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ARTISTIC COLLABORATION IN DESIGNING VR VISUALIZATIONS


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This article describes some of the lessons we have learned from our collaborations with artists on visualization problems. Over the past several years, we have worked closely with artists to develop, refine, and critique visualizations ranging from archaeological dig data from the Great Temple of Petra site in Jordan to the fluid dynamics and wing bone shape deformations that begin to explain how bats, the only flying mammals, stay aloft. Perhaps, the most important conclusion we have drawn from this experience is that artists can fill an important role in the visualization design pipeline. In our experience, artists routinely provide an unique source of visual insight and creativity for tackling difficult visual problems. They are also expertly trained in critiquing and refining visual works, an essential task in the iterative visualization process.

The second major conclusion we have drawn from our collaborations with artists is that we need more appropriate design tools to support them and their role. We discuss here the experiences that led us to this conclusion along with some of the tools we have developed to facilitate working with artists. The lack of appropriate design tools is particularly evident in visualizations using new technologies, such as virtual reality (VR) or volume rendering. It is difficult for artists to get involved in design in these visual spaces since, with rare exceptions, one needs to know how to program in order to create within them. Unfortunately, these are also the types of technologies that offer great potential for visualizing many of today's complex datasets [4]. Additionally, they are probably the technologies in which we can most benefit from artistic insight, since guidelines for good visual depiction are far less developed in unconventional visual spaces, such as virtual reality, than in more traditional 2D media.

We begin by describing one of our recent major collaborative efforts, a class on designing virtual reality scientific visualizations that was co-taught with professors and students from Brown's computer science department and from the Rhode Island School of Design (RISD)'s illustration department. Many of the experiences and conclusions relayed here are the results of this class. We then discuss three important themes that we have derived from our experiences, all motivated by a desire better to facilitate artistic collaborations. In some cases, these themes can be thought of as guidelines for software tools that may aid collaboration. In others we are not yet ready to offer a guideline, but we have at least identified issues that were major factors in our efforts and deserve consideration before working with artists on visualization problems.

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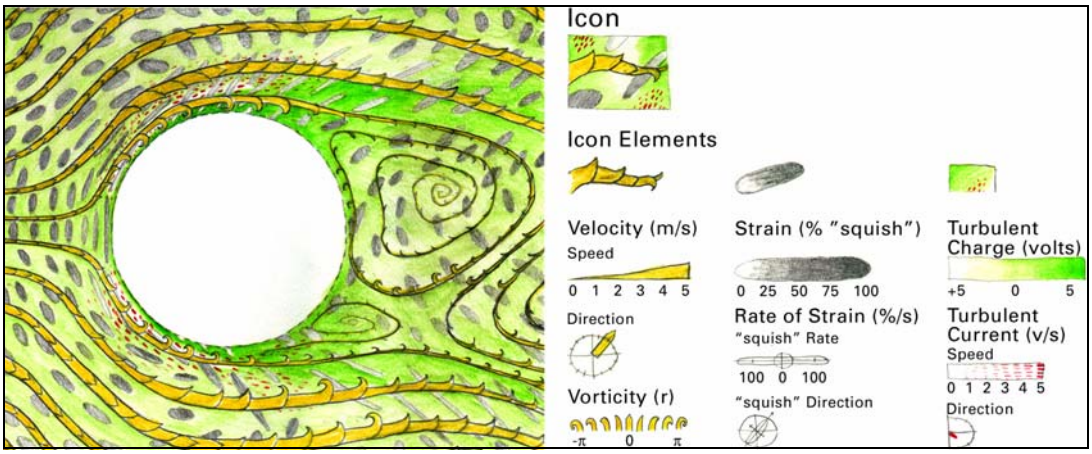

Figure 1. An art student's visualization design of 2D steady fluid flow past a cylinder. Courtesy of Deborah Grossberg

Teaching Art to Computer Scientists, Computer Science to Artists, and Fluid Flow to Everyone

Our interdisciplinary visualization class brought artists and computer scientists together to solve visualization problems driven by science. Students worked in teams on visualization and design assignments. We began the semester with 2D fluid flow visualization assignments, as in Figure 1, and gradually built up to the final projects, which were virtual-reality visualizations of pulsatile blood flow through a branching coronary artery. We found more obstacles to collaboration as we moved towards VR and more complex data, as discussed below. Despite these obstacles, the students learned how to collaborate with one another, learned to value what each discipline (computer science and art) could offer to the project, and produced some very interesting visualizations.

Although artists rarely work with complex scientific data, they do train to convey information effectively through imagery, given the constraints imposed by their media, employers, or audience. In this abstract sense, normal artistic practice is not such a far cry from typical visualization design tasks. The images in Figure 1 show one art student's early visualization design assignment. We asked the students to create a visualization and legend that convey eight continuous variables describing a steady, 2D fluid flow in a single picture. This is a very difficult visual problem; in fact, it is still being actively researched in the visualization community. We found that artists were adept at investigating visual problems like this one when we could clearly convey the scientific goals and constraints of the problem.

Figure 2. Students prepare for a critique of arterial blood flow visualization designs

Collaboration was sometimes difficult to manage. In early assignments, such as in Figure 1, the right tools for the job were colored pencil, oil paint, gouache, watercolors, and Photoshop. In later assignments, the essential tool for the job moved closer and closer to programming. At this point, the art students often had visual insights to offer but had difficulty conveying them. It was easy for the non-programmers to feel left out of the loop. As Fritz Drury (the RISD illustration professor who co-taught the class) remarked, the programmers are the ones with the ultimate power: they have the final say about what ends up on the screen.

One device that helped us keep artists, computer scientists, and fluid flow researchers on the same page is the critique, a common teaching tool in art classes. All the class work was displayed on a wall, as seen in Figure 2, and as a class, we discussed important design lessons in relation to each work. We critiqued the work both from a visual and a scientific standpoint. Visually, we explored color, scale, form, metaphor, and narrative. Scientifically, we learned about the data we were trying to represent and critiqued the work on the basis of how truthfully and completely the science was represented, given the tasks our scientists wished to perform. We have now adopted 'crits' into the visualization development process for many of our projects.

How Can Artists Approach Design Problems in VR?

As we move from 2D visualizations into more complex 3D situations such as virtual reality, collaboration with artists becomes much more difficult to facilitate. The first theme we have derived from our class experiences (along with other collaborative efforts) is that visualization design should occur within the visualization target medi-

Figure 3. A CavePainting visualization design of bat flight data, snapshots from a 3D VR program. The bat appears to fly into the page in these snapshots, but viewers walk around the entire model when seen in VR

um. This sounds simple, but it has fairly significant ramifications for the visualization media we often use. For example, it is very difficult for anyone, and nearly impossible for an artist who is not a programmer, to create visualizations or simply experiment with design ideas in virtual reality.

A starting approximation for designing within VR is to design with more traditional, often 2D, media and hope that some of these design ideas will translate to VR. We were forced to take this approach during many of the class assignments. The difficulty is the drastic difference between what we can convey on paper and what we can convey in VR. We use a four-wall Cave VR display environment for much of our research. So much changes when we enter the Cave: scale, interaction, stereo vision, vividness of color, and contrast. When designing traditionally with an eye towards VR, we are left with the problem that a good 2D design does not necessarily translate into a good 3D, much less VR, design. Further, it is very difficult to evaluate or propose refinements to a design without actually seeing it implemented in the Cave. We thus lose the power of the critique, which we have found so useful. We need to be able to design and critique within VR.

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With this motivation in mind, we began exploring ways to work with artists to design visualizations directly within the Cave. Figure 3 shows some snapshots of one of our VR design results. In this project we are collaborating with Sharon Swartz of Brown's evolutionary biology department, who studies bat flight from experimental data collected in wind tunnels. Two important clues to understanding bat locomotion are the air-flow information surrounding the wing and the pattern of deformations of the wing bones during flight. Artists worked directly in VR to create the visualization design shown in Figure 3. Since the bat data assumes symmetry between the two wings, the artists chose to represent different aspects of the data on each side of the bat. On the left side of these images, flow close to the wing is described by color and texture along the wing surface. Vortex cores and vortical structures in the flow behind the bat are also represented. Changes in bone shape at two distinct times during a wing beat cycle are shown on the right side of the images along with a 3D trace of an important bone joint through the wing beat cycle.

The basis for our VR design tools is the CavePainting program [3], a tool intended for artists to use inside the Cave environment to create free-form 3D objects. It has been described as a form of zero-gravity sculpture. Artists interact with the system by moving a tracked paintbrush prop through the air to create 3D 'paint' strokes. (Figure 6 shows an artist using the system.) The 'paintings' are actually 3D models, since each brush stroke exists in 3-space. The intuitive interface of the system makes it easy for artists to pick up and quickly begin modeling in the Cave.

There are several benefits to working directly in the Cave with a tool like CavePainting. The most important is that the design can be easily critiqued and refined with proper attention to the nuances of the target medium. In practice, we have gained valuable insight from these critiques. We have made several alterations to our initial bat visualization designs based on feedback from Dr. Swartz and her collaborators after meeting for critiques in the Cave. During these critiques we have even been able to sketch modifications to designs and discuss them immediately.

Using CavePainting to design visualizations also has the advantage that we can investigate, refine, and converge on a successful visual design at an early stage in the process. With the usual approach of implementing before visual refinement, it might take weeks or months of implementation before we discover our design is flawed from a visual standpoint, and once we notice a problem and brainstorm another design, it could take another few weeks before we are ready to visually critique that one. Thus, particularly in VR, where imple-

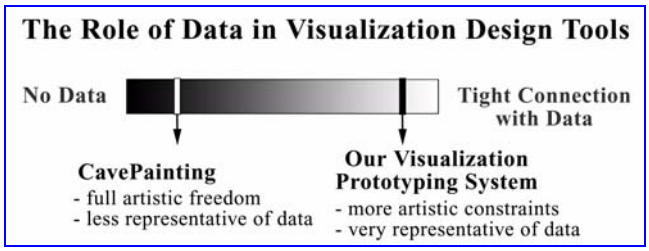

Figure 4. Design tools can have a stronger or weaker built-in connection with data. Tools at both ends of the spectrum are useful

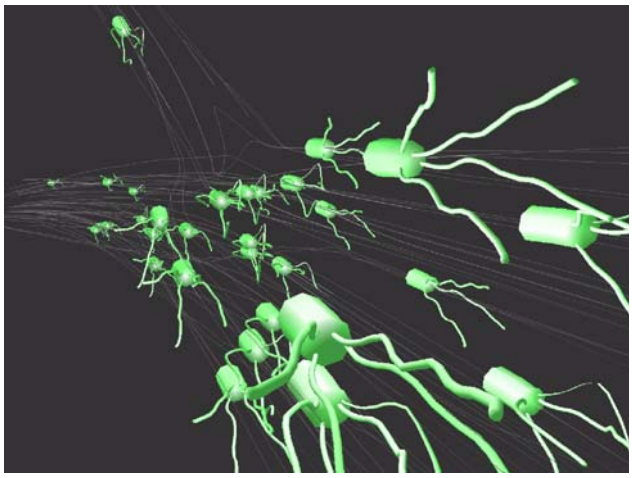

Figure 5. A result from our visualization prototyping system. The 3D icons were sketched by an artist, then connected to an arterial blood flow dataset so they morph in direct response to the data

mentation can be difficult and time consuming, putting visual design decisions in series with implementation can extend the time between iterations on a visual design. Designing directly in VR, on the other hand, lets us converge upon a visually successful design early in the implementation process. We can quickly work through many more iterations of the design because we do not have to wait for them to be implemented before critiquing them in the Cave.

Where's the Data?

The second theme that has emerged from our collaborative work is that we should incorporate varying levels of data involvement in the design process. In the bat visualization design shown in Figure 3, there is no programmed link between the visuals and the bat flight data. Designs such as this lie at one end of the spectrum shown in Figure 4. Despite the lack of a low-level link with the data, this type of design is extremely useful. The designer has imagined some representative data and sketched it out. The visualization is not far fetched; he has seen previous attempts at bat visualizations and talked with the scientist about her goals. Essentially, he knows enough about the structure of the data to sketch out a typical situation so that we can meet with the scientist and critique the visualization idea in the Cave.

The danger in going too far in the design process without a program-level connection of the visuals to the data is that we may converge upon a design that works well for our perception of the data but not so well with the actual data. In an effort to explore this issue, we built some design tools to explore the other end of the spectrum of data involvement. As we see in Figure 4, tools like CavePainting lie at the far left end of the spectrum, with no program-level connection to the scientific data. The visualization prototyping system described below is much closer to the right side of the spectrum, where data plays a key role in generating the visualization design.

Our visualization prototyping system [2] lets an artist draw icon-based 3D visualizations that are completely driven by the underlying scientific data. Figure 5 is a snapshot of one such visualization design. The squidlike icons represent data values within a fluid-flow dataset of pulsatile blood flow through a branching coronary artery. In this design, the squid's tentacles morph in response to data values. At high speeds, they straighten out and the squid appears quite streamlined. At lower speeds, they flail out to the sides, as the squid assumes a sluggish posture. This tool has been useful in evaluating several different designs for arterial blood flow visualization. Since we are working with time-varying, pulsatile fluid flow, the ability to see the design animated, with icons flowing down the artery and changing shape in response to the data, is critical in evaluating the design's success. This would be a difficult display to realize without a program-level link to the flow data. Despite the success of this approach in achieving these animated visualization designs, we have had difficultly moving beyond these relatively simple cases to the more complex ones required in many of our driving scientific problems.

This experience illustrates the tradeoff that exists in many design systems based on the role they provide for data. Given plenty of preprogrammed connections to data, design tools can produce visualization designs that are so representative of the data that they can be trusted and critiqued as completely accurate visualizations. However, preprogrammed connections to data can be constraining to the artist. For example, in our current implementation of the prototyping tool, the icons must be drawn in a special way in order to establish a solid correspondence for our morphing algorithm. This means that the artist must have this in the front of her mind while working on the design. Creating very complex designs, for example icons that respond to six different variables, can become almost impossible to manage cognitively. Again, these difficult design tasks are the ones our driving scientific problems require and the ones in which we can most benefit from artistic insight. We need to continue to develop intuitive design tools that provide this type of solid connection to the data, but also allow artists to work naturally.

Needed: Tools for Real Design Work in VR

The final theme that has emerged again and again in our collaborations is the need to support continued, evolving work with VR tools. This has been evident in two areas. First, getting started in VR is hard. Often our artists have done several preparatory sketches or studies before entering the Cave to work. We need to make it easier for them to build on those sketches when they get to the Cave, rather than shutting out the real world and concentrating only on VR. Second, we need to facilitate returning again and again to a design to rework and refine it. The real-world problems with which we anticipate artists will work are sufficiently complex that they will require many design iterations to complete. Tools to facilitate artistic collaboration in visualization need to be accessible to artists in these ways if we want to support artistic involvement in difficult visual problems.

Figure 6. The 3D visualization design, also for the bat flight problem, was inspired by the Miró painting "The Gold of Azure" [1]. We scanned and imported the elements of the painting into our Cave design program as textures. The designer used this inspiration to hit the ground running when she began her design in the Cave

Let us look at CavePainting again as an example of an artistic design tool to see how it can be difficult to get started on a VR design. When the program begins, we walk into the Cave, a dark blank room of projection screen walls. We carry a tracked paintbrush prop and a pair of glasses. Once we put on our stereo glasses, it is too dark to see any paper or other real objects we might have brought in with us. By default, we start with a completely blank canvas and no external inspiration, something designers almost never want to do.

One approach that has been helpful to us is to import our design inspiration, often 2D work such as sketches or paintings, directly into the VR design program. In Figure 6, we see a 3D CavePainted design inspired by a Miró painting [1]. One of our designers saw the painting and it prompted an idea for visualizing the bat dataset. We cut out subregions of the Miró and imported them into CavePainting as brush stroke textures. Then our designer was able to work directly with elements of the inspirational imagery to create the 3D design she imagined. This gave her a jump-start on her 3D design and helped her quickly create a coherent design.

The ability to return to a design and refine it again and again is just as important as starting with something in VR. The design task is necessarily an iterative one, with critiques by other designers, implementors, and scientists all playing an important role in refining each iteration. Normally artists refine work in two ways. First, they add additional layers of clarification. In painting, for example, additional layers of paint conceal what lies below. A rough outline of a face can be laid down as a place holder for a much more complex rendering to come later, applied with additional paint layers. Second, they create many studies of an idea, sometimes ending up with a studio full of renderings and re-renderings. At the end of this period the idea is clear enough in the artist's mind that she feels ready to produce a final work.

These approaches are not at all mutually exclusive; however, we have difficulty supporting either with our current design tools. In the first case, we can add some additional layers of clarification with the CavePainting system, but this can have the effect of distorting the original form. We are a little closer to supporting the second style of refinement, which amounts to letting an artist quickly reel off many sketches before creating a final work. However, it is unclear how to refer back to several studies while working on a new piece, since each design is usually intended to be viewed in the full space of the Cave. These issues are among the most important to address before working closely with artists on design problems, since they can be very frustrating and limit the amount of real design work that can be accomplished.

Conclusions

We have had many exciting and fruitful collaborations with artists, and we are convinced that they have a place in the visualization design pipeline. One of the driving motivations in our recent work has been to consider what an artist would do for eight hours a day if hired by a visualization lab. Given current visualization practice, this is a difficult question to answer. However, the key seems to lie in enabling an artist to get involved in design at a level that goes deeper than simply turning knobs of existing visualization techniques. We anticipate that artists will be hired to fill positions in exploratory visualization. That is, rather than

merely making a picture pretty or visually clear for publication, we see artists as having key roles in working closely with scientists to design novel visual techniques for exploring data and testing hypotheses.

From our experience, three of the most important themes to consider in trying to obtain this goal are:

- Enabling artists to design directly with typical visualization target media.
- Considering and supporting the varying roles that data can play in artistic design tools.
- Facilitating getting starting and continuing to refine designs for difficult visualization problems.

We hope we have illustrated some of the potential of this type of collaborative visualization work, along with presenting some of the lessons we have learned along the way in our collaborations with artists. We also hope to have further motivated the need for additional research in design tools that can be easily targeted towards visualization problems.

Acknowledgments

We would like to thank the Brown and RISD students of our visualization design class, as well as RISD illustration professor Fritz Drury. We would also like to thank our collaborators Sharon Swartz and Peter Richardson. This work uses the VRPN library, which is supported by the NIH National Research Resource in Molecular Graphics and Microscopy at the University of North Carolina at Chapel Hill. This work was partially supported by NSF (CCR-0086065).

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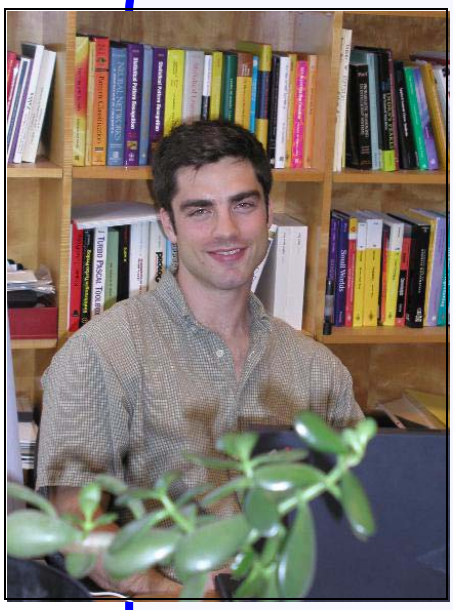

NEW FACULTY MEMBER, Assistant Professor **John Jannotti** joined the department this spring. He was born in Newburgh, NY, and is the youngest of four children. In junior high he enjoyed chemistry and didn't use a computer until 11th grade—when he found the computer much more fun. He took computer classes but remained 'well-rounded' academically, and didn't become a real computer geek until college. John played varsity soccer and traveled widely with the debating team; said he, "I just liked to argue!" In high school John won a T.J. Watson Scholarship, in graduate school he won an IBM Fellowship, and at Brown he says, "Now IBM's built my building!"

At MIT he minored in architecture, his interest sparked perhaps by his father's having designed and built the family home. During grad school he was involved in a .com called SightPath, founded by his advisor Frans Kaashoek and David Gifford, that was eventually bought by Cisco. His job was to write their prototype content distribution system. He worked for SightPath on and off until he graduated. During a period as a post-doc at MIT, he worked for Cisco on the same system before coming to Brown.

John lives on the East Side and likes it that Providence is geographically small and walkable. His hobbies include growing and propagating house plants--he's hoping for a south-facing office on the third floor. He plays soccer with the department's 'ByteSoccer' team, and softball with the 'Dingers'. Recently he had his first flying lesson at T.F. Green Airport. John's area of interest is computer systems, broadly construed, especially networking and operating systems. He is particularly interested in loosely coupled distributed systems enabling qualitatively new functionality. Last semester he taught CS296-6, Large-Scale Networked Systems, and in the fall will teach his new course, CS161, Building High-Performance Servers.

WiCS holds GIRL SCOUT TECHNOLOGY DAY

In March the department's Women in Computer Science (WiCS) group held its annual Girl Scout Technology Day. Girl Scout Troop 941 from Franklin, Mass. participated in order to earn their technology badges.

Top l to r: Ashley, Casey, Teresa and Krista with their hardware group

The scouts, ranging in age from 10 to 13, first learned about the components of computer hardware, including input and output devices, types of memory, and the CPU. With the help of WiCS members, the girls worked in groups to disassemble old computers to see all the components and how they fit together to form a computer. The scouts particularly enjoyed the "ripping apart" aspect of the exercise. Each scout took one computer part home with them for show and tell.

After a pizza lunch, WiCS members led the girls in a game of Hardware Bingo to help them remember what they had learned. WiCS members followed this with an HTML tutorial, where the Girl Scouts were able to create webpages individualized with their favorite colors, their choice of images, and links to favorite sites. These webpages, filled with information about their pets, hobbies, and families, and pictures from the event are linked off the WiCS webpage, which can be found at *http://www.cs.brown.edu/people/orgs/wics/*.

Andi, Dulissa and Sarah pose with Girl Scouts and computer parts

Sarah shows Girl Scout Emily Luther how to add a link to her webpage

Participating WiCS members included Andi Fein, Teresa McRann, Sara Hillenmeyer, Krista Greer, Caitlyn Schmidt, Casey Jones, Katrina Ligett, Stacy Wong, and Danielle Karr. Additionally, two students from the Artemis Project 2003, Dulissa Rosario and Ashley Fernandes, joined WiCS members to help teach the material they learned in Artemis last summer. The Girl Scout Technology Day was funded by a recent gift to WiCS from Google. WiCS and the girl scouts concluded the day with a discussion of all the career opportunities in technology-related fields, including jobs in teaching, programming, technical support, and research.

Upcoming WiCS events include a talk by Professor Pascal Van Hentenryck, a course registration bagel lunch, the annual senior brunch, and a tentatively scheduled trip to New York City in the fall to tour Goldman Sachs' Technology Division.

changelog

*Ex-avd student **Stephen Cantrill** received the Outstanding Teaching Award at Denver Health's annual medical staff dinner in October 2003. He is associate director of emergency services at the University of Colorado Health Sciences Center and also serves on the Colorado governor's emergency epidemic response committee. His son Bryan and Mike Shapiro (both '96) wrote an article in the fall 2002 issue of* **conduit!** *about their lives at Sun Microsystems.*

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*Coincidentally, Shriram Krishnamurthi noticed a glowing article about **Bryan Cantrill** (center in photo next page), **Mike Shapiro** (l) and **Adam Leventhal** ('01) in a British publication,* **The Register**, *under the heading, "Sun delivers*

LIDDY SHRIVER, ’90

In the spring ’03 issue, we learned of Liddy’s illness and her great enthusiasm for biking and read her inspirational online journal. It is with great sadness that we report her passing this January. From the final entry on her website:

January 15, 2004—Liddy took her final steps on her journey with Ewing’s sarcoma today at 11:15 AM. No more pain. No more labored breathing. No more trembling hands and wobbliness. No more auras. She is at rest and at peace. A version of the obituary printed in the local newspaper follows:

Shriver, Elizabeth:

Elizabeth Anne Marie Shriver, known to her family and friends as ‘Liddy’, died on Jan. 15, 2004 after a 22-month battle with Ewing’s sarcoma.

She was born November 12, 1966 in East Los Angeles, CA, to Bruce and Beverly Shriver, who live in Ossining, NY. Liddy is survived by her husband Tom Swartz, her parents, and her three brothers Bruce, Jr., Mark, Matthew and their families. Liddy resided with Tom in Jersey City, NJ.

She was a graduate of SUNY/Stony Brook (BS), Brown University (MS) and NYU (PhD). She worked at Lucent’s Bell Labs in New Jersey after graduating from NYU. Liddy was an avid cyclist and during her bout with cancer she inspired many patients and caregivers with her online journal and her bike tours.

A graveside ceremony was held at St. Augustine Cemetery in Ossining, NY, this spring and a memorial service took place at Liberty State Park in New Jersey, where Liddy and Tom frequently biked.

In lieu of flowers, the family requested that donations be made to the Liddy Shriver Sarcoma Initiative, a non-profit charitable entity for those dealing with sarcoma. Your check should be made out to ‘FJC’ and the memo line should read ‘Liddy Shriver Sarcoma Initiative’. Please send the check to FJC, 520 Eight Avenue, 20th Floor, New York, NY 10018.
Peace,

Bruce, Bev and Tom

changelog

Unix shocker with DTrace.” DTrace is a key addition to Sun’s flagship

operating system in the upcoming release of Solaris 10. Bryan is quoted as saying, “With the exception of system calls, the [debugging] tools, such as they exist at all, are ad hoc, and at best designed for developer use. For example, there is no tool anywhere that allows for arbitrary dynamic instrumentation of a production operating system kernel.” To read this fascinating piece, go to:

http://www.theregister.co.uk/2004/07/08/dtrace_user_take/

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John Hughes made another good alumnus find in **The New Yorker**’*s piece on “dorkbot”, a group whose*

IPP SYMPOSIUM: TRUSTED COMPUTING GROUP

Anna Lysyanskaya

Modern computer tools are becoming increasingly complex, from gigantic databases to computer-aided surgery. Yet a primitive virus can still disrupt millions of personal computers in one day. Two natural questions to ask are what brought about this sad state of affairs, and what can be done to fix it?

Where do security problems come from? When testing software, one cannot possibly test for all cases and might miss a bug here and there; the bigger the system, the more bugs creep in. Low-level architecture and operating-system design also affect security. For example, as systems are designed today, an attacker can take control of a program that has a buffer overrun bug: a buffer overrun can cause a program to start executing malicious code. Even in the absence of bugs and viruses, security problems can arise as a result of a bad access-control policy or other unanticipated user decisions, such as file sharing.

The CS Department recently hosted an IPP Symposium on the Trusted Computing Group's (TCG) effort to make personal computers more secure. TCG (*www.trustedcomputinggroup.org*) is an industrial consortium whose membership includes most major computer companies, including several of our IPP partners: Microsoft, Sun, IBM, and Intel. The TCG replaced the Trusted Computing Platform Alliance (TCPA) a year ago, incorporating all of their previous work.

The TCG is trying to create a personal computer that does not have the gaping security holes present in today's PCs. It also aims at creating technology to alleviate security problems with platforms other than just the PC. This involves a separate gadget—a trusted platform module (TPM) chip—that can insure that each program's data is protected, that programs do not interfere with one another and that their code is not modified. A PC or other device that has a TPM chip would be able to prove to other machines on the network that it is enhanced with this technology.

The computer companies involved with the TCG are working on all aspects of this solution. They are creating standards for making this chip and the supporting software. Intel is making a TCG-compliant chip and shipping it with its chipsets, and Microsoft is developing an operating system called NGSCB ("Next-Generation Secure Computing Base," pronounced "ensgkib," formerly known as Palladium) that uses TCG technology. All TCG partners are involved in writing the specifications.

The TCG is trying to create a personal computer that does not have the gaping security holes present in today's PCs

On March 25th, some of the key people behind TCG specification design came to Brown and presented their ideas. The title of the symposium was "Trusted Computing Group: Goals, Achievements, and Controversies."

Joe Pato (HP), Brown '81, kicked off the day by covering the "goals" part of the Symposium. He explained the current state of affairs that motivates the TCG efforts, and the vision for developing the TCG architecture. He explained that the core idea of the TCG architecture is to build a large secure system by using one standard hardware component that can be

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motto is "People doing strange things with electricity." At the meeting last May in SoHo, ***Scott (Spot) Draves*** *(Math ScM '90) was the first speaker. His presentation concerned his Web site, Electric Sheep, on which abstract images constantly change form in response to information coming from other people's computers via the Internet. Said Draves, "The project started in '99. It was based on an algorithm developed in 1992. The title is based on the novel* ***Do Androids Dream of Electric Sheep?****, by Philip K. Dick." Said he at the end of his talk, "Please buy my DVD. I quit my day job to do this."*

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Steve Marschner *'93, former CS224 TA and, according to Spike, "general all-around nice guy", won a Technical Achievement Academy*

Symposium speakers, l to r: Ari Schwartz, CDT; John Jannotti, Brown; Seth Schoen, EFF; Ernie Brickell, Intel; Anna Lysyanskaya, Brown; Jan Camenisch, IBM Zurich; Brian LaMacchia, Microsoft; Joe Pato, HP Labs; Simson Garfinkel, MIT

trusted to perform a few simple tasks correctly and securely. The goal of the standardization effort is to establish what these tasks are and to come up with a set of building blocks that make it possible securely to realize any type of computing platform. Having one established industrial standardization effort around is a good idea when public review is concerned—the more experts are involved in critiquing a standard, the better. Also, anyone should be able to produce products that comply with the standard.

Next, I gave an overview talk on the wider challenges of creating trustworthy systems, such as what constitutes identity in the digital world (in my view, it is the knowledge of a secret key or password, since online you have nothing but your data to represent you), identity theft versus identity fraud (the former is when someone steals your identity, the latter is when you let your friends pretend to be you so they can enjoy the same privileges you do) and how to prevent them, and other challenges.

Brian LaMacchia (Microsoft) presented the Microsoft NGSCB operating system whose security features rely on the TCG standard. The four key components of the NGSCB are strong process isolation, sealed storage, secure path to and from the user, and attestation. Strong process isolation guarantees that one program cannot interfere with another one's execution. Sealed storage protects the data of one program from another. Secure path insures that a user can interact with an application without interference from other applications. Finally, attestation allows a program to prove to another program, running on a remote machine, something about its state.

Ernie Brickell (Intel) described how TPM version 1.2 was designed to support the cryptographic functionality needed for a trusted platform. He went over the purpose, functionality, and implementation of the cryptographic protocols. In particular, he described the protocols for sealing secrets, creating and using an endorsement key, creating and using an attestation identity key, and resetting and extending a platform configuration register and locality. The ability to seal secrets has many uses; for example, it is crucial for making data available only to authorized applications. Endorsement and attestation identity keys come in, for example, when an application is required to prove that it is in a certain state. Each TPM has a public endorsement key (which can be thought of as an identifier for this TPM) and a corresponding secret key. If a TPM also has an endorsement certificate from some trusted authority (for example, the entity that manufactured this particular TPM), then it can prove to third parties some properties about the state of its platform. More precisely, it provides a verifiable statement of the form "An entity in possession of a secret key corresponding to a certified public endorsement key attests that its platform is in a state with the following properties," etc. From the privacy point of

changelog

Award. The Oscar went to Steve and his collaborators for their pioneering research in simulating subsurface scattering of light in translucent materials. These groundbreaking techniques were used to create realistic-looking skin on digitally created characters.

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You're sure to enjoy the highly entertaining ***Folklore*** *Web site created by* ***Andy Hertzfeld*** *'75, a student of Andy's, one of the four legendary designers of the Mac, and an originator of Apple. In particular, check out the tale of the Mac team's visit to Brown, entitled "What's a Megaflop?"*

http:/www.folklor.orgStoryView.py?project=Macintosh&story=Whats_A_Megaflop?.txt

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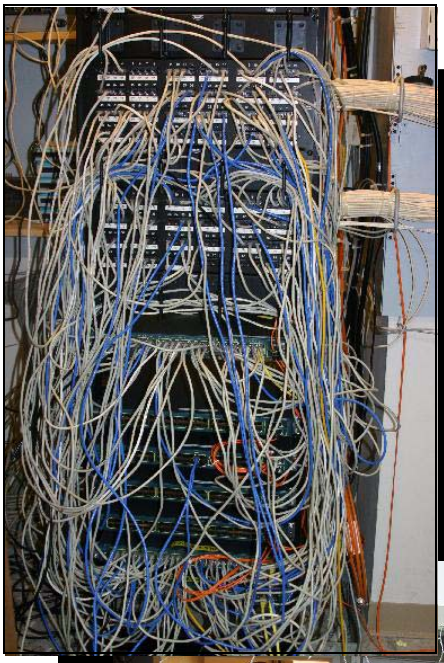
CLASS OF '22?*...Gamze and Ugur Cetintemel's baby daughter, Ece (Little Princess in archaic*

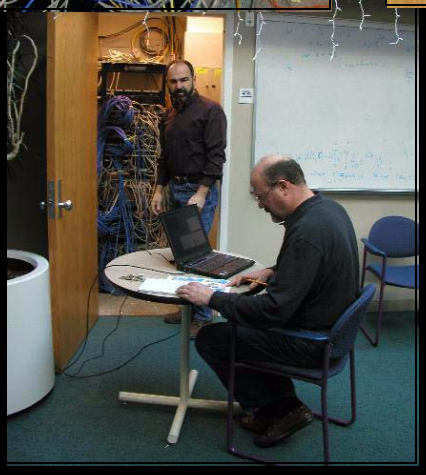
view, it is important to insure that this statement does not actually reveal the endorsement key or any other information that can uniquely identify the underlying TPM. Otherwise, it would be equivalent to providing your name and address to everyone with whom you wish to talk. So instead, this statement should reveal nothing except the properties of the platform that are needed, and also some attestation identity key, which is just a pseudonym that this TPM can use in further transactions with the same third party.

Jan Camenisch (IBM) presented the underlying cryptographic technique for this protocol (called "direct anonymous attestation"), as well as how to prevent "rogue TPMs" from making such statements. The take-home message is that you can have authentication and anonymity at the same time.

A very interesting part of the day was the panel discussion that followed these technical talks. Besides earlier speakers, **Simson Garfinkel (MIT)**, **John Jannotti (Brown)**, **Seth Schoen (Electronic Frontiers Foundation)** and **Ari Schwartz (Center for Democracy and Technology)** participated in the panel. The audience also joined in the discussion.

A number of controversies around the TCG standard were discussed. Both Simson and John raised pragmatic concerns over whether this effort was likely to make an impact at all. They doubted that people would write software that used TCG or the security features of NGSCB; they felt that people would find these things too hard to use. Someone willing to make a time investment to learn how to write better, more secure code would probably opt for studying better software engineering practices rather than the technicalities of the TCG or NGSCB design.





After many years of network cable hodgepodge, Max and Jeff take advantage of a switch upgrade to organize the network closets. Images are before, during and after the job.

changelog

Turkish), was born March 18. Andy and Ali Forsberg are now the proud parents of Mia, born June 3rd. And tstaffer Mark Dieterich and his wife Karen have a baby son, Nathan, born August 10. All are first babies!

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In a note to avd, ***David Salesin*** *@ Microsoft ('83) tells of a visit by* ***Ed Lazowska*** *('72) and*

Susan Hutchison, who runs the Charles Simonyi Foundation, for a demo of 'photomontage,' a tool for recombining digital photographs. So lovely!

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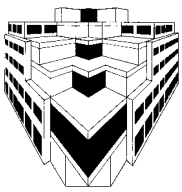


They challenged the TCG and NGSCB advocates to come up with example applications that needed a TCG architecture feature that was unattainable by simpler means.

Another concern was that voiced by Seth, joined by many in the audience: the remote attestation feature of the TCG design. The idea that an outside party can demand to know what program you are running and in what configuration seemed dangerous to them. This was not from the point of view of privacy. Indeed, our main privacy voice, Ari, expressed satisfaction with Ernie's and Jan's (and HP's Liqun Chen's) work in ensuring that the TCG technology did not compromise user privacy. Rather, the concern is that the technology that lets a remote party find out what software you are running (even though ostensibly just to make sure you are running software that this remote party trusts) is dangerous because it may result in anti-competitive practices. Powerful third parties, such as banks, will end up requiring that their customers use certain applications produced by specific vendors, thereby limiting competition.

I moderated the discussion, and so it fell on me to stop the debate to make sure that the yummy treats awaiting us in the Atrium did not go unconsumed. But the discussion continues offline, and I would be curious to receive readers' opinions. I can be reached at *anna@cs.brown.edu*.

TEACHING COMPUTER SYSTEMS WITH A TASTE OF DANGER

The first in what we hope will be a series of articles by the faculty on the current curriculum.

Roberto Tamassia

Vesselin Arnaudov

Virus attacks and other Internet threats have rapidly increased over the years and are causing major disruption to computer users worldwide, with 2003 damage estimated at $55 billion, according to reports by *Computer Economics* (CEI) and *Trend Micro, Inc.* But while 2003 was named the *Year of the Worm*, the number of computer security threats in 2004 will be much higher. According to statistics compiled by *MessageLabs*, in February 2004 alone there were 50 billion intercepted email messages containing virus code, the total number of interceptions of 2003. Also, the latest *Symantec Internet Security Threat Report* states that in the second half of 2003, five attacks originated from U.S. computers for every 100 computer users and that export of confidential data from compromised machines to the attacker (especially passwords obtained by monitoring keyboard activity) is dramatically increasing as the payload of choice for malicious code.

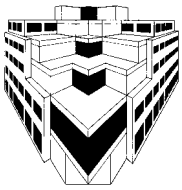
The above gloomy statistics reflect the multitude of exploitable vulnerabilities in widely deployed software applications and operating systems, the general lack of adequate knowledge about security by both end users and software developers, and the power of new attack tools produced by the recent alliance between spammers and virus writers.

The silver lining behind the sad state of cybersecurity today is that the business of defending computers and networks against threats is flourishing. Various surveys on workers' compensation have shown that computer security skills remained in high demand even during the technology downturn of 2001-2002 and continue to command large salaries today. In addition, investors in computer security c ompanies have been handsomely rewarded in the past five years. For

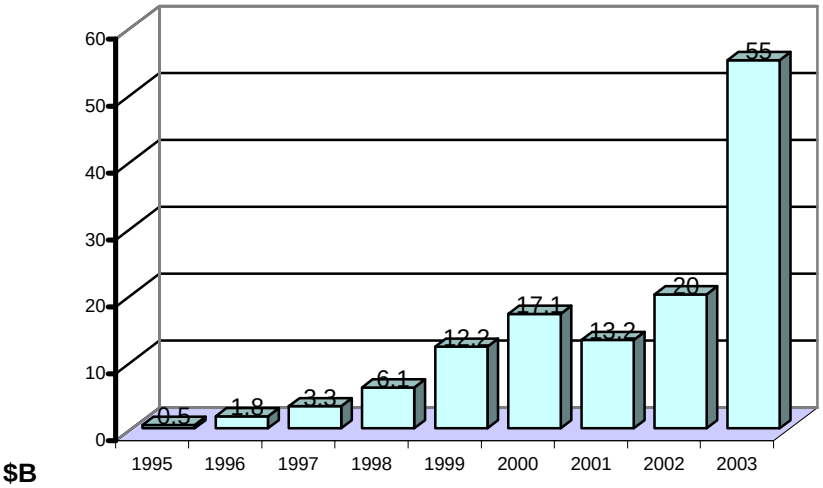
changelog

Danah Boyd *('01), currently a grad student at Berkeley, is making quite a name for herself. She was recently profiled in the NYT for her work with Friendster.com, whose millions of members have*

transformed it from a dating site into a free-for-all of connectedness where new social rules are born of necessity. Danah studies Friendster with a Web log called 'Connected Selves' (www.zephoria.org/snt)*. Her observations have made her a social-network guru for the programmers and venture capitalists who swarm around Friendster and its competitors. Said*



Estimated Virus Damage



example, *Symantec Corporation*, a company focused on security software and services, has seen its revenues grow from $650 million in FY1999 to $1.9 billion in FY2004 and its market capitalization climb from about $1.6 billion at the beginning of 1999 to over $13 billion today; it now ranks among the top ten software companies worldwide.

A New Course

Motivated by the growing importance of cybersecurity in today's computer systems, Roberto Tamassia and undergraduate research assistant Vesselin Arnaudov are developing a new undergraduate course, tentatively dubbed *Introduction to Computer Systems Security*, to be taught in the 2005-2006 academic year. The new course will teach general principles of computer security from an applied viewpoint, providing hands-on experience in dealing with current security threats and available countermeasures. Students will learn about common cyberattacks, including Trojans, viruses, worms, password crackers, keystroke-loggers, denial of service, spoofing, and phishing. They will learn how to identify and patch vulnerabilities in machines and networks as well as detect and repair infected systems. They will study fundamental building blocks of secure systems such as encryption, fingerprints, digital signatures and basic cryptographic protocols. Finally, they will also be exposed to the human and social aspects of computer security, including usability, interfaces, copyright and digital rights management, social engineering, and ethical issues.

The course will be organized around a collection of projects and will use the facilities of the *Internet Computing Lab* (described in the previous issue of ***conduit!***). The course will complement our current CS151, *Introduction to Cryptography and Computer Security*, which focuses on the mathematical and computational foundations of security. In developing the new course, we are leveraging ongoing research collaborations with academic colleagues at Brown and other institutions and with our industrial partners. We hope that our new course will serve as a blueprint for new computer-security courses in other schools and will help give the new generation of computer professionals an increasing awareness and knowledge of computer security.

Goals and Prerequisites

Teaching a course on computer security has often proven to be both controversial and challenging. A first issue is the prerequisites for such a course. Traditionally, computer security courses taught today assume extensive computer science background and require as prerequisites a variety of junior/senior computer science courses such as algorithms, operating systems, computer networks, and software engineering. The typical assumption is that students need an advanced knowledge of how computers and networks function and significant programming ability in order to start learning about computer security. This approach gives instructors flexibility in selecting advanced topics and projects. However, it has led to small enrollments in computer

changelog

high-tech venture capitalist Joichi Ito, "She's definitely a Pied Piper for a bunch of different people. At the same time she, as an academic, is able to articulate what is going on in a way that the people building the tools rarely understand or can articulate." The CEO of tribe.net sought her advice because she is involved in some of the groups to which his site tries to appeal: "Danah's this researcher, but she also lives the whole thing—the Burning Man scene, the rave scene, the techno music scene." Her academic supervisors at Berkeley are envious of her advantage. Said Peter Lyman, "I look at cyberspace the way a deep-sea diver looks at the sea: through a glass plate. She is out there swimming in it."

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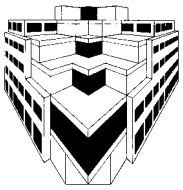


security courses and to a consequent shortage of computer-security experts, since most computer science concentrators graduate today without ever learning about computer security.

We will make our security course widely accessible by setting as its sole prerequisites one of the introductory sequences (CS 15/16 or 17/18). We will cover computer security while at the same time providing background on the foundations of computing. Thus, the course will serve the dual purpose of teaching computer security topics such as access control, firewalls, and viruses and introducing a variety of fundamental computer-science concepts especially in operating systems, networking, and programming languages. We believe it is possible to convey fundamental computer security concepts and give students a working knowledge of security threats and countermeasures by providing just-enough and just-in-time background CS material for their understanding. The course will leverage and exercise the student's knowledge of programming and algorithms in the setting of information security. Indeed, both a solid programming discipline and efficient algorithms are essential for developing effective security solutions.

Another reason to make our security course widely accessible is to encourage our students to think about security issues and deploy security mechanisms early in designing a software application. This skill will certainly be appreciated by their future employers, who include leading corporations in the financial, health-care and technology sectors for whom the security of software applications is often a critical requirement. Besides training information technology professionals in security, our course aims to create security-savvy computer users who will have a clear understanding of the security ramifications of using computers and the Internet in their daily life (e.g., for online banking and shopping). Last but hardly least, motivated by the recent debate on electronic voting, we want to make our students aware of the potential threats to individual privacy, and possibly to our whole political process, that may arise from inappropriate computer security technology.

Special Challenges

Two special challenges in teaching computer security are the need to provide an isolated yet realistic computing environment for safely experimenting with security threats and defenses, and the ethical and legal issues associated with teaching potentially hazardous knowledge to students. To address the first challenge, we will leverage the powerful computing and network resources in our Internet Lab. We will give each student a virtual computer network consisting of multiple virtual machines with selected unpatched OS images that will be separated from the rest of the departmental network and will be completely under the student's control. Thus students will be able to design and inject threats into the network as well as deploy into the network tools for prevention, intrusion detection and repair. Students can experiment freely with and witness the devastating effects of a cyberattack without having to worry about corrective action by our technical staff. Also, should the student be unable to contain the attack or should the student-crafted repair tool actually do even more damage than the threat itself, a convenient "restart" feature will bring the virtual network back to working order.

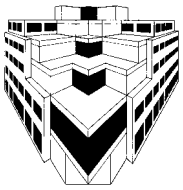
Through a specially crafted course missive and mandatory student agreement and with extensive TA training, we will also discourage illegal use of the knowledge and experience gained in the course.

Assignments

An integral component of courses in our department is their projects. Besides making students spend many hours in a flux of alternating joy and frustration, projects give a course its identity: they provide a concrete grasp of the subject matter and linger in the students' memories for a long time after the course ends. We discuss below three sample projects currently being developed for our new course.

The project code-named ***Sentinel*** will test students' knowledge about autonomously propagating system infections such as viruses and worms. Faced with a hidden yet mighty foe, an "educational worm" developed specifically for this course, students will perform forensic analysis on a snapshot of a live compromised machine, determine the worm's propagation, execution, and payload, and come up with an automated tool for its

removal. Our educational Java-based worm ***Little Kraken*** (named after the mythical Scandinavian sea monster) is fully configurable to spread autonomously in a controlled manner and deploy its payload by launching various types of attacks on



several operating systems. The students will be able to study its means of infection and reproduction and be frustrated by and convinced of the harmful effects and dangers such infections pose. The project itself introduces students to operating systems, file systems, access control, fingerprints, execution environments and (indirectly) the dangers of buffer overflows.

Another project, code-named ***SpiderNet***, will challenge students to defend against a network-based denial-of-service attack. Traditionally, such threats are difficult to counter and require extensive knowledge of the network stack, protocols and particular OS implementations. To make such a project possible here, we have abstracted the low-level handling of TCP/IP packets by the operating system into a Java-based firewall framework. Thus students can focus on the efficient design and implementation of packet-filtering rules without having to understand the details of how packets are retrieved from the wire and handled within the operating system kernel. Using the design of a simple firewall as a motivating challenge, *SpiderNet* will introduce the important subject of network architectures and protocols.

Our third project, ***Agent Bond***, on the other hand, will introduce students to digital signatures and service negotiation in the process of building an electronic wallet. It will touch on the theory of pseudo-random-number generators and public and private key infrastructure, as well as the use of application sandboxing. We plan to use JavaCard-compliant smart card devices to provide the hardware platform for this task.

In addition to projects, the course will have in-class demonstrations of commercial software applications, focusing on their vulnerabilities and ways of overcoming them. In addition, we are considering a possible field trip (!) on which we would perform a so-called "war-drive" to scan and map unprotected available wireless networks in a city's neighborhood.

ALUMNI/AE email

JANET INCERPI BERTOT PhD '86

Hi Trina, I've just received in my mail (of the snail kind) a brochure for the upcoming celebration for 25 yrs of CS at Brown. I'm not sure you will remember me, but hell I'll give it a try (you certainly haven't changed in all the ***conduit!*** photos I've seen over the years). I started in the Ph.D program in '79, the dept's first year and even got out (alive!) defending my thesis (working w/Bob Sedgewick) in August '85. Then I slipped out of the country for a one-year visiting professor position at INRIA in France, where I should have spent six months in the Antibes area and six months in the Versailles area at two of the INRIA research centers. Well, that was 19 years ago and I still haven't made it up to do my six months in the Versailles area! I remember Andy telling me, if I took this job, "they'd never be able to keep me down on the farm" and he was right; so I stayed!

L'INRIA (Institut National de Recherche en Informatique et Automatique) is the French national institute for computer science and control theory. I've been working as a research engineer (in software development, mostly in the domain of software and proof development environments) for various research teams ever since. I head a small group of research engineers that work with the researchers doing software development and experimentation on various hardware platforms (robots, virtual reality, clusters) at the Sophia center.

I recently saw John Hughes who stopped in Sophia for a final review of a European-funded graphics project. He said that you or Tom had mentioned I was in this corner of the world, which is true. My adopted neck of the woods, as it were.

My email address is deceptive as I'm certainly listed as Ms. Incerpi chez Brown! But my ***conduit!*** copy always finds me... and as my email implies, there is a Mr. Bertot and even two little—well, they're no longer that little, they're taller than me—Bertot boys. I won't be in the US in May, but seeing the Alumni/ae Life Histories section of the program with Barbara, Norm, and Dilip, I thought I'd drop a line to say "hey there". Pass on my hello to Tom, Andy, and the others.

cheers (et bonne fête à tous pour le 27 mai!)

janet (*Janet.Bertot@sophia.inria.fr*)

RANDY CALISTRI-YEH PhD '90

Randy's email is included in Eugene's "Charniak Unplugged" column at the end of this newsletter...

RUSS ELLSWORTH AB '79, ScM '85

Hello! Russ Ellsworth here—still working at Raytheon in Portsmouth RI. I recently received "best paper" honors at the 2004 Raytheon Joint Systems Engineering/Software Engineering Symposium held in Los Angeles last March. The paper, entitled "Resolving Intermittent Failures: A Disciplined Approach," was co-authored with Rob Raposo, a Raytheon systems engineer.

On the home front, my daughter Katrina is still named after Trina Avery and she attends the American Musical and Dramatic Academy on Broadway in NYC, which is as far from computer science as she could get without actually leaving the east coast; son Craig will be a second-generation CS major, starting at Maris College in the fall. Wife Darleen is still a saint for having to put up with all of us...

STUART KARON, ScB ’85, ScM ’86

The following email exchange ensued after Stuart Karon contacted Suzi Howe to get in touch with pilot Mark Stern, ’91.

Hello. I’m a Brown alum, computer-engineering ScB in ’85 and a CS master’s in ’86. In the latest issue of ***conduit!***, you had an article about Mark Stern. I was wondering if you could forward his email address to me or this message to him.

I got my private-pilot’s license a couple years ago while living on the Navajo reservation in Arizona. I had a ’72 Cessna 172 that stayed in AZ when my wife and I moved back east to New Hampshire. We live a couple towns away from Mark. Due to having a child and the typical time one sinks into work, I’ve yet to get behind the yoke of a small plane since moving back east. I’d be interested in chatting with Mark about his flying experience in this part of the country. I’d also like to offer my services if he ever wanted company (and someone to share expenses) while tooling around above the New England hills.

Hoping Mark would respond, Suzi asked Stuart if he’d write an alum letter about their conversation—her questions are in italics.

If it ever happens, I’d be happy to write something for you. When I’m done developing and supporting software and running the little business that goes with it, I hope to do some creative writing. It’s something I’ve always enjoyed. Writing software requires creativity but it’s strictly logical. In prose, you can explore much more than logic and functionality.

...Are you flying again?

I never enjoyed flying as an activity in itself. Learning to take off, land and otherwise control an airplane was a challenge which I did enjoy. I mastered it enough to get a license and fly with a sufficient level of safety. I never logged enough time to become completely comfortable flying into places I’d never visited before, though, and that took some of the fun out of it.

In northern Arizona, the small plane was a great way to cover long distances. We were in the Four Corners region and the closest commercial airport was 3.5 hours away by car. We once flew to Albuquerque to catch a flight back east. We flew to Las Vegas to meet my in-laws who were there for a few days. That would have been 6.5 hours by car.

Flying is an expensive and time-consuming hobby and unless you’re crossing a number of states, it doesn’t even save much time. Between getting to the airport, planning your flight, the pre-flight check of the plane and more, you can often be halfway to your destination by car before you even get off the ground.

Steve Reiss’s recently completed Internet Lab on the newly renovated third floor. The floor-to-ceiling white boards, both in the lab and outside in the new lounge area, are well used. The lab is for experimenting with Internet-scale applications and is used both for teaching and research

VIP visitors from Industrial Partner ***Sun Microsystems*** *display a 25th Anniversary T-shirt outside the CIT building. L to r: Emil Sarpa, Jud Cooley and Joerg Schwarz. The folks from California experienced the start of a New England snowstorm. Despite their smiles, and no thanks to digital delay, they were frozen by the end of the shoot!*

I hope to get back to flying one day but that might not be for a few years when my son, Holden, is a little older. My wife and I bought an old farmhouse in New Hampshire and it came with 30 acres of land. Beyond our trees and fields are thousands of acres of undeveloped woodlands. There's plenty to do on the ground.

The previous owners left us with lots of gardens and flower beds. They take time to maintain and we're not quite keeping up with it all. The house even came with a sugar shack for making maple syrup. I made syrup the first year we were here but I probably spent the equivalent of four or five days to produce one gallon of syrup. I'll get back into tapping trees and boiling sap when Holden is old enough to participate. He'll turn two next month and isn't quite ready to toss wood into the evaporator.

...living on the Navajo Rez in AZ sounds fascinating—more grist for the conduit! mill?

When viewed through the filter of some creative writing, I'm sure it could make for interesting reading. I'm not sure anyone in the department or more than one or two graduates would remember me. My biggest claim to fame might be that I ended up marrying Dina Goldin, one of your more long-term grad-student fixtures. That didn't last too long, though, and it's ancient history by now.

As an undergraduate, I defied advice from Andy and others and wrote a space-flying video game as my final project for Andy's class (don't even remember the number by now). He didn't look very kindly on video games back then. Perhaps the multi-billion-dollar gaming industry has softened his view a bit by now. It was a fun project and I saw people playing the game on the Sun workstations over the next year or two until they finally wiped it off the system.

Stuart Karon. *http://www.spiralsoftware.com*

JAMES PIECHOTA '02

Hey, Andy, James Piechota, here. I realize I've been remiss in my promise to "keep in touch" after leaving Brown. Here's a whirlwind attempt to make up for a year and a half of silence:

Graduated.

Cut my hair. Got a girlfriend (cause and effect?).

Moved to Toronto to work on Maya at Alias. Learned the cool people call the city "T-dot".

Learned to drink beer (ranked #2 to hockey as a national pastime).

Took hip-hop dance lessons. Tried to keep the spirit of CS15 alive by putting on a "choreographed" dance show with some other guys at our company Hallowe'en party. Made a fool of myself, and got a lot of laughs. A success.

Worked hard. Saw interns come and go. Thought a lot about the good ole days of CS15.

Took some breakdancing lessons. Decided a dance show would be pathetic and awkward. Wisely opted against a repeat performance.

Saw Bill Buxton leave the company and hoped he still made it down for CS123 every now and then.

Worked hard. Saw interns come and go. Thought a lot about the good ole days of CS15.

Decided the spirit of CS15 needed some reviving, and put on an almost-full-Monty show (socks, smiley-face boxers, and undershirts) at our second company Hallowe'en Party. Made a bigger fool of myself, got a lot of laughs and way too many photographs. A success. Worked hard. Saw interns come and go. Thought a lot about the good ole days of CS15.

Decided to branch out from self-humiliation and

tried some sportier activities. Learned that there are only two types of sports up here: indoor and snow. Snowboarding hurts (in a good way), and wall climbing's wicked awesome. It's not sea kayaking, but I think you'd dig it.

So now I'm still working hard, starting to feel a little older than the interns, and wondering how CS15 has been going these past two years (namely: who played Fabio?).

Word on the street is that CS enrollments at Brown, and in fact at universities across Canada and the US, are way down, especially in the intro classes. It seems people are naming the dot.com bubble burst and current outsourcing trends as likely culprits. As far as outsourcing goes: definitely a concern for many of the developers I've spoken to up here. Especially since, by all reports, the talent and skill level of the developer pool in India is at least on par with what can be found in North America.

I'm thinking, and this is pure conjecture, that one of the major reasons we haven't seen even more expansion into India by major software development companies is that the majority of sales are still in North America. As such they're always going to need product specialists and product managers here as an interface to the end users. And, at least for a while, that communication channel from user to product manager to developer is going to be much better accomplished face-to-face than through whatever means current idea-sharing technology can enable.

Then again, staking one's career on the slow evolution of communication technology is not the safest bet. I was reading an article about Bill Gates' recent university tour to talk up computer science, and in it Professor Guttag[1] from MIT said something to the effect of "Computer science is a great preparation for almost anything you want to do". I guess I've been aware of this all along, but something clicked when he reiterated it. Perhaps more and more software development positions will be moving abroad, but that doesn't mean there'll no longer be a need for people savvy in computer science.

It got me thinking about Sarah Papp ('02) and Zilian Cheuk ('02), both super-competent software engineers and both interested in careers outside of software development. And then I thought of our own documentation team here at Alias. For the most part their degrees are in English, but the complexity of modern text layout applications (e.g. FrameMaker) means they are constantly tweaking scripts and managing complex layout schemas. Heck, one member of the team wrote most of our new documentation web server, complete with thousands of lines of javascript. And, as I've recently been reminded, Duncan Brimsmead, a brilliant and creative programmer who has created some of the most artistically innovative features in Maya, got his degree in the French horn from Juilliard.

Maybe that's the future of the industry? Computing will become so pervasive that it will be as tough to be a software engineer without knowledge of another field as it will to be a non-software engineer without knowledge of computer science.

I wish there were some way to convince new students that CS15 and CS16 are not only for software engineers, but that they teach the fundamentals of a science that is increasingly wheedling its way into every profession.
Hope all is well, and, as always, tx, James.

1. John Guttag '71 recently gave the third of our four 25th Anniversary Distinguished Lectures. See next article.

DAVID VORBRICH '95

Immediately after leaving Brown I took a road trip with Shuang Ji (MS '94) and Katuya Tomioka (of Electronic Book Technologies). I then went to work for Citicorp helping deploy internal global applications, predominantly in South America and Asia. Who knew Lotus Notes wouldn't last? At least the travel was exciting. I then went to work at EF Education (think Louise Woodward), a small education, culture, and travel company upon receiving a job tip from Vince Rubino (BA '92, MS '94). I found myself managing a network of Macintosh computers, which some might even view as a step back from my prior Lotus Notes experience. Personally, I love Macs.

For the last seven years I've been working at Accenture (formerly Andersen Consulting) as an Enterprise architect within their financial services practice. I've worked mostly in the northeast with some projects in Silicon Valley (back when dot com companies had money). In addition to Shuang and Vince, I have also kept in loose contact with David Langworthy (PhD '95) and Stanislav Markovic.

My wife Lisa and I started our family a few years ago, and we live in Grafton, MA with our two sons Gregory (3 years) and Nicholas (4 months). Feel free to contact me at *david@vorbrich.com* if you'd like to catch up!

CS CELEBRATES ITS 25TH !

In the Beginning

On July 1, 1979, after nearly 15 years of research, teaching and awarding of degrees in the Divisions of Applied Math and Engineering led by co-founders Andy van Dam, Peter Wegner and me, the Department of Computer Science came into existence. Shortly before its formal creation seven departmental colleagues moved into a newly renovated building at the corner of George and Thayer Streets, later dubbed kassar House. Computer Science has come a long way since 1979. We have hired a stellar faculty, now 24 strong, educated many generations of very talented students, occupied the top two floors of the Thomas J.Watson Center for Information Technology (we're currently expanding into the third floor), and developed an enviable track record as an academic department.

John Savage and President Ruth Simmons enjoy a laugh at the 25th Gala cocktail reception

In 1979 the field of computer science was mostly inward directed: it was still developing concepts, frameworks, tools, analysis and theory so as to understand, use and control computers. While many hard computational problems still require solutions, this department and computer science as a field have become more outward directed today. Many of us are now interested in solving the hard computational problems arising in other fields. We are dealing with applications that didn't exist twenty-five years ago. We have evolved dramatically and will continue to do so.

Anniversary Events

We celebrated the 25th anniversary of the department in three ways. We organized a lecture series in which four distinguished alums spoke, we discussed industry/academic cooperation at a "summit" meeting on Monday, May 24 under the auspices of the department's Industrial Partners Program (it celebrates its 15th anniversary this year), and we held a symposium and banquet on Thursday, May 27 as a reunion for students, faculty, alumni/ae and friends. The lecture series and symposium were organized by a committee I chaired whose members included Michael Black, Eugene Charniak, Tom Doeppner, Philip Klein, and Don Stanford. Michael Black and I organized the summit. Our distinguished lecturers were:

John Crawford '75, Sept. 18, 2003: *20 Years of Growth in Microprocessor Performance: A Look Back and Glimpse Ahead*
David Salesin '83, Nov. 20, 2003: *Next Frontier in Graphics: Unleashing the Computer's Potential for Communication*
John Guttag '71, March 4, 2004: *Sensor-Based Medical Decision Systems*
Robert Schapire '86, April 22, 2004: *Modern Approaches to Machine Learning*

The May 24 IPP summit was entitled "The National Research Landscape: Leveraging the Academic/Industry Partnership." We were honored to have the participation of the Director of Business Development for the Rhode Island Economic Development Corporation, research vice presidents for Hewlett Packard, IBM, Microsoft, Mitsubishi Research Labs and Sun Microsystems, and the president of Atomic Ordered Materials LLC. Michael Black describes the summit in the following article.

A Commencement Forum was held on Saturday May 29 to celebrate our 25th anniversary. The speakers were Joe Pato '81, Distinguished Technologist at Hewlett Packard Research Labs, and Pascal Van Hentenryck and Stan Zdonik of our faculty. Joe described methods of protecting computers from malicious software. The magnitude of the problem is reflected by the fact that thousands of computers can be infected in seconds. Pascal, who specializes in combinatorial optimization, gave a fascinating account of the importance of

John Crawford '75

David Salesin '83

John Guttag '71

Robert Schapire '86

his topic. One of the examples he gave is its use in scheduling football games for the NFL. Stan described the data management problems that arise in the new world of ubiquitous computing. Important and challenging data collection and management problems will arise in this new context.

Anniversary Symposium

On Thursday, May 27, 2004, a day-long symposium was held on campus to celebrate the department's 25th anniversary. It was a wonderful occasion for students, faculty, alumni/ae, and friends to reconnect with one another and with the department. About 300 were in attendance. Eli Upfal, the fifth and current chair of Computer Science, opened the meeting. To introduce our visitors to the department, we invited six of our newest faculty arrivals to give twenty-minute presentations on their research during the morning. The titles of their talks illustrate the extent to which our newest faculty members are outward directed. Tom Dean, the fourth chair during whose term these six faculty members were hired, introduced them.

David Laidlaw—Scientific Discovery Through Visualization
Amy Greenwald—Internet Agent Economics
Ugur Cetintemel—Mobile Pervasive Computing
Shriram Krishnamurthi—Constructing Robust Software
Anna Lysyanskaya—Trustworthy Systems
Michael Black—A Neural Motor Prosthesis for Augmenting the Damaged Brain

The theme of **David Laidlaw**'s talk is illustrated by a Fred Brooks quote that he cited: "Hitching our research to someone else's driving problems, and solving those problems on the owners' terms, leads us to richer computer science research." David's many dramatic videos and images demonstrated the power of good user interface design and well chosen visualization paradigms for scientific understanding. David and his group are working with biologists, physicians and physicists to help understand phenomena through visualization.

Amy Greenwald described her research on the design of internet agents in which she uses a combination of decision theory and game theory, illustrating this work by an example of bidding patterns in eBay auctions that work to the detriment of the person offering an item for sale. She went on to describe her leading role in the annual international trading agent competitions.

Ugur Cetintemel gave examples of large-scale mobile networks in commerce and in the military that will emerge in the near term and described the challenges of managing vast amounts of data that these networks will produce. Interestingly, these data-management problems, while new, have elements in common with traditional database-management problems.

Astaffers man the souvenir T-shirt table. L to r: Trina Avery, Kathy Kirman, Lori Agresti, Fran Palazzo and Genie deGouveia

Shriram Krishnamurthi motivated his topic by describing errors that occur every day when accessing a popular web-based travel reservation system. Shockingly, he reported that such errors have been found in accessing prominent commercial and government web sites as well. He argued for the power of state machines to model and verify programs and described his group's efforts to integrate design and verification tools and programming languages to build robust software.

Anna Lysyanskaya opened her remarks by observing that, although we have pretty good methods of assuring accountability and privacy in the analog world, it is much harder to provide both in the digital world in which our identities are represented by our secret keys. She described a variety of problems that arise with electronic signing of documents and protecting digital identities, including her work on anonymous electronic certification, and discussed progress in building trustworthy systems and the problems that remain.

Michael Black described his work with Brown's Brain Sciences Program to develop neural prostheses in the motor cortex. Translating the output signals from motor neurons into meaningful actions by an arm, for example, requires the skills of pattern-recognition experts. He sees great potential for computer scientists to help develop biologically embedded hybrid neural-computer systems to help those impaired by disease and injury.

Two afternoon sessions were devoted to talks by seven alumni/ae. Each had very interesting stories to tell. Andy van Dam, our first chair, moderated the first of the panels at which **Ed Lazowska** '72, **Barbara Meier** '83, '87 ScM, **Norman Meyrowitz** '81, and **Dilip D'Souza** '84 ScM spoke.

Gloria Satgunam '03

Don Stanford '71, '77

Michael Littman '96

Vibha Kamat, Sahir and Dilip D'Souza '84

Ed Lazowska amused the audience with tales of escapades by Andy and his students and humorous photos of many kinds. He remembered fellow students now deceased and expressed his gratitude for the positive lessons he learned while at Brown, and also proudly showed a photo of the large contingent of Brown graduates who are now on the faculty of his department at the University of Washington.

While **Barb Meier** impressed the audience with the range and quality of the computer graphics design projects in which she participated, including documentaries, movies, and the cover of *SIGGRAPH Proceedings*, they were spellbound by her description of her personal struggles in deciding between raising a family and pursuing her professional career. She left us awestruck by the sensitive and caring way in which she resolved this issue.

Norm Meyrowitz marveled at both the advances that have been seen in technology since he was a student in the late '70s and early '80s and at how little has changed in the range of ideas to which he was exposed then and is using today. At Macromedia, where he is the principal developer, he has brought into existence many products that reflect these ideas. For example, he drew connections between Brown's early BALSA animation package and Macromedia's Flash and between FRESS and Intermedia, two hypertext document linking systems, and Macromedia's Dreamweaver/Contribute. He also drew an analogy between the cookie can used to collect coins left in Andy's couch with the top-secret pouch that he was carrying around and would be part of an announcement during the cocktail party.

Dilip D'Souza has become a writer of considerable note on political, social and human-rights issues. He has authored two books, *Branded by Law: Looking at India's Denotified Tribes* and *The Narmada Dammed: An Inquiry into the Politics of Development*. Under British occupation a number of Indian tribes were declared criminal in the 19th century and "denotified" under the Indian constitution. Although their status has long since been normalized, they continue to be stigmatized by their history. Dilip told about the building of a dam and the first introduction of electricity in Billdong, a town of 300 homes, by young electrical engineers; for him, their work exemplified a quiet patriotism that he finds very appealing.

The second afternoon session was moderated by yours truly, the second chair of the department and the organizer of the symposium. The speakers in this session were **Gloria Satgunam** '03, **Donald Stanford** '71, '77 ScM and **Michael Littman** '96 PhD. One other speaker was unable to attend at the last minute.

Lunch on the green outside Starr Auditorium

Gloria Satgunam, who graduated last year with a concentration in computer science, represented the new graduates. She attended high school in Pawtucket where she was identified as a talented young person by Don Stanford and encouraged to apply to Brown. She is now working for Goldman Sachs. Throughout her time at Brown and while in New York she has been involved in volunteer work with young people, giving back some of the opportunity that was given to her.

Don Stanford majored in international relations at Brown because as an amateur radio operator he thought he already knew enough about the technical world. It took several years of post-graduate work and a year as a law student to convince Don that his calling was in fact in computer science. After intensive on-the-job training he entered our professional Master's degree program, graduating in 1977. In 1979 he joined GTech Holdings Corp. in Rhode Island as CTO (their seventh employee) and remained there until his retirement in 2002. "GTech operates the world's most reliable, secure and high performance transaction systems for the purpose of selling online lottery tickets;" it has a 70% market share and $1.1B in annual sales. On retirement Don became an adjunct faculty member in CS where he teaches CS2, our course with the largest enrollment.

Michael Littman, our last alumni speaker, joined the department in 1992 as a PhD student while an employee at Bellcore, a spin-off of Bell Labs, graduating in 1996 with a thesis called "Algorithms for Sequential Decision Making." Michael then went to Duke where he spent a very successful four years producing a couple of PhD students, earning an NSF Career Award, and starting the Crossword Project, the first automatic puzzle solver. The latter earned him great fame and a best-paper award at the most competitive AI conference. He is now on the faculty of Rutgers and is very active in robotics, evolutionary learning, puzzle solving and reinforcement learning.

After the alumni/ae presentations we were honored to be joined by Provost Robert Zimmer. Bob, who joined Brown in 2002, welcomed the audi-

ence by telling us of the high standing that the department enjoys in the university and sharing with us his expectations for the leadership role of the department.

The afternoon was concluded with a cocktail party in the CIT lobby at which President Ruth Simmons joined us. We all greatly enjoyed the conversation and camaraderie. At the end of the party Eli Upfal presented me with a plaque recognizing my efforts in organizing this event, after which President Simmons reflected on the accomplishments of the department since its inception, mentioning among other things the three founders of the department, Andy van Dam, myself, and Peter Weg-

Chairman Eli Upfal presents John Savage with an award in recognition of his catalyzing all the 25th anniversary celebrations

President Simmons addressing the gathering in the CIT lobby during the cocktail hour

Andy van Dam flanked by President Ruth Simmons and Norm Meyrowitz after the "Andy Chair" was announced

ner. After she concluded her remarks, Norm Meyrowitz made the surprise announcement that he and a few other computer science alums had organized a four-week fund raising campaign that raised more than $4.1 million to fund an "Andy Chair." Andy was very pleased by this recognition of his many years as an in inspirational member of the computer science faculty.

A banquet for 275 followed in Sayles Hall, after which Eugene Charniak regaled us with an amusing slide show that chronicled the history of computer science at Brown since 1965. Some of us looked awfully young and dorky. Because I failed to provide a photo taken in the 1980s, Eugene showed me masquerading in a Santa suit!

A strong department and a great education are the result of many hands. First among these is the faculty. Thus, it is important to recognize the faculty members who are not mentioned above but who play key roles in the success of the department. In order of their arrival at Brown they are Steve Reiss, John Hughes, Roberto Tamassia, Franco Preparata, Maurice Herlihy, Thomas Hofmann and John Jannotti.

Alumni at the banquet in Sayles Hall. Eugene's slide show can be seen in the background of the photo at left

INDUSTRIAL PARTNERS PROGRAM SUMMIT: THE AMERICAN RESEARCH LANDSCAPE

"It's not necessary for companies to invest in basic research to make money from it."
Henry W. Chesbrough

Professor Michael Black, co-director of the Industrial Partners Program and co-host of the IPP Summit

Corporate investment in R&D is declining and companies are increasingly looking to academia to provide research innovations. How will this shift affect the academic-industry relationship, and how should computer science departments like Brown's respond and adapt to these changes? To address these questions, Computer Science's Industrial Partners Program (IPP) hosted a special one-day "summit meeting" on "The National Research Landscape: Leveraging the Academic/Industry Partnership." The summit brought together leaders from industry, academia, and government to explore trends in corporate R&D and to debate emerging models for capitalizing on innovation.

The changes taking place in corporate R&D might best be characterized by the move to what is called "open innovation". As Henry Chesbrough points out, "not all the smart people work for us." This observation has led to the idea that companies don't need to invest in basic research to benefit from it. While this is obviously appealing with today's focus on containing costs and increasing profits, is it wise? Is it good for industry? Are universities willing partners and beneficiaries? The summit speakers explored these and similar questions.

Enabling the move to open innovation is the fact that universities have a responsibility to see that government-funded research is properly commercialized for the benefit of society

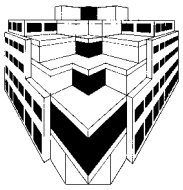
Merck, like other companies, increasingly scours journals, conferences, and patents and then evaluates the developments, picks the best, and pursues them further. Procter and Gamble implements open innovation using technology "scouts" who search the world for good ideas. Dow, like BASF and others, is farming out its problems to the world by putting them on the InnoCentive website; now anyone can try to solve their open problems for a cash prize. With such outsourcing of innovation, companies have downsized their commitment to in-house basic research. Xerox, for example, once had one of the nation's premier research labs but has now spun it off into an independent company. Intel, which long shunned basic research, has instead reinvented it in lablets that blur the boundary between corporate and academic research. These lablets are associated with universities, are run by academics on leave, and are staffed with both graduate students and Intel employees. Microsoft is bucking these recent trends by investing heavily in traditional research labs; this approach may be accessible only to near-monopolies with the deep pockets necessary for a long-term view.

According to NSF, corporate spending on research and development dropped from $198.5B in 2001 to $190.8B in 2002 (4.9 percent in inflation-adjusted dollars), the largest single-year decline since the NSF started keeping track in 1953. Corporations did not, however, compensate for their declining internal research investment by increasing academic research funding: this actually declined by 1.2 percent over the same period. In contrast, federal funding for university-based R&D increased 13.6 percent in 2002, the largest such increase since 1979. These data suggest that the burden of corporate R&D is moving to universities and the cost is being funded by taxpayers. They also suggest the need for coordination between academic an industry leaders to mediate what are bound to be conflicting goals.

Enabling the move to open innovation is the fact that universities have a responsibility to see that government-funded research is properly commercialized for the benefit of society. The Bayh-Dole Act gives universities an entrepreneurial mandate and encourages academic-industry collaboration. Many worry, however, that by focusing on commercialization, academia may lose some of the freedom that makes it an incubator of ideas. It may also change the academic mission. A recent study published in the January 2002 *Journal of the American Medical Association* reports that 21% of geneticists withhold information from other researchers to protect its commercial value. There are also dangers for industry if, by relying on academia for innovation, they lose the ability to drive research to solve their business problems.

To focus the summit discussion, we posed a number of questions to our speakers:

- Is the industrial research lab disappearing?



- Can industrial research be outsourced?
- What are the best ways to advance industrial research over the next decade?
- Is curiosity-driven industrial research dead?
- What role should government play in funding corporate research?
- Have industrial affiliates programs failed industry?
- Can they, and should they, be saved?

Addressing these, and other, questions were the following distinguished speakers:

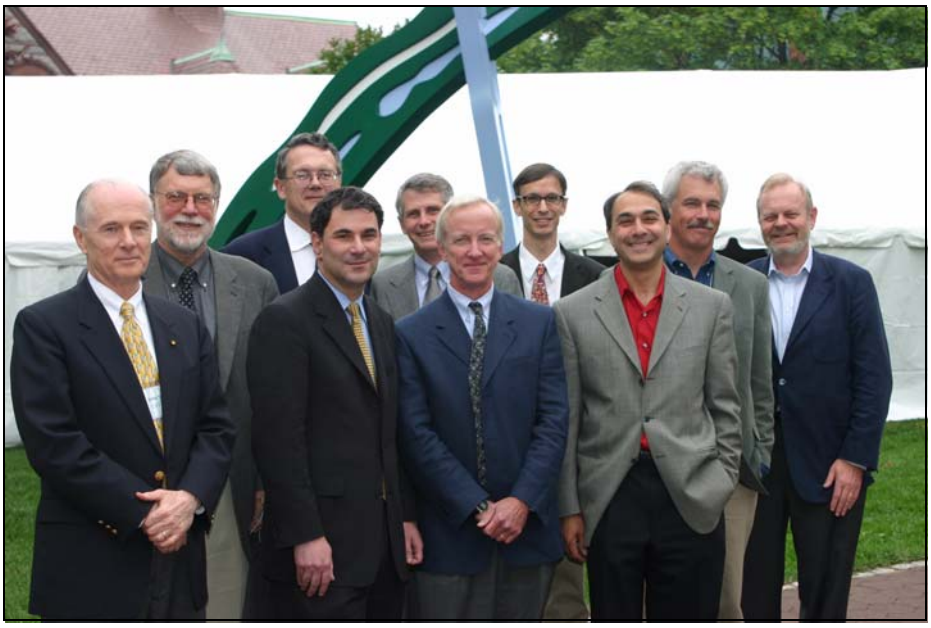
- **John Seely Brown** '62, former head of Xerox PARC, former Chief Scientist of Xerox, and currently Visiting Scholar, Annenberg Center at USC
- **Per-Kris Halvorsen**, VP & Director, Solutions and Services, Research Center, HP Labs
- **Alfred Spector**, VP Services and Software, IBM Research
- **Robert Sproull**, Fellow and VP, Sun Microsystems
- **Jack Breese**, Director, Microsoft Research
- **Richard Waters** '72, President and CEO, MERL
- **Saul Kaplan**, Director, Business Development, Rhode Island Economic Development Corporation
- **John Preston**, Senior Lecturer, MIT

According to **John Seely Brown**, the key lesson of industrial research labs is that research must be deeply rooted in real problems for it to have an impact. Innovation, Brown tells us, is easy; turning it into a successful business is the hard part. The old model of innovation "thrown over the wall" to developers is clearly flawed. In his words, "knowledge flows on the rails of practice;" and communities of practice are needed to develop shared beliefs and trust between innovators and developers. In fact, Brown points out the false dichotomy between innovators and developers—the process of developing a product and the associated manufacturing processes is full of innovation, possibly more than was involved in the initial idea. The university is not something special in terms of innovation; instead, we are all producers and consumers of knowledge and innovation. From his experience as head of Xerox PARC, Brown likens the successful research laboratory to an "ivory basement". In contrast to the iconic and much maligned ivory tower, the ivory basement is rooted in practice, bold but grounded, and fundamentally cross disciplinary.

During breaks between sessions

Kris Halvorsen of HP shed more light on the academic funding picture. The increases we have seen in federal funding during the last 30 years are almost entirely in the life sciences, with only slight increases for math and computer science. He also pointed out that, while the US funding picture is bleak, other countries have been dramatically increasing investment in R&D. He sees this as part of a move from a multinational business model, in which you invent once then sell worldwide, to a meta-national model where business invents where the skills and needs converge. Asian countries are producing more and more PhDs, and more of them are staying in their home country or returning after a PhD abroad; Chinese universities granted 465,000 science and engineering degrees in 2001, approaching the U.S. total. While Halvorsen sees industries embracing the open-innovation view of the research university as a source of graduates and applied research, he sees a crisis emerging around how universities protect and manage intellectual property (IP). His view, which was echoed by most of the industry speakers, is that universities are too aggressive about getting value out of their IP and thus discourage companies from picking up on academic inventions. He points out that few universities have realized substantial returns on their IP. Since there have been so few successes, the argument goes, it makes sense for academia to forgo IP as a means of generating revenue.

For Microsoft the story is somewhat different and more traditional. **Jack Breese** describes a good-old-fashioned research laboratory in which research and development are tightly coupled. While maintaining a strong internal research effort, Microsoft also reaches out to universities, often in creative ways. The big problem for Microsoft is finding well trained computer scientists to satisfy the needs of a multinational R&D effort. Breese described the difficulty of hiring 100 software engineers at their Asia Advanced Technology Center, Beijing, despite receiving 120,000 applications from all around China. In looking at the industry/university partnership, Microsoft's



IPP Summit speakers and hosts: l to r: John Savage, keynote speaker John Seeley Brown, Richard Waters, Saul Kaplan, John Preston, Robert Sproull, Michael Black, Alfred Spector, Jack Breese, Per-Kristian Halvorsen

focus today is on training and recruiting future employees, and a significant focus of its academic funding involves innovations around education. Like other companies, when Microsoft looks to universities for IP, it prefers a "non-exclusive, non-transferable, worldwide, royalty-free license" with an option for an exclusive license. In many cases there is a safer model for companies like Microsoft: to wait for entrepreneurs to take the risk of developing new products and then buy the company once the kinks are worked out.

Speaker Jack Breese and Deputy Provost Tom Dean share a laugh over dessert

As with Microsoft, MERL's **Richard Waters** sees in-house basic research as essential for a large company such as Mitsubishi. Research at labs such as MERL can be focused on Mitsubishi's specific needs and can follow through on ideas. Waters pointed out that basic research in computer science is often much more applied or easily applicable than basic research in the physical sciences. Despite this, research with a long time horizon is difficult to sustain and a successful lab must maintain a balance of work with some being directly applicable today. To make innovations successful requires a tight coupling between researchers and developers (Brown's ivory basement), and this makes IP developed at universities less valuable than in-house IP. Like Microsoft, MERL sees the power of universities in the students we train, in faculty consulting relationships, and in the collaborations between MERL researchers and their academic peers. Most forms of direct funding to universities prove too expensive for MERL with too little payoff—Waters has yet to see a university/industry consortium worth its cost. If, like MERL, a research lab has top researchers in a field, then membership in an industrial affiliates program is really unnecessary to gain access to university researchers and students. Like Breese, Waters sees the aggressive stance that university licensing departments are taking with respect to IP as counterproductive. He feels that universities overvalue their IP and ask too much for it; as a result, they limit collaboration.

Robert Sproull recognizes that good ideas may come from outside Sun's research labs but the labs function as the eyes and ears of the company. The approximately 100 people in Sun Labs provide an impedance match between academia and Sun by being both comfortable with basic research and deeply immersed in Sun's business. Consequently the focus of academic partnerships is on people—interns, visiting scientists, and collaborative projects.

At IBM, research labs provide a talent pool that can funnel information into IBM. But even at IBM, with its long-standing culture of valuing research, the demands and expectations are high. **Alfred Spector** pointed out that a company the size of IBM is looking to create new $10 billion business. This is a tall order that may be more easily satisfied without research; for example, IBM sold its disk-drive business and used the proceeds to buy PricewaterhouseCoopers. Along similar lines, Spector sees IBM's highly respected research as something that could be sold as a service—IBM scientists could provide consulting

services either in house or externally for a fee.

Eugene Charniak (l) holds forth with program speakers and John Schuster (r) from CS Industrial Partner Network Appliance. The sculpture in the background is a Lichtenstein called "Brushstrokes." It is on loan to the University for two years

Saul Kaplan of the Rhode Island Economic Development Corporation (RIEDC) discussed the role of government in fostering innovation. As RIEDC's Director of Business Development, he provided a view of how a small state such as Rhode Island has unique qualities that let businesses "think big, start small, and scale fast." He argued that RI's compact geography, diverse population, and accessible government allow companies to try out ideas here before investing nationally. As an example he des-cribed the development of hydrogen-powered cars and the difficult task of building the necessary infrastructure for delivering hydrogen to consumers. Here RI's small size is an asset: with only 350 gas stations, the environment is appropriate to developing and evaluating the necessary technology and infrastructure. Kaplan also argued that government should be seen as an active partner in the industrial/academic relationship. In particular, the small size of RI's government makes it accessible, flexible and creative.

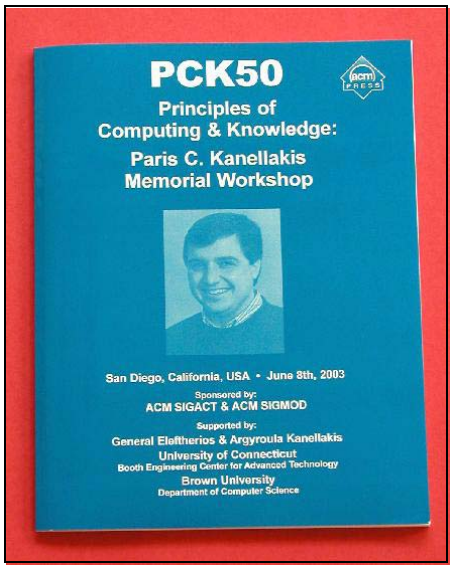
John Preston focused on how universities can spin off companies, a subject he knows well, having crafted MIT's patent and licensing policy. MIT has spun off over 4000 companies worldwide, including 1065 in Massachusetts. In 1997 these companies had over $237 billion in revenues, making them equivalent to the 27th largest economy in the world. He pointed out that 70% of new jobs in the US come from 4% of the companies and that universities have a role in spawning these "gazelles". In contrasting European universities with their U.S. counterparts, Preston argued strongly that U.S. universities are well positioned to spin off technology, engage new businesses, generate capital, and create entrepreneurs. Like many of the speakers, Preston worries that universities interested in short-term revenues are stifling new businesses and discouraging investment in IP. He argued that universities should prefer equity in new companies over licensing revenues, so as to own a small part of a potentially large pie. In listening to Preston, one could argue that universities should focus less on partnering with companies and more on partnering with venture capitalists. Bold innovations are the lifeblood of entrepreneurs while they may fall on deaf ears at a large corporation. This also suggests a possible role for universities in helping larger corporations connect with venture capitalists in the context of new technologies.

At the end of the day, the emerging consensus among the business leaders was that the primary benefit universities provide industry is in training new employees. The value of access to university-generated IP was less clear. As Halvorsen pointed out, large technology companies increasingly focus on shifting from products to services, and services do not lend themselves to improvements from R&D the way products do. He also noted that there are no examples of great research environments in small or mid-sized companies and that this may provide an opportunity for universities.

Both industry and academic (Preston) speakers agreed that university licensing policies were too aggressive and needed to be changed to spur technology transfer. It seems that industry would prefer not to pay for innovation; their ideal model appears to be one in which the government funds academic research that is then given freely to industry. The idea has undeniable appeal to industry but remains fundamentally flawed as a model for sustainable innovation. While industry may be relying more and more on academia for innovation, our IPP summit meeting revealed that the model under which this work is funded, innovation is rewarded, and business people and academics collaborate remains poorly understood. One of the goals of IPP over the next few years will be to work with our partner companies to formulate a viable model that works for both parties. The summit was a first, and very illuminating, step in that direction.

PCK50—A TRIBUTE TO PARIS KANELLAKIS' 50th BIRTHDAY

Professor Paris Kanellakis (1953-1995) was a member of the CS department from 1981 until his tragic and untimely death in an airplane crash in 1995, along with his wife Maria-Teresa and two children, Alexandra and Stephanos.



2003 was the year of Paris's 50th birthday. To commemorate his legacy to computer science, a memorial workshop was held in San Diego on June 8. The workshop, formally called 'Principles of Computing & Knowledge: Paris C. Kanellakis Memorial Workshop on the occasion of his 50th Birthday,' and abbreviated to 'PCK50', was a retrospective of his work and a celebration of his impact on computer science through his research and its influence on research directions taken by the computer science community.

The workshop consisted of talks by invited speakers and by several of Paris's past students. The invited speakers included Paris's advisor, Dr. Christos Papadimitriou, and his close colleague, Dr. Moshe Vardi. The highlight of the workshop was a talk by the winner of the ACM 2001 Paris Kanellakis Theory and Practice Award, Dr. Gene Myers of the University of California at Berkeley. The day was capped by a banquet at which colleagues, former students, and friends offered their personal recollections of Paris.

PCK50 was organized by three of Paris's PhD students, Alexander Shvartsman, Dina Goldin and Scott Smolka, and two of his close colleagues, Jeff Vitter (Purdue) and Stan Zdonik (Brown). The workshop was affiliated with the ACM Federated Computing Research Conference (FCRC).

It was sponsored by the ACM Special Interest Groups (SIG) on Management of Data (SIGMOD) and Algorithms and Computation Theory (SIGACT). The workshop was generously supported by Paris's parents, Eleftherios and Roula Kanellakis, the University of Connecticut, and the Computer Science Department at Brown.

The proceedings of the workshop were published by ACM and included an In Memoriam article written by Drs. Serge Abiteboul, Gabriel Kuper, Harry Mairson, Alex Shvartsman, and Moshe Vardi; the abstracts of the invited talks; and the papers presented at the workshop.

Said Todd Millstein '96, "It was a fabulous celebration of the life and legacy of Paris Kanellakis." The workshop began with an invited talk by Christos Papadimitriou on "the new problems," the application of several areas of theoretical computer science to the study of the Internet. Papadimitriou conjectured that Paris would have loved these problems, which combine several of his interests and areas of expertise, and that he would doubtless have been a leader in this field.

The remainder of the workshop consisted of talks by former colleagues and Paris's students, discussing research inspired by their work with him. Paris's incredible range was evident, with topics including logic databases, constraint databases, parallel and distributed algorithms, and computational complexity. As in Papadimitriou's talk, it was amazing how often speakers intimated that were he here, "Paris would no doubt be working on these kinds of problems"—a testament to his broad reach and impact across computer science."

A composite image of the ACM conference. I to r: Alex Schwartzman, Chryssis Georgiou, Iris Bahar, Peter Wegner, Dina Goldin, Peter Revesz and Gosta Grahne. Credit and thanks for the image to Peter Revesz

MICHAEL BLACK.

Michael was promoted to full professor effective July 1. He also joined the Editorial Board of the *International Journal of Computer Vision* and he and Ben Kimia (Engineering) edited a special issue of the journal focused on computer vision research at Brown.

Haute Provence

Conference travel took Michael to Nice, Cancun, Vancouver, Whistler, and New Orleans. Before the conference in Nice, Michael and his wife managed to squeeze in a weekend in Haute Provence. They stayed at La Bastide de Moustier, a small country inn run by Alain Ducasse, where the food and hiking are superb. At Whistler, Michael gave an invited talk in a workshop on 'Open Challenges in Cognitive Vision.' Also he gave a keynote talk at the International Conference on Machine Learning in Banff in July on 'Learning to See People.'

Michael Black (center) shares the deservedly underappreciated ***Lucia Prize*** *for best talk at the NIPS2003 Workshop on "Open Challenges in Cognitive Vision". Co-winners l to r: Andrew Zisserman, Oxford; Jitendra Malik, Berkeley*

Michael and his collaborators in Neuroscience and Engineering received new funding for their work on neural prostheses from the Office of Naval Research and the National Institutes of Health. They also received funding as part of a large team of European researchers working on neurobotics with the goal of combining ideas from robotics and neuroscience to improve human health.

Renovations are now complete on Brown's video and motion-capture facility. This unique facility is on the first floor of the CIT. It houses equipment for the analysis of human motion used for research on vision, graphics, and learning, and has enabled Michael and his students to develop new algorithms for detecting and tracking people in video streams.

TOM DEAN.

Tom's new book *Talking with Computers* is now on the shelves. In it, he explores a wide range of fundamental topics in CS, from digital logic and machine language to AI and the Web. He continues his duties as Deputy Provost and still manages to teach a freshman seminar.

AMY GREENWALD.

This summer Amy attended two conferences in Banff and followed them up with a week of hiking and camping in Jasper National Park with her husband and one-year-old daughter, Ella. (It was Ella's second time sleeping in the great outdoors.) She gave a tutorial on Game-Theoretic Learning at ICML and presented a paper on Bidding Under Uncertainty at UAI.

Amy headed straight from Canada to NYC, where she and her TAC posse (Victor Naroditskiy, Jonathan Bankard, Bryan Guillemette, Haru Sakai (UTRA), and Lucia Ballard (UTRA)) attended the fifth annual Trading Agent Competition at AAMAS. Botticelli, Brown's TAC SCM entrant, placed first in its semi-final heat. RoxyBot, Brown's new and improved TAC Classic entrant, was a finalist once again.

SHRIRAM KRISHNAMURTHI.

Shriram has now served on the PCs of both FOAL and FOOL. He looks forward to invitations from

FOIL and FOUL, which surely also exist. And if all else fails, he plans to create a workshop on the Foundations of Ornamentally Extravagant Languages. (Getting submissions shouldn't be hard.).

Shriram served on the usual pile of program committees, including PLAN-X, AOSD, ECOOP and PASTE. The AOSD PC meeting took him only as far as Boston, but ECOOP lured him to Switzerland. While the PC meeting and a research visit to Bern were fun, they didn't compare as attractions to the Alps. He was fortunate to have cool, crisp and sunny days for most of his time. He spent several hours just gazing at the Bernese Oberland from the Uetliberg Hill, outside Zürich, and then got to take them in while sweeping down the west of the country, before switching to the French Alps in Lausanne. Lausanne also holds the Collection de l'Art Brut, a refreshing kind of art museum.

DAVID LAIDLAW.

Congratulations to David, who received tenure this year. He was awarded another ITR from NSF last October, and is gearing up to teach his joint Brown/RISD class, Interdisciplinary Scientific Visualization, again this fall. He gave talks at Imaging in 2020 at Jackson Hole, the Winter Conference on Brain Research, Copper Mountain, CO, a Dagstuhl seminar in Germany, and several other venues. Together with Sharon Swartz (Ecology & Evolutionary Biology) and Kenny Breuer (Engineering), David has received a Salomon Award from Brown for his interdisciplinary work on the aerodynamic mechanisms of bat flight. This multidisciplinary collaboration holds promise for identifying principles that might help in creating animal-sized flying machines.

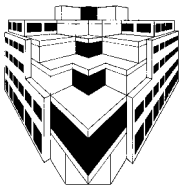
ANNA LYSYANSKAYA.

Anna has started advising Math/CS concentrators. The result is they have told her everything about the department and she now finally feels that she knows the ropes fairly well—perhaps the information is flowing in the wrong direction! This year, she will also be serving as a CAP advisor, which she's really looking forward to. Her other recent activities include serving on the Eurocrypt 2004 program committee, hosting the spring IPP Symposium, teaching CS22 (says Anna, "My TAs rock!"), and coordinating the Theory Colloquium. To ice the cake, she has also been awarded an NSF CAREER grant.

*With support from the CS Department, eleven Brown student members of the **National Society of Black Engineers** (NSBE) attended the NSBE's annual conference earlier this year, including ten engineering majors and one CS major. The mission of the NSBE is to increase the number of culturally responsible black engineers who excel academically, succeed professionally and affect the community positively. As NSBE's key event, the national convention draws thousands of black engineers from schools across the country to network, find internships and jobs and work on resume-writing and interviewing skills.*

This year's conference fair featured over 400 hi-tech corporations, government agencies and non-profit organizations all looking for possible hires. While the engineers had mixed feelings about the job fair, it proved extremely helpful for the CS major. Having a good GPA and studying in the Brown CS department made him a prime candidate. By the time the dust had settled a week later, he had had six interviews and four summer job offers!

Thanks to Chipalo Street, Brown's NSBE CS Consultant and Kelly Jackson, Brown's NSBE President, for this sidebar.



MAURICE HERLIHY.

The 2004 Gödel Prize for outstanding journal articles in theoretical computer science was shared by Maurice for his paper "The Topological Structure of Asynchronous Computability" coauthored with Nir Shavit, and by Michael Saks and Fotios Zaharoglo for their paper,"Wait-Free *k*-Set Agreement Is Impossible: The Topology of Public Knowledge." According to the citation, "These two papers offer one of the most important breakthroughs in the theory of distributed computing. The problem attacked is the complete understanding of asynchronous wait-free deterministic computation in the basic shared-memory model. These papers demonstrate that one can avoid the inherent difficulty of analyzing a dynamic model, transforming it into a static one by associating computational tasks with simplicial complexes and translating the question of existence of a wait-free protocol into (distinct but related) topological questions about the complexes. This reformulation allows the introduction of powerful topological invariants, such as homologies, to show the impossibility of numerous tasks, including set-agreement and renaming. The discovery of the topological nature of distributed computing provides a new perspective on the area and represents one of the most striking examples, possibly in all of applied mathematics, of the use of topological structures to quantify natural computational phenomena."

Next year Maurice and his family will spend a sabbatical in England at Cambridge. His children will attend school locally and aren't too keen on the idea of wearing school uniform!

JOHN SAVAGE.

During the last academic year, as reported above, John chaired the department's 25th anniversary committee, which organized not only the gala on May 27 but also our anniversary distinguished lecture series in which four outstanding alumni spoke. Michael Black and John, co-directors of IPP, organized the May 24 IPP summit that Michael summarizes in this issue. John also chaired the search committee for Vice President for Public Affairs and University Relations, a committee whose members included four members of the Brown Corporation, four faculty members, and six senior administrators. The committee successfully completed its work when the president appointed Michael Chapman, formerly of NYU Medical Center to fill the position.

On July 1 John started a sabbatical leave that he'll spend in part in Paris at L'Ecole Polytechnique. The year will be devoted to research on computational nanotechnologies. He has just received a $1.3 M four-year NSF Nanotechnology Interdisciplinary Research Team grant that funds my work and that of a chemist at Harvard and a computer scientist/electrical engineer at Caltech.

ELI UPFAL.

Together with Adam Kirsch (ScB '03, now a graduate student at Harvard) and Aris Anagnostopoulos (his graduate students), Eli gave a paper at the 44th Annual Symposium on the Foundation of Computer Science (FOCS '03) in Boston. He will be the chair of the program committee for this conference next year, in Rome. Eli visited his ex-graduate student Gopal Pandurangan, now an assistant professor at Purdue, and gave a talk—his first visit to the "real" midwest!

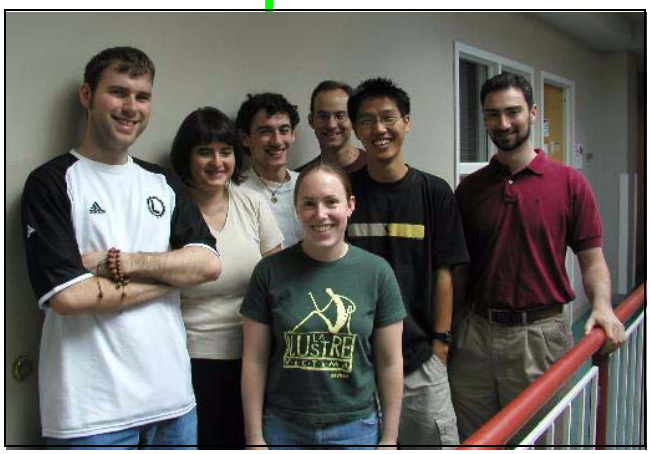
ANDY VAN DAM.

Andy gave a talk at Brown about visualization activities in the CCV (Center for Computation and Visualization), then TCASCV (Technology Center for Advanced Scientific Computing and Visualization), entitled "Visualization: New Dimensions, New Domains, Old Questions". This spring he gave a keynote, "Distributed Computing for Graphics: Then and Now" in Japan at the IEEE ICDCS conference, which he co-founded as a workshop at Brown in 1985 (his co-founder was his then Ph.D. student Jack Stankovic, now guru in the field and department chair at UVA). In between, in addition to his teaching and VP Research responsibilities, he managed to spend a week backpacking in the Grand Canyon and a week scuba diving with his family (including grandchildren) in Bonaire, and managed to get in some good dives.

CS224 STUDENTS WIN @ SIGGRAPH !

CS224 (Spring '04) student papers won first prize, second prize, and one of the two undergrad research awards at the ACM SIGGRAPH '04 Student Research Competition held in LA in early August. Two more CS224 student papers made it to the semifinals (25 semifinalists out of 118 accepted submissions).

Morgan McGuire (G), Andi Fein ('04) and Colin Hartnett ('04) won first prize and a total of $750 for their paper "Real-Time Cartoon Rendering of Smoke". Pawel Wrotek ('05), Alexander Rice ('05), and Morgan McGuire (G) won second prize and a total of $550 for their paper "Real-Time Bump Map Deformations." Gabriel Taubman ('05) and Edwin Chang ('05) won one of the two undergrad research awards and $500 for their paper "A Fast Fracture Method for Exploding Structures."



L to r: Pawel Wrotek, Liz Marai, Gabe Taubman, Andi Fein (front), Tomer Moscovich (back), Edwin Chang, Morgan McGuire,

The following grad students were awarded $250 per paper as semifinalists: Peter Sibley, Philip Montgomery and Liz Marai for their paper "Wang Cubes for Video Synthesis and Geometry Placement"; and Ethan Bromberg-Martin (ugrad '05), Arni Jonsson, Liz Marai and Morgan McGuire for their paper "Hybrid Billboard Clouds for Model Simplification". Congratulations are definitely in order to the grad TAs who taught CS224 under Andy van Dam's direction: Tomer Moscovich, Liz Marai and Morgan McGuire–well done indeed!

Winners of ACM student research competitions held at ACM Special Interest Group conferences throughout the year (SIGGRAPH, SIGPLAN, SIGOPS and SIGCSE) will compete against each other in the ACM Grand Finals in early 2005. The winners of the Grand Finals will be recognized at the prestigious annual ACM Awards banquet.

Immediately before the conference Morgan McGuire also won a $25,000 fellowship from NVIDIA Corporation for his research on hardware accelerated graphics.

Shriram Krishnamurthi and menagerie

COURSE REPORT, CS 190: WE KNOW WHERE YOU ARE!

Here is another in our series of articles by the faculty on the current curriculum.

"How long do you think it'll take a pair of students?", I asked Ugur. "Oh, about a week," he asserted. Perfect, I thought. I had just shy of 20 students. One week for two students meant about ten weeks for 20 students. Just the length I was looking for.

Brown CS has two courses that would loosely be classified as "software engineering" in other computer science departments. One is a sophomore-level course, CS032, that introduces students to medium-scale program design, group programming, and a collection of concepts (depending on instructor) ranging from network programming to low-level memory management. The other course, CS190, is meant to be a senior capstone course where students learn to work in larger groups, build more significant products, gather requirements, and so on. This course report is about the latter course as taught last spring semester. (Brown has one more course, Roger Blumberg's CS092, on building educational software. It's a real software engineering class in its own right, but really is unique to Brown, and therefore not one you might find elsewhere.)

In recent years, CS190 has been taken annually by 20-30 students.

Initially, the students work in small groups to present ideas of projects they'd like to build. The class votes on these projects to identify the most popular ones. The students then split into groups of 8-10 students each, and each

group takes on one project. The projects range from games to Web services to software development tools.

I changed two things in CS190 this year. First, I wanted the students to deal with problems in integrating large components, especially ones that were themselves evolving. The best way to tackle this was to have the groups work on different parts of the same system, thereby (inadvertently) creating trouble for one another. The second was to choose a project for them, to better reflect practice. Of course, I then needed to find a project that would be interesting enough to hold their attention (and get over their disappointment at not being able to push their own favorite concept).

That's where I got lucky. In mid-fall, Abigail Rider contacted the department with a proposal for a course project. Abbi is a director at Brown whose portfolio includes Brown's recently overhauled SafeRIDE service.

SafeRIDE is a motorized escort with two parts. One is a fleet of escort vans that runs on a fixed route every fifteen minutes or so. The shuttles, in contrast, respond to calls from riders who need to travel between specific locations on- and off-campus. There are currently four shuttles, and the SafeRIDE dispatcher must group together calls to plan a route for each shuttle, evolving the route as new calls arrive. Abbi noticed that the dispatchers sometimes lose track of where a vehicle is, necessitating repeated calls to find out its location. She felt it would be a lot easier if the dispatchers could instead track the location of each van using some sort of map-display program. She referred the problem to us.

It was immediately clear that this problem was perfect for our needs.

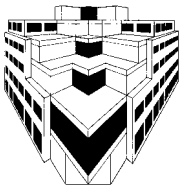
First, it involved real users: students would have to interview actual clients, most of whom would be nontechnical (drivers, dispatchers, riders, supervisors, ...) and then deploy their product to the same audiences.

Second, they would have to deal with an external business, since Brown outsources the day-to-day running of the shuttles. Third, they'd have to contend with a host of technical challenges: processing (roughly) real-time data, handling absent data, working with ugly, real-world data files (such as road databases), programming for future changes (such as new buildings, or new names for existing ones), offering different interfaces for different users (especially technologically naive ones), building simulators, and so on. Fourth, they'd have to make this all affordable. And finally, they would get to play with cool devices.

Cool devices? My TAs, Nathan Weston and John Goodwin, and I (especially Nathan) did a fair bit of research over winter break to determine that we're at an interesting technological cusp. While there are many devices that would help tackle such a problem, we wanted something as flexible and extensible as possible—i.e., something programmable. Cell-phone technology has, fortunately, just gotten to this point. The phones have GPS receivers, in part to comply with new E-911 laws. This is fine for telling the phone where it is, but would be useless if we couldn't notify a base station. The phones also have wireless Internet access—also handy, but we'd still need to get data from the GPS to the Internet. The crucial cog in this machine is that the same phones also have Java Virtual Machines, with the ability both to use the Internet connectivity and, more importantly, an API for accessing the GPS data.

We took a while getting the class to the project. Since they were going to deal with a real customer, we had them conduct mock interviews with the course staff, masquerading as employees of a library in a small town in Texas (an excuse for me to trot out my cowboy hat and bolo tie). You can read the exercise setup from the course's Web page—search for "Brown CS190 spring 2004". (Wondering about the choice of town? Search on "Archer City Texas Larry McMurtry".) Some of the course staff played technological ignoramuses and even Luddites, and it was interesting to watch some students really struggle with this. So this was useful preparation for the main project.

I had a few desires for what should happen during the project. I wanted to see the requirements, or at least their focus, change; I



wanted administrative structures to get in the way; I wanted team personnel to alter along the way; and I wanted to stress the importance of prototyping.

In case these didn't occur naturally, the course staff had plans for injecting them (even if a little artificially) into the process.

Fortunately, we never needed to intervene on any of these accounts. The requirements changed because interviews with the dispatchers revealed that the real-time map wasn't their greatest need. In fact, we found that they had much more mundane concerns—tasks such as producing audit trails were far more bothersome and time-consuming. We also found later on that drivers were sometimes frustrated with getting insufficient or incorrect information over their crackly two-way radios; fortunately the cell phones had usable displays, so the group eventually added address transmission as a feature.

The administrative structures became a concern because of the separation between Brown and the contractor running the shuttles. The contractor naturally wanted to protect his drivers' time, so students were forced to route questions through the manager. They later worked around this by informally interviewing the drivers while riding with them in the shuttles at night.

The most important personnel change I wanted to make was to reduce the size of one of the teams. As luck would have it, the very week I wanted to scale down that team, a student in that team dropped the class. I initially announced this to the class by saying we had fired him. A few of them looked terrified until I explained I'd been joking.

Finally, the need for prototyping came naturally. Because the students had had only limited access to the drivers, they knew that their requirements were quite incomplete. They quickly realized that it was crucial to deploy a prototype both to improve their understanding of the requirements and to use the feedback phase as a covert way of interviewing the drivers some more.

The class divided into three teams. The phone team of five people was responsible for figuring out the intricacies of the devices and actually making them work as advertised. (I confess to thinking this would be the weak link in the chain—not because of the students but because of the novelty of the technology. The students did have to put in an extraordinary effort to overcome buggy systems, poor and missing documentation, and CIS's and Nextel's technical support and bureaucracy, but they made it work!) The server team of seven was responsible for receiving messages from the phone, generating logs, and presenting vehicle status and real-time map information. Finally, a five-member AI team coordinated with the server to generate route information and estimate rider wait times.

Each team was organized into a hierarchy resembling a small company.

The team had an overall administrative head, as well as a head of quality assurance. In addition, specific students in each team were tagged with responsibility for documentation and team-specific tasks.

In addition, the class project was headed by two managers: Peter Woo, the product manager, and Daniel Stowell, the head of integration and product-level quality assurance.

The students did produce a prototype, though a bit later than we'd planned.

Each deployment of the software was greeted with excitement.

I had planned to both visit the dispatching office and ride in the vans, but decided to stay away the first day. This was fortunate.

Due to outdated initial data, the system crashed when it was first deployed.

Peter Woo joked that some students aged hours while fixing it and, had I been there, they'd have aged years. (What they didn't know at the time is that I was monitoring progress through the Web-interface.) But after this was fixed, the system ran splendidly.

Sure, there were some small bugs, and the interface needed several improvements—but that's the point of prototyping, right? In another month, they had these bugs worked out and the result is a very professional product.

I've worked students pretty hard in courses before, but this group surpassed all demands. One night midway through the semester, they had a meeting that grew into a three-hour jam session. They weren't arguing about personalities; they were arguing about the best way to build the product.

That kind of enthusiasm is, of course, a Brown characteristic, but this group of students seemed especially motivated. In end-of-semester surveys, they admitted that having a concrete client expecting a product from them, and knowing that it would be used by real users (especially their fellow students), was an exceptionally strong motivation. At the end of the semester, Peter produced a CD with photographs culled from class sessions, group meetings and parties from across the semester. It was a touching gesture.

I owe thanks to several people who gave freely of their time. Steve Reiss and David Laidlaw offered a lot of advice from having taught

CS190 in the past. Ugur and John Jannotti helped me better understand wireless technologies. Amy Greenwald taught the entire AI team, and their work and enthusiasm was a testament to her training. Abbi Rider got us started on this project and supported its development; the folks at Nextel gave us freebies to keep us well under budget. Thanks also to the department's technical staff, for setting up a server and supporting it; to Bob Perreira and Robin Carillo in Telecommunications at Brown, who helped us get cell phones and resolved administrative issues with Nextel; and to Alan Usas of CIS.

There's a happy sequel to this course. A group of students has spun off a company, East Transit Technologies, Inc., to market this software to other universities and, they hope, later expand into other markets that can utilize such tracking. They tell me they've just set up their first demonstration for a potential client outside Brown, so there's great excitement about their prospects.

East Transit Technologies is named for the street on which they're living in Providence this summer. But perhaps there's a more cosmic connection.

Transit Street in Providence gets its name not from some public transportation connection, but rather from popular enthusiasm for observation at the then-fledgling Rhode Island College of the 1764 Transit of Venus. Perhaps it's fitting that the company formed on the rare repetition of the same astral phenomenon, 240 years later.

CHARNIAK UNPLUGGED

Probably you are tired of rubber chicken stories, but they are like kittens, they seem to lead to yet more rubber chicken stories, and I could not resist this one.

Eugene delivering his "Snapshots of the Department's Past" talk at the 25th anniversary banquet

Eugene,

I loved the recent Conduit stories about the rubber chicken tradition. I had actually been thinking about that recently, wondering exactly how the tradition started—now I know. My own rubber chicken is carefully stored away in the closet, still in fine shape after almost 14 years.

Last summer, my daughter—then 3.5 years old—saw it and asked if she could play with it. I explained to her that it was very special and not a toy. She asked when she could get her own rubber chicken. I said she had to finish preschool, then elementary school, then middle school, then college, then graduate school, then get her PhD and then she could have a rubber chicken.

Nothing more was mentioned for several months. Then in November, our family was sitting around the dinner table discussing jobs and retirement. My daughter asked if she could retire. I said no, she had to have a job before she could retire. She asked when she could get a job. I said first she had to finish preschool, then ... When I got to the part about the PhD, she got all excited and said, "then I can get my rubber chicken!"

Who knows—maybe there's a whole new generation of rubber chickens on its way.

Randy Calistri-Yeh Ic.U. (Ickenchay Ubberray) 1990

(give me a break— I never studied Latin...)

Randy, when your daughter applies to our PhD program, make sure she puts on the application that she is a legacy rubber chicken.

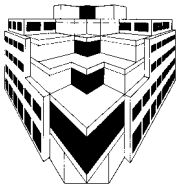
Off and on during my life I have created "art" of various forms. When I first arrived at Brown I produced an abstract "painting" made of various common materials all held together with glue, and it has been in my office ever since. In my current CIT office it is right behind my desk, so anyone talking to me has to be staring at it, but to my amazement large numbers of people never notice it. Those who do have a variety of opinions, mostly negative. The mostly negative group stays mostly silent, of course, with the exception of Andy van Dam, who tells me what he thinks of it about every other time he comes

to my office. I was going to get a quote from Andy for this article, but I decided not to. On the topic of my painting his creativity seems to disappear, and besides, the comment would be unprintable. Andy's evaluation, however, was nothing compared to another visitor to my office. After our new caretaker had been in my office several times, he asked me, in all seriousness, if anyone had called buildings and grounds about the problem with the wall behind my desk. I did not have a smart reply.

Many a ***conduit!*** ago I mentioned that when I was spending four days a week away from my family on a sabbatical at Johns Hopkins, my wife gave me a 1000-piece puzzle of a polar bear on snow. After reading this, Suzi Howe loaned me one of her jigsaws, this one of hundreds of marbles spilled all over. This puzzle sat in my office unsolved for a few years until I decided I was very unlikely to get around to it and I should give it back to Suzi. Instead, however, I put it in the grad student lounge. Lo and behold, it was all put together the very next day. I then returned it to Suzi, along with the story. She noted the similarity to the scene at the start of 'Good Will Hunting' when Will solves the math problem at MIT. (But I don't think the movie rights are going to be worth much.)

I was talking to Trina Avery and she told me that she finally broke down and started putting her pills for the week in a seven-compartment pill box so that she could track having taken them. She (quite rightly I think) saw this as a geriatric thing to be doing, but when she mentioned this to Tom Doeppner he said that this was simply "pre-fetching" and thus perfectly OK. This led her and Tom to a discussion of other CS terms that applied to daily life, but unfortunately I cannot remember what they were. (I went to ask Trina about this, only to discover that we were having simultaneous senior moments.)

At any rate, Trina asked me if I wanted to use this for my ***conduit!*** column. I said "no", but I had a hard time thinking of why not. Eventually I came to an important realization. My



conduit! article was not really about the department, it was about ME, and secondarily about ME and the department. Since Trina's story was not about me, it did not qualify. For example, Suzi told me a very nice story about Shriram for my column. It seems that he decided to teach on the CS balcony one day, but was unable to remove the "portable" whiteboard from Lubrano. Instead, he found that if he lowered the window blinds, the windows onto the balcony made a perfectly usable blackboard—see the pictures above. I was planning on rejecting this story, too, for the same reason. Having had this realization, I went back to Trina and explained why I had said "no". Trina said too bad, it's a nice story, but I responded that now I could use it, because now it was no longer a story about Trina and Tom discussing the use of CS terms, but a story about me having a realization about a story about Trina and Tom... Trina responded, "Ah, recursion!"

When this ***conduit!*** was in proof, Shriram Krishnamurthi pointed out that it's not recursion, it's self-reference. But this is my column, so the word means what I want it to mean; as Humpty Dumpty says, 'the question is who's to be master, that's all.'

conduit!

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*the **conduit!** team salutes the department's 25th anniversary. I to r: Jeff Coady, Suzi Howe, Eugene Charniak, Trina Avery*

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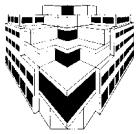

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