Self-Evaluation

Ken Goldberg
IEOR and EECS Departments and the School of Information, UC Berkeley

After 4 years as Assistant Professor of Computer Science at USC, I came to UC Berkeley's IEOR Department in 1995 and was promoted to Associate Professor in 1997. In 2000, I was granted a secondary appointment in the EECS Department (0%, above the line), and in 2001 was promoted to Full Professor. In Spring 2005 I was promoted to Full Professor Step V. In Spring 2007 I was honored to accept a third appointment in the School of Information (0%, below the line).

This self-evaluation has been prepared for my evaluation for promotion to Full Professor, Step VI. It summarizes research and creative work, teaching, and service activities overall from 1991 – June 2007. The summary is followed by a more detailed review of activities during the three years since my last review: July 2004 – June 2007.

Cumulative Period: 1991-June 2007

My primary challenge is containing my curiosity. Despite my best intentions, I have been unable to do so. I've been curious about art, rockets, and robots since I was a boy. My wife Tiffany Shlain, a documentary filmmaker, and our 4 year old daughter, Odessa, are also extremely curious, so they are not helping matters. Serving as a professor at UC Berkeley has only exacerbated my condition.

I'm somewhat of a hybrid. I pursue research in engineering and create artworks that ask questions about technology's impact on nature, perception, and culture. Although C.P. Snow correctly described the differences between these "two cultures", in my experience they have much in common. Both demand extensive training and persistence, and both appreciate originality and counter-intuitive ideas. I'm fortunate to have achieved some recognition from both spheres which has allowed me to continue working within and across disciplines. In the next phase of my career I hope to facilitate new dialogues, research, and collaborations between these worlds.

Research and Creative Work. My research in robotics and automation has two foci. The first is primarily theoretical, the second primarily experimental. Most of my theoretical work is in the area of "algorithmic automation", developing algorithmic approaches to problems in manufacturing: feeding (orienting), grasping, and fixturing industrial parts. My secondary focus is on "networked telerobots", developing robots that are controlled remotely via networks such as the Internet. My theoretical work has increasingly influenced my experimental work, and my experimental work suggests new theoretical questions. I serve as Director of the Berkeley Automation Sciences Lab where I work

with 10-15 graduate and undergraduate students per semester. In 2005, I was elected Fellow of the Institute of Electrical and Electronics Engineers (IEEE), "for contributions to networked telerobotics and geometric algorithms for automation."

In manufacturing today, automation is where computer technology was in the early 1960's: a patchwork of ad-hoc solutions lacking a rigorous scientific methodology. CAD has progressed a long way toward elegant modeling of mechanical parts and behavior. Yet the systematic design of automated manufacturing systems that handle these parts (to grasp, assemble, inspect, sort, and feed) has proved elusive. An algorithmic approach to automation requires mathematical abstractions for these basic operations. Such abstractions allow functionality to be specified independent of hardware and software implementation, which in turn provides the foundation for formal specification and analysis, algorithmic design, consistency checking and optimization. Three characteristics of algorithmic approaches are: (1) formal specification of sets of admissible inputs and operations, (2) method for computing all solutions or terminating with a negative report, and (3) characterizing computational complexity as a function of input size. I'm pursuing this research with colleagues in Holland, Israel, UK, France, Japan, Korea, Canada, and many universities in the US. In April 2007, I presented a plenary talk, *"Putting the Turing into Manufacturing,"* on this line of research in Rome at the premier conference in my field, the IEEE International Conference on Robotics and Automation.

Over the past 20 years, my students, collaborators, and I have developed a series of results in "algorithmic automation". In the early 1990s, I focused on algorithmic part feeding. I developed a patented modification to the parallel-jaw gripper that improves grasp stability [IIA02,03] [All references are to publications in C.V.], and a quadratic time algorithm based on this gripper for finding an optimal sequence of gripper angles to orient a polygonal part with n edges. I proved that such a sequence exists for any polygonal part, a result considered the first formal characterization of a class of manipulable parts [IA02]. I extended that approach to the class of algebraic planar parts [IA09] , to cases with friction[IA07] , and developed an algorithmic approach to computing fence angles for orienting parts on conveyor belts [IA16], and improvements in computational complexity [IA23], and other results including stochastic models [IA11], algorithmic approaches to building manipulation fields from vibrating surfaces [IA22], trap design [IA25], and a very exciting new primitive for part feeding that we call "blades" [IA39]. My colleagues have developed a number of related results. In 2005, I developed an interactive Java applet to demonstrate one of our part feeding algorithms. It allows users to draw a part shape. The applet then computes an optimal sequence of gripper motions and presents an animation of the resulting feeder. This applet was featured in the IEEE Institute's March 2007 cover story on the IEEE Transactions on Automation Science and Engineering.

As I pursued research on part feeding, I began work on algorithmic approaches to a related problem, part fixturing. Our first algorithm, developed with Randy Brost, computes the set of all fixture configurations that kinematically constrain a part in the plane [IA12] . This algorithm resulted in two patents [IIA04,05]. Working with students and collaborators, we discovered an infinite class of polygonal parts that cannot be fixtured with modular fixtures [IA15], developed a model of part tolerancing [IA29], and algorithms for fixture loading [IA19]. Recently we developed a new class of "unilateral fixtures" that facilitate access for part inspection and welding [IA34], and a new model and algorithms for fixturing deformable parts [IA36]. This work on feeding and fixturing resulted in several Best Paper Awards at refereed conferences and a series of journal publications.

My interest in networked telerobots began in 1994, when I led the research team that developed the first robot remotely operated over the Internet. My students and I designed it to be available for operation by anyone 24 hours a day, 7 days a week. Our second networked robot went online in 1995 and remained online, around the clock, for nine years, where it was operated by tens of thousands of users from their desktops IA10]. Today, Networked Telerobotics is an active research area. Networked telerobotic systems provide unprecedented access to machines and laboratories, coping with large variations in time delay, demand, and user skill level. I developed new interfaces and algorithms for collaborative filtering and control of networked robots that allow groups of people to simultaneously operate telerobots and for remote explorations with humans (the 'Tele-Actor') and developed analytical models and new unsupervised metrics for assessing operator performance [IA32]. We developed and analyzed provably efficient algorithms for sharing control of pan-tilt-zoom robotic cameras via networks [IA31, 37]. Our work was described in *Time Magazine, CNN, NPR, New York Times, London Times, Los Angeles Times, Chronicle of Higher Education, Fortune Magazine, the New Yorker, Le Monde, El Pais,* and *Scientific American*, and our research was recognized with several awards, including the Robot Industries Association Joseph Engelberger Award and the IEEE Major Educational Innovation Award. I co-edited a book from MIT Press on Networked Telerobots [IE11]. We are now working under an NSF grant to develop networked systems for observing animal behavior, developing what we call "collaborative observatories for natural environments".

Medical dose delivery is an exciting new application area for algorithmic automation. With funding from the NIH and working closely with researchers at UCSF and Johns Hopkins, my group recently started pursuing three problems: registering images from different sensing modalities, computing dose distributions that maximize exposure to diseased tissue while minimizing damage to healthy tissue, and developing new devices and algorithms for accurately reaching regions inside the human body. This is a relatively new research area for my group but we've been fortunate to achieve several results and have published two papers in the Journal of Medical Physics [IA38, 40].

My art installations have been exhibited at the Whitney Biennial (2000), Venice Biennale, Pompidou Center (Paris), Walker Art Center, Ars Electronica (Linz Austria), ZKM (Karlsruhe), ICC Biennale (Tokyo), Kwangju Biennale (Seoul), Artists Space, and The Kitchen (New York). My work has been reviewed in over 50 publications including the *New York Times, Art Forum,* and a number of books. In 2000 I edited a book that solicited essays on "net art" from six artists, six philosophers, and six engineers, *The Robot in the Garden: Telerobotics and Telepistemology in the Age of the Internet,* MIT Press, June, 2000 [IE09]. I regularly present talks on art and technology. In 1997 I founded UC Berkeley's Art, Technology, and Culture Colloquium and have brought 99 speakers to campus to present public lectures. I'm represented by the Catharine Clark Gallery in San Francisco. In 2006, I co-wrote the screenplay for "The Tribe", a documentary short film on Jewish American identity that was selected for the Sundance, Tribeca, and over 50 film festivals worldwide and won 6 awards. To commemorate the 1906 San Francisco Earthquake, I developed Ballet Mori a networked performance that was presented by the San Francisco Ballet at the Opera House in April 2006. (Details are below under Period 2004-2007).

Teaching. Teaching and advising is an important and highly rewarding part of my job. I've graduated ten PhD students and advised dozens of undergrads in my lab. I regularly teach undergraduate and graduate courses on Relational Database Design and Analysis, these are project courses where student teams work with local organizations (from Intel to a campus volunteer teaching organization) to analyze needs and design and implement working database systems. I also teach a course on Human Factors and Industrial Design which treats the topics of perception of color, sound, and touch from the constructive perspectives of contemporary graphic design, industrial design, and computer human interface design. I introduced team-based design projects and bring in guest speakers from Intel, Sony, IDEO, and other design companies. For K-12 students, we used our Tele-Actor system to organize Internet-Based field trips by San Francisco's Galileo High and Lincoln High students to biotechnology labs at LBL and Applied Biosystems, and worked with 7th graders from Dolores Huerta Learning Academy in Oakland to use our internet system to remotely visit UC Berkeley MicroElectronics Lab. I recently initiated a new 2-unit seminar on Advanced Topics in New Media and collaborated with Prof. Hubert Dreyfus of Philosophy to develop a new cross-disciplinary course, Questioning Efficiency: Human Factors and Existential Phenomenology. (Details are below under Period 2004-2007).

Service. External to campus, I am active in the IEEE Robotics and Automation Society (RAS), the largest international society in my field, with over 6000 members.
I've been elected to three three-year terms on its Advisory Board and now serve as Vice President of Technical Activities, where I am responsible for technical initiatives and overseeing 21 Technical Committees and 24 Distinguished Lecturers. I've also been active as a member of the steering committee of the biannual Workshop on Algorithmic

Foundations of Robotics (WAFR), and serve on the Editorial Advisory Board of the Springer-Verlag Advanced Robotics Book Series.

My most significant service contribution was my role in co-founding a new archival journal. In 2001, I was appointed to chair an international RAS committee that extensively reviewed competing journals, interviewed researchers inside and outside our area, studied IEEE subscription data, and analyzed the content of the Society's other publications. After a year of study, recognizing that Automation plays an increasingly important role in the global economy, we recommended that the IEEE establish the *Transactions on Automation Science and Engineering* to publish the abstractions, algorithms, theory, methodologies, models, systems, and case studies that can be applied across industries to significantly advance efficiency, quality, productivity, and reliability for society. After approval from our Society, we began a lengthy proposal and approval process at the IEEE level. The first issue of T-ASE appeared in July 2004 and after a detailed review in 2006, T-ASE was approved as a permanent IEEE archival journal. I continue to serve as Founding Chair of its Advisory Board.

I have been active in service on campus. In addition to organizing monthly public lectures for the Art, Technology, and Culture Colloquium, I've Chaired our Academic Senate Committee on Computing and Communications (COMP). I expanded COMP's membership and scope and invited leaders of related committees to our meetings. We identified the lack of a campus strategic plan for computing and proposed development of such a plan to the Senate and Administration. Our proposal was accepted and beginning in Fall 2003, COMP began work with Jack McCredie and others to develop a Strategic Plan for Information Technology at UC Berkeley, starting with identifying a set of Guiding Principles for IT on campus and a comprehensive survey of department chairs to assess the usage and availability of computing for faculty across departments.

I am actively involved with the College of Engineering's Center for Information Technology in the Interest of Society (CITRIS), where I work to facilitate interactions with faculty outside of Engineering. I Chair the Academic Advisory Committee to the Berkeley Art Museum and Pacific Film Archive (BAM/PFA), which includes 12 faculty who meet with curators at BAM/PFA to explore future exhibitions and programs as opportunities for collaboration. I am also beginning a new relationship with Uc Berkeley's School of Information where I am cross listing my graduate database course.

I am a founding member of the Berkeley Center for New Media (BCNM). In 2003, in response to the New Initiatives campus competition to develop new cross-disciplinary programs, I worked closely with faculty from Art Practice, Rhetoric, Art History, Architecture, School of Information, and Journalism to propose a new research program in New Media. The Center for New Media was approved by the Administration and by the Academic Senate and granted two FTE faculty positions. I have served actively on

the BCNM Executive Committee, on two faculty search committees (chairing the latter) and in July 2007 was appointed Director of the Center.

Period Since Last Review: July 2004 – June 2007

Research and Creative Work, July 2004 – June 2007

10 Refereed Journal papers

17 Refereed Conference Papers and Abstracts

2005, Elected *Fellow* of the Institute of Electrical and Electronics Engineers (IEEE), "for contributions to networked telerobotics and geometric algorithms for automation."

2007, Appointed 0% (below the line) to UC Berkeley's School of Information.

2007, *Isadora Duncan Award (Izzie).* to Ballet Mori, a collaboration with the San Francisco Ballet, for Music / Score / Text. Bay Area Dance Awards and Voice of Dance.

2006, *The Tribe* (short documentary film, co-writer). Official Selection for Film Festivals: Rotterdam, Sundance, Zurich, Tribeca, Nashville (Best Short Documentary), Black Maria (Director's Choice Award), United Nations Film Festival, Warsaw Film Festival.

2005, *Best Journal Paper Award:* "Unilateral Fixtures for Sheet Metal Parts with Holes." IEEE Transactions on Automation Science and Engineering.

2005, *Most Active Technical Committee.* (Networked Robots). IEEE Robotics and Automation Society.

NSF Research Grant: *CONE: Collaborative Observatory for Natural Environments (Award 0535218).* NSF Robotics Program, Division of Information and Intelligent Systems, Three-Year Joint Project with Dezhen Song at Texas A&M. July 2005 – June 2008.

56 Invited Lectures, including:

- Plenary Lecture: Workshop on Algorithmic Foundations of Robotics (WAFR), Zeiss, Holland, Jul 04

- Plenary Lecture: First IEEE Conference on Automation Science and Engineering (CASE), Edmondton, Canada, Aug 05

- Plenary Lecture: ACM Conference on User Interface Software and Technology (UIST), Seattle, WA, Oct 05

- Plenary Lecture: ACM Multi-Media Conference (MM), Santa Barbara, CA, Oct 06

- Plenary Lecture: IEEE International Conference on Robotics and Automation (ICRA), Rome, Italy, Apr 07

- Banquet Lecture: Robotics: Science and Systems Conference (RSS), Atlanta, GA, Jun 07

As described above, my students and I pursue research in:

(1) part feeding and fixturing for automated manufacturing,
(2) tissue modeling and path planning for medical dose delivery,
(3) networked robots for remote monitoring and exploration.
(4) creating artworks that ask questions about technology's impact on nature, perception, and culture.

During the three years since my last academic review, my students and collaborators and I have made progress in each of the four areas.

(1) Part feeding and fixturing for automated manufacturing

The automated feeding (orienting) of industrial parts is a critical aspect of automated manufacturing. A longstanding open problem is to develop an infinite class of devices and an algorithm that accepts a CAD model of the part and generates the specifications for a device that will filter out all but one orientation of the part. In prior work we developed a variety of device classes based on grippers, fences, pins, and traps, and algoritithms using planar projective models of the parts. In 2005 we created a Java applet to demonstrate one of our algorithms. It allows users to draw a part shape, the applet then computes an optimal sequence of gripper motions and presents an animation of the resulting feeder. This applet was featured in the IEEE Institute's March 2007 cover story: http://ieor.berkeley.edu/~goldberg/part-feeder/

Our primary contribution during the last 3 years was initiated in 2005 with Onno Goemans and Frank van der Stappen of Utrecht University in Holland. We introduced a new geometric primitive for part feeding: the "blade" is a class of devices designed for the vibratory bowl feeder, the most common approach to feeding industrial parts. The blade is a horizontally mounted convex polygonal surface that can feed a broad class of three dimensional parts. We also developed a complete algorithm that takes as input any polyhedral part along with its center of mass and outputs all single blade solutions that feed the part. The output is either the set of all valid blade designs or a notification that the part cannot be fed using a single blade. This work resulted in a Best Manipulation Paper Award at the 2006 IEEE International Conference on Robotics and

Automation. This research was supported in part by NSF. We are currently developing hardware and a commercial version of this method with Siemens Automation. [See CV, Journal Paper IA39, October 2006].

For fixturing (holding) parts, we introduced "unilateral fixtures", a new class of fixtures for sheet-metal parts with holes. These fixtures use cylindrical jaws with conical grooves that facilitate part alignment; each jaw provides the equivalent of four point contacts. The fixtures are unilateral in the sense that their actuating mechanisms are restricted to one side/surface of the part, facilitating access to the other side for assembly or inspection. We presented a two-phase algorithm for computing unilateral fixtures. Phase I is a geometric algorithm that assumes the part is rigid and applies two-dimensional and three-dimensional kinematic analysis of form closure to identify all candidate locations for pairs of primary jaws.We prove three new grasp properties for 2-D and 3-D grips at concave vertices and define a scale-invariant quality metric based on the sensitivity of part orientation to infinitesimal relaxation of jaw position. Phase II uses a finite element method to compute part deformation and to arrange secondary contacts at part edges and interior surfaces. For a given sheet-metal part, given as a 2-D surface embedded in 3-D with e edges, n concavities and m mesh nodes, Phase I takes O(e + n^ 4/3 log^ 1/3 n + g log g) time to compute a list of g pairs of primary jaws ranked by quality. Phase II computes the location of secondary contacts in O(grm^3) time. This research was supported in part by NSF and the Ford Motor Company. Our paper on this work received the Best Journal Paper of 2004 Award. [See CV, Journal Paper IA34, October 2004].

With van der Stappen and others, we studied the problem of fixturing a chain of hinged objects in a given placement with frictionless point contacts. We formalized the notions of immobility and robust immobility in this context and showed a number of results, for example that any chain of p arbitrary polygons can be immobilized with at most p + 3 contacts. [See CV, Journal Paper IA41, February 2007].

In related projects, my students and I extended previous work on analyzing belt velocities for vision-based part feeders and extended a previous model for aligning parts in the vertical plane using parallel-jaw grippers.

(2) Tissue modeling and path planning for medical dose delivery

There is great room for improved treatment of patients with tumors or infections. With funding from the NIH and working closely with researchers at UCSF and Johns Hopkins, my group is pursuing three problems: registering images from different modalities, computing dose distributions that maximize exposure to diseased tissue while minimizing damage to healthy tissue, and developing new devices and algorithms for accurately reaching regions inside the human body. This is a relatively new research area for my group but working with my PhD student Ron Alterovitz, we've been

fortunate to achieve two results in the past 3 years and have articles on each published in the Journal of Medical Physics.

Magnetic resonance imaging (MRI) and magnetic resonance spectroscopic imaging (MRSI) have been shown to be very useful for identifying prostate cancers. For high sensitivity, the MRI/MRSI examination is often acquired with an endorectal probe that may cause a substantial deformation of the prostate and surrounding soft tissues. Such a probe is removed prior to radiation therapy treatment. To register diagnostic probe-in magnetic resonance (MR)images to therapeutic probeout MR images for treatment planning, we developed a a new deformable image registration method based on biomechanical modeling of soft tissues and estimation of uncertain tissue parameters using nonlinear optimization, which offered significant ($P<0.05$) improvement in registration over previous methods. [See CV, Journal Paper IA38, February 2006].

The newest treatment for prostate cancer is high-dose-rate (HDR) brachytherapy, where a radioactive source is guided through catheters temporarily implanted in the prostate. Clinicians must set dwell times for the source inside the catheters so the resulting dose distribution minimizes deviation from dose prescriptions that conform to patient-specific anatomy. With my student Ron Alterovitz, James O'Brien of EECS, and researchers at UCSF, we studied the clinically approved Inverse Planning by Simulated Annealing (IPSA) dose planning method developed at UCSF and widely used around the world. We reformulated it as a linear programming (LP) problem to obtain an optimal and deterministic method. We implemented our version and compared with clinical solutions obtained the IPSA probabilistic method. Our method resulted in improved objective function values but confirmed the quality of solutions generated by the IPSA methods. We are currently working to apply our method to "harder" versions of the dose optimization problem involving highly non-uniform doses and robustness. [See CV, Journal Paper IA40, November 2006].

For the third challenge, developing new devices and algorithms for accurately reaching regions inside the human body, we're working closely with Allison Okamura and her colleagues at Johns Hopkins on design of "flexible needles" with asymmetric tips that can be steered from outside the body by rotation along their primary axis. Under a new NIH grant, we're developing a new approach to real-time image-guided adaptive needle placement. Our longer term objective is to design, prototype, and evaluate a working system that will steer flexible needles from outside the body through deformable tissues to reach specified 3D anatomical targets. This will require us to integrate real-time imaging, adaptive modeling and planning, and image-guided intraoperative needle control. Preliminary results have appeared in conferences and we are now developing a new approach to planning optimal needle paths based on Markov Decision Processes. More information is available at: http://www.ieor.berkeley.edu/~ron/research/SteerSim/

In June 2007, I organized a meeting with researchers at Lucas Digital Arts (the special effects and gaming company that created Star Wars) and faculty from UC Berkeley's IEOR and EECS departments and UCSF's Radiation Oncology department to discuss the prospect of a collaborative project using Lucas' simulation engine for medical training and pre-operative planning. This is at the very early stages and we are now working on a preliminary simulation.

(3) Networked robots for remote monitoring and exploration.

Over the past three years, the subfield of Networked Robots has expanded internationally and is supported by major government projects in Japan and Korea. My students and I focus on how networks such as the Internet can support communication between robots and one or more remote human operators. Since 9/11/2001, there has been a growing market for networked robotic cameras with pan-tilt-zoom capabilities. The prices continue to fall and the power of these cameras has increased dramatically. For his PhD, my student Dez Song formalized the "frame selection problem" for shared camera control: given frame requests from n operators, compute an optimal frame for the camera to servo to that will maximize a measure of "satisfaction" for the group. We developed a series of algorithms, including exact, approximate, and distributed versions. [See CV, Journal Paper IA37, January 2006].

Experience with this new generation of cameras raised our concerns about their uses for security/surveillance and their capability for intrusions on privacy. In January 2004, I was invited to develop a networked artwork for the Whitney Museum of American Art in New York. I immediately began work on an online installation to demonstrate the increased power of surveillance cameras. Since the 40th anniversary of Berkeley's Free Speech Movement was in Oct 2004, my idea was to position such a publically accessible robotic camera over Sproul Plaza (See (4) below). My intention: to make people think about encroaching technology, was achieved. The project raised concerns and I was invited to an emergency meeting with the Chancellor, Vice-Chancellor, and heads of the Academic Senate, Legal Affairs, and Public Affairs. After a detailed discussion of the merits of the project, we found a constructive compromise where I reduced the zoom capacity of the camera and initiated research on the legal issues with Prof. Deirdre Mulligan of the Law School and organized a campus Committee on Visual Privacy.

Afterward, thinking about how such robotic cameras could be constructively applied, I started thinking about their use to monitor and observe remote natural environments. My PhD student Dez Song, now at Texas A&M, and I applied and were granted a three-year NSF Award to design and experiment with Collaborative Observatories for Natural Environments (CONEs). In this project, we are consulting with natural scientists and documentary filmmakers to investigate a new class of hybrid teleoperated/autonomous robotic "observatories" that allow groups of scientists, and the public, via the internet, to remotely observe, record, and index detailed animal activity. Such observatories are

made possible by emerging advances in robotic cameras, long-range wireless networking, and distributed sensors. Our goal is to advance the fundamental understanding of automated and collaborative systems that combine sensors, actuators, and human input to observe and record detailed natural behavior in remote settings.

In Fall 2005, we offered to assist Cornell's search for the presumed extinct Ivory Billed Woodpecker by developing a high resolution robotic video system to observe the sky over an extended time period. We are now collaborating with the Cornell team and designing a new camera system. Detailed high resolution video images are required to distinguish an ivory-billed woodpecker from its cousin, the common pileated woodpecker. Our goal is to develop a computer vision system that detects when birds fly into the field of view, recording the associated video segments, and discarding video where there are no birds present. Subsequent analysis by human experts (perhaps with computer post processing) will be required to sift through the Gigabytes of video data collected. The system is now installed in a clearing in the Bayou DeView, which is mostly swamp. Some challenges are: lack of network connectivity, variations and noise in sky images, limited power supply, high temperatures and moisture conditions. The first prototype Automated Collaborative Observatory for Natural Environments, ACONE 1.0, incorporates two Arecont Vision 2Megapixel video cameras and one 1.4 GHz MiniITX computer. We installed ACONE 1.0 in October 2006. I was invited to report on this project at the Annual Meeting of the American Association for the Advancement of Science in February 2007 and the project was reported in a number of international newspapers and magazines. More information is available at our project website: http://www.c-o-n-e.org/acone/

We are also developing publicly accessible collaborative robot cameras. The latest, CONE Sutro Forest, is designed as an interactive online "game" using a robotic webcamera to observe and classify wild birds in San Francisco's Sutro Forest: http://cone.berkeley.edu/

(4) **Artwork.** In this period I've created three new projects.

Demonstrate, 2004.

Emerging developments in politics and technology have have altered privacy's ecosystem of expectations, laws, and behaviors. To expand the dialogue on visual privacy, Demonstrate installed a state-of-the-art robotic webcamera over UC Berkeley's Sproul Plaza for six weeks during the 40th Anniversary of the Free Speech Movement. Anyone on the Internet could share remote control of the camera, zooming in to frame and photograph activity on the Plaza any time of day or night. Over 4000 people visited online; their photos, textual captions, and dialogue are archived at: http://demonstrate.berkeley.edu/ (Click image, then "Archive" to view over 2000 photos taken by anonymous users)

Exhibition History:

- Whitney Museum of American Art: Artport
- ZKM (Center for Art and Media, Karlsruhe): Fair Assembly
- InLiquid, Philadelphia: Alphaville Under Construction
- Cantor Art Center, Stanford: Crowds and Revolutionary Tides

Ballet Mori, 2006.

To commemorate the 1906 San Francisco Earthquake, I developed Ballet Mori to engage the Earth as a living medium and a conductor for dance. For the first time, we combined network technology with ballet to directly link the natural world to classical performance. In this improvisational performance, SF Ballet Principal Dancer Muriel Maffre responded to a musical composition modulated live by the unpredictable fluctuations of the Earth's movement as measured in real time by a UC Berkeley seismometer at the Hayward Fault. Over 3000 people attended the premier of this performance at the SF Opera House on 4 April 2006. Ballet Mori won the 2007 Izzie (Isadora Duncan) Award for Best Music/Score/Text. Details, Press Coverage, and images are available at: http://goldberg.berkeley.edu/art/Ballet-Mori/

The Tribe, 2006.

With Director Tiffany Shlain, I co-wrote the screen play for this award-winning short documentary film about the unorthodox, unauthorized history of the Jewish people and the Barbie doll. It has been selected for 50 film festivals internationally, including the Sundance, Tribeca, Rotterdam, and Warsaw Film Festivals. "What can the most successful doll on the planet show us about being Jewish today? Narrated by acclaimed actor Peter Coyote, The Tribe mixes old school narration with a new school visual style. This short film weaves together archival footage, graphics, animation, Barbie dioramas, and slam poetry to take audiences on a fast ride through the complex history of both the Barbie doll and the Jewish people, from Biblical times to present day. The Tribe provokes discussion about what it means to be a member of a tribe in the 21st century."'"...smart, funny..." -The New York Times. "The Tribe is a powerful, universal film that will surprise and challenge anyone who has wrestled with issues of faith, identity and history." -Roberta Munroe, Sundance Film Festival. See http://tribethefilm.com

I have also worked with Prof. Pam Samuelson of the iSchool and Law School, and Prof. Deirdre Mulligan of the Law School to develop and co-chair a conference on privacy policy and issues that result from the next generation of high resolution digital cameras,

Unblinking: New Perspectives on Visual Privacy in the 21st Century was held on campus in Nov 2006 and included over 30 international experts.

As an artist, I'm represented by the Catharine Clark Gallery in San Francisco.

Teaching Summary, July 2004 – June 2007

As my regular IEOR courseload, I annually teach:
IEOR 115 : Industrial and Commercial Data Systems
IEOR 215: Analysis and Design of Databases
IEOR 170: Human Factors and Industrial Design

I've been very fortunate to supervise the research of three top-notch students who were granted PhD's during the past three years.

- Dr. Ron Alterovitz, *Planning and Optimization Algorithms for Image-Guided Medical Procedures.* UC Berkeley IEOR Dept, Aug 2006. Currently completing at post-doc at LAAS in Toulouse.

- Dr. K. Gopal Gopalakrishnan. *Algorithms, Models, and Metrics for the Design of Fixtures using Part Concavities*. UC Berkeley IEOR Dept, Aug 2005. Currently at Intel Research Labs, Portland.

- Dr. Dezhen Song. *Systems and Algorithms for Collaborative Tele-Operation*. UC Berkeley IEOR Dept, Aug 2004. Currently Asst. Prof. of Computer Science at Texas A&M (and recipient of a 2007 NSF Career Award).

I'm currently advising 2 PhD candidates, Jeremy Schiff and Ephrat Bitton.
I've supervised 6 undergrad research projects under the URAP and URO programs. I also participate in the Regents and Chancellor's Scholarship Interviews, and judge the Irving Prize for American Wit and Humor.

Developed and Co-Taught New Course: **L&S 160A / IEOR 190G: Questioning Efficiency: Human Factors and Existential Phenomenology**, L&S Discovery Course co-taught with Prof. Hubert Dreyfus (Philosophy) in Spring 2006. Efficiency in human behavior is a goal that is rarely questioned in contemporary culture. This course investigated and drew connections between disparate fields to trace the development and influence of this view. The course, drawing a mix of humanities and engineering students, included readings and lectures on 19th and 20th century philosophers with discussions of new technology and team experimental projects..

Developed and Taught New Course: **CNM 201 / IEOR 298-3: Advanced Topics in New Media** in Fall 2006 and Spring 2007. This 2-unit seminar course is held in conjunction

with the Art, Technology, and Culture Colloqium, a monthly lecture series which brings internationally-known speakers to campus to present work on advanced topics in new media. Students enhance skills in "interrogating" new media: how to think critically about advanced topics in new media, how to use new media resources such as the internet to research pioneering work in new media, how to formulate incisive questions about new media, and how to evaluate and create effective presentations on topics in new media.

Service Summary , July 2004 – June 2007

External:

2006-present, Vice President of Technical Activities**,** IEEE Robotics and Automation Society, overseeing 21 Technical Committees and 24 Distinguished Lecturers worldwide.

Founding Chair of T-ASE Advisory Board: IEEE Transactions on Automation Science and Engineering (T-ASE). Worked closely with Editor in Chief to promote and expand this archival publication and to secure permanent approval after Year 3 Review by IEEE.

2005-present, Advisory Board, Robotics Science and Systems (RSS) Conference.

Editorial Advisory Board, IEEE Spectrum Magazine.

Member, IEEE Fellow Evaluation Committee for the Robotics and Automation Society (Spring 2007)

F04-present, Member, Tech Museum Experience Design Advisory Board, San Jose, CA.

2002-present, Editorial Advisory Board, Springer-Verlag Book Series: Advanced Robotics.

2006, Program Committee, Symposium Jury**,** International Symposium on Electronic Art (ISEA), San Jose, CA.

2006, Organizing Committee, The 2nd China Art & Science International Exhibition & \ Symposium, Oct, Beijing.

Internal:

Founder and Director. Berkeley's Art, Technology, and Culture Colloquium. Organized 8 public lectures per year.

Founding member of Executive Committee. Berkeley's Center for New Media, one of five New Initiatives selected by the Academic Senate and Administration

2004-present, Chair, Academic Advisory Committee, Berkeley Art Museum/Pacific Film Archive.

2004-present, Member (ex-officio), Board of Trustees, Berkeley Art Museum/Pacific Film Archive.

UC Berkeley Academic Senate Committee on Computing and Communications,

F2006-present. Member. UC Academic Senate Committee on Information Technology and Telecommunications Policy (ITTP).

Member, UC Berkeley Management of Technology (MoT) Certificate Program, CITRIS Strategic Planning Committee, IEOR Undergrad and Transfer Admissions Chair (F04-F05), IEOR Etcheverry Hall Network Upgrade Liason (F04-F06), Chair, IEOR Advisory Board Task Force (F05-).

Narrative on Service Activities, July 2004 – June 2007

As described in the Cumulative Narrative, I'm active in the IEEE Robotics and Automation Society and in 2006-2007 am serving as Vice President of Technical Activities where I am responsible for a variety of technical initiatives and overseeing 21 Technical Committees and 24 Distinguished Lecturers. I'm also Chair of the Advisory Board of the IEEE Transactions on Automation Science and Engineering and have played an active role in the creation of the new IEEE Conference on Automation Science and Engineering.

On campus, I serve on a variety of committees. The Art, Technology, and Culture lecture series has developed an international reputation and last year celebrated its Tenth Anniversary. It has a mailing list of over 900, and has presented 99 speakers, including Billy Kluver, David Byrne, Gary Hill, Julia Scher, Bruno Latour, Pierre Huyghe, Charles Ray, Rirkrit Tiravanija, Diana Thater, Woody Vasulka, Peter Selz, Hubert Dreyfus, DJ Spooky, Lev Manovich, Christiane Paul, Mark Pauline, Michael Joaquin Grey, Miranda July, and Will Wright. The ATC is sponsored by UC Berkeley's: Center for New Media, Office of the Executive Vice Chancellor and Provost, College of Engineering Interdisciplinary Studies Program, Center for Information Technology in the Interest of Society, Consortium for the Arts, BAM/PFA, and the Townsend Center for the Humanities.

I currently serve on the UC (all campus) Academic Senate, Intercampus, Telecommunications and Technology (ITTP) Committee.

Since Fall 2004, I've Chaired the Academic Advisory Committee to the Berkeley Art Museum/Pacific Film Archive and serve as ex-officio member of its Board of Trustees where I'm active in the fundraising efforts for the new Museum building and on the steering committee for the new BAM Digital Art Exhibitions (DMAX) program.

In July 2007, I was appointed to serve as Director of the Berkeley Center for New Media where I'm developing a number new initiatives and programs.

Further information and full CV is available at:
http://goldberg.berkeley.edu/

Ken Goldberg
July 2007