living. It was used by researchers until 2008 to collect fine-grained human behavior and environmental data, and to systematically test and evaluate strategies and technologies for the home in a natural setting with volunteer occupants. BoxLab is a portable version with many of the data collection capabilities of PlaceLab. BoxLab can be deployed in any home or workplace. (A House_n Research Consortium project funded by the National Science Foundation.)

Alumni Contributors: Jennifer Suzanne Beaudin, Manu Gupta, Pallavi Kaushik, Aydin Oztoprak, Randy Rockinson and Emmanuel Munguia Tapia

134. Wheel Robots

William Lark, Jr., Raul-David Poblano, Nicholas Pennycooke, Charles Guan, Ryan C.C. Chin and Kent Larson

The mechanical components that make driving a vehicle possible—acceleration, braking, steering, springing—are located inside the space of the wheel, forming independent wheel robots and freeing the vehicular space of these components. Connected to the chassis are simple mechanical, power, and data connections, allowing for the wheel robots to plug in to a vehicle simply and quickly. A CPU in the vehicle provides the input necessary for driving according to the vehicle's dimensions or loading condition. The design of the wheel robots provides optimal contact patch placement, lower unsprung and rotational mass, omnidirectional steering, great space savings, and modularity, as the wheel robots can function appropriately on vehicles of different dimensions and weight. By "putting the whole car in the wheel," it is possible to separate production, service, and life-cycles of the mechanical components of the car from those of its architectural components. (Continuing the vision of William J. Mitchell.)

Alumni Contributors: Patrik Kunzler, Philip Liang and William J. Mitchell
135. WorkLife

Jarmo Suominen and Kent Larson

The nature of work is rapidly changing, but designers have a poor understanding of how places of work affect interaction, creativity, and productivity. We are using mobile phones that ask context-triggered questions and sensors in workplaces to collect information about how spaces are used and how space influences feelings such as productivity and creativity. A pilot study took place at the Steelcase headquarters in 2007, and in the offices of EGO, Inc. in Helsinki, Finland 2009. (A House_n Research Consortium project funded by TEKES.)

Alumni Contributor: Kenneth Cheung

Henry Lieberman—Software Agents

How software can act as an assistant to the user rather than a tool, by learning from interaction and by proactively anticipating the user's needs.

136. Common-Sense Reasoning for Interactive Applications

Henry Lieberman

A long-standing dream of artificial intelligence has been to put common-sense knowledge into computers—enabling machines to reason about everyday life. Some projects, such as Cyc, have begun to amass large collections of such knowledge. However, it is widely assumed that the use of common sense in interactive applications will remain impractical for years, until these collections can be considered sufficiently complete, and common-sense reasoning sufficiently robust. Recently we have had some success in applying common-sense knowledge in a number of intelligent interface agents, despite the admittedly spotty coverage and unreliable inference of today's common-sense knowledge systems.

Alumni Contributors: Xinyu H. Liu and Push Singh

137. CommonConsensus: A Game for Collecting Commonsense Goals

Henry Lieberman and Dustin Smith

We have developed, Common Consensus: a fun, self-sustaining web-based game, that both collects and validates Commonsense knowledge about everyday goals. Goals are a key element of commonsense knowledge; in many of our interface agents, we need to recognize goals from user actions (plan recognition), and generate sequences of actions that implement goals (planning). We also often need to answer more general questions about the situations in which goals occur, such as when and where a particular goal might be likely, or how long it is likely to take to achieve.

Alumni Contributor: Push Singh

138. ConceptNet

Catherine Havasi, Robert Speer, Kenneth Arnold, Henry Lieberman and Marvin Minsky

Imparting common-sense knowledge to computers enables a new class of intelligent applications better equipped to make sense of the everyday world and assist people with everyday tasks. While previous attempts have been made to
acquire and structure common-sense knowledge, they have either been inadequate in capturing the breadth of knowledge needed for the enterprise, or their complicated representation schemes have made them difficult to incorporate into applications. Our approach to this problem is ConceptNet, a freely available common-sense knowledge base that possesses a great breadth of knowledge that can be easily incorporated into applications. Built from the Open Mind Common Sense corpus, which acquires common-sense knowledge from a Web-based community of instructors, ConceptNet is a semantic network of 1.6 million items of common-sense knowledge, and a set of tools for making inferences using this knowledge.

Alumni Contributors: Jason Alonso, Ian Eslick, Xinyu H. Liu and Push Singh

139. ConnectMe

*Catherine Havasi and Robert Speer*

Who should you meet in your organization? Whose work is complimentary and who thinks like you? When an organization is large, it may be difficult to keep up to date with what everyone is doing. ConnectMe reads what people say about their work, and recommends who they should meet and what they should talk about. The demo works for students and sponsors!

140. Divisi: Reasoning Over Semantic Relationships

*Henry Lieberman, Jason Alonso, Kenneth Arnold, Catherine Havasi and Robert Speer*

We have developed technology that enables easy analysis of semantic data, blended in various ways with common-sense world knowledge. The results support reasoning by analogy and association. A packaged library of code is being made available to all sponsors.

141. E-Commerce When Things Go Wrong

*Henry Lieberman*

One of the biggest challenges for the digital economy is what to do when things go wrong. Orders get misplaced, numbers mistyped, requests misunderstood; then what? Consumers are frustrated by long waits on hold, misplaced receipts, and delays to problem resolution; companies are frustrated by the cost of high-quality customer service. Online companies want customers’ trust, and how a company handles problems directly impacts that. We explore how software agents and other technologies can help with this issue. Borrowing ideas from software debugging, we can have agents help to automate record-keeping and retrieval, track dependencies, and provide visualization of processes. Diagnostic problem-solving can generate hypotheses about causes of errors, and seek information that allows hypotheses to be tested. Agents act on behalf of both the consumer and the vendor to resolve problems more quickly and at lower cost.

142. Goal-Oriented Interfaces for Consumer Electronics

*Henry Lieberman and Pei-Yu Chi*

Consumer electronics devices are becoming more complicated, intimidating users. These devices do not know anything about everyday life or human goals, and they show irrelevant menus and options. Using common-sense reasoning, we are building a system, Roadie, with knowledge about the user’s intentions; this knowledge will help the device to display relevant information to reach the user’s goal. For example, an amplifier should suggest a play option when a new instrument is connected, or a DVD player suggest a sound configuration based on the movie it is playing. This will lead to more human-like interactions with these
143. Graphical Interfaces for Software Visualization and Debugging

Henry Lieberman

This project explores how modern graphical interface techniques and explicit support for the user's problem-solving activities can make more productive interfaces for debugging, which accounts for half the cost of software development. Animated representations of code, a reversible control structure, and instant connections between code and graphical output are some of the techniques used.

144. Human Goal Network

Henry Lieberman and Dustin Smith

What motivates people? What changes do people want in the world? We approach questions of this kind by mining goals and plans from text-based websites: wikiHow, eHow, 43things, to-do lists, and commonsense knowledge bases. 43things tells us about people’s long term ambitions. How-to instructions and to-do lists tell us about everyday activities. We’ve analyzed the corpus to find out which goals are most popular, controversial, and concealed. The resulting goal network can be used for plan recognition, natural language understanding, and building intelligent interfaces that understand why they are being used. Come by and learn about how you can use this knowledge about actions/goals, their properties (cost, duration, location) and their relations in your own applications.

145. Learning Common Sense in a Second Language

Henry Lieberman, Ned Burns and Li Bian

It’s well known that living in a foreign country dramatically improves the effectiveness of learning a second language over classroom study alone. This is likely because people make associations with the foreign language as they see and participate in everyday life activities. We are designing language-teaching sequences for a sensor-equipped residence that can detect user interaction with household objects. We use our common-sense knowledge base and reasoning tools to construct teaching sequences, wholly in the target language, of sentences and question-answering interactions that gradually improve the learner’s language competence. For example, the first time the user sits in a chair, the system responds with the foreign-language word for “chair,” and later with statements and questions such as, "You sit in the chair" (complete sentence), "You sat in the chair" (tenses), "What is the chair made of?" (question, materials), or "Why are you sitting in the chair?" (goals, plans).

146. Luminoso: Understanding and Visualizing People’s Opinions

Catherine Havasi and Robert H. Speer

Luminoso is a tool that uses common sense and blending to "read between the lines" and better understand opinions and feedback expressed in free text such as customer reviews. It creates a semantic space from the ideas in a set of documents, including common-sense background information, and allows interactive exploration. This interface can be used to discover trends in a text corpus, such as free-text responses to a survey.
147. Moral Compass: A Model of Self-Conscious Learning

*Henry Lieberman, Marvin Minsky, Joe Paradiso and Bo Morgan*

Moral Compass is a model of how children learn in a problem-solving environment where the child is learning to accomplish goals in the context of parents, strangers, and cultural knowledge. The child learns in multiple ways: playing alone, being told stories, and being rewarded or punished. Our model aims to provide an explanation for relatively complex reflective states of mind, such as desire, avoidance, focus, ignorance, and personality traits. Our model also emphasizes different types of failure in its reflective approach to learning, including surprise, disappointment, and guilt. Possible applications include better understanding of the mental health of cognition in social domains.

148. Multi-Lingual ConceptNet

*Hyemin Chung, Jaewoo Chung, Wonsik Kim, Sung Hyon Myaeng and Walter Bender*

A ConceptNet in English is already established and working well. We are now attempting to expand it to other languages and cultures. This project is an extended ConceptNet with Korean common sense, which is fundamentally different from English. Through this project, we can learn how to expand the ConceptNet into other languages and how to connect them. By connecting English and Korean ConceptNets, we are hoping not only to see cultural or linguistic differences, but also to solve problems such as the ambiguity of multivocal words, which were difficult to solve with only one ConceptNet.

149. Multilingual Common Sense

*Aparecido Fabiano Pinatti de Carvalho, Jesus Savage Carmona, Marie Tsutsumi, Junia Anacleto, Henry Lieberman, Jason Alonso, Kenneth Arnold, Robert Speer, Vania Paula de Almeida and Veronica Arreola Rios*

This project aims to collect and reason over common-sense knowledge in languages other than English. We have collected large bodies of common-sense knowledge in Portuguese and Korean, and we are expanding to other languages such as Spanish, Dutch, and Italian. We can use techniques based on AnalogySpace to discover correlations between languages, enabling our knowledge bases in different languages to learn from each other.

Alumni Contributors: Hyemin Chung, Jose H. Espinosa, Wonsik Kim and Yu-Te Shen

150. Navigating in Very Large Display Spaces

*Henry Lieberman*

How would you browse a VERY large display space, such as a street map of the entire world? The traditional solution is zoom and pan, but these operations have drawbacks that have gone unchallenged for decades. Shifting attention loses the wider context, leading to that "lost in hyperspace" feeling. We are exploring alternative solutions, such as a new technique that allows zooming and panning in multiple translucent layers.

151. Open Mind Common Sense

*Henry Lieberman, Marvin Minsky, Jason Alonso, Kenneth Arnold, Ian Eslick, Catherine Havasi, Bo Morgan, Dustin Smith and Robert Speer*

The biggest problem facing artificial intelligence today is how to teach computers enough about the everyday world so that they can reason about it like we do—so that they can develop "common sense." We think this problem may be solved by harnessing the knowledge of people on the Internet, and we have built a Web site
to make it easy and fun for people to work together to give computers the millions of little pieces of ordinary knowledge that constitute "common sense." Teaching computers how to describe and reason about the world will give us exactly the technology we need to take the Internet to the next level, from a giant repository of Web pages to a new state where it can think about all the knowledge it contains; in essence, to make it a living entity.

Alumni Contributor: Push Singh

152. ProcedureSpace: Managing Informality by Example

Henry Lieberman and Kenneth C. Arnold

Computers usually require us to be precise about what we want them to do and how, but humans find it hard to be so formal. If we gave computers formal examples of our informal instructions, maybe they could learn to relate ordinary users’ natural instructions with the specifications, code, and tests with which they are comfortable. Zones and ProcedureSpace are examples of this. Zones is a code search interface that connects code with comments about its purpose. Completed searches become annotations, so the system learns by example. The backend, ProcedureSpace, finds code for a purpose comment (or vice versa) by relating words and phrases to code characteristics and natural language background knowledge. Users of the system were able describe what they wanted in their own words, and often found that the system gave them helpful code.

153. Programming in Natural Language

Henry Lieberman and Moin Ahmad

We want to build programming systems that can converse with their users to build computer programs. Such systems will enable users without programming expertise to write programs using natural language. The text-based, virtual-world environments called the MOO (multi-user, object-oriented Dungeons and Dragons) allow their users to build objects and give them simple, interactive, text-based behaviors. These behaviors allow other participants in the environment to interact with those objects by invoking actions and receiving text messages. Through our natural-language dialogue system, the beginning programmer will be able to describe objects and the messages in MOO environments.

154. Raconteur: From Chat to Stories

Henry Lieberman and Pei-Yu Chi

Raconteur is a story-editing system for conversational storytelling that provides intelligent assistance in illustrating a story with photos and videos from an annotated media library. It performs natural language processing on a text chat between two or more participants, and recommends appropriate items from a personal media library to illustrate a story. A large common-sense knowledge base and a novel common-sense inference technique are used to find relevant media materials to match the story intent in a way that goes beyond keyword matching or word co-occurrence based techniques. Common-sense inference can identify larger-scale story patterns such as expectation violation or conflict and resolution, and helps a storyteller to chat and brainstorm his personal stories with a friend.
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<tr>
<th>155. Relational Analogies in Semantic Networks</th>
<th>Henry Lieberman and Jayant Krishnamurthy</th>
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<td>Analogy is a powerful comparison mechanism, commonly thought to be central to human problem solving. Analogies like &quot;an atom is like the solar system&quot; enable people to effectively transfer knowledge to new domains. Can we enable computers to do similar comparisons? Prior work on analogy (structure mapping) provides guidance about the nature of analogies, but implementations of these theories are inefficient and brittle. We are working on a new analogy mechanism that uses instance learning to make robust, efficient comparisons.</td>
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<th>156. Ruminati: Tackling Cyberbullying with Computational Empathy</th>
<th>Karthik Dinakar, Henry Lieberman, and Birago Jones</th>
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<td>The scourge of cyberbullying has assumed worrisome proportions with an ever-increasing number of adolescents admitting to having dealt with it either as a victim or bystander. Anonymity and the lack of meaningful supervision in the electronic medium are two factors that have exacerbated this social menace. This project explores computational methods from natural language processing and reflective user interfaces to alleviate this problem.</td>
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<th>157. Scruffy Planning</th>
<th>Cynthia Breazeal, Henry Lieberman, Jason Alonso, Kenneth C. Arnold and Catherine Havasi</th>
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<td>Scruffy Planning is an effort to use dimensionality reduction to model learning, memory, recall, and planning as all part of the same imprecise process. This approach would allow robots and other artificial agents to learn from experience, even superstitions. We aim to use this to train artificial agents, including synthetic characters, using corpora of human-human interactions recorded with crowd-sourcing tools.</td>
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<th>158. Storied Navigation</th>
<th>Henry Lieberman</th>
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<td>Today, people can tell stories by composing, manipulating, and sequencing individual media artifacts using digital technologies. However, these tools offer little help in developing a story's plot. Specifically, when a user tries to construct her story based on a collection of individual media elements (videos, audio samples), current technological tools do not provide helpful information about the possible narratives that these pieces can form. Storied Navigation is a novel approach to this problem; media sequences are tagged with free-text annotations and stored as a collection. To tell a story, the user inputs a free-text sentence and the system suggests possible segments for a storied succession. This process iterates progressively, helping the user to explore the domain of possible stories. The system achieves the association between the input and the segments' annotations using reasoning techniques that exploit the WordNet semantic network and common-sense reasoning technology.</td>
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Alumni Contributors: Barbara Barry, Glorianna Davenport and edshen

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<th>159. Time Out: Reflective User Interface for Social Networks</th>
<th>Birago Jones, Henry Lieberman and Karthik Dinakar</th>
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<tr>
<td>&quot;Time Out&quot; is an experimental user interface system for addressing cyberbullying on social networks. A Reflective User Interface (RUI) is a novel concept to help users consider the possible consequences of their online behavior, and assist in intervention or mitigation of potentially negative/harmful actions.</td>
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NEW LISTING
Andy Lippman—Viral Spaces
How to make scalable, mobile networks that enhance the social experience of real places.


Dawei Shen, Marshall Van Alstyne and Andrew Lippman
Creative and productive information interchange in organizations is often stymied by a competitive setting among the members. We transform that competition into a positive exchange by using market principles. Specifically, we apply innovative market mechanisms to construct incentives while still encouraging pro-social behaviors. Barter includes means to enhance knowledge sharing, innovation creation, and productivity. It is being tested at MIT and in three sponsor companies and is becoming available as a readily installable package. We will measure the results and test the effectiveness of an information market in addressing organizational challenges.

161. Ego

Henry Holtzman, Andy Lippman and Polychronis Ypodimatopoulos
Ego presents an agent-based, user-centered architecture for storing, discovering, and sharing information about an expandable set of applications, such as location, reviews, or buying and selling goods. Users can fluidly create agents that hold information relevant to their intentions. For example, for buying or selling, users could announce a product they are interested in, then the system creates a group of users interested in the same product, allowing direct discovery and analysis. Tradeoffs between factors such as reputation and physical location are considered. We demonstrate an interactive, tabletop visualization of different urban scenarios involving 1,000 agents that discover each other in the context of some personal interest.

Alumni Contributor: Charles Amick

162. Electric Price Tags

Andy Lippman, Matthew Blackshaw and Rick Borovoy

Electric Price Tags are a realization of a mobile system that is linked to technology in physical space. The underlying theme is that being mobile can mean far more than focusing on a portable device—it can be the use of that device to unlock data and technology embedded in the environment. In its current version, users can reconfigure the price tags on a store shelf to display a desired metric (e.g., price, unit price, or calories). While this information is present on the boxes of the items for sale, comparisons would require individual analysis of each box. The visualization provided by Electric Price Tags allows users to view and filter information in physical space in ways that was previously possible only online.

163. Ghosts of the Past

Henry Holtzman, Andy Lippman, Julia Shuhong Ma and Daniel Edward Schultz

What if you could see what the past looked like from where you are standing? What if you could relive any event that happened at your current location? Ghosts of the Past allows you to create, save, and geotag panoramic canopies. Anyone
who subsequently visits that space can see what you have seen, joining with you to create time-lapped socialization. Since each canopy is time-stamped and geotagged, it gives the user an anchor in space while they explore history. Any event, special or mundane, can be captured for anyone in the same location to view. QR codes are posted in building locations with an active canopy.

164. Junkyard Jumbotron

Chris Csikszentmihályi, Andy Lippman, Rahul Bhargava, Rick Borovoy and Brian Knep

The Junkyard Jumbotron (JJ) lets one take a collection of random screens and instantly stitch them into one large virtual display simply by taking a picture or their arrangement. The software works with laptops, smartphones, tablets—anything that runs a web browser. It shows a new way of using mobile devices to create a feeling of community: ganging mobile devices together to create a shared experience. And the JJ is designed from the ground up to make the process of connecting heterogeneous user devices together “in the wild” easy and fun, with no anti-social wireless configuration, app installation, or device compatibility anxiety.

165. Line of Sound

Rick Borovoy, Andy Lippman and Grace Rusi Woo

This is a project which shows how information codes can be used in conjunction with screens. The demonstration is done using two 55in screens which are transmitting both human and machine relevant information. Each screen is used to show a video which flashes a single bit indicator which is transmitted to a camera mounted on headphones. This is used to distinguish between the two screens i.e. and correlates an audio track to the video track.

166. Pixel Infrastructures

Andrew Lippman and Grace Rusi Woo

We are building a wireless network that is faster, less expensive to implement, and has location and orientation designed in. It is based on optical technologies that range from LED stoplights to HDTV screens. We show this using an array of Samsung electronic picture frames as transmitters and a simple Webcam as the receiver.

167. QRtcullis

NEW LISTING

Henry Holtzman, Andy Lippman, Boris Kizelshteyn, Julia Ma and Daniel Schultz

Online games bring geographically separated people together in a virtual world. Board games bring people together in the physical world. QRtcullis is a game that does both. It is a place-based, multi-player, social game that can be played on any smartphone, tablet, or computer. It is a remix of the fort-explorer genre, updated to have a connection to the physical world through QR code-based markers. Play can be affected by real-world environment factors. Each fort can be populated with various objects that either help or hinder other players. Completing the fort may require solving a maze or other puzzles, answering riddles, or finding answers to questions about the real world. The goal is to find and complete as many forts as possible. QR codes will be placed throughout the Media Lab and on a screen in the Viral Spaces area where you can see and interact with all the players.
168. Reach

Andy Lippman, Boris G Kizelshteyn and Rick Borovoy

Reach merges inherently local communications with lexical analysis of requests or offers of services. It is built on a foundation provided by EGO and common sense-based analysis of user entries. Reach is intended to demonstrate a flexible, attractive mobile interface that allows one to discover "interesting" aspects of the environment and to call upon services as needed. These can range from a broadcast offer to serve as a triage medic, to a way to share a cab or get help for a technical service problem like plugging into a video projector.

169. Recompose

Hiroshi Ishii, Matthew Blackshaw, Anthony DeVincenzi and David Lakatos

Human beings have long shaped the physical environment to reflect designs of form and function. As an instrument of control, the human hand remains the most fundamental interface for affecting the material world. In the wake of the digital revolution, this is changing, bringing us to reexamine tangible interfaces. What if we could now dynamically reshape, redesign, and restructure our environment using the functional nature of digital tools? To address this, we present Recompose, a framework allowing direct and gestural manipulation of our physical environment. Recompose complements the highly precise, yet concentrated affordance of direct manipulation with a set of gestures, allowing functional manipulation of an actuated surface.

170. Social Energy

Andy Lippman, Julia Shuhong Ma and Kristjan Kaseniit

Buildings consume more than a third of the energy used in the United States, but most people have no sense of how much their actions can affect a building's energy use. We are testing the hypothesis that if people have a convenient way to record their energy use and learn ways to improve it, they will change their habits. We have created visualizations of HVAC use throughout the Media Lab to test this hypothesis in a large-scale space. The system uses touch-screen networked displays strategically placed throughout the building to convey real-time and historical temperature and thermostat settings, and ultimately electric usage. Not only can people see a heat map of their lab area, they can also observe trends and compare their energy usage to those in other areas.

171. Social Transactions/Open Transactions

Andy Lippman, Kwan Lee, Dawei Shen, Eric Shyu and Phumpong Watanaprapornkul

The Social Transactions application allows communities of consumers are able to collaboratively sense the market from a mobile device, enabling more informed financial decisions in a geo-local and timely context. The mobile application not only allows users to perform transactions, but also to inform, share, and purchase in groups at desired times. It could, for example, help people connect opportunistically in a local area to make group purchases, pick up an item for a friend, or perform reverse auctions. Our framework is an Open Transaction Network that enables applications from restaurant menu recommendations to electronics purchases. We tested this with MIT's TechCASH payment system to investigate whether shared social transactions could provide just-in-time influences to change behaviors.
172. t(ether)  

*New Listing*

*Hiroshi Ishii, Andy Lippman, Matthew Blackshaw and David Lakatos*

What if you could draw anywhere, on the objects around you, or simply in the air? What if you could walk through digital volumetric data, exploring these as you would real objects in physical space? t(ether) explores this possibility. By using tablets as views into a virtual world we are able to create a shared space for exploration and expression. Altering your viewpoint in t(ether) is as simple as changing the position and orientation of a tablet. Volumetric data are viewed at human scale, a 1:1 coordinate mapping between the virtual and the real, allowing intuitive navigation of space. Unlike Augmented Reality applications, which often separate us from the physical world, t(ether) grounds our experiences by allowing objects to be viewed, explored, annotated and manipulated as if they were in real space.

173. T+1  

*New Listing*

*Dawei Shen, Rick Borovoy and Andrew Lippman*

T+1 is an application that creates an iterative structure to help groups organize their interests and schedules. Users of T+1 receive instructions and send their personal information through mobile devices at discretized time steps, orchestrated by a unique, adaptive scheduling engine. At each time-step t, T+1 takes as inputs several relevant factors of human interactions, such as participants' interests, opinions, locations, and partner matching schedules. It then computes and optimizes the structure and format of a group interactions for the next interval. T+1 facilitates consensus formation, better group dynamics, and more engaging user experiences by using a clearly visible and comprehensible process. We are planning to deploy the platform in both academic and political discussion settings, analyze how user opinions and interests evolve in time to understand its efficacy.

174. The Glass Infrastructure  

*Henry Holtzman, Andy Lippman, Matthew Blackshaw, Rick Borovoy, Greg Elliott, Jon Ferguson, Catherine Havasi, Boris G Kizelshteyn, Julia Shuhong Ma, Daniel Edward Schultz and Polychronis Ypodimatopoulos*

This project builds a social, place-based information window into the Media Lab using 30 touch-sensitive screens strategically placed throughout the physical complex and at sponsor sites. The idea is get people to talk among themselves about the work that they jointly explore in a public place. We present Lab projects as dynamically connected sets of "charms" that visitors can save, trade, and explore. The GI demonstrates a framework for an open, integrated IT system and shows new uses for it.

175. VisualizeMe  

*New Listing*

*Hiroshi Ishii, Andy Lippman, Matthew Blackshaw, Anthony DeVincenzi and David Lakatos*

VisualizeMe provides a new perspective on your social life. By presenting your social graph as a moving picture, VisualizeMe breaks free from the text-centric interfaces of today's social networks, offering a fresh, holistic perspective. Unseen trends, before lost in mountains of text, can be better understood, providing an organic and evolving view of your relationships. VisualizeMe is a semi-finalist in the MIT 100k Entrepreneurship Competition.
176. X-Ray Audio

**Andy Lippman, Boris G Kizelshteyn and Victor Hung**

X-Ray Audio is the ability to locate an audio conference in space. Occupants of the designated geo-located space become automatic participants in the conference, and hear each other’s voices emanating from their relative directions, modulated by orientation and distance. By creating a voice conference attached to a locale, we enable people to continue the experience of a close-quarters discussion over any distance, through walls and around corners. We focus on the notion of connectivity that is local and based on intention, relationship, or service rather than address, with orientation serving as a way of indicating weight of attention.

177. Advanced Audio Systems for Live Performance

**Tod Machover and Ben Bloomberg**

This project explores the contribution of advanced audio systems to live performance, their design and construction, and their integration into the theatrical design process. We look specifically at innovative input and control systems for shaping the analysis and processing of live performance; and at large-scale output systems which provide a meaningful virtual abstraction to DSP in order to create flexible audio systems that can both adapt to many environments and achieve a consistent and precise sound field for large audiences.

178. Brain Instrument Interfaces

**Adam Boulanger**

We are developing a multimodal interface for hand rehabilitation following stroke. EMG forearm sensors read attempted finger presses in disordered limbs, and serve as an input to an expressive feedback interface. Auditory, visual, and tactile cues are presented to support rehabilitation of the representation of finger movements across sensory domains. The multisensory feedback is embedded in a rich task, situated between piano learning and expressive music performance. A user of this system will rehabilitate finger movement while developing an expressive music performance. Imagine a complete shift in the form and function of rehabilitation, towards something empowering, where individuals strive in tandem with tailored interfaces, mapped to push them forward at each step, and as part of fundamentally enriching expressive tasks. Our rehabilitative health care environments can sculpt our minds, while changing our lives, if we invent the right tools.

179. Death and the Powers: Redefining Opera

**Tod Machover, Ben Bloomberg, Elena Jessop, Bob Hsiung, Michael Miller and Peter Torpey**

"Death and the Powers" is a groundbreaking opera that brings a variety of technological, conceptual, and aesthetic innovations to the theatrical world. Created by Tod Machover (composer), Diane Paulus (director), and Alex McDowell (production designer), the opera uses the techniques of tomorrow to address age-old human concerns of life and legacy. The unique performance
180. Disembodied Performance

*Tod Machover, Peter Torpey and Elena Jessop*

Early in the opera "Death and the Powers," the main character Simon Powers is subsumed into a technological environment of his own creation. The set comes alive through robotic, visual, and sonic elements that allow the actor to extend his range and influence across the stage in unique and dynamic ways. This environment must assume the behavior and expression of the absent Simon; to distill the essence of this character, we recover performance parameters in real time from physiological sensors, voice, and vision systems. Gesture and performance parameters are then mapped to a visual language that allows the off-stage actor to express emotion and interact with others on stage. To accomplish this, we have developed a suite of innovative analysis, mapping, and rendering software systems. Our approach takes a new direction in augmented performance, employing a non-representation abstraction of a human presence that fully translates a character into an environment.

181. DrumTop v1.0

*Tod Machover and Akito Oshiro van Troyer*

This project aims to transform everyday objects into percussive musical instruments, encouraging people to rediscover their surroundings through musical interactions with the objects around them. DrumTop is a drum machine made up of eight transducers. Placing objects on top of the transducers triggers a "hit," causing sounds to come out from the objects themselves. In addition, users can program drum patterns by pushing on a transducer, and the weight of an object can be measured to control the strength of a “hit.”

182. Gestural Media Framework

*Tod Machover and Elena Jessop*

Many performance artists and interaction designers use human gestures to drive, manipulate, or generate digital media. However, the existing systems for developing mappings between incoming data streams and output media have extremely low-level concepts of “gesture,” forcing the user to focus on the particulars of input sensor or video data, rather than on meaningful and expressive gestures. We are developing a new framework for gestural control of media in performance, allowing users to easily create clear, intuitive, and comprehensible mappings by using high-level descriptions of gestures and of gestural qualities. This system currently is realized in a set of tools for gestural media manipulation in performance and rehearsal, mapping gestural vocabularies and qualities of movement to parameters of interactive visual applications.

183. Hyperinstruments

*Tod Machover*

The Hyperinstrument project creates expanded musical instruments and uses technology to give extra power and finesse to virtuosic performers. They were designed to augment a wide range of traditional musical instruments and have been used by some of the world’s foremost performers (Yo-Yo Ma, the Los Angeles Philharmonic, Peter Gabriel, and Penn & Teller). Research focuses on designing computer systems that measure and interpret human expression and feeling, exploring appropriate modalities and content of interactive art and
entertainment environments, and building sophisticated interactive musical instruments for non-professional musicians, students, music lovers, and the general public. Recent projects involve both new hyperinstruments for children and amateurs, and high-end hyperinstruments capable of expanding and transforming a symphony orchestra or an entire opera stage.

Alumni Contributors: Roberto M. Aimi, Mary Farbood, Ed Hammond, Tristan Jehan, Margaret Orth, Dan Overholt, Egon Pasztor, Joshua Strickon, Gili Weinberg and Diana Young

184. Hyperscore

Tod Machover

Hyperscore is an application to introduce children and non-musicians to musical composition and creativity in an intuitive and dynamic way. The "narrative" of a composition is expressed as a line-gesture, and the texture and shape of this line are analyzed to derive a pattern of tension-release, simplicity-complexity, and variable harmonization. The child creates or selects individual musical fragments in the form of chords or melodic motives, and layers them onto the narrative-line with expressive brushstrokes. The Hyperscore system automatically realizes a full composition from a graphical representation, allowing individuals with no musical training to create professional pieces. Currently, Hyperscore uses a mouse-based interface; the final version will support freehand drawing, and integration with the Music Shapers and Beatbugs to provide a rich array of tactile tools for manipulation of the graphical score.

Alumni Contributors: Mary Farbood, Ed Hammond, Tristan Jehan, Margaret Orth, Dan Overholt, Egon Pasztor, Joshua Strickon, Gili Weinberg and Diana Young

185. Mobile Music Diagnostics: Targeting Alzheimer's Disease

Alzheimer's Association, Tod Machover, Adam Boulanger, Intel and McLean Geriatric Hospital

The scientific community is making marked progress in the area of Alzheimer's disease (AD) treatment: memory-related pharmaceuticals are available, the neurobiology of AD is fairly well understood, and the genetic underpinnings of the disease continue to be unraveled. However, despite these advances, it has been shown that individuals often present the symptoms of AD years before they seek a diagnosis. The barrier to treatment is the lack of structure with which to obtain a diagnosis or even predict the onset of disease in a stigmatized environment. With technology, we can build clinically valid assessment into the tools we use every day—the tools we care about. We are developing music tools to detect cognitive performance in the memory domains at risk of decline in the earliest stages of AD. These tools are mobile, longitudinal, and the patient is the first point of feedback.

186. Music, Mind, and Health

Tod Machover and Adam Boulanger

Our work in Music, Mind, and Health has culminated in a recent PhD thesis, showing the technologies and perspectives required to build on the transformative nature of music to drive specific neurological, physical, and psychological change. A radically new "Personal Instrument" is currently being used by Dan Ellsey, a quadraplegic individual, who controls this interface to sculpt an expressive performance of music in real time. A three-month study of Ellsey's expressive behavior—its potential as well as its limits—resulted in an interface tailored just for him, enabling him to access expressive performance despite his physical disability. This new line of work highlights principles for future instruments and
applications, where the impact is in the marriage of the interface and uniqueness of the person. In this way, we are pursuing new design philosophies, technologies, and collaborations within the scientific community, public performance, and clinical research.

187. Musical Robotics  
Tod Machover, Michael Miller, Bob Hsiung, Karen Hart, Donald Eng

Robots and performers make beautiful music together. The opera "Death and the Powers" features a chorus of seven-foot tall, autonomous, polymorphic Operarobots and three large fifteen-foot tall robotic walls. At various times, these function as characters, set pieces, and lighting elements. Using state-of-the-art control electronics, and a novel real-time performance control system, a total of 9 individually addressable Operarobots reflect on, participate in, and illuminate the action onstage.

Alumni Contributors: Andrew Albert Cavatorta, Wei Dong, Mike Fabio and Noah Landwehr Feehan

188. Personal Opera  
Tod Machover and Peter Torpey

Personal Opera is a radically innovative creative environment that enables anyone to create musical masterpieces sharing one’s deepest thoughts, feelings, and memories. Based on our design of, and experience with, such projects as Hyperscore and the Brain Opera, we are developing a totally new environment to allow the incorporation of personal stories, images, and both original and well-loved music and sounds. This development is based on two guiding principles: first, active music creation yields far more powerful benefits than passive listening; and second, increasing customization of the musical experience is both desirable and possible, as evidenced in our group’s development of Personal Instruments (see Music, Mind, and Health) and Personal Music. Personal Opera goes a step further, using music as the medium for assembling and conveying our own individual legacies, representing a new form of archiving, easy to use and powerful to experience.

189. Skellig: A "Surround" Opera  
Tod Machover, Ben Bloomberg and Simone Ovsey

Skellig is an opera with music by Tod Machover and a libretto based on the best-selling novel for young people by David Almond. It premiered in the UK in November 2008. Besides blending acoustics and electronics, natural noise, and soaring melodies, Skellig also presents several live performance breakthroughs. A non-professional teenage chorus is used throughout, blended seamlessly with high-level professionals; this chorus is guided by an interactive "sonic score" that provides auditory cues, textures to imitate, and electronic reinforcement for the entire 100-minute show. In addition, specially designed "ambisonics" were developed to allow sound to emanate from the stage and engulf the audience in all dimensions, the first time such a technique has been used in a full-scale theatrical setting.

190. Spheres and Splinters  
Tod Machover, Ben Bloomberg, and Peter Torpey

Spheres and Splinters is a new work composed by Tod Machover for hypercello, electronics, and responsive visuals commissioned for the Faster than Sound at Aldeburgh Music. The work was premiered with cellist Peter Gregson in the UK in 2010 and had its US premiere as part of FAST Festival of Art, Science, and
Technology in celebration of MIT’s 150th anniversary. Utilizing audio analysis and a multitude of wireless sensors on the cello and the bow that capture how the instrument is being played, the performer has control over transformations and extensions of the sound produced. This control extends into the ambisonic spatialization of sound in the performance space. The performance data is also used to produce realtime visual accompaniment on an array of LED strips surrounding the cellist.

191. The Chandelier

_Tod Machover, Wei Dong, Paula Marie Countouris, Karen Hart and Calvin Chung_

The Chandelier is a large-scale robotic musical instrument that is being developed for "Death and the Powers." Its 48 strings can be actuated both through powerful electromagnets, and tactiliy (plucked like a harp or bowed like a cello). With the strings driven by electromagnets, the tactile player can also repeatedly damp strings or create overtones by carefully touching the strings' anti-nodes, creating a new intimacy between players, who play not just the same instrument, but the same strings. The Chandelier is composed of many systems—logic for control of music and lighting, networked servers, and playable interfaces—all built around an elegant, articulated skeletal structure which allows changes to the length, angle, and tensions of the strings. We are currently experimenting with playing it through new types of interfaces to take advantage of its unusual tuning and sonorities.

Alumni Contributors: Andrew Albert Cavatorta and Wei Dong

192. Toy Symphony

_Tod Machover_

Toy Symphony combines children, virtuosic soloists, composers, and symphony orchestras around the world to alter radically how children are introduced to music, as well as to redefine the relationship between professional musicians and young people. A complete set of Music Toys will be distributed to children in each host city (including Berlin, Dublin, Glasgow, Manchester/London, and Tokyo), where children will be mentored to create their own sounds and compositions for toys and traditional instruments. A pedagogy for using these Music Toys to teach and to instill a love for musical creativity will also be developed. Final concerts will be presented in each host city including children's compositions and specially commissioned works by young composers, to be performed by children, soloists, and orchestra, playing Music Toys, Hyperinstruments, and traditional instruments.

Alumni Contributors: Roberto M. Aimi, Mary Farbood, Tristan Jehan, Ariane Martins, Laird Nolan, Gili Weinberg and Diana Young

193. Vocal Augmentation and Manipulation Prosthesis (VAMP)

_Tod Machover and Elena Jessop_

The Vocal Augmentation and Manipulation Prosthesis (VAMP) is a gesture-based, wearable controller for live-time vocal performance. This controller allows a singer to capture and manipulate single notes that she sings, using a gestural vocabulary developed from that of choral conducting. By drawing from a familiar gestural vocabulary, this controller and the associated mappings can be more intuitive to both performer and audience. This instrument was inspired by the character of Nicholas in Death and the Powers.
Pattie Maes—Fluid Interfaces

How to integrate the world of information and services more naturally into our daily physical lives, enabling insight, inspiration, and interpersonal connections.

194. Augmented Product Counter

_Natan Linder and Pattie Maes_

We have created an augmented reality (AR) based product display counter that transforms any surface or object into an interactive surface, blending digital media and information with physical space. This system enables shoppers to conduct research in the store, learn about product features, and talk to a virtual expert to get advice via built-in video conferencing. The Augmented Product Counter is based on LuminAR technology, which can transform any standard product counter, enabling shoppers to get detailed information on products as well as web access to read unbiased reviews, compare pricing, and conduct research while they interact with real products. This system delivers an innovative in-store shopping experience combining live product interactions in a physical environment with the vast amount of information available on the web in an engaging and interactive manner.

195. Bimba

_Pattie Maes and Pol Pla i Conesa_

Bimba is a playful interface that sonifies movement by embedding electronics into inflatable balls. By means of physical manipulation of the balls, users can create musical compositions. The musical output of the system is directly mapped to the motion of the balls, thus, the creations depend on physical laws.

196. Blossom

_Pattie Maes and Sajid Sadi_

Blossom is a multiperson awareness system that uses ioMaterials-based techniques to connect distant friends and family. It provides an awareness medium that does not rely on the attention- and reciprocity-demanding interfaces that are provided by digital communication media such as mobile phones, SMS, and email. Combining touch-based input with visual, haptic, and motile feedback, Blossoms are created as pairs that can communicate over the network, echoing the conditions of each other and forming an implicit, always-there link that physically express awareness, while retaining the instantaneous capabilities that define digital communication.

197. Celebrating MIT's 150th with Light

_Pattie Maes, Pol Pla i Conesa, Susanne Seitinger and Philips Color Kinetics_

We are designing a responsive and interactive low-resolution public LED-display for MIT's 150th Anniversary. Located on the Harvard Bridge, the project symbolically connects Cambridge and Boston where MIT was chartered in 1861. We are exploring sensors for interaction and responsiveness, the potential for user-programmable urban screens, and new configurations of low-resolution displays that blur the boundaries between traditional city lighting and the responsive infrastructures of today.
198. Defuse

Aaron Zinman, Judith Donath and Pattie Maes

Defuse is a commenting platform that rethinks the medium's basic interactions. In a world where a single article in The New York Times can achieve 3,000 comments, the original design of public asynchronous text systems has reached its limit; it needs more than social convention. Defuse uses context to change the basics of navigation and message posting. It uses a combination of machine learning, visualization, and structural changes to achieve this goal.

199. DepthJS

Pattie Maes, Henry Holtzman, Aaron Zinman, Doug Fritz, Greg Elliott and Roy Shilkrot

DepthJS is a framework that allows any web page to interact with Microsoft Kinect via Javascript. Navigating the web is only one application of the framework—we envision all sorts of applications that run in the browser, from games to specific utilities for specific sites. The great part is that now web developers who specialize in Javascript can work with Kinect without having to learn any special languages or code. We hope this will allow a new set of interactions beyond what we first developed.

200. Hyperego

Pattie Maes and Aaron Zinman

NEW LISTING

When we meet new people in real life, we assess them using a multitude of signals relevant to our upbringing, society, and our experiences and disposition. When we encounter a new individual virtually, usually we are looking at a single communication instance in bodiless form. How can we gain a deeper understanding of this individual without the cues we have in real life? Hyperego aggregates information across various online services to provide a more uniform data portrait of the individual. These portraits are at the user's control, allowing specific data to be hidden, revealed, or grouped in aggregate using an innovative privacy model.

201. Inktuitive: An Intuitive Physical Design Workspace

Pranav Mistry and Kayato Sekiya

Despite the advances and advantages of computer-aided design tools, the traditional pencil and paper continue to exist as the most important tools in the early stages of design. Inktuitive is an intuitive physical design workspace that aims to bring together conventional design tools such as paper and pencil with the power and convenience of digital tools for design. Inktuitive also extends the natural work-practice of using physical paper by giving the pen the ability to control the design in physical, 3-D, freeing it from its tie to the paper. The intuition of pen and paper are still present, but lines are captured and translated into shapes in the digital world. The physical paper is augmented with overlaid digital strokes. Furthermore, the platform provides a novel interaction mechanism for drawing and designing using above the surface pen movements.

202. InterPlay: Full-Body Interaction Platform

Pattie Maes, Seth Hunter and Pol Pla i Conesa

InterPlay is a platform for designers to create dynamic social simulations that transform public spaces into immersive environments where people become the central agents. It uses computer vision and projection to facilitate full-body interaction with digital content. The physical world is augmented to create shared experiences that encourage active play, negotiation, and creative composition.
203. ioMaterials

**Pattie Maes, Sajid Sadi and Amir Mikhak**

ioMaterials is a project encompassing a variety of collocated sensing-actuation platforms. The project explores various aspects of dense sensing for humane communication, memory, and remote awareness. Using dense collocated sensing actuation and sensing, we can change common objects into an interface capable of hiding unobtrusively in plain sight. Relational Pillow and Blossom are instantiations of this ideal.

204. Konbit

**Greg Elliott, Aaron Zinman, Henry Holtzman and Pattie Maes**

Konbit is a service that helps communities rebuild themselves after a crisis by indexing the skillsets of local residents, allowing NGOs to find and employ them. Haitians, their diaspora, and the international community can volunteer their skills via phone, SMS, or Web. Skills can then be searched in real time and location by NGOs such as the American Red Cross and Partners-in-Health. Konbit is language and medium neutral, where Kreyol voice and text messages may be translated into other languages through the Konbit phone, text, or Web interface.

205. Liberated Pixels

**Susanne Seitinger**

We are experimenting with systems that blur the boundary between urban lighting and digital displays in public spaces. These systems consist of liberated pixels, which are not confined to rigid frames as are typical urban screens. Liberated pixels can be applied to existing horizontal and vertical surfaces in any configuration, and communicate with each other to enable a different repertoire of lighting and display patterns. We have developed Urban Pixels a wireless infrastructure for liberated pixels. Composed of autonomous units, the system presents a programmable and distributed interface that is flexible and easy to deploy. Each unit includes an on-board battery, RF transceiver unit, and microprocessor. The goal is to incorporate renewable energy sources in future versions.

Alumni Contributor: William J. Mitchell

206. Light.Bodies

**Susanne Seitinger, Alex S. Taylor and Microsoft Research**

“Light bodies” are mobile and portable, hand-held lights that respond to audio and vibration input. The motivation to build these devices is grounded in a historical reinterpretation of street lighting. Before fixed infrastructure illuminated cities at night, people carried lanterns with them to make their presence known. Using this as our starting point, we asked how we might engage people in more actively shaping the lightscapes which surround them. A first iteration of responsive, LED-based colored lights were designed for use in three different settings including a choreographed dance performance, an outdoor public installation and an audio-visual event.

Alumni Contributor: William J. Mitchell

207. LuminAR

**Natan Linder and Pattie Maes**

LuminAR reimagines the traditional incandescent bulb and desk lamp, evolving them into a new category of robotic, digital information devices. The LuminAR Bulb combines a Pico-projector, camera, and wireless computer in a compact
form factor. This self-contained system enables users with just-in-time projected information and a gestural user interface, and it can be screwed into standard light fixtures everywhere. The LuminAR Lamp is an articulated robotic arm, designed to interface with the LuminAR Bulb. Both LuminAR form factors dynamically augment their environments with media and information, while seamlessly connecting with laptops, mobile phones, and other electronic devices. LuminAR transforms surfaces and objects into interactive spaces that blend digital media and information with the physical space. The project radically rethinks the design of traditional lighting objects, and explores how we can endow them with novel augmented-reality interfaces.

208. MemTable  
*Pattie Maes, Seth Hunter, Alexandre Milouchev and Emily Zhao*

MemTable is a table with a contextual memory. The goal of the system is to facilitate reflection on the long-term collaborative work practices of a small group by designing an interface that supports meeting annotation, process documentation, and visualization of group work patterns. The project introduces a tabletop designed both to remember how it is used and to provide an interface for contextual retrieval of information. MemTable examines how an interface that embodies the history of its use can be incorporated into our daily lives in more ergonomic and meaningful contexts.

209. Mouseless  
*Pranav Mistry and Pattie Maes*

Mouseless is an invisible computer mouse that provides the familiarity of interaction of a physical mouse without actually needing a real hardware mouse. Despite the advances in computing hardware technologies, the two-button computer mouse has remained the predominant means to interact with a computer. Mouseless removes the requirement of having a physical mouse altogether, but still provides the intuitive interaction of a physical mouse with which users are familiar.

210. Moving Portraits  
*Pattie Maes*

Moving portrait is a framed portrait that is aware of and reacts to viewers’ presence and body movements. A portrait represents a part of our lives and reflects our feelings, but it is completely oblivious to the events that occur around it or to the people who view it. By making a portrait interactive, we create a different and more engaging relationship between it and the viewer.

211. MTM "Little John"  
*Natan Linder*

MTM "Little John" is a multi-purpose, mid-size, rapid prototyping machine with the goal of being a personal fabricator capable of performing a variety of tasks (3D printing, milling, scanning, vinyl cutting) at a price point in the hundreds rather than thousands of dollars. The machine was designed and built in collaboration with the MTM—Machines that Make Project at MIT Center for Bits and Atoms.

212. PalimPost  
*Li Bian, Roy Shilkrot, Pattie Maes and Henry Holtzman*

PalimPost is a converged system for storing, searching, and sharing digital and physical world information using sticky notes and mobile devices. PalimPost extracts contextual cues from a user’s physical environment and activities, connects them to the user’s digital world research, and subsequently presents to
the user systematically categorized, relevant, and JIT information. Whether a user is writing down a shopping list on a sticky note after surfing the internet at home, or checking out hundreds of products at hand in a physical store, whether a user is preparing a list of dinner ingredients in the kitchen or buying food outside in the market, PalimPost integrates information from different time and location to form a seamlessly connected experiences for the user.


*Marcelo Coelho, Pattie Maes, Joanna Berzowska and Lyndl Hall*

Pulp-Based Computing is a series of explorations that combine smart materials, papermaking, and printing. By integrating electrically active inks and fibers during the papermaking process, it is possible to create sensors and actuators that behave, look, and feel like paper. These composite materials not only leverage the physical and tactile qualities of paper, but can also convey digital information, spawning new and unexpected application domains in ubiquitous and pervasive computing at extremely affordable costs.

214. Quickies: Intelligent Sticky Notes

*Pranav Mistry and Pattie Maes*

The goal of Quickies is to bring one of the most useful inventions of the twentieth century into the digital age: the ubiquitous sticky note. Quickies enriches the experience of using sticky notes by linking hand-written sticky notes to mobile phones, digital calendars, task-lists, email, and instant messaging clients. By augmenting the familiar, ubiquitous sticky note, Quickies leverages existing patterns of behavior, merging paper-based sticky note usage with the user's informational experience. The project explores how the use of artificial intelligence (AI), natural language processing (NLP), RFID, and ink-recognition technologies can make it possible to create intelligent sticky notes that can be searched, located, can send reminders and messages, and more broadly, can act as an I/O interface to the digital information world.

215. ReflectOns: Mental Prostheses for Self-Reflection

*Pattie Maes and Sajid Sadi*

ReflectOns are objects that help people think about their actions and change their behavior based on subtle, ambient nudges delivered at the moment of action. Certain tasks—such as figuring out the number of calories consumed, or amount of money spent eating out—are generally difficult for the human mind to grapple with. By using in-place sensing combined with gentle feedback and understanding of users’ goals, we can recognize behaviors and trends, and provide a reflection of their own actions tailored to enable both better understanding of the repercussions of those actions, and changes to their behaviors to help them better match their own goals.

216. Remnant: Handwriting Memory Card

*Pattie Maes and Sajid Sadi*

Remnant is a greeting card that merges the affordances of physical materials with the temporal malleability of digital systems to create, enshrine, and reinforce the very thing that makes a greeting personal: that hand of the sender. The card records both the timing and the form of the sender's handwriting when it is first used. At a later time, collocated output recreates the handwriting, allowing the invisible, memorized hand of the sender to write his or her message directly in front of the recipient.
217. Sensei: A Mobile Tool for Language Learning

Pattie Maes, Suranga Nanayakkara and Roy Shilkrot

Sensei is a mobile interface for language learning (words, sentences, pronunciation). It combines techniques from computer vision, augmented reality, speech recognition, and commonsense knowledge. In the current prototype, the user points his cell phone at an object and then sees the word and hears it pronounced in the language of his choice. The system also shows more information pulled from a commonsense knowledge base. The interface is primarily designed to be used as an interactive and fun language-learning tool for children. Future versions will be applied to other contexts such as real-time language translation for face-to-face communication and assistance to travelers for reading information displays in foreign languages; in addition, future versions will provide feedback to users about whether they are pronouncing words correctly. The project is implemented on a Samsung Galaxy phone running Android, donated by Samsung Corporation.

218. Shutters: A Permeable Surface for Environmental Control and Communication

Marcelo Coelho and Pattie Maes

Shutters is a permeable kinetic surface for environmental control and communication. It is composed of actuated louvers (or shutters) that can be individually addressed for precise control of ventilation, daylight incidence, and information display. By combining smart materials, textiles, and computation, Shutters builds upon other facade systems to create living environments and work spaces that are more energy efficient, while being aesthetically pleasing and considerate of their inhabitants’ activities.

219. Siftables: Physical Interaction with Digital Media

Pattie Maes

Siftables are compact electronic devices with motion sensing, graphical display, and wireless communication. One or more Siftables may be physically manipulated to interact with digital information and media. A group of Siftables can thus act in concert to form a physical, distributed, gesture-sensitive, human-computer interface. Each Siftable object is stand-alone (battery-powered and wireless); Siftables do not require installed infrastructure such as large displays, instrumented tables, or cameras in order to be used. Siftables' key innovation is to give direct physical embodiment to information items and digital media content, allowing people to use their hands and bodies to manipulate these data instead of relying on virtual cursors and windows. By leveraging people’s ability to manipulate physical objects, Siftables radically simplify the way we interact with information and media.

Alumni Contributors: Jeevan James Kalanithi and David Merrill

220. Six-Forty by Four-Eighty: An Interactive Lighting System

Marcelo Coelho and Jamie Zigelbaum

Six-Forty by Four-Eighty is an interactive lighting system composed of an array of magnetic physical pixels. Individually, pixel-tiles change their color in response to touch and communicate their state to each other by using a person’s body as the conduit for information. When grouped together, the pixel-tiles create patterns and animations that can serve as a tool for customizing our physical spaces. By transposing the pixel from the confines of the screen and into the physical world, focus is drawn to the materiality of computation and new forms for design emerge.
221. SixthSense

Pranav Mistry

Information is often confined to paper or computer screens. SixthSense frees data from these confines and seamlessly integrates information and reality. With the miniaturization of computing devices, we are always connected to the digital world, but there is no link between our interactions with these digital devices and our interactions with the physical world. SixthSense bridges this gap by augmenting the physical world with digital information, bringing intangible information into the tangible world. Using a projector and camera worn as a pendant around the neck, SixthSense sees what you see and visually augments surfaces or objects with which you interact. It projects information onto any surface or object, and allows users to interact with the information through natural hand gestures, arm movements, or with the object itself. SixthSense makes the entire world your computer.

222. SoundForms

Pattie Maes, Seth Hunter and Pol Pla i Conesa

Soundforms is a tabletop interface for collaborative composition. The shapes and sizes of objects are used as simple icons for controlling sound output, affording a playful interface for people to experiment together in a short sound composition.

223. SPARSH

Pranav Mistry and Pattie Maes

SPARSH explores a novel interaction method to seamlessly transfer data among multiple users and devices in a fun and intuitive way. A user touches a data item to be copied from a device, conceptually saving the item in his or her body. Next, the user touches the other device to which he or she wants to paste/pass the saved content. SPARSH uses touch-based interactions as indications for what to copy and where to pass it. Technically, the actual transfer of media happens via the information cloud.

224. Spotlight

Pattie Maes and Sajid Sadi

Spotlight is about an artist's ability to create a new meaning using the combination of interactive portraits and diptych or polyptych layouts. The mere placement of two or more portraits near each other is a known technique to create a new meaning in the viewer's mind. Spotlight takes this concept into the interactive domain, creating interactive portraits that are aware of each other's state and gesture. So not only the visual layout, but also the interaction with others creates a new meaning for the viewer. Using a combination of interaction techniques, Spotlight engages the viewer at two levels. At the group level, the viewer influences the portrait's "social dynamics." At the individual level, a portrait's "temporal gestures" expose much about the subject's personality.

Alumni Contributor: Orit Zuckerman

225. Sprout I/O: A Texturally Rich Interface

Marcelo Coelho and Pattie Maes

Sprout I/O is a kinetic fur that can capture, mediate, and replay the physical impressions we leave in our environment. It combines embedded electronic actuators with a texturally rich substrate that is soft, fuzzy, and pliable to create a dynamic structure where every fur strand can sense physical touch and be individually moved. By developing a composite material that collocates kinetic I/O, while preserving the expectations that we normally have from interacting with
physical things, we can more seamlessly embed and harness the power of computation in our surrounding environments to create more meaningful interfaces for our personal and social activities.

226. Surflex: A Shape-Changing Surface  

Marcelo Coelho and Pattie Maes

Surflex is a programmable surface for the design and visualization of physical objects and spaces. It combines the different memory and elasticity states of its materials to deform and gain new shapes, providing a novel alternative for 3-D fabrication and the design of physically adaptable interfaces.

227. TaPuMa: Tangible Public Map  

Pranav Mistry and Tsuyoshi Kuroki

TaPuMa is a digital, tangible, public map that allows people to use everyday objects they carry to access relevant, just-in-time information and to find locations of places or people. TaPuMa envisions that conventional maps can be augmented with the unique identities and affordances of the objects. TaPuMa uses an environment where map and dynamic content is projected on a tabletop. A camera mounted above the table identifies and tracks the locations of the objects on the surface, and a software program identifies and registers the location of objects. After identifying the objects, the software provides relevant information visualizations directly on the table. The projector augments both object and table with projected digital information. TaPuMa explores a novel interaction mechanism where physical objects are used as interfaces to digital information. It allows users to acquire information through tangible media, the things they carry.

228. Textura  

Pattie Maes, Marcelo Coelho and Pol Pla i Conesa

Textura is an exploration of how to enhance white objects with textures. By projecting onto any white surface, we can simulate different textures and materials. We envision this technology to have great potential for customization and personalization, and to be applicable to areas such as industrial design, the game industry, and retail scenarios.

229. thirdEye  

Pranav Mistry and Pattie Maes

thirdEye is a new technique that enables multiple viewers to see different things on a same display screen at the same time. With thirdEye: a public sign board can show a Japanese tourist instructions in Japanese and an American in English; games won't need a split screen anymore—each player can see his or her personal view of the game on the screen; two people watching TV can watch their favorite channel on a single screen; a public display can show secret messages or patterns; and in the same movie theater, people can see different ends of a suspense movie.

230. VisionPlay  

Pattie Maes and Seth Hunter

VisionPlay is a framework to support the development of augmented play experiences for children. We are interested in exploring mixed reality applications enabled by web cameras, computer vision techniques, and animation that are more socially oriented and physically engaging. These include using physical toys to control digital characters, augmenting physical play environments with projection, and merging representations of the physical world with virtual play spaces.
231. Watt Watcher  
*Pattie Maes, Sajid Sadi and Eben Kunz*

Energy is the backbone of our technological society, yet we have great difficulty understanding where and how much of it is used. Watt Watcher is a project that provides in-place feedback on aggregate energy use per device in a format that is easy to understand and intuitively compare. Energy is inherently invisible, and its use is often sporadic and difficult to gauge. How much energy does your laptop use compared to your lamp? Or perhaps your toaster? By giving users some intuition regarding these basic questions, this ReflectOn allows users both to understand their use patterns and form new, more informed habits.

**Frank Moss—New Media Medicine**

How radical new collaborations between doctors, patients, and communities will catalyze a revolution in human health.

232. Awaken  
*Frank Moss, Alex (Sandy) Pentland, Sai T. Moturu and Kimberly Shellenberger*

Sleep problems such as insomnia have a significant impact on public health, affect the quality of life and productivity of millions daily, present a yearly economic burden in the billions, and are strongly associated with multiple comorbid conditions. Several factors affecting sleep are primarily behavioral and not always obvious. This project aims to detect the behaviors that affect sleep and use this knowledge to help users improve sleep habits. While asleep, a wearable sensor headband is used to track the quality of sleep. While awake, smart phones are used to capture behaviors that can impact sleep. Based on the data collected, the phones also provide context-sensitive suggestions and coaching elements borrowed from cognitive behavioral therapy to improve awake behaviors and sleep habits, while their communication capabilities are used to enhance social support from sleeping partners and family members.

233. CollaboRhythm  
*John Moore MD and Frank Moss*

The doctor-patient relationship is deteriorating. CollaboRhythm implements new paradigms in doctor-patient interaction to improve health outcomes and the patient experience. It uses ubiquitous connectivity, collaborative decision-making, and compelling interfaces to educate patients, improve treatment adherence, and deliver care seamlessly at any point in time or space. The foundation is a speech- and touch-controlled hub for the office where doctor and patient make shared decisions and where patients are encouraged to actively engage with their data. Patients also own their data: everything they see in the doctor's office is available at home, when they visit another doctor, change jobs, or move across the world. Patients can contribute data that are important to their health and lifestyles—information that today is invisible to the doctor. By making patients active, informed participants in their own care, we believe we can reduce health-care costs, increase quality, and improve health outcomes.
234. Collective Discovery

Frank Moss, Deb Roy and Ian Eslick

The choices we make about diet, environment, medications, or alternative therapies constitute a massive collection of "everyday experiments." These data are largely unrecorded and underutilized by the traditional research establishment. Collective Discovery aims to leverage the intuition and insight of patient communities to capture and mine information about everyday experiences. Moving the community discourse from anecdotes to data will lead to better decision-making, stronger self-advocacy, identification of novel therapies, and inspiration of better hypotheses in traditional research, accelerating the search for new drugs and treatments. The unique characteristic of our Collective Discovery model is the use of knowledge representation and natural language processing to mediate communal hypothesis generation and to compensate for methodological errors and self-reporting bias. This model is being deployed in a real-world context as part of a partnership with the LAM Treatment Alliance and the greater LAM community.

235. ForgetAboutIT?

John Moore MD and Frank Moss

Currently only 50% of patients with chronic diseases take their medications. The problem is not simple forgetfulness; it is a complex combination of lack of understanding, poor self-reflection, limited social support, and almost non-existent communication between provider and patient. ForgetAboutIT? is a system to support medication adherence which presupposes that patients engaged in tight, collaborative communication with their providers through interactive interfaces would think it preposterous not to take their medications. Technically, it is an awareness system that employs ubiquitous connectivity on the patient side through cell phones, televisions, and other interactive devices and a multi-modal collaborative workstation on the provider side.

236. I'm Listening

John Moore MD, Henry Lieberman and Frank Moss

Increasing understanding of how to categorize patient symptoms for efficient diagnosis has led to structured patient interviews and diagnostic flowcharts that can provide diagnostic accuracy and save valuable physician time. But the rigidity of predefined questions and controlled vocabulary for answers can leave patients feeling over-constrained, as if the doctor (or computer system) is not really attending to them. I’m Listening is a system for automatically conducting patient pre-visit interviews. It does not replace a human doctor, but can be used before an office visit to prepare the patient, deliver educational materials or triage care, and preorder appropriate tests, making better use of both doctor and patient time. It uses an on-screen avatar and natural language processing to (partially) understand the patient's response. Key is a common-sense reasoning system that lets patients express themselves in unconstrained natural language, even using metaphor, and that maps the language to medically relevant categories.

237. IDA: Inexpensive Networked Digital Stethoscope

Yadid Ayzenberg

Complex and expensive medical devices are mainly used in medical facilities by health professionals. IDA is an attempt to disrupt this paradigm and introduce a new type of device: easy to use, low cost, and open source. It is a digital stethoscope that can be connected to the Internet for streaming the physiological data to remote clinicians. Designed to be fabricated anywhere in the world with minimal equipment, it can be operated by individuals without medical training.
238. **LAMsight: A Data-Driven Disease Community**

*Frank Moss, Ian Eslick, Amy Farber and LAM Treatment Alliance*

LAMsight is a practical experiment in creating new models for collaboration between researchers, clinicians, and patients. We are working with a rare-disease advocacy organization to identify and implement collaboration modes that help accelerate research on the rare disease LAM (Lymphangioleiomyomatosis), a multi-system, fatal disease that typically strikes women in their child-bearing years.

239. **Oovit PT**

*Sai T. Moturu, John Moore, Sonny Thai and Frank Moss*

Patient adherence to physical therapy regimens is poor, and there is a lack of quantitative data about patient performance, particularly at home. This project aims to build an end-to-end virtual rehabilitation system for supporting patient adherence to home exercise that addresses the multi-factorial nature of the problem. Using the proposed system, the physical therapist and patient would make shared decisions about appropriate exercises and goals and patients would use a sensor-enabled gaming interface at home to perform exercises. Quantitative data is then fed back to the therapist, who can properly adjust the regimen and give reinforcing feedback and support.

240. **WeightMate**

*Sai T. Moturu, Frank Moss and Alex (Sandy) Pentland*

Nearly one-third of the population of the United States is obese, and another one-third is overweight, resulting in significant health risks. Behavioral aspects including dietary habits, emotional states, and lack of physical exercise are the primary contributors to this phenomenon. In this project, we use smart phones to log dietary habits; track user behaviors, social interactions and emotional states; and gather the context of their actions. This information is then used to provide context-sensitive education based on trend detection, and just-in-time persuasive feedback to improve eating habits, reduce emotional eating, moderate exposure to unhealthy eating environments, and encourage better choices including greater physical activity. Social reinforcement is used to further motivate users.

241. **Neri Oxman—Mediated Matter**

How digital and fabrication technologies mediate between matter and environment to radically transform the design and construction of objects, buildings, and systems.

241. **3D Printing of Functionally Graded Materials**

*Neri Oxman and Steven Keating*

Functionally graded materials—materials with spatially varying composition or microstructure—are omnipresent in nature. From palm trees with radial density gradients, to the spongy trabeculae structure of bone, to the hardness gradient found in many types of beaks, graded materials offer material and structural efficiency. But in man-made structures such as concrete pillars, materials are typically volumetrically homogenous. While using homogenous materials allows for ease of production, improvements in strength, weight, and material usage can be obtained by designing with functionally graded materials. To achieve graded material objects, we are working to construct a 3D printer capable of dynamic
mixing of composition material. Starting with concrete and UV-curable polymers, we aim to create structures, such as a bone-inspired beam, which have functionally graded materials.

242. Beast  

*Neri Oxman*

Beast is an organic-like entity created synthetically by the incorporation of physical parameters into digital form-generation protocols. A single continuous surface, acting both as structure and as skin, is locally modulated for both structural support and corporeal aid. Beast combines structural, environmental, and corporeal performance by adapting its thickness, pattern density, stiffness, flexibility, and translucency to load, curvature, and skin-pressured areas respectively.

243. Carpal Skin  

*Neri Oxman*

Carpal Skin is a prototype for a protective glove to protect against Carpal Tunnel Syndrome, a medical condition in which the median nerve is compressed at the wrist, leading to numbness, muscle atrophy, and weakness in the hand. Night-time wrist splinting is the recommended treatment for most patients before going into carpal tunnel release surgery. Carpal Skin is a process by which to map the pain-profile of a particular patient—its intensity and duration—and to distribute hard and soft materials to fit the patient’s anatomical and physiological requirements, limiting movement in a customized fashion. The form-generation process is inspired by animal coating patterns in the control of stiffness variation.

244. CNSILK: Computer Numerically Controlled Silk Cocoon Construction  

*Neri Oxman*

CNSILK explores the design and fabrication potential of silk fibers—inspired by silkworm cocoons—for the construction of woven habitats. It explores a novel approach to the design and fabrication of silk-based building skins by controlling the mechanical and physical properties of spatial structures inherent in their microstructures using multi-axes fabrication. The method offers construction without assemblies such that material properties vary locally to accommodate for structural and environmental requirements. This approach stands in contrast to functional assemblies and kinetically actuated facades which require a great deal of energy to operate, and are typically maintained by global control. Such material architectures could simultaneously bear structural load, change their transparency so as to control light levels within a spatial compartment (building or vehicle), and open and close embedded pores so as to ventilate a space.

245. FABRICOLOGY: Variable-Property 3D Printing as a Case for Sustainable Fabrication  

*Neri Oxman*

Rapid prototyping technologies speed product design by facilitating visualization and testing of prototypes. However, such machines are limited to using one material at a time; even high-end 3D printers, which accommodate the deposition of multiple materials, must do so discretely and not in mixtures. This project aims to build a proof-of-concept of a 3D printer able to dynamically mix and vary the ratios of different materials in order to produce a continuous gradient of material properties with real-time correspondence to structural and environmental constraints.

Alumni Contributors: Mindy Eng, William J. Mitchell and Rachel Fong
246. Monocoque  
*Neri Oxman*

French for "single shell," Monocoque stands for a construction technique that supports structural load using an object's external skin. Contrary to the traditional design of building skins that distinguish between internal structural frameworks and non-bearing skin elements, this approach promotes heterogeneity and differentiation of material properties. The project demonstrates the notion of a structural skin using a Voronoi pattern, the density of which corresponds to multi-scalar loading conditions. The distribution of shear-stress lines and surface pressure is embodied in the allocation and relative thickness of the vein-like elements built into the skin. Its innovative 3D printing technology provides for the ability to print parts and assemblies made of multiple materials within a single build, as well as to create composite materials that present preset combinations of mechanical properties.

247. Morphable Structures  
*Neri Oxman and Steven Keating*

Granular materials can be put into a jammed state through the application of pressure to achieve a pseudo-solid material with controllable rigidity and geometry. While jamming principles have been long known, large-scale applications of jammed structures have not been significantly explored. The possibilities for shape-changing machines and structures are vast and jamming provides a plausible mechanism to achieve this effect. In this work, jamming prototypes are constructed to gain a better understanding of this effect. As well, potential specific applications are highlighted and demoed. Such applications range from a morphable chair, to a floor which dynamically changes its softness in response to a user falling down to reduce injury, to artistic free-form sculpting.

248. Rapid Craft  
*Neri Oxman*

The values endorsed by vernacular architecture have traditionally promoted designs constructed and informed by and for the environment while using local knowledge and indigenous materials. Under the imperatives and growing recognition of sustainable design, Rapid Craft seeks the integration sought between local construction techniques and globally available digital design technologies to preserve, revive, and reshape these cultural traditions.

249. Raycounting  
*Neri Oxman*

Raycounting is a method for generating customized light-shading constructions by registering the intensity and orientation of light rays within a given environment. 3D surfaces of double curvature are the result of assigning light parameters to flat planes. The algorithm calculates the intensity, position and direction of one, or multiple, light sources placed in a given environment and assigns local curvature values to each point in space corresponding to the reference plane and the light dimension. Light performance analysis tools are reconstructed programmatically to allow for morphological synthesis based on intensity, frequency and polarization of light parameters as defined by the user.
Joseph Paradiso—Responsive Environments
How sensor networks augment and mediate human experience, interaction, and perception.

250. 3D Printed Flute

Joe Paradiso and Amit Zoran
This project presents a new approach for the design and fabrication of the acoustic instrument, using digital fabrication technologies, and specifically 3D printing. A concert flute was 3D printed, including (almost) all of its mechanisms, without the need to assemble the moving parts. In order to fulfill this challenge a new design of the instrument was made. Instead of proposing the machine can easily replace the human craft - we use this research to examine the possible contributions of rapid prototyping to the design and fabrication of traditional instruments.

Alumni Contributor: Objet Geometries Ltd.

251. Chameleon Guitar:
Physical Heart in a Virtual Body

Joe Paradiso and Amit Zoran
How can traditional values be embedded into a digital object? We explore this concept by implementing a special guitar that combines physical acoustic properties with virtual capabilities. The acoustical values will be embodied by a wooden heart—a unique, replaceable piece of wood that will give the guitar a unique sound. The acoustic signal created by this wooden heart will be digitally processed in order to create flexible sound design.

Alumni Contributor: Objet Geometries Ltd.

252. Dense, Low-Power Environmental Monitoring for Smart Energy Profiling

Nan-Wei Gong, Ashley Turza, David Way and Joe Paradiso with Phil London, Gary Ware, Brett Leida and Tim Ren (Schneider Electric)
We are working closely with our industrial sponsor Schneider Electric in deploying a dense, low-power wireless sensor network aimed at environmental monitoring for smart energy profiling. This distributed sensor system measures temperature, humidity, and 3-dimensional airflow, and transmits this information through a wireless Zigbee protocol. These sensing units are currently deployed in the lower atrium of E14. The data is being used to inform CFD models of airflow in buildings, explore and retrieve valuable information regarding the efficiency of commercial building HVAC system, energy efficiency of different building materials, and lighting choices in novel architectural designs.

253. DoppelLab:
Exploring Dense Sensor Network Data Through A Game Engine

Joe Paradiso, Gershon Dublon, Laurel Smith Pardue, Anisha Jethwani, Jeffrey Prouty, Turner Bohlen, Tanya Liu and Noah Swartz
Homes and offices are being filled with sensor networks to answer specific queries and solve pre-determined problems, but there are no comprehensive visualization tools for fusing these disparate data to examine relationships across spaces and sensing modalities. DoppelLab is a new, cross-reality virtual environment that serves as an active repository of the multimodal sensor data produced by a building and its inhabitants. We transform architectural models into browsing environments for real-time sensor data visualizations, as well as open-ended platforms for building visual applications atop those data. These
applications in turn become sensor-driven interfaces to physical world actuation and control. As a visuospatial repository designed to enable rapid parsing, visualization, and application development, DoppelLab proposes to organize these data by the space from which they originate and thereby provide a platform to make both broad and specific queries about the activities, systems, and relationships in a complex, sensor-rich environment.

254. Feedback Controlled Solid State Lighting

Joe Paradiso and Matt Aldrich

At present, luminous efficacy and cost remain the greatest barriers to broad adoption of LED lighting. However, it is anticipated that within several years, these challenges will be overcome. While we may think our basic lighting needs have been met, this technology offers many more opportunities than just energy efficiency: this research attempts to alter our expectations for lighting and cast aside our assumptions about control and performance. We will introduce new, low-cost sensing modalities that are attuned to human factors such as user context, circadian rhythms, or productivity, and integrate these data with atypical environmental factors to move beyond traditional lux measurements. To research and study these themes, we are focusing on the development of superior color-rendering systems, new power topologies for LED control, and low-cost multimodal sensor networks to monitor the lighting network as well as the environment.

255. Free_D

Joe Paradiso and Amit Zoran

Free_D is a hybrid sculpturing tool, merging personal, expressive craft qualities with digital CAD abilities. A hand-held milling device, Free_D preserves the user's freedom when carving in raw materials such as wood or wax. The computer monitors and guides the tool's robotic abilities, preventing the craftsperson from making a mistake, and helping student artists gain skills. The computer will join in the action only when the user is about to make a mistake; the rest of the time it gives the user total freedom, allowing the user to manipulate and shape the work in any creative way.

256. Funk2: Causal Reflective Programming

Joe Paradiso and Bo Morgan

Funk2 is a novel process-description language that keeps track of everything that it does. Remembering these causal execution traces allows parallel threads to reflect, recognize, and react to the history and status of other threads. Novel forms of complex, adaptive, nonlinear control algorithms can be written in the Funk2 programming language. Currently, Funk2 is implemented to take advantage of distributed grid processors consisting of a heterogeneous network of computers, so that hundreds of thousands of parallel threads can be run concurrently, each using many gigabytes of memory. Funk2 is inspired by Marvin Minsky's Critic-Selector theory of human cognitive reflection.
257. Interaction with Ubiquitous Dynamically Responsive Media

Joe Paradiso, Nan-Wei Gong, Mathew Laibowitz and Alexander Reben

This project takes advantage of our group's Ubiquitous Media Portals platform, which enables a large suite of research around the broad theme of what we call Dynamic Ubiquitous Media. This will include relevant, personalized information delivered ambiently to Lab visitors, with intuitive non-contact gestural input for interacting with this information. This project will build a framework for implementing dynamic media, and demonstrate it running throughout our building through a variety of applications.

258. Lab-Wide and Wearable Sensor and Video Network

Joe Paradiso and Mathew Laibowitz

This is a suite of devices and protocols to support applications in wearable human/social sensing linked to a distributed camera and vision system. The current system includes a sensate wristwatch with biological and gestural sensors, and a lapel-pin device with motion and audio-affect sensing. These all communicate with wall-mounted devices (Portals), each of which has a high-resolution camera, environmental sensors, and a localization system for all devices in the network. All devices record data and audio in sync with the recorded video. A full-spec Zigbee network supports device synchronization and mesh networking. All devices have enough on-board power to extract features from the data.

259. Moral Compass: A Model of Self-Conscious Learning

Henry Lieberman, Marvin Minsky, Joe Paradiso and Bo Morgan

Moral Compass is a model of how children learn in a problem-solving environment where the child is learning to accomplish goals in the context of parents, strangers, and cultural knowledge. The child learns in multiple ways: playing alone, being told stories, and being rewarded or punished. Our model aims to provide an explanation for relatively complex reflective states of mind, such as desire, avoidance, focus, ignorance, and personality traits. Our model also emphasizes different types of failure in its reflective approach to learning, including surprise, disappointment, and guilt. Possible applications include better understanding of the mental health of cognition in social domains.

260. New Object Studio

Peter Schmitt, Susanne Seitinger and Amit Zoran

New Object Studio challenges traditional design paradigms by approaching old and new design questions with innovative digital tools and fabrication processes. Using this approach, [N][O] Studio focuses on creating new artifacts. These new products combine mechanical and electronic components to challenge traditional notions of manufactured objects through their integrated functional, visual, and narrative qualities.

Alumni Contributor: William J. Mitchell

261. Personal Video Layers for Privacy

Joe Paradiso and Gershon Dublon

We are developing an opt-in camera network, in which users carrying wearable tags are visible to the network and everyone else is invisible. Existing systems for configurable dynamic privacy in this context are opt-out and catch-all; users desiring privacy carry pre-registered tags that disable sensing and networked media services for everyone in the room. To address these issues, we separate video into layers of flexible sprites representing each person in the field of view,
and transmit video of only those who opt-in. Our system can also define groups of
users who can be dialed in and out of the video stream dynamically. For
cross-reality applications, these dynamic layers achieve a new level of video
granularity, allowing users and groups to uncover correspondences between their
activities across spaces.

262. Wearable, Wireless
Sensor System for
Sports Medicine
and Interactive
Media

Joe Paradiso, Michael Thomas Lapinski, Dr. Eric Berkson and MGH Sports
Medicine

This project is a system of compact, wearable, wireless sensor nodes, equipped
with full six-degree-of-freedom inertial measurement units and node-to-node
capacitive proximity sensing. A high-bandwidth, channel-shared RF protocol has
been developed to acquire data from many (e.g., 25) of these sensors at 100 Hz
full-state update rates, and software is being developed to fuse this data into a
compact set of descriptive parameters in real time. A base station and central
computer clock the network and process received data. We aim to capture and
analyze the physical movements of multiple people in real time, using unobtrusive
sensors worn on the body. Applications abound in biomotion analysis, sports
medicine, health monitoring, interactive exercise, immersive gaming, and
interactive dance ensemble performance.

Alumni Contributors: Ryan Aylward and Mathew Laibowitz

Alex (Sandy) Pentland—Human Dynamics

How social networks can influence our lives in business, health, and governance, as
well as technology adoption and diffusion.

263. Awaken

Frank Moss, Alex (Sandy) Pentland, Sai T. Moturu and Kimberly
Shellenberger

Sleep problems such as insomnia have a significant impact on public health,
 affect the quality of life and productivity of millions daily, present a yearly
economic burden in the billions, and are strongly associated with multiple
comorbid conditions. Several factors affecting sleep are primarily behavioral and
not always obvious. This project aims to detect the behaviors that affect sleep and
use this knowledge to help users improve sleep habits. While asleep, a wearable
sensor headband is used to track the quality of sleep. While awake, smart phones
are used to capture behaviors that can impact sleep. Based on the data collected,
the phones also provide context-sensitive suggestions and coaching elements
borrowed from cognitive behavioral therapy to improve awake behaviors and
sleep habits, while their communication capabilities are used to enhance social
support from sleeping partners and family members.

264. Economic
Decision-Making in
the Wild

Coco Krumme

How predictable are people? We are using credit card transaction data to look at
how patterns of human behavior change over time and space, and with which
macroeconomic features these changes correlate. How does spending/merchant
composition evolve as a region gets bigger/richer/more economically diverse? Do
network features help to predict economic ones?
265. Learning Humans

**Alex (Sandy) Pentland, Wen Dong, Taemie Kim, Ankur Mani and Daniel Olguin**

With our crowd sourcing technology, we can predict nation-wide road traffic 15% more accurate than Google traffic by tracking 1,000 vehicles, and we can predict information flows and performance of organizations by locating their key structures. Our technology is based on fitting model of human dynamics with big human behavior data and then reasoning about the derived models.

266. Meeting Mediator

**Taemie Kim**

Meeting Mediator is a real-time, portable system that detects social interactions and provides persuasive feedback to enhance group collaboration. Social interactions are captured using sociometric badges, and are visualized on mobile phones to promote behavioral change. Particularly in distributed collaborations, MM attempts to bridge the gap among the distributed groups by detecting and communicating social signals.

267. Modeling Corporate Epidemiology

**Alex (Sandy) Pentland, Benjamin Waber, Manuel Cebrian, Riley Crane, Ellen Pollock (London School of Hygiene and Tropical Medicine) and Leon Danon (University of Warwick)**

Corporate responses to illness (are employees forced to go home or can they stay at work when they are sick) is currently an ad-hoc, subjective process that has little basis in data on how disease actually spreads at the workplace. Additionally, many studies have shown that productivity is not an individual factor but a social one: in any study on epidemic responses this social factor has to be taken into account. Using data from the Sociometric Badges, we are able to simulate diseases spreading through face-to-face interactions with realistic epidemiological parameters. In this project we construct a curve trading off productivity with epidemic potential. We are able to take into account impacts on productivity that arise from social factors. We also propose new organizational responses to diseases that take into account behavioral patterns that are associated with a more virulent disease spread.

268. Modeling the Dynamics of Urbanization on Social Support Networks

**Yves-Alexandre de Montjoye, Nathan Eagle and Luis M.A. Bettencourt**

What is attracting migrants to urban areas within the developing world? Using four years of movement and communication data, it is possible to model the reinforcing social mechanisms that could explain the recent rapid growth of urban areas.

269. Network analysis and module detection

**Yves-Alexandre de Montjoye, Aaron Clauset and Ben Good**

What can really be inferred from communities unfold by modularity-based algorithms? A broad and systematic characterization of the theoretical and practical performance of modularity contradicts the widely held assumption that the modularity function typically exhibits a clear global optimum. This implies that (i) modules identified via modularity maximization are not unique and should therefore be interpreted with extreme caution, and (ii) even moderate differences in modularity scores are meaningless.
270. Privacy-Preserving Personal Data Storage

*NEW LISTING*

Alex (Sandy) Pentland, Yves-Alexandre de Montjoye and Wei Pan

In a world where sensors, data storage and processing power are too cheap to meter how do you ensure that users can realize the full value of their data while protecting their privacy? Relying on the concept of sufficient statistics as well as on web-technologies such as xml and json, our system provides users with intuitive ways of managing their personal data while allowing companies to offer innovative data-enabled services and products. A fully working prototype was presented at the World Economic Forum 2011 in Davos.

271. Quantifying the Stability of Society

*NEW LISTING*

Yves-Alexandre de Montjoye, Nathan Eagle and Aaron Clauset

Is there such a thing as a 'poverty trap'? Logistic classifiers applied to communications and census data point to a new mechanism for poverty that relates to the persistence of relationships. This analysis shows that economic exchanges flow primarily through these persistent edges and the inability to maintain these ties can prevent upward economic mobility.

272. Reality Mining

Alex (Sandy) Pentland, Wen Dong, Anmol Madan and Ankur Mani

Every time you use your cell phone, you leave behind a few bits of information, and the newest smart phones can record everything from users' physical activity to their conversational cadences. People are—rightfully—nervous about trailing these sorts of digital bread crumbs behind them. But the same information could help to solve problems of identity theft and fraud by automatically determining security settings. More significantly, cell-phone data can shed light on workplace dynamics and on the well-being of communities. It could even help project the course of disease outbreaks and provide clues about individuals' health.

Alumni Contributors: Sumit Basu, Tanzeem Choudhury, Brian Clarkson, Nathan Eagle, Yuri Ivanov, Tony Jebara and Oliver Strimpel

273. Sensible Organizations

Alex (Sandy) Pentland, Benjamin Waber, Daniel Olguin Olguin, Taemie Kim, Wen Dong and Ankur Mani

Data mining of email has provided important insights into how organizations function and what management practices lead to greater productivity. But important communications are almost always face-to-face, so we are missing the greater part of the picture. Today, however, people carry cell phones and wear RFID badges. These body-worn sensor networks mean that we can potentially know who talks to whom, and even how they talk to each other. Sensible Organizations investigates how these new technologies for sensing human interaction can be used to reinvent organizations and management.

274. Social Evolution

Alex (Sandy) Pentland, Anmol Madan, Manuel Cebrian and Nadav Aharony

How do opinions and behaviors spread in face-to-face networks? In this project, we measure the spread of political opinions, influenza and common colds, stress and loneliness, and weight changes from 320,000 hours of automated sensor data. These characteristic variations in individual behavior and network structure can be used to accurately predict outcomes across various different contexts.

Alumni Contributors: Iolanthe Chronis and Luis Sarmenta
275. Social Signals in Biomedicine  
Max Little

We are using non-invasive measurement of social signals found in voice, body movement, and location to quantify symptoms in neurological disorders such as Parkinson’s Disease.

276. The Friends and Family Study  
Alex (Sandy) Pentland, Nadav Aharony, Cory May Ip and Wei Pan

The Friends and Family Study (FunF) is a long-term, mobile phone-based experiment that has transformed a graduate family community into a living lab for social-science investigation. Data from this study, collected via Android-based phones equipped with our software platform for passive data collection, will be used to look at issues including individual and group identity, real-world decision making, social diffusion, social health, and boundaries of privacy. The experiment began in March 2010, and continues through the 2011 academic year. The FunF dataset is one of the world’s most comprehensive social-science datasets to date, and will allow researchers to investigate a wide range of social and behavioral questions. The FunF Android data collection software is a platform that can be reused for future studies and applications.

277. WeightMate  
Sai T. Moturu, Frank Moss and Alex (Sandy) Pentland

Nearly one-third of the population of the United States is obese, and another one-third is overweight, resulting in significant health risks. Behavioral aspects including dietary habits, emotional states, and lack of physical exercise are the primary contributors to this phenomenon. In this project, we use smart phones to log dietary habits; track user behaviors, social interactions and emotional states; and gather the context of their actions. This information is then used to provide context-sensitive education based on trend detection, and just-in-time persuasive feedback to improve eating habits, reduce emotional eating, moderate exposure to unhealthy eating environments, and encourage better choices including greater physical activity. Social reinforcement is used to further motivate users.

Rosalind W. Picard—Affective Computing

How new technologies can help people better communicate, understand, and respond to affective information.

278. Analysis of Autonomic Sleep Patterns  
Akane Sano, Rana el Kaliouby, Rosalind W. Picard, Suzanne E. Goldman, Beth A. Malow (Vanderbilt) and Robert Stickgold (Harvard)

We are examining autonomic sleep patterns using a biosensor that enables comfortable measurement of skin conductance, skin temperature, and motion. We are looking at sleep patterns in healthy group, groups with autism or sleep disorders, and groups in memory task.
279. **Auditory Desensitization Games**

*Rosalind W. Picard, Matthew Goodwin and Robert Morris*

Persons on the autism spectrum often report hypersensitivity to sound. Efforts have been made to manage this condition, but there is wide room for improvement. One approach—exposure therapy—has promise, and a recent study showed that it helped several individuals diagnosed with autism overcome their sound sensitivities. In this project, we borrow principles from exposure therapy, and use fun, engaging, games to help individuals gradually get used to sounds that they might ordinarily find frightening or painful.

280. **Automatic Stress Recognition in Real-Life Settings**

*Rosalind W. Picard, Robert Randall Morris and Javier Hernandez Rivera*

Technologies to automatically recognize stress, are extremely important to prevent chronic psychological stress and the pathophysiological risks associated to it. The introduction of comfortable and wearable biosensors have created new opportunities to measure stress in real-life environments, but there is often great variability in how people experience stress and how they express it physiologically. In this project, we modify the loss function of Support Vector Machines to encode a person’s tendency to feel more or less stressed, and give more importance to the training samples of the most similar subjects. These changes are validated in a case study where skin conductance was monitored in nine call center employees during one week of their regular work. Employees working in this type of settings usually handle high volumes of calls every day, and they frequently interact with angry and frustrated customers that lead to high stress levels.

281. **Cardiocam**

*Ming-Zher Poh, Daniel McDuff and Rosalind W. Picard*

Cardiocam is a low-cost, non-contact technology for measurement of physiological signals such as heart rate and breathing rate using a basic digital imaging device such as a webcam. The ability to perform remote measurements of vital signs is promising for enhancing the delivery of primary health care.

282. **CrowdCounsel**

*Rosalind W. Picard and Robert Randall Morris*

Efforts to build emotionally responsive forms of artificial intelligence have been hampered by many difficulties, not least of which include the challenges of natural language processing. Although there have been many gains in this domain, it is still difficult to build technologies that offer nuanced forms of emotional support. To address these challenges, researchers might look towards human computation—an approach that harnesses the power of large, distributed online communities to solve artificial intelligence problems that might otherwise be intractable. We present a new technological approach that uses human computation algorithms, in conjunction with on-demand online workforces, to provide expedient emotional support.

283. **Embedding Special Interests into Computer-Mediated Interventions**

*Rosalind W. Picard and Robert Morris*

Individuals diagnosed with autism spectrum disorder (ASD) often have intense, focused interests. These interests, when harnessed properly, can help motivate an individual to persist in a task that might otherwise be too challenging or bothersome. For example, past research has shown that embedding focused interests into educational curricula can increase task adherence and task performance in individuals with ASD. However, providing this degree of
customization is often time-consuming and costly and, in the case of computer-mediated interventions, high-level computer-programming skills are often required. We have recently designed new software to solve this problem. Specifically, we have built an algorithm that will: (1) retrieve user-specified images from the Google database; (2) strip them of their background; and (3) embed them seamlessly into Flash-based computer programs.

284. Emotion Communication in Autism

Rosalind W. Picard, Matthew Goodwin, Jackie Lee, Rich Fletcher, Kyunghee Kim and Robert Morris

People who have difficulty communicating verbally (such as many people with autism) sometimes send nonverbal messages that do not match what is happening inside them. For example, a child might appear calm and receptive to learning—but have a heart rate over 120 bpm and be about to meltdown or shutdown. This mismatch can lead to misunderstandings such as "he became aggressive for no reason." We are creating new technologies to address this fundamental communication problem and enable the first long-term, ultra-dense longitudinal data analysis of emotion-related physiological signals. We hope to equip individuals with personalized tools to understand the influences of their physiological state on their own behavior (e.g., "which state helps me best maintain my attention and focus for learning?"). Data from daily life will also advance basic scientific understanding of the role of autonomic nervous system regulation in autism.

Alumni Contributor: Hoda Eydgahi

285. Emotional-Social Intelligence Toolkit

Rosalind W. Picard, Rana el Kaliouby, Matthew Goodwin, Mish Madsen, Micah Eckhardt and M. Ehsan Hoque

Social-emotional communication difficulties lie at the core of autism spectrum disorders, making interpersonal interactions overwhelming, frustrating, and stressful. We are developing the world's first wearable affective technologies to help the growing number of individuals diagnosed with autism—approximately 1 in 150 children in the United States—learn about nonverbal communication in a natural, social context. We are also developing technologies that build on the nonverbal communication that individuals are already using to express themselves, to help families, educators, and other persons who deal with autism spectrum disorders to better understand these alternative means of nonverbal communication.

Alumni Contributor: Alea Teeters

286. Evaluation Tool for Recognition of Social-Emotional Expressions from Facial-Head Movements

Rosalind W. Picard

To help people improve their reading of faces during natural conversations, we developed a video tool to evaluate this skill. We collected over 100 videos of conversations between pairs of both autistic and neurotypical people, each wearing a Self-Cam. The videos were manually segmented into chunks of 7-20 seconds according to expressive content, labeled, and sorted by difficulty—all tasks we plan to automate using technologies under development. Next, we built a rating interface including videos of self, peers, familiar adults, strangers, and unknown actors, allowing for performance comparisons across conditions of familiarity and expression. We obtained reliable identification (by coders) of categories of smiling, happy, interested, thinking, and unsure in the segmented
videos. The tool was finally used to assess recognition of these five categories for eight neurotypical and five autistic people. Results show some autistics approaching the abilities of neurotypicals while several score just above random.

Alumni Contributor: Alea Teeters

287. Externalization Toolkit

**Rosalind W. Picard, Matthew Goodwin and Jackie Chia-Hsun Lee**

We propose a set of customizable, easy-to-understand, and low-cost physiological toolkits in order to enable people to visualize and utilize autonomic arousal information. In particular, we aim for the toolkits to be usable in one of the most challenging usability conditions: helping individuals diagnosed with autism. This toolkit includes: wearable, wireless, heart-rate and skin-conductance sensors; pendant-like and hand-held physiological indicators hidden or embedded into certain toys or tools; and a customized software interface that allows caregivers and parents to establish a general understanding of an individual's arousal profile from daily life and to set up physiological alarms for events of interest. We are evaluating the ability of this externalization toolkit to help individuals on the autism spectrum to better communicate their internal states to trusted teachers and family members.

288. FaceSense: Affective-Cognitive State Inference from Facial Video

**Daniel McDuff, Rana el Kaliouby, Abdelrahman Nasser Mahmoud, Youssef Kashef, M. Ehsan Hoque, Matthew Goodwin and Rosalind W. Picard**

People express and communicate their mental states—such as emotions, thoughts, and desires—through facial expressions, vocal nuances, gestures, and other non-verbal channels. We have developed a computational model that enables real-time analysis, tagging, and inference of cognitive-affective mental states from facial video. This framework combines bottom-up, vision-based processing of the face (e.g., a head nod or smile) with top-down predictions of mental-state models (e.g., interest and confusion) to interpret the meaning underlying head and facial signals over time. Our system tags facial expressions, head gestures, and affective-cognitive states at multiple spatial and temporal granularities in real time and offline, in both natural human-human and human-computer interaction contexts. A version of this system is being made available commercially by a spin-off Affectiva (http://www.affectiva.com), indexing emotion from faces. Applications range from measuring people's experiences to training tool for autism spectrum disorders and people who are nonverbal learning disabled.

Alumni Contributor: Miriam A Madsen

289. Facial Expression Analysis Over the Web

**Rosalind W. Picard, Rana el Kaliouby, Daniel Jonathan McDuff, Affectiva and Forbes**

We present the first project analyzing facial expressions over the internet. The interface analyzes the participants' smile intensity as they watch popular commercials. They can compare their responses to an aggregate from the larger population. The system also allows us to crowd-source data for training expression recognition systems.
290. **Frame It**  
*Rosalind W. Picard and Micah Eckhardt*

Frame It is an interactive, blended, tangible-digital puzzle game intended as a play-centered teaching and therapeutic tool. Current work is focused on the development of a social-signals puzzle game for children with autism that will help them recognize social-emotional cues from information surrounding the eyes. In addition, we are investigating if this play-centered therapy results in the children becoming less averse to direct eye contact with others.

291. **Gesture Guitar**  
*Rosalind W. Picard, Robert Morris and Tod Machover*

Emotions are often conveyed through gesture. Instruments that respond to gestures offer musicians new, exciting modes of musical expression. This project gives musicians wireless, gestural-based control over guitar effects parameters.

292. **Health Interventions Using Mobile Phones**  
*Rich Fletcher, Rosalind Picard, Sharon Tam, Javier Hernandez Rivera and Micah Ekhardt*

We are developing a mobile phone-based platform to assist people with chronic diseases, panic-anxiety disorders or addictions. Making use of wearable, wireless biosensors, the mobile phone uses pattern analysis and machine learning algorithms to detect specific physiological states and perform automatic interventions in the form of text/images plus sound files and social networking elements. We are currently working with the Veterans Administration drug rehabilitation program involving veterans with PTSD.

293. **Heartphones**  
*Ming-Zher Poh and Rosalind W. Picard*

We are developing wearable sensors that measure cardiovascular parameters such as heart rate and heart rate variability (HRV) in real time. HRV provides a sensitive index of autonomic nervous system activity. These sensors will be capable of communication with mobile devices such as the iPhone and iPod Touch.

Alumni Contributor: Kyunghee Kim

294. **Infant Monitoring and Communication**  
*Rana el Kaliouby, Rich Fletcher, Matthew Goodwin and Rosalind W. Picard*

We have been developing comfortable, safe, attractive physiological sensors that infants can wear around the clock to wirelessly communicate their internal physiological state changes. The sensors capture sympathetic nervous system arousal, temperature, physical activity, and other physiological indications that can be processed to signal changes in sleep, arousal, discomfort or distress, all of which are important for helping parents better understand the internal state of their child and what things stress or soothe their baby. The technology can also be used to collect physiological and circadian patterns of data in infants at risk for developmental disabilities.
295. Machine Learning and Pattern Recognition with Multiple Modalities

Hyungil Ahn and Rosalind W. Picard

This project develops new theory and algorithms to enable computers to make rapid and accurate inferences from multiple modes of data, such as determining a person's affective state from multiple sensors—video, mouse behavior, chair pressure patterns, typed selections, or physiology. Recent efforts focus on understanding the level of a person's attention, useful for things such as determining when to interrupt. Our approach is Bayesian: formulating probabilistic models on the basis of domain knowledge and training data, and then performing inference according to the rules of probability theory. This type of sensor fusion work is especially challenging due to problems of sensor channel drop-out, different kinds of noise in different channels, dependence between channels, scarce and sometimes inaccurate labels, and patterns to detect that are inherently time-varying. We have constructed a variety of new algorithms for solving these problems and demonstrated their performance gains over other state-of-the-art methods.

Alumni Contributor: Ashish Kapoor

296. Measuring Arousal During Therapy for Children with Autism and ADHD

Rosalind W. Picard and Elliott Hedman

Physiological arousal is an important part of occupational therapy for children with autism and ADHD, but therapists do not have a way to objectively measure how therapy affects arousal. We hypothesize that when children participate in guided activities within an occupational therapy setting, informative changes in electrodermal activity (EDA) can be detected using iCalm. iCalm is a small, wireless sensor that measures EDA and motion, worn on the wrist or above the ankle. Statistical analysis describing how equipment affects EDA was inconclusive, suggesting that many factors play a role in how a child’s EDA changes. Case studies provided examples of how occupational therapy affected children’s EDA. This is the first study of the effects of occupational therapy’s in situ activities using continuous physiologic measures. The results suggest that careful case study analyses of the relation between therapeutic activities and physiological arousal may inform clinical practice.

297. Measuring Customers’ Experiences

Rosalind W. Picard and Elliott Hedman

How can we better understand people’s emotional experiences with a product or service? Traditional interview methods require people to remember their emotional state, which is difficult. We use psychophysiological measurements such as heart rate and skin conductance to map people’s emotional changes across time. These biological changes provide information about people’s emotional states (excitement, fear, anxiousness, boredom). We then interview people about times when their emotions changed, in order to gain insight into the experiences that corresponded with the emotional changes.

298. MIT Mood Meter


MIT Mood Meter is designed to assess and display the overall mood of the MIT community, by placing cameras at four different prime spots on the MIT campus (Student Center, Infinite Corridor, Stata Center, and Media Lab). The cameras are equipped with affect-sensing software that counts number of people and whether they are smiling or not. Although smiles are not the only sign of a good mood, in
our project, we have used it as a barometer of happiness. This project is intended to raise awareness of how our own smiles can positively affect the surrounding environment, and to assess how congenial MIT is as a community. The dynamic, real-time information may lead to answers to questions such as: Are people from one department happier than others?, Do midterms lower the mood?, or Does warmer weather lead to happiness?“

299. Multimodal Computational Behavior Analysis

David Forsyth (UIUC), Gregory Abowd (GA Tech), Jim Rehg (GA Tech), Shri Narayanan (USC), Rana el Kaliouby, Matthew Goodwin, Rosalind W. Picard, Javier Hernandez Rivera, Stan Scarloff (BU) and Takeo Kanade (CMU)

This project will define and explore a new research area we call Computational Behavior Science—integrated technologies for multimodal computational sensing and modeling to capture, measure, analyze, and understand human behaviors. Our motivating goal is to revolutionize diagnosis and treatment of behavioral and developmental disorders. Our thesis is that emerging sensing and interpretation capabilities in vision, audition, and wearable computing technologies, when further developed and properly integrated, will transform this vision into reality. More specifically, we hope to: (1) enable widespread autism screening by allowing non-experts to easily collect high-quality behavioral data and perform initial assessment of risk status; (2) improve behavioral therapy through increased availability and improved quality, by making it easier to track the progress of an intervention and follow guidelines for maximizing learning progress; and (3) enable longitudinal analysis of a child’s development based on quantitative behavioral data, using new tools for visualization.

300. Passive Wireless Heart-Rate Sensor

Rich Fletcher and Sarang Kulkarni

We have developed a low-cost device that can wirelessly detect a beating heart over a short distance (1m) and does not require any sensor placed on the person's body. This device can be used for wireless medical/health applications as well as security and safety applications, such as automobile/truck drivers as well as ATM machines. We have also created a small battery-powered version of this sensor that can be worn on a person's clothing but does not require touching the person's skin.

301. Sensor-Enabled Measurement of Stereotypy and Arousal in Individuals with Autism

Matthew Goodwin, Clark Freifeld and Sophia Yuditskaya

A small number of studies support the notion of a functional relationship between movement stereotypy and arousal in individuals with ASD, such that changes in autonomic activity either precede or are a consequence of engaging in stereotypical motor movements. Unfortunately, it is difficult to generalize these findings as previous studies fail to report reliability statistics that demonstrate accurate identification of movement stereotypy start and end times, and use autonomic monitors that are obtrusive and thus only suitable for short-term measurement in laboratory settings. The current investigation further explores the relationship between movement stereotypy and autonomic activity in persons with autism by combining state-of-the-art ambulatory heart rate monitors to objectively assess arousal across settings; and wireless, wearable motion sensors and pattern recognition software that can automatically and reliably detect stereotypical motor movements in individuals with autism in real time.
302. The Frustration of Learning Monopoly

Rosalind W. Picard and Elliott Hedman

We are looking at the emotional experience created when children learn games. Why do we start games with the most boring part, reading directions? How can we create a product that does not create an abundance of work for parents? Key insights generated from field work, interviews, and measurement of electrodermal activity are: kids become bored listening to directions, “it's like going to school”; parents feel rushed reading directions as they sense their children’s boredom; children and parents struggle for power in interpreting and enforcing rules; children learn games by mimicking their parents, and; children enjoy the challenge of learning new games.

303. What Do Facial Expressions Mean?

Rana el Kaliouby, Rosalind W. Picard and Daniel McDuff

We are automating recognition of positive/negative experiences (valence) and affect from facial expressions. We present a toolkit, Acume, for interpreting and visualizing facial expressions whilst people interact with products and/or concepts.

Ramesh Raskar—Camera Culture

How to create new ways to capture and share visual information.

304. BiDi Screen

Henry Holtzman, Matt Hirsch, Douglas Lanman and Ramesh Raskar

The BiDi Screen is an example of a new type of thin I/O device that possesses the ability both to capture images and display them. Scene depth can be derived from BiDi Screen imagery, allowing for 3D gestural and 2D multi-touch interfaces. This bidirectional screen extends the latest trend in LCD devices, which has seen the incorporation of photo-transistors into every display pixel. Using a novel optical masking technique developed at the Media Lab, the BiDi Screen can capture light field-like quantities, unlocking a wide array of applications from 3D gesture and touch interaction with CE devices, to seamless video communication.

305. Bokode: Imperceptible Visual Tags for Camera-Based Interaction from a Distance

Ramesh Raskar, Ankit Mohan, Grace Woo, Shinsaku Hiura and Quinn Smithwick

With over a billion people carrying camera-phones worldwide, we have a new opportunity to upgrade the classic bar code to encourage a flexible interface between the machine world and the human world. Current bar codes must be read within a short range and the codes occupy valuable space on products. We present a new, low-cost, passive optical design so that bar codes can be shrunk to fewer than 3mm and can be read by unmodified ordinary cameras several meters away.
306. **CATRA: Mapping of Cataract Opacities Through an Interactive Approach**

*Ramesh Raskar, Vitor Pamplona, Erick Passos, Jan Zizka, Manuel M. Oliveira, Everett Lawson and Estebam Clua*

We introduce a novel interactive method to assess cataracts in the human eye by crafting an optical solution that measures the perceptual impact of forward scattering on the foveal region. Current solutions rely on highly trained clinicians to check the back scattering in the crystallin lens and test their predictions on visual acuity tests. Close-range parallax barriers create collimated beams of light to scan through sub-apertures scattering light as it strikes a cataract. User feedback generates maps for opacity, attenuation, contrast, and local point-spread functions. The goal is to allow a general audience to operate a portable, high-contrast, light-field display to gain a meaningful understanding of their own visual conditions. The compiled maps are used to reconstruct the cataract-affected view of an individual, offering a unique approach for capturing information for screening, diagnostic, and clinical analysis.

307. **Coded Computational Photography**

*Jaewon Kim, Ahmed Kirmani, Ankit Mohan and Ramesh Raskar*

Computational photography is an emerging multi-disciplinary field that is at the intersection of optics, signal processing, computer graphics and vision, electronics, art, and online sharing in social networks. The first phase of computational photography was about building a super-camera that has enhanced performance in terms of the traditional parameters, such as dynamic range, field of view, or depth of field. We call this ‘Epsilon Photography.’ The next phase of computational photography is building tools that go beyond the capabilities of this super-camera. We call this ‘Coded Photography.’ We can code exposure, aperture, motion, wavelength, and illumination. By blocking light over time or space, we can preserve more details about the scene in the recorded single photograph.

308. **Femtosecond Transient Imaging**

*Ramesh Raskar, Andreas Velten, MIT Department of Chemistry and Mouni Bawendi*

Using a femtosecond laser and a camera with one trillion frames per second, we can capture movies of light as it moves through a scene, gets trapped inside a tomato, or bounces off the surfaces in a bottle of water. We use this ability to see the time of flight and to reconstruct images of objects that our camera can not see directly (i.e., to look around the corner).

Alumni Contributor: Ahmed Kirmani

309. **HR3D: Glasses-Free 3DTV**

*Ramesh Raskar, Douglas Lanman, Matt Hirsch and Yunhee Kim*

For 3D displays to be successful, they must be bright enough to compete with 2D displays and not diminish display resolution. To date, stacked-LCD displays have employed parallax barriers, which use pinhole or bar patterns to provide view-dependent imagery. We show a prototype that adapts the imagery on both layers to multi-view 3D content, increasing brightness while maintaining display resolution. This promises a future of devices with sharp 2D screens and 3D displays with full horizontal and vertical parallax.
310. Inverse Light Transport

Ramesh Raskar and Rohit Pandharkar

How can we solve the ill-posed problem of inverse light transport using novel capture systems? Estimating BRDF using inverse light transport using trivial capture techniques is a cumbersome capture process and also has mathematical restraints on solutions. We present the framework for a new inverse light transport theory and experimentally calculate the BRDFs.

311. LensChat: Sharing Photos with Strangers

Ramesh Raskar, Rob Gens and Wei-Chao Chen

With networked cameras in everyone's pockets, we are exploring the practical and creative possibilities of public imaging. LensChat allows cameras to communicate with each other using trusted optical communications, allowing users to share photos with a friend by taking pictures of each other, or borrow the perspective and abilities of many cameras.

312. NETRA: Smartphone Add-On for Eye Tests

Vitor Pamplona, Manuel Oliveira, Erick Passos, Ankit Mohan and Ramesh Raskar

Can a person look at a portable display, click on a few buttons, and recover his refractive condition? Our optometry solution combines inexpensive optical elements and interactive software components to create a new optometry device suitable for developing countries. The technology allows for early, extremely low-cost, mobile, fast, and automated diagnosis of the most common refractive eye disorders: myopia (nearsightedness), hypermetropia (farsightedness), astigmatism, and presbyopia (age-related visual impairment). The patient overlaps lines in up to eight meridians and the Android app computes the prescription. The average accuracy is comparable to the prior art—and in some cases, even better. We propose the use of our technology as a self-evaluation tool for use in homes, schools, and at health centers in developing countries, and in places where an optometrist is not available or is too expensive.

313. Second Skin: Motion Capture with Actuated Feedback for Motor Learning

Ramesh Raskar, Kenichiro Fukushi and Jan Zizka

We have created a 3D motion-tracking system with an automatic, real-time vibrotactile feedback with an assembly of photo-sensors, infrared projector pairs, vibration motors, and wearable suit. This system allows us to enhance and quicken the motor learning process in variety of fields such as healthcare (physiotherapy), entertainment (dance), and sports (martial arts).

Alumni Contributor: Dennis Ryan Miaw

314. Shield Field Imaging

Jaewon Kim

We present a new method for scanning 3D objects in a single shot, shadow-based method. We decouple 3D occluders from 4D illumination using shield fields: the 4D attenuation function which acts on any light field incident on an occluder. We then analyze occluder reconstruction from cast shadows, leading to a single-shot light field camera for visual hull reconstruction.
315. Slow Display

Daniel Saakes, Kevin Chiu, Tyler Hutchison, Blyeun Buczyk, Naoya Koizumi and Masahiko Inami

How can we show our 16 megapixel photos from our latest trip on a digital display? How can we create screens that are visible in direct sunlight as well as complete darkness? How can we create large displays that consume less than 2W of power? How can we create design tools for digital decal application and intuitive-computer aided modeling? We introduce a display that is high resolution but updates at a low frame rate, a slow display. We use lasers and monostable light-reactive materials to provide programmable space-time resolution. This refreshable, high resolution display exploits the time decay of monostable materials, making it attractive in terms of cost and power requirements. Our effort to repurpose these materials involves solving underlying problems in color reproduction, day- night visibility, and optimal time sequences for updating content.

316. Soundaround

Henry Holtzman, Ramesh Raskar, Matt Hirsch, Alex Olwal and Thomas A. Baran

Recently, multi-view display hardware has made compelling progress in graphics. Soundaround is a multi-viewer interactive audio system, designed to be integrated into unencumbered multi-view display systems, presenting localized audio/video channels with no need for glasses or headphones. Our technical work describes a framework for the design of multi-viewer interactive audio systems that is general and supports optimization of the system for multiple observation planes and room responses.

317. Theory Unifying Ray and Wavefront Lightfield Propagation

Ramesh Raskar, George Barbastathis, Tom Cuypers and Se Baek Oh

This work focuses on bringing powerful concepts from wave optics to the creation of new algorithms and applications for computer vision and graphics. Specifically, ray-based, 4D lightfield representation, based on simple 3D geometric principles, has led to a range of new applications that include digital refocusing, depth estimation, synthetic aperture, and glare reduction within a camera or using an array of cameras. The lightfield representation, however, is inadequate to describe interactions with diffractive or phase-sensitive optical elements. Therefore we use Fourier optics principles to represent wavefronts with additional phase information. We introduce a key modification to the ray-based model to support modeling of wave phenomena. The two key ideas are "negative radiance" and a "virtual light projector." This involves exploiting higher dimensional representation of light transport.

318. Vision on Tap

Ramesh Raskar and Kevin Chiu

Computer vision is a class of technologies that lets computers use cameras to automatically stitch together panoramas, reconstruct 3-D geometry from multiple photographs, and even tell you when the water's boiling. For decades, this technology has been advancing mostly within the confines of academic institutions and research labs. Vision on Tap is our attempt to bring computer vision to the masses.
Mitchel Resnick—Lifelong Kindergarten
How to engage people in creative learning experiences.

319. 4chan and /b/: Anonymity and Ephemeralty

Michael S. Bernstein, Andrés Monroy-Hernández, Drew Harry, Paul André, Katrina Panovich and Greg Vargas

Many of our online interactions take place in community spaces. We keep track of friends and share pictures on Facebook, chatter with friends on Twitter, and participate in discussions on online forums. But how do the design choices we make impact the kinds of social spaces that develop? To better understand this relationship, we conducted a study of a discussion forum with a particularly unusual design: 4chan.org. Perhaps best known for its role in driving Internet culture and its involvement with the “Anonymous” group, we believe 4chan’s design plays a large role in its success, despite its counter-intuitiveness. In our first paper exploring this area, we quantify 4chan’s ephemerality (there are no archives; most posts are deleted in a matter of minutes) and anonymity (there are no traditional user accounts, and most posts are fully anonymous) and discuss how the community adapts to these unusual design strategies.

320. Block Exchange

Sayamindu Dasgupta and Mitchel Resnick

Block Exchange is a website where Scratch users can share data sets and data sources in the form of Scratch programming blocks. For example, a soccer enthusiast can share a block that retrieves data about the number of goals scored by different players in the English Premier League. Other blocks in the Exchange can retrieve information from web-based dynamic data sources. For example, a Scratch user can share a block that dynamically retrieves meta-data on the books that are currently on the New York Times bestsellers list. With Block Exchange, you can create a large variety of projects, ranging from interactive data visualizations to stories and animations which incorporate information from the real world dynamically and in real-time.

321. Color Code

Jay Silver, Eric Rosenbaum, and Mitchel Resnick

Color Code allows anyone to program using colors in the real world. The result is that you can program a computer, compose a musical score, or make a game level, just by drawing on a piece of paper with crayons, building with LEGO bricks, arranging your program with the multi-colored leaves of early fall. Color Code has been added to a test version of Scratch so you can do things like build levels for characters using Post-It Notes.

322. Computer Clubhouse

Mitchel Resnick, Natalie Rusk, Chris Garrity, Claudia Urrea, Amon Millner, and Robbie Berg

At Computer Clubhouse after-school centers, young people (ages 10-18) from low-income communities learn to express themselves creatively with new technologies. Clubhouse members work on projects based on their own interests, with support from adult mentors. By creating their own animations, interactive stories, music videos, and robotic constructions, Clubhouse members become more capable, confident, and creative learners. The first Computer Clubhouse
was established in 1993, as a collaboration between the Lifelong Kindergarten group and The Computer Museum (now part of the Boston Museum of Science). With financial support from Intel Corporation, the network has expanded to more than 20 countries, serving more than 20,000 young people. The Lifelong Kindergarten group continues to develop new technologies, introduce new educational approaches, and lead professional-development workshops for Clubhouses around the world.

Alumni Contributors: Leo Burd, Robbin Chapman, Rachel Garber, Tim Gorton, Michelle Hlubinka and Elisabeth Sylvan

323. **Computer Clubhouse Village**  
*Chris Garrity, Natalie Rusk and Mitchel Resnick*

The Computer Clubhouse Village is an online community that connects people at Computer Clubhouse after-school centers around the world. Through the Village, Clubhouse members and staff (at more than 100 Clubhouses in 21 countries) can share ideas with one another, get feedback and advice on their projects, and work together on collaborative design activities.

Alumni Contributors: Robbin Chapman, Rachel Garber and Elisabeth Sylvan

324. **Drawdio**  
*Jay Silver and Mitchel Resnick*

Drawdio is a pencil that draws music. You can sketch musical instruments on paper and play them with your finger. Touch your drawings to bring them to life—or collaborate through skin-to-skin contact. Drawdio works by creating electrical circuits with graphite and the human body.

325. **Glowdoodle**  
*Eric Rosenbaum*

Glowdoodle is free software for painting with light. In front of your webcam, just move a a glowing object, or anything brightly colored, and see the traces appear on the screen in real time. Then participate in the worldwide Glowdoodle community by sharing your creations on the web.

326. **Jots**  
*Eric Rosenbaum and Mitchel Resnick*

How can we help people reflect on their own learning process? The goal of this project is to develop new technological tools and pedagogical strategies to cultivate reflection. Jots are brief updates that people write as they use our Scratch programming environment, to describe their thoughts, frustrations, and excitement. Users' Jots are displayed on their Scratch user pages, so they can explore their own processes and share them with others.

327. **MelodyMorph**  
*Eric Rosenbaum and Mitchel Resnick*

MelodyMorph is an interface for constructing melodies and making improvised music. It removes a constraint of traditional musical instruments: a fixed mapping between space and pitch. What if you blew up the piano so you could put the keys anywhere you want? With MelodyMorph you can create a customized musical instrument, unique to the piece of music, the player, or the moment.
328. Scratch


Scratch is a programming language and online community that makes it easy to create your own interactive stories, games, animations, and simulations—and share your creations online. Scratch is designed to enhance the technological fluency of young people (ages 8 and up), helping them learn to express themselves creatively with new technologies. As they create and share Scratch projects, young people learn to think creatively, reason systematically, and work collaboratively—while also learning important mathematical and computational ideas.

Alumni Contributors: Margarita Dekoli, Evelyn Eastmond, Amon Millner and Tamara Stern

329. Scratch Day

Karen Brennan and Mitchel Resnick

Scratch Day is a network of face-to-face local gatherings, on the same day in all parts of the world, where people can meet, share, and learn more about Scratch, a programming environment that enables people to create their own interactive stories, games, animations, and simulations. We believe that these types of face-to-face interactions remain essential for ensuring the accessibility and sustainability of initiatives such as Scratch. In-person interactions enable richer forms of communication among individuals, more rapid iteration of ideas, and a deeper sense of belonging and participation in a community. The first Scratch Day took place on May 16, 2009, with 120 events in 44 different countries. The second Scratch Day took place on May 22, 2010.

330. Scratch Worlds

Eric Rosenbaum and Mitchel Resnick

What if everyone could create their own interactive content in virtual worlds? We are putting the playful and intuitive features of Scratch into a new programming language for Second Life. We hope to make it easier for everyone to create their own interactive virtual pets, dancefloors, games, clothing, houses, and whatever else they can imagine.

331. ScratchEd

Karen Brennan, Michelle Chung, and Mitchel Resnick

As Scratch proliferates through the world, there is a growing need to support learners. But for teachers, educators, and others who are primarily concerned with enabling Scratch learning, there is a disconnect between their needs and the resources that are presently available through the Scratch Web site. ScratchEd is an online environment for Scratch educators to share stories, exchange resources, ask questions, and find people.
332. ScratchR  
**Andres Monroy-Hernandez and Mitchel Resnick**

ScratchR is a platform for sharing programmable media online, allowing people to publish their own interactive stories, games, and animations. ScratchR is the engine behind the Scratch online community, a social network of young programmers. Unlike other user-generated content communities, ScratchR makes it easy to reuse other people’s creations to foster collaborative learning. ScratchR allows members to rate, comment, tag, and create galleries. ScratchR is to programmable media what YouTube is to videos.

333. Singing Fingers  
**Eric Rosenbaum, Jay Silver and Mitchel Resnick**

Singing Fingers allows children to fingerpaint with sound. Users paint by touching a screen with a finger, but color only emerges if a sound is made at the same time. By touching the painting again, users can play back the sound. This creates a new level of accessibility for recording, playback, and remixing of sound.

334. Twinkle  
**Jay Silver, Eric Rosenbaum and Mitchel Resnick**

Twinkle is a new system that lets you program using crayons, LEGO bricks, or anything that has colors—like a striped shirt or fall leaves. Compose a song with markers, program a robot by drawing instructions on paper, or create a custom interface just by doodling.

335. What's Up  
**Chris Csikszentmihályi, Mitchel Resnick and Leo Burd**

What's Up is a neighborhood news system that combines power of the telephone and of the Web to make it easier for youth to organize community events and find out what is happening in the place where they live. By dialing a central number, youth can send and receive voicemail messages, publish audio community announcements, create voicemail groups, add events to a shared community calendar and more. When field tested in Lawrence, MA, What's Up helped increase awareness of and accessibility to important local youth resources, provided youth with opportunities to express their opinions about their neighborhoods and, with that, contributed to transform Lawrence into a community that is both friendlier and more empowering for young people.

**Deb Roy—Cognitive Machines**

How to build machines that learn to use language in human-like ways, and develop tools and models to better understand how children learn to communicate and how adults behave.

336. 10,000x More Efficient Computing  
**Joseph Bates, George Shaw and Deb Roy**

Varied important problems can be solved using surprisingly approximate arithmetic. We’ve designed a co-processor for such arithmetic that provides 100,000 cores on a single standard chip, or 1,000 cores in a sub-watt mobile device. We are exploring applications of such machines in image and video processing. Cost can be under a penny per core, and compared to CPUs, improvements in speed and energy use can exceed 10,000x.
337. BlitzScribe: Speech Analysis for the Human Speechome Project

Brandon Roy and Deb Roy

BlitzScribe is a new approach to speech transcription driven by the demands of today's massive multimedia corpora. High-quality annotations are essential for indexing and analyzing many multimedia datasets; in particular, our study of language development for the Human Speechome Project depends on speech transcripts. Unfortunately, automatic speech transcription is inadequate for many natural speech recordings, and traditional approaches to manual transcription are extremely labor intensive and expensive. BlitzScribe uses a semi-automatic approach, combining human and machine effort to dramatically improve transcription speed. Automatic methods identify and segment speech in dense, multitrack audio recordings, allowing us to build streamlined user interfaces maximizing human productivity. The first version of BlitzScribe is already about 4-6 times faster than existing systems. We are exploring user-interface design, machine-learning and pattern-recognition techniques to build a human-machine collaborative system that will make massive transcription tasks feasible and affordable.

338. Collective Discovery

Frank Moss, Deb Roy and Ian Eslick

The choices we make about diet, environment, medications, or alternative therapies constitute a massive collection of "everyday experiments." These data are largely unrecorded and underutilized by the traditional research establishment. Collective Discovery aims to leverage the intuition and insight of patient communities to capture and mine information about everyday experiences. Moving the community discourse from anecdotes to data will lead to better decision-making, stronger self-advocacy, identification of novel therapies, and inspiration of better hypotheses in traditional research, accelerating the search for new drugs and treatments. The unique characteristic of our Collective Discovery model is the use of knowledge representation and natural language processing to mediate communal hypothesis generation and to compensate for methodological errors and self-reporting bias. This model is being deployed in a real-world context as part of a partnership with the LAM Treatment Alliance and the greater LAM community.

339. Data-Driven Simulation of Human Behavior and Language

Jeff Orkin, Hilke Reckman and Deb Roy

We are crowd-sourcing the creation of socially rich interactive characters by collecting data from thousands of people interacting and conversing in online multiplayer games, and mining recorded gameplay to extract patterns in language and behavior. The tools and algorithms we are developing allow non-experts to automate characters who can interact and converse with humans and with each other. The Restaurant Game recorded over 16,000 people playing the roles of customers and waitresses in a virtual resturant. Improviso is an effort to capture data from humans playing the roles of actors on the set of a low-budget sci-fi movie.
340. **HouseFly:** Immersive Video Browsing and Data Visualization

**Philip DeCamp, Rony Kubat, George Shaw and Deb Roy**

HouseFly combines audio-video recordings from multiple cameras and microphones to generate an interactive, 3D reconstruction of recorded events. Developed for use with the longitudinal recordings collected by the Human Speechome Project, this software enables the user to move freely throughout a virtual model of a home and to play back events at any time or speed. In addition to audio and video, the project explores how different kinds of data may be visualized in a virtual space, including speech transcripts, person tracking data, and retail transactions.

341. **Human Speechome Project**

**Philip DeCamp, Brandon Roy, Soroush Vosoughi and Deb Roy**

The Human Speechome Project is an effort to observe and computationally model the longitudinal language development of a single child at an unprecedented scale. To achieve this, we are recording, storing, visualizing, and analyzing communication and behavior patterns in over 400,000 hours of home video and speech recordings. The tools that are being developed for mining and learning from thousands of terabytes of multimedia data offer the potential for breaking open new business opportunities for a broad range of industries—from security to Internet commerce.

Alumni Contributors: Michael Fleischman, Jethran Guinness and Alexia Salata

342. **Learning Language Using Virtual Game Context**

**Hilke Reckman, Jeff Orkin, Tynan Smith and Deb Roy**

This project uses the gameplay data from The Restaurant Game and Improviso as linguistic corpora for automated language learning. These corpora are special because they include computer-interpretable non-linguistic context that contains cues as to what the players might mean with the words and sentences they utter. The results feed back into the original projects by contributing to the linguistic competence of the AI that is being developed for those games.

343. **Realtime Behavior Analysis**

**Matt Miller**

People are surprisingly predictable. We use real-time video analysis to extract patterns of behavior from crowds browsing demos in our lab space. We can discover meaningful locations and sequences just from observing how people interact in the space. We can even begin to predict what people might do next.

344. **Speech Interaction Analysis for the Human Speechome Project**

**Brandon Roy and Deb Roy**

The Speechome Corpus is the largest corpus of a single child learning language in a naturalistic setting. We have now transcribed significant amounts of the speech to support new kinds of language analysis. We are currently focusing on the child's lexical development, pinpointing "word births" and relating them to caregiver language use. Our initial results show child vocabulary growth at an unprecedented temporal resolution, as well as a detailed picture of other measures of linguistic development. The results suggest individual caregivers "tune" their spoken interactions to the child's linguistic ability with far more precision than expected, helping to scaffold language development. To perform these analyses, new tools have been developed for interactive data annotation and exploration.
345. **Speechome Recorder for the Study of Child Development Disorders**

*Soroush Vosoughi, Joe Wood, Matthew Goodwin and Deb Roy*

Collection and analysis of dense, longitudinal observational data of child behavior in natural, ecologically valid, non-laboratory settings holds significant benefits for advancing the understanding of autism and other developmental disorders. We have developed the Speechome Recorder—a portable version of the embedded audio/video recording technology originally developed for the Human Speechome Project—to facilitate swift, cost-effective deployment in special-needs clinics and homes. Recording child behavior daily in these settings will enable us to study developmental trajectories of autistic children from infancy through early childhood, as well as atypical dynamics of social interaction as they evolve on a day-to-day basis. Its portability makes possible potentially large-scale comparative study of developmental milestones in both neurotypical and autistic children. Data-analysis tools developed in this research aim to reveal new insights toward early detection, provide more accurate assessments of context-specific behaviors for individualized treatment, and shed light on the enduring mysteries of autism.

Alumni Contributors: George Shaw and Philip DeCamp

346. **Speechome Video for Retail Analysis**

*George Shaw, Rony Kubat, Philip DeCamp, Kenneth Jackowitz (BOA) and Deb Roy*

We are adapting the video data collection and analysis technology derived from the Human Speechome Project for the retail sector through real-world deployments. We are developing strategies and tools for the analysis of dense, longitudinal video data to study behavior of and interaction between customers and employees in commercial retail settings. One key question in our study is how the architecture of a retail space affects customer activity and satisfaction, and what parameters in the design of a space are operant in this causal relationship.

347. **4chan and /b/: Anonymity and Ephemerality**

*Michael S. Bernstein, Andrés Monroy-Hernández, Drew Harry, Paul André, Katrina Panovich and Greg Vargas*

Many of our online interactions take place in community spaces. We keep track of friends and share pictures on Facebook, chatter with friends on Twitter, and participate in discussions on online forums. But how do the design choices we make impact the kinds of social spaces that develop? To better understand this relationship, we conducted a study of a discussion forum with a particularly unusual design: 4chan.org. Perhaps best known for its role in driving Internet culture and its involvement with the "Anonymous" group, we believe 4chan's design plays a large role in its success, despite its counter-intuitiveness. In our first paper exploring this area, we quantify 4chan's ephemerality (there are no archives; most posts are deleted in a matter of minutes) and anonymity (there are no traditional user accounts, and most posts are fully anonymous) and discuss how the community adapts to these unusual design strategies.
348. Back Talk

**Chris Schmandt and Andrea Colaco**

The living room is the heart of social and communal interactions in a home. Often present in this space is a screen: the television. When in use, this communal gathering space brings together people and their interests, and their varying needs for company, devices, and content. This project focuses on using personal devices such as mobile phones with the television; the phone serves as a controller and social interface by offering a channel to convey engagement, laughter, and viewer comments, and to create remote co-presence.

349. Flickr This

**Chris Schmandt and Dori Lin**

Inspired by the fact that people are communicating more and more through technology, Flickr This explores ways for people to have emotion-rich conversations through all kinds of media provided by people and technology—a way for technology to allow remote people to have conversations more like face-to-face experiences by grounding them in shared media. Flickr This lets viewable contents provide structure for a conversation; with a grounding on the viewable contents, conversation can move between synchronous and asynchronous, and evolve into a richer collaborative conversation/media.

350. Going My Way

**Chris Schmandt and Jaewoo Chung**

When friends give directions, they often don't describe the whole route, but instead provide landmarks along the way which with they think we'll be familiar. Friends can assume we have certain knowledge because they know our likes and dislikes. Going My Way attempts to mimic a friend by learning about where you travel, identifying the areas that are close to the desired destination from your frequent path, and picking a set of landmarks to allow you to choose a familiar one. When you select one of the provided landmarks, Going My Way will provide directions from it to the destination.

Alumni Contributors: Chaochi Chang and Paulina Lisa Modlitba

351. Guiding Light

**Chris Schmandt, Jaewoo Chung, Ig-Jae Kim and Kuang Xu**

Guiding Light is a navigation-based application that provides directions by projecting them onto physical spaces both indoors and outdoors. It enables a user to get relevant spatial information by using a mini projector in a cell phone. The core metaphor involved in this design is that of a flashlight which reveals objects in and information about the space it illuminates. For indoor navigation, Guiding Light uses a combination of e-compass, accelerometer, proximity sensors, and tags to place information appropriately. In contrast to existing heads-up displays that push information into the user's field of view, Guiding Light works on a pull principle, relying entirely on users' requests and control of information.

352. Indoor Location Sensing Using Geo-Magnetism

**Chris Schmandt, Jaewoo Chung and Matthew Joseph Donahoe**

We present an indoor positioning system that measures location using disturbances of the Earth's magnetic field by structural steel elements in a building. The presence of these large steel members warps the geomagnetic field such that lines of magnetic force are locally not parallel. We measure the divergence of the lines of the magnetic force field using e-compass parts with slight physical offsets; these measurements are used to create local position...
signatures for later comparison with values in the same sensors at a location to be measured. We demonstrate accuracy within one meter 85% of the time in experiments in two buildings and across multiple floors within the buildings.

353. Merry Miser

*Chris Schmandt and Charlie DeTar*

Merry Miser is a mobile application which persuades people to spend less money, and think more about their spending. By combining users’ real financial transaction information, their location, and personal assessments of spending, the application presents deeply personalized and compelling interventions at the time and place when they are near an opportunity to shop. The interventions help to reinforce choices that are in the users’ better long-term self interest, against short-term impulses.

354. Musicpainter

*Chris Schmandt, Barry Vercoe and Wu-Hsi Li*

Musicpainter is a networked, graphical composing environment that encourages sharing and collaboration within the composing process. It provides a social environment where users can gather and learn from each other. The approach is based on sharing and managing music creation in small and large scales. At the small scale, users are encouraged to begin composing by conceiving small musical ideas, such as melodic or rhythmic fragments, all of which are collected and made available to all users as a shared composing resource. The collection provides a dynamic source of composing material that is inspiring and reusable. At the large scale, users can access full compositions that are shared as open projects. Users can listen to and change any piece. The system generates an attribution list on the edited piece, allowing users to trace how it evolves in the environment.

355. Musicscape

*Chris Schmandt, Barry Vercoe and Wu-Hsi Li*

Musicscape is a two-dimensional, spatial music navigation interface designed for browsing large-scale sound archives. It simulates a 2D sound field by applying Head-Related Transfer Function (HRTF), and enables users to virtually walk around the sound space with a computer mouse.

356. My Second-Bike

*Chris Schmandt, Jaewoo Chung, Andrea Colaco and Kuang Xu*

This project is a novel concept for a social TV application, targeting the demographic of viewers enjoying live sports events, such as road bicycle racing. We intend to enhance the viewing experiences of spectators with sensor-fitted bikes tied to an interactive biking environment on television. The system enables a new form of personalized, physical, and virtual-reality interaction between viewers and a TV program, as well as interactions within or among communities of friends. We have created a prototype, My Second Bike, which uses a 3-D mirrored world environment (Google Earth) to visually represent participating spectators, competing athletes, and outdoor bikers. We contend that the system has the potential to attract and support a large user base on account of its scalability, ease of deployment, and ability to promote audience participation in live sports events on TV.
357. Radio-ish Media Player

Chris Schmandt, Barry Vercoe and Wu-Hsi Li

How many decisions does it take before you hear a desired piece of music on your iPod? First, you are asked to pick a genre, then an artist, then an album, and finally a song. The more songs you own, the tougher the choices are. To resolve the issues, we turn the modern music player into an old analog radio tuner, the Radio-ish Media Player. No LCDs, no favorite channels, all you have is a knob that will help you surf through channel after channel accompanied by synthesized noise. Radio-ish is our attempt to revive the lost art of channel surfing in the old analog radio tuner. Let music find you: your ears will tell you if the music is right. This project is not only a retrospective design, but also our reflection on lost simplicity in the process of digitalization. A mobile phone version is also available for demo.

358. Run By Us

Chris Schmandt and Charlie DeTar

NEW LISTING

Bringing deliberative process and consensus decision making to the 21st century, asynchronous case! A practical, enhanced mailing list that allows intelligent extraction of contextual information from a discussion to support decision making and deliberation.

359. Sharemote: Collaborative TV

Chris Schmandt and Matthew Donahoe

Watching TV with multiple people can be an enjoyable social experience, but control of the television is still limited to a single person with the remote. The goal of this project is to improve group interactions by allowing everyone in the room to share control of the television. Traditionally everyone must wait for a single person to flip through the channels in order to find interesting content to watch. With our system, each person can look for content on their individual device and then share it with the group by sending it to the television.

360. Tin Can

Chris Schmandt, Matthew Donahoe and Drew Harry

Distributed meetings present a set of interesting challenges to staying engaged and involved. Because one person speaks at a time, it is easy (particularly for remote participants) to disengage from the meeting undetected. However, non-speaking roles in a meeting can be just as important as speaking ones, and if we could give non-speaking participants ways to participate, we could help support better-run meetings of all kinds. Tin Can collects background tasks like taking notes, managing the agenda, sharing relevant content, and tracking to-dos in a distributed interface that uses meeting participants’ phones and laptops as input devices, and represents current meeting activities on an iPad in the center of the table in each meeting location. By publicly representing these background processes, we provide meeting attendees with new ways to participate and be recognized for their non-verbal participation.

361. Tin Can Classroom

Chris Schmandt, Drew Harry and Eric Gordon (Emerson College)

NEW LISTING

Classroom discussions may not seem like an environment that needs a new kind of supporting technology. But we’ve found that augmenting classroom discussions with an iPad-based environment to help promote discussion, keep track of current and future discussion topics, and create a shared record of class keeps students engaged and involved with discussion topics, and helps restart the discussion when conversation lags. Contrary to what you might expect, having another
discussion venue doesn't seem to add to student distraction; rather it tends to focus distracted students on this backchannel discussion. For the instructor, our system offers powerful insights into the engagement and interests of students who tend to speak less in class, which in turn can empower less-active students to contribute in a venue in which they feel more comfortable.

362. Wish You Were Here

*Chris Schmandt and Matthew Donahoe*

Postcards are a visually pleasing way to share our location with friends and family. Traditionally we send postcards only when we go someplace special, like on vacation. What if we sent postcards everywhere we went? Wish You Were Here replaces paper postcards with a digital photo frame that automatically updates its photo as the user travels. To friends and family members, these pictures can be very meaningful because they have some expectations about where you are, while strangers can glean only very general information from them.

363. All Cows Eat Grass

*Mihir Sarkar, Robin Bose and Sean Leow*

"All Cows Eat Grass" is a mnemonic used in music instruction for A C E G—the notes on the white spaces of the bass clef. The All Cows Eat Grass project is an online platform that provides cost-effective, real-time private music lessons. The system connects music instructors and students using a low-latency audio and video link, provides motivational support to practice between lessons, and lowers the barrier to learn music with self-instruction material and self-evaluation musical games.

364. Modeling Indian Music

*Barry Vercoe and Mihir Sarkar*

Synthesizing music from non-Western cultures is a problem for current music technology, which is based on constant pitch and note-oriented concepts such as MIDI. This is an issue for Indian music because time-varying pitch inflections, called gamakas, are an essential part of its construct. We are analyzing songs and instrumental pieces from the South Indian tradition, and developing software that enables musicians to synthesize Indian music with the required ornamentations. Such innovations will allow the music industry to cross cultural boundaries and provide appropriate representations for the expressive artifacts of non-Western music, in particular from Asia and the Middle-East.

365. Musicpainter

*Chris Schmandt, Barry Vercoe and Wu-Hsi Li*

Musicpainter is a networked, graphical composing environment that encourages sharing and collaboration within the composing process. It provides a social environment where users can gather and learn from each other. The approach is based on sharing and managing music creation in small and large scales. At the small scale, users are encouraged to begin composing by conceiving small musical ideas, such as melodic or rhythmic fragments, all of which are collected
and made available to all users as a shared composing resource. The collection provides a dynamic source of composing material that is inspiring and reusable. At the large scale, users can access full compositions that are shared as open projects. Users can listen to and change any piece. The system generates an attribution list on the edited piece, allowing users to trace how it evolves in the environment.

366. Musicscape

**Chris Schmandt, Barry Vercoe and Wu-Hsi Li**

Musicscape is a two-dimensional, spatial music navigation interface designed for browsing large-scale sound archives. It simulates a 2D sound field by applying Head-Related Transfer Function (HRTF), and enables users to virtually walk around the sound space with a computer mouse.

367. Network Music Performance

**Barry Vercoe and Mihir Sarkar**

A live music event where musicians are located remotely from each other is possible through the Internet but highly constrained by network latency. This is especially true with rhythmic music that requires tight synchrony, or in situations where musicians are separated by long distances. To overcome time delays, we propose an intelligent system that listens to the audio input at one end and synthesizes a predicted audio output at the other. In this context, we study how our musical exposure, or enculturation, gives rise to musical anticipation. Moreover, as we admit that such prediction cannot be error-free, we aim to model the musical intentions of the performers and the expectations of the listeners.

368. Radio-ish Media Player

**Chris Schmandt, Barry Vercoe and Wu-Hsi Li**

How many decisions does it take before you hear a desired piece of music on your iPod? First, you are asked to pick a genre, then an artist, then an album, and finally a song. The more songs you own, the tougher the choices are. To resolve the issues, we turn the modern music player into an old analog radio tuner, the Radio-ish Media Player. No LCDs, no favorite channels, all you have is a knob that will help you surf through channel after channel accompanied by synthesized noise. Radio-ish is our attempt to revive the lost art of channel surfing in the old analog radio tuner. Let music find you: your ears will tell you if the music is right. This project is not only a retrospective design, but also our reflection on lost simplicity in the process of digitalization. A mobile phone version is also available for demo.

369. Sound Design with Everyday Words

**Barry Vercoe and Mihir Sarkar**

Sound designers, audio professionals, and musicians often spend time and energy looking for the right sound for a particular piece of music or sonic environment. Current sound synthesizers either contain numerous sound presets that are laborious to parse, or batteries of parameters to tweak without straightforward connections to one's intuitive expectation. We propose a sound retrieval and modification engine based on everyday words like "bright," "warm," and "fat." The perceptual sound synthesis engine is informed by a survey of musicians and listeners worldwide and can also be customized. This system allows dynamic tagging of sound material from online libraries, and "sound sculpting" based on common verbal descriptors instead of obscure numerical parameters.