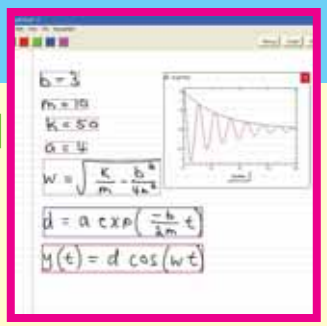
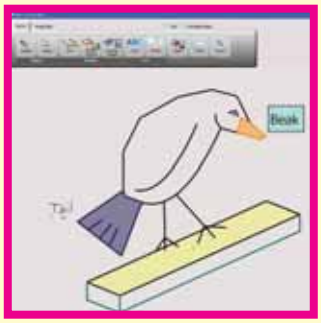
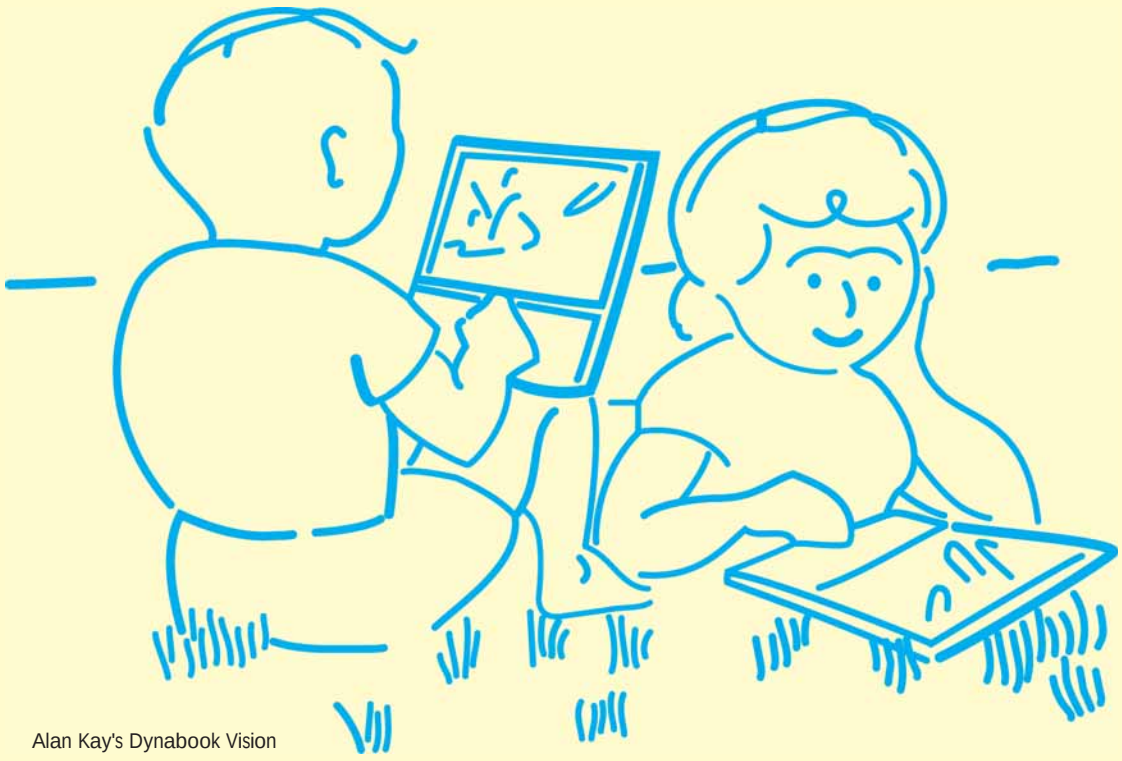
Conduit

A RESEARCH AND ALUMNI NEWS MAGAZINE
DEPARTMENT OF COMPUTER SCIENCE
BROWN UNIVERSITY

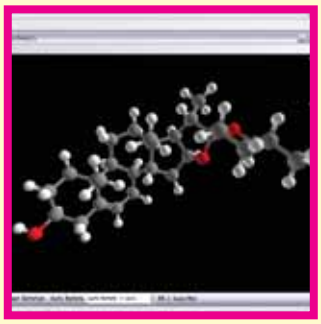


WHEN IS THE PEN MIGHTIER THAN THE KEYBOARD?





Alan Kay's Dynabook Vision



Notes from the Chair: the Latest News from 115 Waterman

Greetings to all CS alums, supporters and friends!

We are well into the second semester of the year and are as busy as ever. Great things continue to happen in the department and I am thrilled to be able to share the highlights with you.

Amy Greenwald and Anna Lysyanskaya will be promoted to Associate Professor with tenure, effective July 1, 2008. Amy's research focuses on game-theoretic artificial intelligence. Her honors include a Sloan Research Fellowship, a Presidential Early Career Award for Scientists and Engineers and an NSF CAREER award. Anna works in the area of cryptography. She is the recipient of a Sloan Research Fellowship and an NSF CAREER Award. She has been included in the 2007 TR35, Technology Review's list of 35 innovators in science and technology under the age of 35. Congratulations to Amy and Anna!

The first few months of the year also brought a number of awards and honors to our faculty and students. Congratulations are in order for the following people: Michael Black, recipient of a grant from the Rhode Island Science and Technology Advisory Council; Anna Lysyanskaya, who has been awarded a Sloan Research Fellowship; Claire Mathieu, recipient of the 2007 INFORMS Computing Society prize; Ben Raphael, selected for a Brown Career Development Award; Andy van Dam, appointed as chair of CRA's new Education Committee; Yanif Ahmad, recipient of an IBM Ph.D. Fellowship; and Colin Gordon '08, selected for Honorable Mention in the Computing Research Association's Outstanding Undergraduate Award competition for 2008. More details about these awards can be found within this publication.

Congratulations are also in order for Lauren Clarke, who is now the faculty and student affairs manager. Lauren is new to the position but not to the department, having worked with Andy van Dam and his research team for the past three years. We are delighted to have her assume this new role. With Lauren moving on, Rachel Reisner has joined the staff as Andy van Dam's executive assistant.

The department currently has eight talented post-doctoral researchers who collaborate with faculty members on new exciting research directions:

- Manuel Cebrián, Grégoire Dooms, Ivan Dotu and Yannis Vergados work with Pascal Van Hentenryck in the optimization laboratory. The lab aims at pushing the frontiers of optimization technology, from its theoretical foundations, to the design of fundamental algorithms, the implementation of pioneering optimization platforms, and innovative applications in various domains.
- Jian Chen and Daniel Keefe are part of David Laidlaw's Visualization Research Lab which focuses on developing ways to visualize a range of problems and phenomena from science as well as the arts and humanities.
- Sung-Phil Kim is working with Michael Black on several research areas including the analysis and design of mathematical decoding models used for neural prostheses and data mining and feature extractions in neural population activities.
- Fumei Lam is working in the Center for Computational Molecular Biology, directed by Sorin Istrail. Her research focuses on the human genome and the genetic basis of disease.
- Working with Andy van Dam in the Microsoft Center for Research on Pen-Centric Computing, Chuanjun Li investigates the recognition of various 2D handwritten notations for pen-centric computing.

Our quest to expand the CS curriculum continues with a new course, Programming for Digital Art & Literature. A joint effort between CS and Literary Arts at Brown and Digital+Media at RISD, this course explores advanced tools and techniques for the creation of innovative and expressive works of digital art by applying best practices from the software design community to the context of digital media. Students from both Brown and RISD are currently taking the course, which is taught by Daniel C. Howe, a digital artist and researcher from NYU's Media Research Lab who received a Master's from Brown's literary arts program in 2007.

In other recent news, Brown has joined forces with more than a dozen research universities and historically black colleges and universities to promote robotics and computer science education for African-American students. At Brown, Chad Jenkins is spearheading the program, which will develop outreach programs to encourage African-American students at both the K-12 and college levels to pursue careers in computer science and robotics. The program also provides mentoring programs for undergraduates.

Recently, the department received a substantial gift from an anonymous alum. We are very grateful for this contribution, which will help to support such initiatives as the Artemis Project and the Women in Computer Science group. Gifts sent to the department directly benefit CS students and faculty members who keep Brown at the forefront of information technology research.

Finally, we urge you to contribute your professional and personal stories for inclusion in upcoming issues of the Conduit. Your support of and participation in department activities is always appreciated and we are grateful to have such a tight knit community—thank you!

Roberto Tamassia
Professor and Chair
Department of Computer Science
Brown University

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SKETCH (1996) 1

Robert Zeleznik, Ken Herndon, and John Hughes

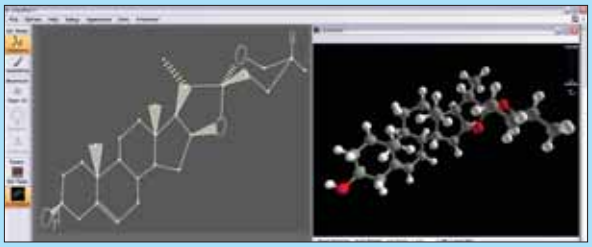
Legend: The figure shows a room that was drawn using SKETCH

Description: The goal of SKETCH is to combine the advantages of both hand-drawn sketching and precise computer modeling in order to create an environment for rapidly conceptualizing and editing non-photorealistic 3D scenes.

Sketching communicates ideas rapidly through approximate visual images with low overhead (pencil and paper), no need for precision or specialized knowledge, and ease of low-level correction and revision. In contrast, most 3D computer modeling systems are good at generating arbitrary views of precise 3D models and support high-level editing and revision.

SKETCH is designed to bridge the gap between hand sketches and computer-based modeling programs, combining some of the features of pencil-and-paper sketching and some of the features of CAD systems, to provide a lightweight, gesture-based interface to "approximate" 3D polyhedral modeling.

Website: http://graphics.cs.brown.edu/research/sketch/



ChemPad (2008) 2

Dana Tenneson, Ph.D. project (supervisor Andy van Dam)

Legend: This figure shows ChemPad interpreting the steroid Diosgenin. The rectified hand-sketched 2D diagram on the left has been converted into the interactive, 3D ball-and-stick molecule model on the right. In the 3D molecule model, the oxygen atoms are shown as red, the carbon atoms as grey, and the hydrogen atoms as white.

Description: ChemPad is a pen-centric application with a pedagogical focus that generates 3D molecular structures from hand-drawn digital ink, using a simulation of the molecular mechanics that determines most likely conformations of the sketched molecule. Molecules are inherently 3D objects represented by chemists on paper and classroom blackboards by a system of 2D diagram notations. ChemPad allows student chemists to sketch molecule diagrams in a quick, natural fashion and then have the software automatically generate the corresponding 3D models.

For students who have difficulty with 3D chemistry thinking, a critical skill for would-be chemists, ChemPad's automatic construction of 3D models helps them learn to visualize molecules as the 3D objects they are. ChemPad has been used by hundreds of students in Brown's introductory organic chemistry course since 2004 and is available as a free download at the project website.

Website: http://graphics.cs.brown.edu/research/chempad/

DYNABOOKS AND PENS: A FORTY YEAR QUEST

Andy van Dam and Rosemary M. Simpson

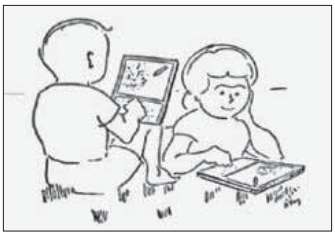


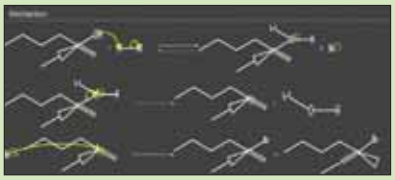
Figure 1

Figure 2

In the late 1960s, during the heyday of "big iron," **Andy van Dam** was inspired by Turing Award winner **Alan Kay's** then science fiction vision of a personal electronic notebook, the DynaBook (see Kay's original sketch in Figure 1 above). It was to be portable, multi-modal (speech, pen and finger, virtual keyboard), collaborative, and simulation-based[1]. The DynaBook would be network-enabled, both local and remote, and would provide interactive and integrated text, graphics, sound, and animations with an intuitive graphical interface useable not only by adults, but even more radically, by children.

In recent years the advent of the Tablet PC has opened possibilities for revisiting and expanding the ideas incorporated in Kay's original vision. (Figure 2, above, shows Faculty and Student Affairs Manager **Lauren Clarke's** daughter Danielle writing and playing music with the Music Notepad running on a Tablet PC). While some aspects of Kay's vision have been realized with the current generation of Tablet PCs, many areas remain to be addressed and many aspects of our current vision and context are outside of the original notion. For example, while Kay included local and remote networks, he did not describe ubiquitous computing in which notebooks were integrated with vastly different form factors such as modern cell phones, smart white-boards, and even smart rooms.

In the Fall 2005 issue of Conduit article "Next Generation Educational Software: Issues and Possibilities,[2]" where we discussed the educational



Reactor 3 (2008)

Chris Maloney

Legend: The figure shows the steps of a substitution reaction between a tertiary alcohol and hydrogen bromide. 1) The alcohol acts as a base, taking a hydrogen from the acid. 2) Water dissociates from the hydrocarbon chain. 3) Negatively charged bromine, a nucleophile, attaches to the positively charged carbocation to form a racemic mixture.

Description: Reactor is a ChemPad-related project that has the goal of allowing students to direct chemical reactions with guidance from the system during the process.

One of the most complex issues for beginning organic chemistry students is predicting the outcome of a reaction process among two or more molecules. In this system students draw molecules, select them, and then click the react button. A series of possible pathways is presented and the student directs the reaction, making choices with the help of hints. The system shows the final products of the reaction and a mechanism that describes how they form. This process can be repeated as many times as desired, a potentially useful aid for chemical synthesis problems.

Lineogrammer (2008) 4

Robert Zeleznik, Andrew Forsberg,
Chu-Chi Liu, Andrew Bragdon

Legend: The figure shows a Lineogrammer screen with a 60-second line drawing in progress that includes recognized lines, curves, text, and polygons all entered by drawing with a stylus without an explicit mode switch. The GestureBar [*sidebar 5*] at the top discloses gestures and drawing strategies.

Description: Lineogrammer allows users to create precise diagrams on a responsive virtual piece of paper that affords a sense of immediacy, fluidity, and flexibility similar to that encountered when drawing with a pencil on paper. On-the-fly, without explicit mode switches, Lineogrammer interprets handwritten text, individual lines, polygons, and command gestures as they are drawn with a stylus.

By snapping lines and inferring higher-level shapes, Lineogrammer supports both precise input and user-imposed strategies for seamlessly editing diagrams at the level of shape primitives or individual line segments. For instance, users frequently discover a novel, but familiar "sculpting" strategy: draw and proportion a primitive shape, like a rectangle, then add to it by intersecting it with new lines, or cut away from it scribbling out unwanted segments.

In addition to such re-interpretations of traditional drawing techniques, Lineogrammer also reinvents conventional straight edges as virtual rulers, which can not only push shapes, but can also align vertices, serve as an axis of symmetry for mirroring operations, and evenly distribute drawing features along a line.

software research currently underway in the Graphics Group, we reported on initial work with MathPad² and ChemPad. In this article we focus on the pen-centric computing that grows out of our interactive user-interface work over multiple decades, including ongoing work with both mathematics and chemistry as well as other areas such as diagramming and electronic notebooks.

Pen Computing in the Brown Computer Graphics Group

Pen computing in the Computer Graphics Group arose out of the sketch-based 3D modeling and post-WIMP user interface work of the mid 1990s. A convenient starting point is **Bob Zeleznik, Ken Herndon,** and **John Hughes'** work on SKETCH [*sidebar 1*], a gestural 3D modeling system that gave rise to a series of multi-modal [*sidebar 8*] and gesture-based applications. In many ways SKETCH can be seen as a forerunner of Google's popular SketchUp utility for building 3D models. During this period work was also being done on haptic user interfaces, freeform modeling, immersive virtual reality applications in Brown's four-walled Cave, and telepresence collaboration.

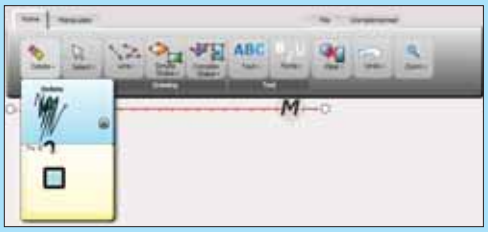
Actual pen-based work was underway in 1998 with two projects: NotePad [*sidebar 12*], an electronic note-taking user interface project of MS student **Matt Lerner** and undergraduate **Jesse Kocher,** and Music Notepad [*sidebar 13*], created by **Andy Forsberg, Bob Zeleznik, Loring Holden,** and **Mark Dieterich.** Music Notepad initially ran on a Wacom Digitizing Tablet, but was, under Microsoft sponsorship, ported by **Andy Forsberg, Loring Holden, Tim Miller,** and **Bob Zeleznik** to the Tablet PC in 2002.

While research in the Cave continues to this day, during this period the group's focus shifted from 3D gesture-based interaction to 2D pen-based, domain-specific applications that involved issues of visual language design and implementation, domain-specific simulation, and user interfaces.

The two principal domain areas—mathematics and chemistry—were the focus of two Ph.D. students—**Joe LaViola** with MathPad² [*sidebar 6*] and **Dana Tenneson** with ChemPad [*sidebar 2*]. Both of these projects have educational as well as domain expert goals. MathPad² spawned several ongoing math-related projects that we discuss in the next section of this article and in the sidebars, as well as a spinoff

The project originated from the notion that pens would appear to be the interface of choice for creating diagrams, given the ease with which people can whip off diagrams on the back of a napkin. However, deeper analysis reveals significant challenges to drawing a diagram fluidly and precisely with a pen. For example, drawing diagrams precisely is tedious, whereas loosely sketched diagrams are typically difficult to interpret without significant error. Alternatively, formatting input as it is given can avoid compound recognition errors but disrupts the flow of input and typically generates more "simple" errors. Thus, Lineogrammer is an initial exploration into the relative merits of different approaches to pen-based diagram entry.

Website: http://pen.cs.brown.edu/lineogrammer.html



GestureBar (2008) 5

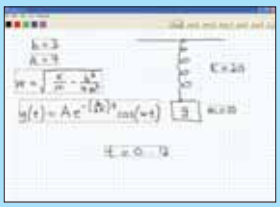
Andrew Bragdon

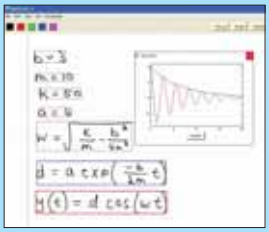
Legend: In the figure, the Delete gesture animation is shown in the blue square, with an invitation to try it in the beige practice area immediately below.

Description: The goal of GestureBar is to make pen and multi-touch gestural commands and techniques discoverable, browseable, and learnable in a natural way to end users (even ones who have never used a Tablet PC before).

Most pen-based applications make use of gestures - such as a lasso to select, or a scribble to delete. Gestures have many advantages - they are natural, fast, inherently parameterized, and do not require the user to leave their work area. However, gestures are not self-disclosing to new users, thus making it harder to learn a new application.

GestureBar, which is a user interface construct similar to a toolbar with tabs, allows the user to browse for commands in a similar way to WIMP applications today. Once users find the command they are looking for, tapping on it will expand the gesture explorer where gestures are demonstrated through animations. A practice area is provided for users to try their hand at making the gesture and to receive contextual feedback on their performance.





MathPad² (2005) 6

Joseph LaViola, Jr., Ph.D. project (supervisor Andy van Dam)

Legend: In the figure, the screenshot to the left shows a mathematical sketch for a damped harmonic oscillator; the handwritten mathematics is associated to the drawing using a simple gestural user interface. The diagram will animate according to this mathematical specification. Users can also change system parameters to see how the oscillator is affected under various conditions. The screenshot to the right shows MathPad²'s graphing capability, where users can simply write down mathematical expressions and graph them using a simple hook gesture.

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company, Fluidity, under the direction of Brown CS database Ph.D. graduate **Don Carney.** Fluidity's goal is to develop a robust pen-based mathematics tool for high school student use. ChemPad was started in 2003 by **Ben Shine** (formerly **Sascha Becker**) and **Dana Tenneson,** with Dana advancing the research as his Ph.D. project. Development has continued to grow more sophisticated in the two and a half years since the 2005 Conduit article[2], progress we discuss in the next section and in the sidebars.

During this same period, **Tim Miller** and **Bob Zeleznik** investigated gestural user interface strategies with the Fluid Inking project, and **Loring Holden, Tim Miller,** and **Bob Zeleznik** started our first Tablet PC electronic notebook project, ReMarkable Texts [*sidebar 14*], building on three decades of our prior work on hypermedia-based Electronic Books.

At this point we were able to more clearly identify those activities and areas that lend themselves to pen use, e.g., where you need to minimize or eliminate the use of the keyboard or to have the kind of fine motor control not possible with a mouse or a touch pad. While expert users of any notation find that notation to be fluid and natural for them, beginners and casual users find keyboard-based notations unnatural when working with intrinsically 2D languages, e.g., sketching, composing music, writing mathematics (even an exponent or subscript makes an expression 2D), drawing molecule or circuit diagrams, ...

Using a keyboard to input expressions in 2D notation systems, such as music, mathematics, and chemistry, requires the user to cognitively dismember the 2D expressions and turn them into a linear sequence of typed characters, or to use non-intuitive WIMP GUI-based systems with long learning curves. Furthermore, keyboards are absent, inappropriate, or awkward in many situations, such as taking notes in an immersive virtual reality Cave [*sidebar 9*] or in an ultra-mobile environment.

Microsoft Center for Research on Pen-Centric Computing

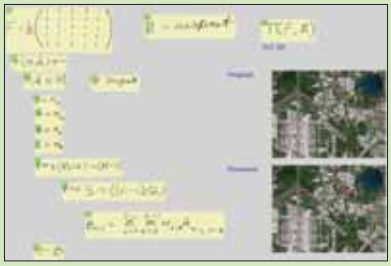
On March 20, 2006, the pen-based work of the previous eight years culminated in the establishment of the Microsoft Center for Research on Pen-Centric Computing (MSpcc)[3], which is housed in Brown's computer science department. In the two years since then, all the concerns of the last several years—education, interactive and multi-

Description: MathPad² is a Tablet PC application for mathematical problem solving. At the core of its functionality is the concept of mathematical sketching, making dynamic illustrations by combining handwritten mathematics and free-form illustrative diagrams of shapes that change size, location, and other properties as a function of the mathematics.

MathPad² is designed so users can create simple illustrations as if they were working with pencil and paper. They can also leverage their physical intuition by watching their hand-drawn diagrams animate in response to continuous or discrete parameter changes in their written formulas. Teachers can use MathPad² to quickly create illustrations to be used in their lessons and students can use the application to aid in their studies.

MathPad² is the forerunner of research currently underway in the MathPaper project, and is the inspiration for FluidMath, Fluidity Software's commercial educational software product.

Website: http://www.cs.brown.edu/~jjl/mathpad/



MathPaper (2008) 7

Robert Zeleznik, Timothy Miller, Joseph LaViola, Jr., Chuanjun Li

Legend: The figure shows a combination of matrix notation with extended algorithmic notations on the left side of the image, with the image processing results, a blurring of a selected area, shown on the right.

Description: The goal of the MathPaper project is to make working with math on the computer as easy as writing it on paper. It provides a virtual sheet of paper that recognizes free-form handwritten entry of multiple mathematical expressions in real-time and provides symbolic and numerical computational assistance. It also exports to math formatting tools such as LaTeX, Mathematica, etc.

Research with this project includes: (1) investigation of techniques for visualizing and allowing the user to correct errors in the computer's recognition with gestural and widget-based interactive editing, including real-time display of the recognition result during interaction; (2) exploration of extended notations to control evaluation, enter matrices with patterns by eliding elements, incorporate flow of control and other algorithmic concepts, support debugging, etc.

The ultimate goal is for MathPaper to provide students, teachers, and professionals with an integrated environment that combines standard symbolic mathematics with geometry, algorithms, and symbolic computational assistance, and that supports devices ranging from PDAs to whiteboards.

Website: http://pen.cs.brown.edu/mathreco.html

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modal user interfaces, sketching, math, and chemistry—have converged within the common reference frame of pen computing.

With the addition of postdoc **Chuanjun Li** to the team, the mathematics research has begun exploring new areas and approaches: error recognition and correction, extensions for linear algebra, and algorithm sketching (adding pseudo-code flow of control primitives, set and logic notation, various convenient shorthands, etc.). All of the current mathematics research has now been consolidated as the MathPaper project [*sidebar 7*].

The ChemPad research has made significant progress in making models and handling bigger molecules based on a completely rewritten molecular mechanics simulation engine that uses the latest optimization techniques. Both chemistry professor **Matt Zimmt** and optimization expert CS professor **Pascal Van Hentenryck** have been advising Dana. In addition to helping on the ink analysis / recognition strategy, MS student **Chris Maloney** has been extending ChemPad with the Reactor project, which helps students predict the outcome of reaction processes among two or more molecules [*sidebar 3*].

Over the last year, **Andy Forsberg, Bob Zeleznik,** MS student **Andrew Bragdon,** and MS student **Chu-Chi Liu** have been developing an intuitive, gesture- and pen-based set of tools for rapid diagramming. The current project, which had its debut at the MS TechFest in February, is Lineogrammer. Lineogrammer's focus is on user-controlled strategies for manipulating diagrams and controlling how they are modified and displayed [*sidebar 4*].

As we move forward, building on the experiences of the last several years, we are expanding both the domains and the scope of our work to include:

- Integration of the Tablet PC work into additional form factors—ranging from the small (mobile devices) to the large (SmartBoards and wall-sized formats) to the complex (immersive virtual reality areas such as the Cave)—and media, such as the Internet where MS student **Kris Jordan** has been working on SurfPad, a next-generation Internet search application [*sidebar 15*]. SurfPad builds on the work of former Brown undergraduate, now researcher at Microsoft Research, **Merrie Ringel Morris.**
- Multi-modal integration of the pen (fine-grained gestures and uses)




Multimodal Scientific Visualization Tool (2000) 8

Joseph LaViola, Jr., MS project

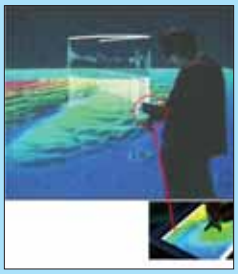
Legend: In the figure, a user is wearing headtracked stereo glasses, so that the image appears in depth, and is using dataglove trackers for position tracking and gestures, as well as a microphone for speech recognition. Several visualization widgets illustrate air flow around the shuttle, including a rake emitting streamlines and a cutplane showing pressure distributions.

Description: MSVT (Multimodal Scientific Visualization Tool) is an application for visualizing fluid flow around a dataset. MSVT uses a multimodal interface which combines whole-hand and voice input to allow users to visualize and interact with the dataset in a natural manner.

This work arose out of research showing that more than one mode of input can be both beneficial and intuitive as a communication medium between humans and computer applications. Although there are many different modes that could be used in these applications, hand gestures and speech are two of the most logical since users will typically be in environments that will have them immersed in a virtual world with limited access to traditional input devices such as the keyboard or mouse.

Website: http://www.cs.brown.edu/~jjl/msvt.html

Pen Computing in the Cave - ADVISER (2008) 9



Andrew Forsberg

Legend: In the figure, a user is planning the path that a rover will follow in a future mission on Mars. The view in the Cave (top image) shows the north polar cap terrain with an elevation-colored overlaid on the terrain (red is high, blue is low). A Tablet PC is used to sketch and edit paths (bottom image). Each path drawn is immediately synchronized with the Cave view and is graphically drawn on the terrain surface. Because the local slope is critical for maneuvering the rover itself, the local slope is also visualized in the Cave view above the path (see the white graph that is embedded in the 3D space above the path).

Description: The goal of ADVISER PSE (Advanced Visualization in Solar System Exploration and Research Problem Solving Environment) is to help geologists do their research by enabling them to go "into the field" through immersive virtual reality technologies that recreate remote places like Mars and Antarctica. Geologists often have many years of in-the-field training during which skills for making on-location decisions and discoveries are developed. Studying the terrain and surface properties from vantage points on or near the surface is a powerful and important capability in the geosciences.

ADVISER's tools provide planetary geoscientists with the capability to operate and analyze data as if they were on or near the surface of a planet. A multidisciplinary team, led by Planetary Geosciences and supported by NASA, has built both on their central strengths in planetary geoscience and on the basic NASA research and exploration theme for "Follow the Water" for Mars, to provide a scientifically credible direction for tool research and scientific discovery.

Pen-centric computing plays three roles in ADVISER. First, Tablet PCs and PDAs with pen input can be used in the Cave to control navigation and other functions like sketching rover paths (see the Figure above). Second, pen-computing may be an important tool for lab use such as for annotating and ➤

with multi-touch (larger-grained gestures and uses) and with speech. Application and user needs are the criteria that drive granularity and modality choices. Indicative of this approach is MS student **Andrew Bragdon's** work on a self-disclosing tutorial GestureBar [*see sidebar*], while a multi-modal example is the multi-touch table hardware and software design work of **Mark Oribello** and MS student **Ed Kalafarski** [*sidebar 11*].

The focus of all of these developments has been the user experience rather than the traditional task performance orientation of older user interface design efforts. While much of the pen work has been single user, we will increasingly focus on support for collaboration.

Research Issues Common to Pen Computing

In 1960, Andy's first project after college at the Burroughs Research Center was to work on optical character recognition of hand-printed characters. It is fascinating to see that it took more than forty years for both cursive handwriting recognition and continuous speech recognition of English to get to the point where they were usable by ordinary people as routine applications. The kind of pen computing we're investigating is not yet ready for prime time in the sense of being sufficiently robust and easy to use, and many fundamental issues remain to form a fascinating research agenda that will keep us busy for years.

The most obvious area is that of improving recognition accuracy, and since no recognition will ever be perfect, we need to address issues of error detection and correction. The latter includes what type of feedback to provide the interactive user as well as when and where to provide it. We've explored many strategies for recognition, building on the Microsoft ink analysis platform and using its character recognizer. We've added our own recognition algorithms (1) for the extended vocabulary we use in various applications, (2) to deal with domain-specific 2D parsing rules that involve spatial relations among lexemes and expressions, and (3) for continuous backtracking as more and more context is provided.

Our current approaches emphasize on-the-fly recognition rather than batch recognition of a finished 'page.' We've tried a variety of recognition strategies, including machine learning and other statistical methods, finely tuned heuristics, multi-level and competing recognizers, etc. Also, we tend to prefer modeless interfaces, where

interacting with satellite imagery, e.g., for indicating regions of unique surface structures and labeling the boundaries of features like craters. Third, we are investigating the extension of the traditional pencil and paper field notebook to an electronic field notebook – this may overlap with and extend Pen Center projects like Lineogrammer, Math Paper, and Analysts' Journal.

Website: http://graphics.cs.brown.edu/research/adviser/

Multi-Touch Interaction (2006) 10

Tomer Moscovitch, Ph.D. project (supervisor Prof. John Hughes)

Legend: In the figure on the left, the hand cursor lets the user move the puzzle pieces as though sliding objects on a physical table, while in the figure on the right, the user animates two swimming fish by using two hand cursors.

Description: The Multi-Touch Interaction project explores novel user interaction techniques that illustrate the benefits of multi-touch interaction. These techniques let users work faster and more fluently than do traditional single-point interaction methods. Many everyday activities rely on our hands' ability to deftly control the physical attributes of objects. Most graphical interfaces only use the hand's position as input, ignoring a rich array of other hand parameters such as orientation or finger configuration.

The multi-touch cursors form a family of interaction mechanisms that use multiple finger contacts to manipulate graphical objects. These instruments allow for parallel control of multiple parameters (such as position and orientation) and reduce the need for separate interaction modes by unifying operations (such as grouping and moving objects).

Website: http://www.dgp.toronto.edu/~tomer/

Multi-Touch Table (2008) 11

Mark Oribello and Ed Kalafarski

Legend: The figure on the left shows the table during the construction, while the one on the right shows multi-point use.

Description: The goal of the multi-touch table construction project is twofold: (1) to demonstrate that such surfaces can be quite cheaply mass-produced, and (2) to learn how applications can take advantage of multi-point and multi-touch opportunities.

The multi-touch table is an interactive surface that is taking the increasingly ubiquitous multi-touch screen found in iPhones and Tablet PCs and growing it to the size of a drafting board or conference table. Multi-touch offers tremendous potential to reshape our interactions with a variety of tasks, such as diagramming, image manipulation, 3D modeling, and architectural planning.

Website: http: //www.cs.brown.edu/~mo/Multitouch/

context or just punctuation (such as an extra tap) is used to disambiguate content from gestural commands. We also combine gestures with more traditional GUI interaction techniques, such as marking menus, to minimize hand movement and keep the user's focus on the current work area.

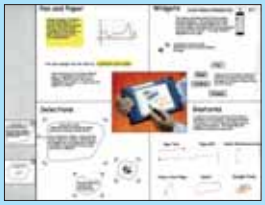
In both the mathematics and chemistry applications, significant use is made of computational backends. In the case of mathematics, we use a combination of our own execution machinery, as well as backends, such as MatLab™ and Mathematica™ to do numeric and analytical solving. In the case of chemistry, as previously mentioned, Dana implemented his own molecular mechanics simulation using optimization strategies guided by topological and geometric cues derived from the rectified sketch of the molecule diagram.

Clearly, domain-specific applications must employ deep domain knowledge in order to provide both recognition and interpretation of sketched input. Our diagramming application, on the other hand, does not need domain knowledge and therefore does not have a simulation component. When we extend it to include greater support for formal geometry, both analytical and trigonometric, then such a 'geompad' will have to once again rely on considerable backend computation.

One of the concerns expressed by both computer scientists and potential users is that applications, which depend largely, if not exclusively, on learned gestures are much less self-disclosing than applications employing conventional WIMP GUIs. Thus, one of our research areas is finding ways of having users discover, learn by example, practice, and then apply an expanding vocabulary of gestures for both content and commands. It seems pretty clear that with pen computing, multi-point, and multi-touch becoming common in UIs that we'll see gestures such as scribble for erase and lasso for selection and moving or copying become 'standardized'. We've tried multiple ways of disclosing and training users on gestures, including interactive tutorials and the latest—*Andrew Bragdon*'s GestureBar [*sidebar 5*].

Finally, no set of techniques, no matter how cool looking, is sufficient to convince anyone of their usability. Instead, rigorous usability testing must be done and the design of such testing is by no means obvious. We have been doing user testing for more than a decade and feel that we are still learning how to do it effectively.

NotePad (1998) 12



Matt Lerner and Jesse Kocher

Legend: The figure highlights the features of NotePad. The gray area on the left of the Notepad (shown to the left) is the margin, which acts as a clipboard and work space. Widgets, shown at the top right corner of the NotePad (in the upper right quadrant of the figure), provide an easy way to navigate through notes. A few simple gestures are summarized in the bottom right quadrant of the figure.

Description: NotePad is a pen-based interface for electronic note taking. It leverages the skills people have developed through years of experience with paper, while providing the benefits of working on a computer. Writing anywhere else on the NotePad adds ink to the page. If the stylus button on the pen is pressed, the stroke is interpreted as a gesture. NotePad supports various pen and page attributes: selecting, moving, copying and resizing strokes, and audio annotations.

In 2000, Matt Lerner, Jesse Kocher, and Oliver Hurst-Hiller migrated NotePad to a web-based startup, E-Quill. The E-Quill online application, which lets users add notes to, highlight, and write on Web pages, erase work, and send marked-up pages via e-mail, was later sold to Microsoft.

Music Notepad (1998, 2005) 13

Mark Dieterich, Loring Holden, Andrew Forsberg, Robert Zeleznik, Timothy Miller

Legend: The figure on the left shows a perspective wall visualization of music being composed on the first version of Music NotePad, while the figure on the right shows a screenshot of one of Bach's Goldberg Variations, in landscape mode, on the Tablet PC version.

Description: Music Notepad employs a gestural user interface for entering common music notation. It approximates sketching music with paper and pencil so that users can informally jot down music and hear the results as they create it, as well as play back the entire piece. In addition, users can edit and professionally format their music.

The system was originally created using a desktop PC and a Wacom tablet, but between 2001 and 2005 it was rewritten for the Tablet PC and became a Microsoft PowerToy (named "Tablet PC Music Composition Tool"). The original system employed a perspective wall to allow users to write on a larger surface than the Wacom digitizing tablet provided, but it is not needed for the Tablet PC version. The current Tablet PC version has MIDI export that enables users to save their work.

Websites: http://graphics.cs.brown.edu/research/music/
http://graphics.cs.brown.edu/research/music/tpc.html

DynaBook(s) redux?

Figure 3: Analyst's Journal

Figure4: Electronic Lab Notebook

All of the approaches we've described thus far have dealt with specific domain, user interface, and technique issues of pen computing. The last research area to be discussed both expands the tight domain focus of previous projects and harks back to some aspects of **Alan Kay's** original DynaBook dream of a portable, multi-modal, collaborative, and simulation-based personal electronic notebook. The 'notebook' in our current vision, however, is more conceptual than physical and can exist on and/or be distributed across multiple form factors and locations.

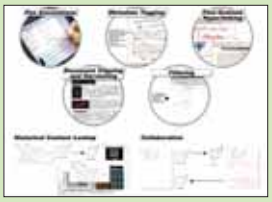
Two such projects, still in early conceptual design phases, are the Analysts' Journal, which will support the information gathering and analysis process of policy, research, and intelligence analysts, and the Electronic Lab Notebook, which will support scientists in their domain-specific tasks of collecting and examining data gathered from sensors and simulations, in individual, collaborative, and educational settings.

In both projects we view the electronic notebook as an active launch platform, not a merely passive recording and playback device. Each 'notebook' is a collection of "semi-infinite" virtual pieces of paper that permit users to sketch ideas for annotated graphical, diagrammatic, and mathematical designs, including proof-of-concept simulations, and to engage in interactions with collaborators on shared portions of the workspace.

As they seamlessly move among domains, users can have the recognition software assign domain-specific semantic interpretations to the digital ink as appropriate or leave the ink as design or annotation marks. Finally, as with ReMarkable Texts, we will support fine-grained hypertext linking, various historical review mechanisms, and notebooks as collections of data gathered both explicitly, e.g., 'clippings' and implicitly, through feeds.

ReMarkable Texts (2004) [14]

Robert Zeleznik and Timothy Miller



Legend: The five figures at the top of the image show the different capabilities of ReMarkable Texts. At the bottom of the image, in the figure to the left the student can't recall the reasons for his notes because they're out of context. On request, the system displays related documents that were open when the notes were taken, which helps refresh his memory. In the figure to the right, the student needs clarification on his notes and establishes a synchronous office hour with his professor, who adds explanations directly into the student's shared notebook.

Description: ReMarkable Texts is a Tablet PC-based digital notebook for students and professionals taking notes on lectures and collaborative projects. The goal of the system is to provide the ease of traditional notetaking on paper while utilizing the power of a computer. The Tablet PC allows the user to write "ink" directly on its screen as if it were a notebook. Thus, it is fairly natural to do handwriting and sketching.

The biggest difference between this project and other note-taking applications like Microsoft's Journal or One Note is that ReMarkable Texts is a vehicle for both general and domain-specific note-taking research. For example, ReMarkable Texts not only has standard inking and annotation features, but also provides various types of query and retrieval mechanisms on ink, tags and other metadata, synchronous and asynchronous collaboration, content filtering, historical context lookup, and fine-grained bidirectional hyperlinking. The system's collaboration functionality is built on ConferenceXP.

Website: http://graphics.cs.brown.edu/research/ReMarkableTexts/

SurfPad (2008) [15]

Kris Jordan

Legend: This image presents a scenario where two users are planning a trip to Florence. By collaborating in a shared space the users can find appealing restaurants, keep track of their hotel arrangements, and maintain an ongoing search for interesting sights to visit in Florence.

Description: SurfPad is a web-based inking application designed for searching the Internet. Today's search engines employ a linear and textual user-interface to deliver results. Saving, organizing, and sharing search results must happen out-of-band from the search itself, thus purging the context of results.

SurfPad allows users to perform searches and then organize and annotate their results in a persistent space. Once a search is performed, it can be manipulated and re-executed. For example, if a search turns up undesired results the user can scribble them away with the pen and future searches will automatically hide the results. With a flick of the pen, items can be clipped from a results list and organized in a 2D space. Days later a user can return to their search spaces with their entire context captured right where they left off.

SurfPad also allows users to collaboratively search with other users synchronously or asynchronously. When multiple users are active in the system, they are able to stay aware of each other's status and recent searches. Multiple users can simultaneously perform independent searches or collaborate on the same one. Working groups are able to benefit from each member's efforts to filter and assimilate useful information. ■

What Might the Future Hold?

This overview has argued, by example, that the pen can be more natural and fluid for a variety of tasks, particularly those that use existing 2D notations such as mathematics, music, and chemistry, and for sketching diagrams. While the bulk of our applications thus far have been developed for the Tablet PC platform, an early 21st century implementation of Alan Kay's Dynabook hardware and software vision, the recent interest in surface computing and multi-touch makes it obvious that our vision should not be restricted to that form factor. Microsoft's Bill Buxton predicts that in the future all screen materials will have built-in touch sensitivity; that and other hardware advances should let us "paper" our workspaces, learning environments, and playrooms with interactive surfaces of arbitrary shape and size. These true multi-modal surfaces will take better advantage of our human sensory capabilities than today's interfaces in that they will be able to listen and talk with us, and will be able to combine the best of two worlds that are too separate today: that of knowledge- and agent-based computing with various forms of natural direct manipulation such as sketching and gesturing.

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[2]"Next Generation Educational Software: Issues and Possibilities" by Andy van Dam and Rosemary M. Simpson, Conduit Fall/Winter 2005, Vol. 14, No. 2 -http://www.cs.brown.edu/about/conduit/conduit_v14n2.pd

[3]Microsoft Center for Research on Pen-Centric Computing - http://pen.cs.brown.edu/

Acknowledgements

We gratefully acknowledge all of the past and present members of the Microsoft Center for Research on Pen-Centric Computing, whose creative contribution we have briefly described in this article. Special thanks to Chemistry Professor Matt Zimmt and CS Professor Pascal Van Hentenryck for their help with various aspects of ChemPad, and to President Ruth Simmons, whose initial grant, funded by Atlantic Philanthropies, allowed us to get started on ChemPad. Finally, it is a pleasure to acknowledge collaboration with and feedback from Microsoft's Paul Oka, Sashi Raghupathy, and Ken Hinckley.

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The Great Divide

By **Matthew Loper**, Ph.D. Student

As a roboticist, the most frequently asked question I hear is, "where is my robot?" People are fascinated by the humanoid mechanical golems that roam across their TV screens, and to them, it's my duty to provide one.

I could answer their question in three ways. I could tell them to buy a robotic vacuum, which cleans floors and has no human interaction. I could suggest a hobbyist kit that burdens them with implementing (or inventing!) vision and localization algorithms. Or, if pressed, I could admit that their robot is still in a research laboratory.

And that's the real problem: there is a large gap between commercially-available robots and those in research settings. Robots in the lab can recognize faces, follow people, spot gestures, parse speech, and learn simple tasks from demonstration. Robots in the home are toys by comparison. The problem is not a lack of effort; companies like iRobot (maker of the Roomba robotic vacuum) and Ugobe (maker of the Pleo toy) are on the forefront of consumer robotics and researchers would like nothing better than to see their creations in every home. But the gap remains and it's worth asking why.

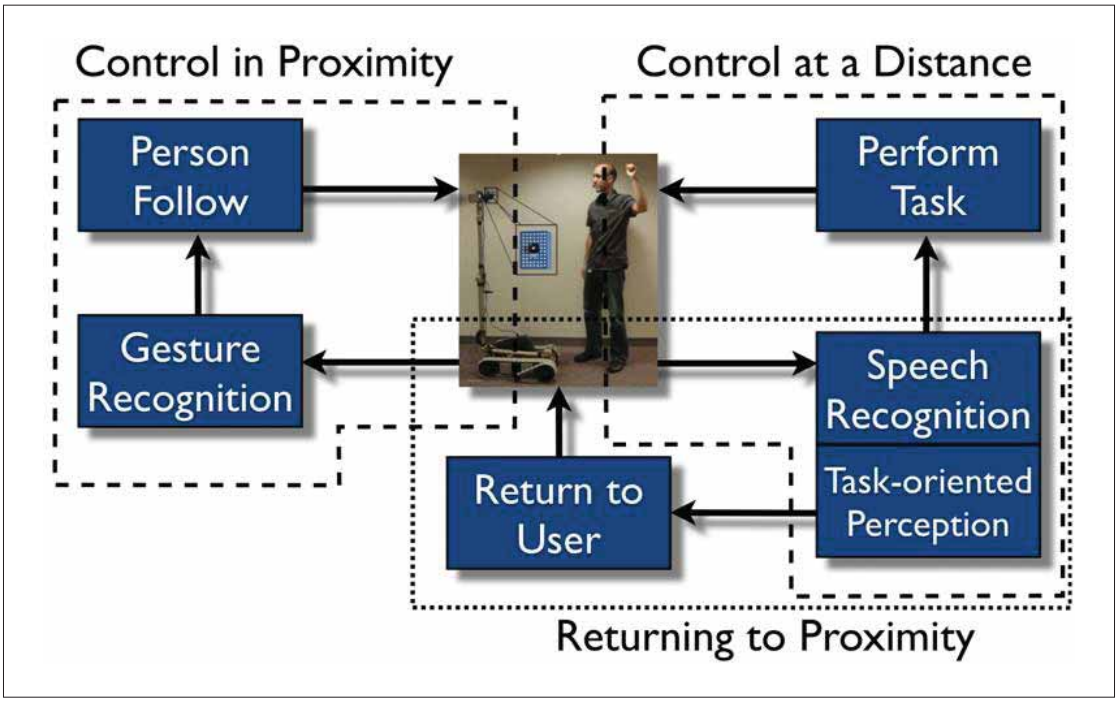
The issue with smart robots designed for the lab is that many can't work anywhere else. We need robotic solutions that follow the write-once, run-anywhere principles of the Java programming language. But, instead of having an abstraction layer that is software-to-software, we need one that is software-to-world. Both perception and manipulation have to be robust to changing environments. It's a daunting task for any roboticist.

As part of the Brown Robotics group, I've recently had the privilege of working with iRobot on this problem. Their "Packbot" platform can run inside or outside, and can even climb stairs—it is physically robust—but has traditionally been remote-controlled (a.k.a "teleoperated"). We want to move away from teleoperation, towards hands-free teamwork between a person and a robot. For us, this meant building perception mechanisms that allow person-following, gesture recognition, and voice-based operation under varying environmental conditions (such as lighting and terrain).

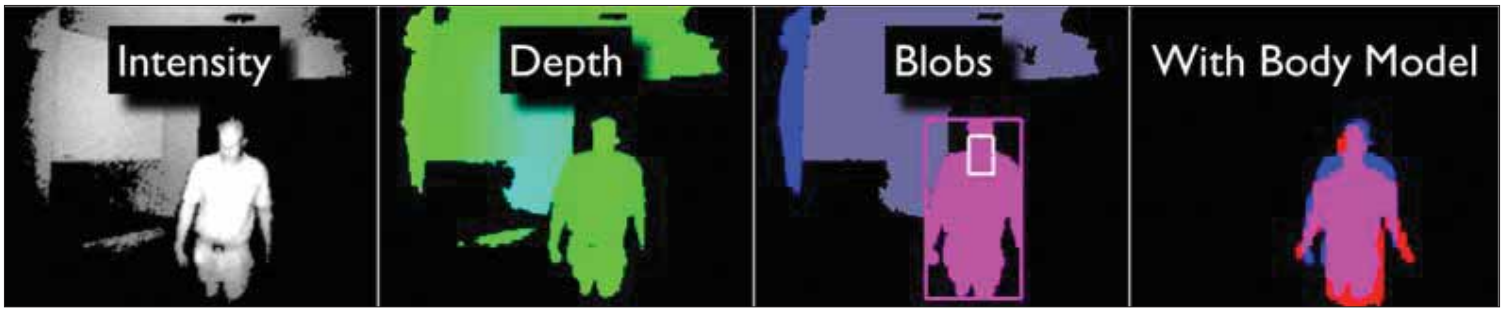
Good perception starts at the sensors, and we chose to do away with one of the most popular sensors in robotics: the color camera. Any camera fan is familiar with the many issues of white balance, F-stops, and unwieldy specular highlights. You are at the mercy of the lighting available to you—unless you control the light yourself.

My collaborator Nate Koenig, being followed by our prototype.

My collaborator Sonia Chernova, gesturing to our prototype.



An illustration of the relationship between interaction modalities and human-robot distance in our framework.



An illustration of our perception pipeline.

"I don't have a good answer to the question, 'where is my robot?' but maybe the right question isn't 'where?' but 'when?' We're working on that."

Our chosen sensor does exactly that. By projecting non-visible (to the human eye) light on a scene and measuring the phase of returned light, a CSEM SwissRanger gives us a distance (instead of a color) at every pixel of our image. Rather than getting something like a color photograph, we get something more like a 3D relief. This frees us of the dependency on color.

An important part of our work is the way in which we balance sensor usage (speech and gestures should be used according to context). Speech works well when a person isn't in direct line-of-sight, but fails when the robot is moving (due to motor noise). Gestures work better for managing the following behavior of the robot. Using sensors according to their strengths is essential for effective interaction.

Another fundamental part of our work is rooted in the details of our recognition pipeline. After segmenting our depth image into blobs and classifying some blobs as human silhouettes, we fit a body model to these silhouettes. By looking at these body model poses over time, we can infer gestures. As with much research, the devil is in the details.

But the most exciting thing for users is that the system as a whole works indoors and outdoors (mostly—direct sunlight is a problem), in hallways and open spaces, and even in complete darkness. We've worked hard to bring that robot out of the lab, so that eventually its grandchild might make it into your living room.

Our prototype: an iRobot PackBot and SwissRanger camera.

I don't have a good answer to the question, "where is my robot?" but maybe the right question isn't "where?" but "when?" We're working on that. ■

(Work done in collaboration with Nate Koenig, Sonia Chernova, Chad Jenkins and Chris Jones)

The Faculty Speaks Out

Maurice Herlihy

Q&A with Maurice Herlihy

How did you end up in Computer Science?

Long story short: As an undergraduate, I concentrated in math and I spent lots of time hanging out with grad students in Harvard's math department, enough time to convince me that I did not want to be a math grad student. After I graduated, I found out about rent and had to get a job. I exaggerated my qualifications and got a minimum-wage job writing FORTRAN programs. I drifted through other programming jobs until one day the think-tank I worked for lost most of their funding. They were laying people off right and left, but the boss called me in and told me the good news: I'm not being laid off. Then the bad news: the guy who does the regular tape backups? He's being laid off, and guess who's got to fill in for him. So I applied to grad school in Computer Science.

You won the 2004 Gödel Prize for your paper "The Topological Structure of Asynchronous Computation." Tell us about the importance of this work.

The paper draws an unexpected connection between distributed computing and algebraic topology. Simplifying somewhat, we were able to demonstrate that certain problems were impossible to solve by showing that a solution would require mapping a solid geometric object around the boundary of a hole without tearing it, which can't be done. I loved algebraic topology as an undergraduate and it was very satisfying to discover the connection to distributed computing.

"They were laying people off right and left, but the boss called me in and told me the good news: I'm not being laid off. Then the bad news: the guy who does the regular tape backups? He's being laid off, and guess who's got to fill in for him. So I applied to grad school in Computer Science."

Would you advise a gifted youngster to become a computer scientist today?

I would advise a gifted youngster to pursue whatever he or she finds appealing. Gifted youngsters can revolutionize vibrant fields and revive dormant fields. I know gifted people (not all youngsters) who have done very well in the most unlikely fields.

A more revealing question would be, "Would you advise an ambitious, but perhaps not-so-gifted youngster to become a computer scientist today?" I'll have to get back to you on that.

How do you pick your research problems?

I'm opportunistic and I look for connections between different areas.

What's the "next big thing" in distributed computing?

In the near future, nearly all computers ranging from supercomputers to smoke detectors, will be shared-memory multiprocessors. This change will affect distributed computing in two ways. First, the experience of confronting real multiprocessors will force us to address problems obscured by many of today's naive computational models. Second, perhaps for the first time ever, research in concurrency will matter to people who don't do research in concurrency, so this is our chance to change the world.

Do you have any words of advice for recent graduates or mid-career computer scientists?

Be opportunistic.

Look for connections between different areas.

Also be patient: transactional memory is a large, lively area today, but our 1993 paper that coined the term went mostly uncited for about ten years (then technological changes caught up).

Among all your past research, what is your favorite piece of work?

My favorite piece of work is whatever I'm working on at the moment.

If you had enough extra time to study one additional area, what would it be?

Classical Greek.

Q&A With Steve Reiss

How did you end up in Computer Science?

I took a course about computers at the Franklin Institute in Philadelphia around 1965 and never looked back.

You've consistently taught the Introduction to Software Engineering course. How has the course evolved? What about the students?

Steve Reiss

Actually I taught the courses that kept getting split into separate courses and eventually yielded the current "Introduction to Software Engineering course (CS101, CS190, CS132, CS32).

The course itself has evolved as the field has evolved. Today's projects are larger and more complex, involving significantly more graphics and typically involving either networked communication (multiplayer games) or web-based front ends for data-oriented applications. The course has changed the underlying language from PL/1 and assembler to C to C++ to Java and now (coming back again) to Java and C and C++. We continually introduce new topics (most recently sockets, threads, agile development, and systems programming; before that design patterns, user interface design, and software architecture). We have also tried to make the course more hands-on, adding a variety of labs.

The students come in a bit more sophisticated, having learned more in their introductory courses than they used to, and quite enthusiastic about implementing a real application of their own design and choosing.

You work in software visualization. Tell us about its importance.

Software visualization is only one of the several areas I work in and one that I haven't really done much in over the past few years.

Different people have different opinions on the importance of software visualization. It is a tool that can help provide insights into the structure and behavior of software and is most useful where the software system or its behavior is complex enough so that the programmer needs to be presented with a high-level view of what is going on or how the program is actually structured. It has become an essential component of fields, such as reverse engineering where programmers are presented with large amounts of code they didn't write and are supposed to understand what that code does so that they can either fix it or reimplement it. General software visualization has not caught on or become a part of today's programming tools or environments and the reasons for this are still being debated in the field.

Our work in software visualization over the last decade has concentrated on using it to understand the dynamic behavior of software systems (i.e., providing insights into exactly what the program is doing). We have emphasized providing both detailed analysis of previous behavior, as well as attempting to provide insights into exactly what the program is doing as it is doing it. A lot of this work has concentrated on getting the right raw data and doing the right analyses so as to present the programmer with the most appropriate information in a timely fashion. Once we can achieve this, we have looked at developing appropriate visualizations for presenting the data so as to provide the programmer with the right overview, let the programmer zero in on detailed information, and highlight the information that the computer thinks will be most useful for the programmer.

What do you think the "next big thing" in software engineering is?

Whatever I'm working on.

No really, I think that there will be more and more use of more and more sophisticated program analysis, machine learning, verification, and testing technologies to provide immediate feedback to the programmer as they both design and code their systems.

Tell us about your most recent project.

Last summer I started doing performance analysis of long-running systems. We developed a system that gathers detailed information about CPU utilization, I/O behavior, the state of the heap, thread activity and synchronization, and memory allocations. It does all this within whatever overhead is specified by the programmer, be it ten percent, five percent, one percent, or even 0.1 percent. The system currently works on arbitrary Java applications, can be attached to an application dynamically, and features a web-based front end that uses Shriram's FlapJax as well as a dynamic Java-based front end.

Would you advise a gifted youngster to become a computer scientist today?

Sure, if that is what they were interested in. Both my sons are doing computer science and my daughter has recently become interested in the field as well. I haven't really encouraged

continued on page 17

Michael Black

Michael Black's travel for conferences and invited talks took him to Rio de Janeiro (where he did not get mugged), Vancouver (where it rained, of course), Paris (during the transit strike), Oxford (where he stayed in Brasenose, the college with the strangest name), California (where it rained even more than Vancouver) and Israel (where he saw George Bush and floated in the Dead Sea). The highlight was clearly sitting on the beach in January in Haifa drinking fresh pomegranate juice.

Michael's research group received a grant from the Rhode Island Science and Technology Advisory Council (STAC) for a collaboration with the Rhode Island State Police to develop algorithms for forensic computer vision. The project explores new methods for tracking people in video using three-dimensional models to estimate biometric information such as height, weight and arm length.

Amy Greenwald

Amy Greenwald had a fantastic fall semester as the new CS17 instructor. Since her arrival at Brown back in 2000, she had been patiently awaiting an opportunity to teach this class. First and foremost, Amy possesses a deep appreciation for its technical content and enjoys sharing her enthusiasm for the subject matter with students. Also, she hopes that as an instructor of an introductory computer science course, she can challenge any preconceived notion that first-year students may have that computer science is an exclusively male discipline. She is sending a message early on to men and women alike that, although our field is male-dominated, there is a place for women in computer science. Further, as the CS17 instructor, Amy serves as a role model for young women and hopes to inspire more of them to join the discipline.

John Hughes

John Hughes has left the role of IPP director, transferring it to the capable hands of Ugur Cetintimel. This leaves him more time to work on the rewrite of Computer graphics: Principles and practice, and the development of a new version of CS224. He and Tomer Moscovich (Ph.D. 2007) had a paper at CHI on multi-touch interaction.

Sorin Istrail

Sorin, co-founder of the International Conference on Research in Computational Biology (RECOMB), attended the 2007 RECOMB Satellite on Regulatory Genomics at MIT, and the RECOMB Satellite on Systems Biology at UCSD. Together with Ken Dill of the University of California San Francisco and Michael Levitt of Stanford University, Sorin organized part of the 2007–2008 Thematic Year on Mathematics of Molecular and Cellular Biology IMA Workshop on Protein Folding that took place during the week of January 14–18, 2008 at the University of Minnesota. He served on the Department of Energy's 2008 Innovative and Novel Computational Impact on Theory and Experimentation (INCITE) Panel for Biological Sciences. Sorin gave a Distinguished Lecture at Tufts University. He also visited Leiden University in December 2007 and delivered an invited lecture entitled, "Towards Breaking the cis-Regulatory Code," as part of the Algorithmic Bioprocesses Workshop, which was organized as a celebration of the sixty-fifth birthday of Professor Grzegorz Rozenberg.

Sorin taught his graduate course, "Algorithmic foundations of computation biology II: The human genome and the genetic basis of disease" in the fall 2007 semester. The students' final presentations on genome-wide association studies for the class were well-attended by Brown Med faculty members. Sorin is excited this semester to be teaching his undergraduate course, "Algorithmic foundations of computational biology," in a new classroom, the CCMB conference room (the SWIG Boardroom), located on the second floor of the CIT building. Sorin's students come from a higher diversity of backgrounds this year including computer science, mathematics, applied mathematics, physics, biochemistry, and one physician.

The research activities in the Istrail lab group included a visit to the California Institute of Technology to work with Eric Davidson in December 2007. Lab members also visited the Pfizer Research Center on February 8, 2008. During this visit Fumei Lam, postdoctoral fellow and Ryan Tarpine, Ph.D. student gave talks related to their research projects. This was the third visit involving Sorin's group and the group of the vice president of world wide research informatics, Matteo Di Tomasso toward establishing a collaborative bridge in the area of pharma-informatics. The lab and the CCMB hosted two visitors, Professor Nathan Edwards of Georgetown University and Professor Oliver Kohlbacher of the University of Tubingen.

The revised proposal for the Computational Biology Undergraduate Concentration, now under CCMB governance, was approved in December 2007. This was the first revision of the Computational Biology Concentration, started in 1997 by professors Franco Preparata (Department of Computer Science), David Rand (Department of Ecology and Evolutionary Biology), and William Suggs (Department of Chemistry), making it the oldest program of its kind in the United States.

Chad Jenkins

One laptop per robot. Chad Jenkins finally got his OLPC XO on February 8, 2008. To his pleasant surprise, he could control an iRobot Roomba using his OLPC by simply installing Player/Stage robot middleware using Yum.

Shriram Krishnamurthi

Shriram spent a good part of winter break in (South) India, interleaving technical and educational talks with personal travel. He was delighted to be back in the tropics, taking great pleasure in emailing local weather conditions to Spike, who was buried under a New England snow-storm. (The weather was so awful, Spike couldn't even conjure a witty retort.)

In February, Shriram completed his own little Tour de France—Nice, Paris, and Lille—giving lectures and attending a thesis defense. He also did a bit of riding, climbing the Col de la Madone (an obscure mountain made famous as Lance Armstrong's winter training site), and juddering along the awful, wretched, inhumane cobbles that feature in the Paris-Roubaix race.

An inhabitant of the Kodanad elephant center in Kerala, India photographed by Shriram Krishnamurthi.

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Claire Mathieu

During the fall of 2007, Claire Mathieu was on leave from Brown and visited the Microsoft Research Theory group. On her first day there, she was pleasantly surprised to meet several other new employees who had recently graduated from Brown, including Dan Leventhal, who was her teaching assistant just last year!

While at Microsoft, she spent much time working with Yossi Azar, another Microsoft Research long-term visitor on leave from Tel-Aviv University, and, together with Anna Karlin from the University of Washington and her Ph.D. students, they studied the budgeted allocation problem in which one sells items to customers to maximize revenue when customers have a limited budget and the value of the items for sale is different for different customers, depending on their perspective. This is loosely connected to the online auctions offered by search engines such as Google, MSN or Yahoo. In general, it is impossible to find the exact best allocation, but they designed a method to find an approximate solution.

In another collaborative project, Claire explored the definition of formal models for customer behavior in online ad auctions and the possibility of incorporating externalities into the model: customers are more likely to buy from a standalone, highly relevant ad than from an ad that is adjacent to another, equally relevant ad. Understanding the algorithmic, computational and optimization questions emerging from economic problems is an exciting research direction, which has been attracting an increasing number of computer scientists.

As a side benefit of her visit to Microsoft, Claire also learned the Hebrew alphabet as a natural consequence of being around numerous visitors and researchers from Israel. Being in contact with people from many different countries is one of the perks of academic life!

Steve Reiss

This fall Steve concentrated mainly on teaching two courses. One, CSCI0190, is a new course representing the department's first attempt to provide an accelerated introduction for freshman who come in with programming experience but not enough to not take CSCI0150 or CSCI0170. Here Steve taught most of the data structures covered in CSCI0160, while trying to give the students the programming background they would normally get out of CSCI0150, both through assignments and through lectures.

The course seemed to go well, but the proof will come later as we see if the students taking this course will succeed in later courses that build on the introductory sequences such as CSCI0320 (which several are taking now) or CSCI1570.

In addition to teaching, Steve also presented papers at both ICSM (finding patterns of unusual code) and ASE (learning coding style from sample code), and even got a little bit of research done.

John Savage

John gave an invited talk entitled, "Nanowire decoders," at the workshop on NSF, Nanoelectronics: Circuits, systems, and CAD tools, last October. The purpose of the workshop was to bring leading researchers in nanotechnology together to advise NSF. He has initiated an NSF funded research program on coded computation in which computation is done on encoded data as a means to cope with increasing failure rates as devices shrink in size.

John continues to be active in faculty committee work. He is chair of the Faculty Committee on the Campaign and co-chair with Al Dahlberg of the subcommittee on Organization and Governance of the NEASC accreditation steering committee that is preparing for Brown's re-accreditation in 2009. He is also a member of the Nominations Committee and is chair of the department's Curriculum Committee. The Curriculum Committee has been very active in revising concentrations, particularly our inter-departmental concentrations, as well as the requirements for the Master's degree.

Meinolf Sellmann

After a spring '07 semester filled with service activities such as the preparation of the department's outreach program Artemis and the CP'07 conference, in the fall 2007 semester Meinolf happily focused on his research again. There are two core concepts that drive the research in combinatorial optimization: the classical concept of inference, which refers to the development of efficient, polynomial-time algorithms that allow us to exclude those parts of the search-space, which cannot contain feasible, improving solutions; and the concept of search, which refers to how the search-space is partitioned and the order in which the partitions are traversed.

Inference has received the most attention in mathematical and constraint programming, which may well be attributed to the fact that it is possible to analyze the worst-case efficiency of inference algorithms theoretically. Lacking adequate fundamental theoretical concepts, the same does not hold for search, which is left to deal with the NP-hard core of the problems.

With respect to inference, in collaboration with his Ph.D. student, Serdar Kadioglu, Meinolf devised a method for filtering an entire sequence of context-free grammar constraints incrementally them, but I haven't discouraged them either.

Do you have any words of career advice for our recent graduates?

Keep current, look ahead to see what is coming, and have fun.

Among all your past research, what is your favorite piece of work?

This would probably be the FIELD programming environment, both because it was so successful and because it was so simple and effective. It used a very simple generic message-based strategy to link together a variety of programming tools, effectively making them into a single environment. We used it for several years for teaching programming at Brown and the ideas (and in one case the code) were adapted as the basis for most of the Unix programming environments in the 90s.

If you had enough extra time to study one additional area, what would it be?

Computer science. There is lots of it that I still don't know that seems quite interesting. Outside of this, probably physics is most intriguing to me. ■

Industrial Partners Program

The primary goals of the Industrial Partners Program (IPP) are to exceed the expectations of our partner companies in terms of recruiting and outreach, to allow our faculty to engage in meaningful research collaborations and to provide resources and employment opportunities to our students.

The department wishes to thank our Industrial Partners for their support:

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in the same cubic time that it takes to parse a complete assignment with the Cocke-Younger-Kasamy algorithm, while using only quadratic space. The latter is a crucial requirement for the practical feasibility of using grammar constraints. Experimental results show speed-ups of a factor of almost two hundred already for small problem instances.

For a couple of years now, Meinolf's research has been gradually shifting more and more towards the study of search, which is much harder to tackle, but therefore holds the promise of the most significant gains that can be achieved in the future. Last fall, in collaboration with Yuri Malitsky, Meinolf's second Ph.D. student, he was able to formulate the fundamental shift of paradigms away from intuitive search heuristics to well-founded probabilistic inference techniques for making reversible search decisions. An experimental study of classic knapsack heuristics was conducted by Meinolf in collaboration with former student Dan Leventhal which has been accepted for publication at CPAIOR'08. By introducing a new randomized search technique called model-restarts, Meinolf and his collaborators, undergraduate student Aurojit Panda, and graduate student Justin Yip, could show that static symmetry, breaking vastly, outperforms dynamic symmetry, breaking on piecewise symmetric satisfaction problems. The new method also beats another symmetry-breaking method that was proposed at CP'07 and that exploits regular grammar constraints by an order of magnitude.

Don Stanford

In addition to all activities both at Brown and elsewhere, Don has become involved as the CEO in a startup venture called mPayUSA (www.mpayusa.com). mPayUSA has acquired the North American and Central American rights to a unique technology for performing secure transactions over cell phones that was developed and is currently operational in Poland. At present Don and his colleagues are negotiating agreements with the U.S. cellular carriers, as well as talking to various alliance partners in preparation for a launch of the service in Rhode Island in the fall 2008. Initially, Don and his colleagues would like to introduce the mobile payments application on college campuses in the Providence area with expansion statewide within the first year.

Eli Upfal

Eli stepped down as department chair on July 1, 2007 and left for a sabbatical year at the University of Padova, Italy, one of the world's oldest universities. During the first few months in Europe, Eli was one of the organizers of a Dagstuhl workshop on Randomized Algorithms; was plenary speaker at the Open Day in Genomics and Bioinformatics, Goteborgs and Chalmers Univrsities, in Sweden; and gave an invited tutorial in a workshop on "Cooperative multi agent systems" at the Centro De Giorgi Scuola Normale Superiore, Italy. Eli had papers in the PODS'07 conference in Beijing, China, the AAAI'07 conference in Seattle, and ICALP'07 in Wroclaw, Poland, but he preferred to stay in Italy and did not travel to any of these conferences.

Pascal Van Hentenryck

Pascal gave a tutorial about high-performance optimization at the Annual INFORMS conference in November, as well as a talk at the MIT OR center on online stochastic combinatorial optimization.

In the spring, he will give plenary talks on constraint programming at SIOPT'08, the ninth (triennial) SIAM Conference on Optimization and at CP'AI'OR'08 in Paris. He will also give a talk in the Jacques Morgenstern Colloquium at Sophia Antipolis.

Andy van Dam

Andy continued his busy travel schedule, which included a visit to California during which he gave lectures at Sun Microsystems and Google.

After a much-needed week of vacation with his wife Debbie in Palm Island, Andy headed out to Redmond, Washington for Microsoft's annual TechFest conference (to showcase work from Brown's Microsoft Center for Research on Pen-Centric Computing). This spring he will be traveling to Salt Lake City, Utah, and then to Japan and Denmark.

Peter Wegner

Peter was invited to Vienna in October 2006 to give a talk at the University on Interactive Computing and to receive an award presented by the Austrian minister of education. In August 2007, he was invited to Estonia to lecture at a summer school on the Baltic coast.

In early November, he lectured at the University of Warwick at a conference entirely devoted to interactive computing. Peter and Dina Goldin recently completed an article on the Church-Turing thesis which will be published later this year. Peter continues to edit the Faculty Bulletin and includes occasional articles when the number of received papers is small. The recent issue included articles by President Simmons and Provost Kertzer. ■

Department Awards and Honors

Michael Black Receives Research Award for Forensic Computer Vision

Michael Black and his research group received a grant from the Rhode Island Science and Technology Advisory Council (STAC) for their collaboration with the Rhode Island State Police on forensic computer vision. The project explores new methods for tracking people in video and using 3D modeling to estimate important biometric information such as height, weight and arm length.

The team will develop and test video analysis tools that will enable the police to recover 3D human motion from low-resolution surveillance video, employ new methods for reconstructing an image of a suspect's face from low-quality video footage and provide biometric information about a suspect's height, weight and waist size.

Michael and his students previously received commendations from the Henrico County Division of Police in Virginia for their work on analyzing and enhancing surveillance video of a homicide crime scene. This new collaboration with the Rhode Island State Police will build on these efforts with the goal of establishing Rhode Island as a leader in forensic video analysis.

Chad Jenkins Spearheads Brown's Efforts to Increase Robotics Education and Research

Brown University has joined forces with more than a dozen research universities and historically black colleges and universities (HBCUs) to promote robotics and computer science education for African-American students.

The Advancing Robotics Technology for Societal Impact (ARTSI) Alliance will develop outreach programs to encourage African-American students at both the K-12 and college levels to pursue careers in computer science and robotics and will provide mentoring programs for undergraduates. The Alliance will also provide development activities for HBCU faculty who teach computer science and robotics courses. ARTSI is funded by a three-year, two million dollar National Science Foundation grant.

At Brown, the program is spearheaded by Chad Jenkins, assistant professor of computer science. "The aim is to develop and strengthen pathways from HBCUs to major research universities for minority students who want to pursue graduate degrees in computer science," Jenkins said. "Robots are a great way to inspire students because they are interactive and fun, but also they pose intellectually deep challenges."

During the summers of 2008 and 2009, Jenkins will bring undergraduate HBCU students to campus for research internships. Students will develop software applications that will allow robots to more effectively interact with humans, a major research focus in Jenkins' laboratory. African-Americans now account for just 4.8 percent of almost two million U.S. computer and information scientists, a job category that the U.S. Bureau of Labor Statistics projects will be among the fastest growing occupations over the next decade.

"To advance computing technology and robotics, we need as many great minds in the field as possible," Jenkins said. "So, it is critical to draw in dedicated and interested students, whether they choose to work in academia or the commercial sector."

Chad Jenkins speaks about robotics at San Miguel Middle School in Providence

HBCUs participating in ARTSI are Spelman College, Hampton University, Morgan State University, Florida A&M University, Norfolk State University, Winston-Salem State University, University of Arkansas-Pine Bluff and the University of the District of Columbia.

They are joined by research universities including Brown University, Carnegie Mellon University, University of Pittsburgh, Georgia Institute of Technology, Duke University, University of Alabama, and University of Washington that will provide research internships, mentoring opportunities and lesson plans and materials. Corporate partners include Seagate Technology, Microsoft, Apple, iRobot and Juxtopia.

Activities will include:

- academic-year student research activities at HBCUs;
- summer internships for HBCU students in research university labs;
- an annual student research conference and workshop;
- local outreach at middle and high schools serving minority populations in each HBCU's community;
- national outreach through an ARTSI web portal, currently under development; and
- "viral marketing" through student-produced robotics videos on YouTube that showcase the achievements of ARTSI-affiliated students and faculty.

Anna Lysyanskaya Receives Sloan Research Fellowship

Anna Lysyanskaya was recently awarded the prestigious Sloan Research Fellowship, the oldest and one of the most competitive fellowship programs in the United States. Anna's extraordinary work in cryptographic protocols, namely anonymous credentials and electronic cash, led to her inclusion in this elite group

"The Sloan Research Fellowships support the work of exceptional young researchers early in their academic careers, often at pivotal stages in their work," Paul L. Joskow, president of the Alfred P. Sloan Foundation, said. "I am proud of the Foundation's rich history in providing the resources and flexibility necessary for young researchers to enhance their scholarship and I look forward to the future achievements of the 2008 Sloan Research Fellows."

Selection procedures for the Sloan Research Fellowships are designed to identify those who show the most outstanding promise and fundamental contributions to new knowledge. "I am very honored to be selected as a Sloan fellow," Anna said. "This award will enable me to pursue problems I am very excited about, those that may take me a long time to solve, and so it would be hard to get, for example, NSF to sponsor them, while the Sloan Foundation gives its fellows freedom to truly explore."

The fellowships are awarded by the Alfred P. Sloan Foundation to honor and promote the science of outstanding researchers early in their academic careers. The 118 winners are faculty members at 64 colleges and universities in the United States and Canada. They receive grants of $50,000 for a two-year period to pursue whatever lines of inquiry are of most interest to them. This money will be used to support the work of Anna and her students in privacy-protecting technologies as well as the theoretical underpinnings of cryptography.

Aside from the monetary aspect of the fellowships, less tangible benefits have been cited by former Fellows. The early recognition of distinguished performance, which the fellowships confer after years of arduous preparation, was said to be immensely encouraging and a stimulus to personal and career development.

The Sloan Research Fellowships have been awarded since 1955. Since then, thirty five Sloan Research Fellows have gone on to win the Nobel Prize in their fields and fourteen have received the Fields Medal, the top honor in mathematics.

Claire Mathieu Receives 2007 ICS Prize

Together with her coauthors, J. Csirik, D. S. Johnson, J.B. Orlin, P.W. Shor, and R.R. Weber, Claire Mathieu received the 2007 ICS Prize given by the Institute for Operations Research and the Management Sciences (INFORMS) computing society to papers at the interface between operations research and computer science.

The prize was given for their paper "On the sum-of-squares algorithm for bin packing."

In 2002, Pascal Van Hentenryck received the award for his many contributions to the field of constraint programming and its integration into operations research.

The ICS Prize is an annual award that promotes the development of high-quality work advancing the state-of-the-art in operations research / computer science interface, publicizes and rewards the contributions of those authors / researchers who have advanced the state-of-the-art and increases the visibility of excellent work in the field. The INFORMS computing society has awarded this prize since 1986.

Ben Raphael Receives Career Development Award from Brown University

Brown's Career Development Award aims to create opportunities for faculty to meet senior colleagues with a high degree of social capital. These meetings could significantly affect a faculty member's ability to participate in new collaborations. The award provides funding for individual faculty to develop peer networks, nationally or internationally, and increases their access to opportunity.

Ben's research is focused on developing and applying computational and mathematical methods to biological questions. To obtain this award, Ben proposed a series of meetings with colleagues with the aims of: 1) developing mentoring and collaborative relationships with senior scientists, (2) training two female graduate students in a discipline underrepresented by women, and (3) continuing research collaborations.

Andy van Dam Tapped to Lead CRA's Effort to Improve the Quality of Computing Education

The Computing Research Association (CRA) recently announced the appointment of Andy van Dam to chair its new Education Committee, called CRA-E. This committee has been tasked with thinking broadly about the future of computing education, especially at the undergraduate level.

Established as part of an ongoing trend toward reexamining the image of computing and the nature of the twenty-first century computing curriculum, the CRA-E seeks to understand how the broad computing community needs to move forward in order to develop principles and philosophy underlying the computing education of the future. "We need to rethink some of our fundamental assumptions about computing education approaches and content, and Professor van Dam is the right person to lead that effort," said Daniel Reed, Microsoft's scalable and multicore computing strategist and chair of CRA.

Andy has been on Brown's faculty for more than forty years and was one of the founders and first chair of the department of computer science. He co-authored more than ten textbooks including, *Computer Graphics: Principles and Practice*, and has authored or co-authored over one hundred papers. Andy is a fellow of the IEEE, Association for Computing Machinery, and the American Association for the Advancement of Science, a member of the National Academy of Engineering and the American Academy of Arts and Sciences, recipient of awards for outstanding contributions to computing education from ACM, IEEE and SIGCSE, and a winner of the 2002 CRA Distinguished Service Award. He also served as the chair of CRA from 1985 to 1987.

Two Awards for CS Ph.D. Student in Data Management Research

Computer science Ph.D. student Yanif Ahmad was recently awarded an IBM Ph.D. fellowship for the 2008-2009 academic year. These prestigious awards consider Ph.D. students nominated by computer science departments worldwide and cover tuition, fees, and a stipend for the year. Award recipients are selected based on their overall potential for research excellence, their academic progress to-date as evidenced by publications, and the degree to which their technical interests align with those of IBM. "I'm honored to be nominated and delighted to receive this award. It's great to have an opportunity to discuss research with IBM and I hope that it will strengthen my insight into and impact on real-world problems," Yanif said.

Yanif's research spans data stream query processing and optimization and investigates how to augment processing with data models capturing

the time-varying nature of attributes to efficiently process queries. This continuously changing, time-dependent data naturally occurs in many stream applications, especially geospatial and financial applications. The models are an approximation of the raw data, requiring techniques to manage errors and their propagation during query processing. Yanif's most recent work focuses on improving system scalability by sharing work common to many queries and on extending Pulse to support alternative data modeling techniques, such as differential equations and time series, to better support scientific and engineering applications.

Yanif was also recently awarded the Best Research Paper at the International Conference for Data Engineering (ICDE). The paper, "COLR-Tree: Communication-Efficient Spatio-Temporal Indexing for a Sensor Data Web Portal," was selected out of the 617 submissions and seventy five full papers accepted to the conference. This work was co-authored with Suman Nath during an internship at Microsoft Research in Redmond, Washington. The paper studies query processing for Microsoft's SensorMap, a web portal for publishing live data from many sensor networks on a geographic map. The paper discusses how to couple caching and sampling techniques with indexing to reduce expensive communication and improve query processing performance. Yanif hopes to see the SensorMap project bring diverse data publishers on board to help address many database researchers' needs for real-world datasets.

Colin Gordon Receives Honorable Mention in 2008 CRA Outstanding Undergraduate Competition

Undergraduate student Colin Gordon was recently selected for Honorable Mention in the Computing Research Association's Outstanding Undergraduate Award competition for 2008.

Colin's research was on a form of consistent, transactional updates in a modeling formalism called Abstract State Machines (ASM). The work resulted in a paper published at the ASM 2007 workshop. The paper was co-authored with two other Brown undergraduates, Leo Meyerovich (who won a CRA Honorable Mention last year) and Joel Weinberger, and their professor, Shriram Krishnamurthi. Colin has also done research on dynamic contention management for software transactional memory with Maurice Herlihy.

Colin's service record is also exemplary. This year he is one of two undergraduates responsible for organizing and running the undergraduate TA program for the department. He has also TAed several courses over the years. In addition to all this academic experience, he has interned at Sun Microsystems, Network Appliance, and Wexford Capital.

Brown CS now has an unbroken eleven-year run of students being recognized in this competition. Chair Roberto Tamassia was thrilled at Colin's inclusion in this prestigious list. "We believe the department's long history of involving undergraduates in research and education has contributed to Colin's success," Roberto said.

Brown Team Competes at "Battle of the Brains" in Canada

Three Brown students, Dimitar Bounov, Greg Pascale, and Adrian Vladu, also known as "Brownian Motion," received an honorable mention at the 32nd Annual ACM International Collegiate Programming Contest (ICPC) in Banff Springs, Alberta, Canada, April 6-10, 2008. Only one hundred of the more than sixty-seven hundred teams, representing 1,821 universities from around the globe, earned coveted spots on the 2008 ACM-ICPC World Finals roster. Brownian Motion was one of only twenty U.S. teams to compete in the World Finals. ■

Report on the 39th IPP Symposium

By **Roberto Tamassia**

On November 15, 2007, the Industrial Partners Program and I hosted the 39th IPP Symposium on the topics of security and privacy. Five speakers, all from partner companies, gave talks on the challenges and obstacles involved in keeping data secure and private.

The first talk of the morning, "Making security scale" was given by Seth Proctor ('99) of Sun Microsystems who reasoned that scalability comes not just from the technical design of a system, but also from its comprehensibility, usability, and manageability. Quoting from his abstract, "It is often failings in these criteria that lead to the security and privacy breakdowns that have become so widespread." Seth went on to discuss the "increasing complexity of systems and the great challenge of maintaining security, providing privacy, and protecting users who often know little or nothing about the ways in which their systems and data are managed. In short, the security of systems hasn't scaled along with the systems themselves. One question is how to integrate the very strong building blocks in the form of robust ciphers and hash algorithms, good cryptographic protocols and solid theory for many aspects of information flow."

Faculty and IPP members mingle during the lunch break.

left to right: Charalampos Papamanthou, David Croston, Moti Yung, Roberto Tamassia, Seth Proctor, Steve Weis and Blair Semple.

The morning session concluded with a talk entitled, "Authentication of outsourced storage," which was given by David Croston of IAM Technology with help from Ph.D. candidate Charalampos Papamanthou and undergraduate Alexander Heitzmann. The talk presented a general method and a practical application for maintaining authenticated files in an untrusted network storage service. The authentication process is managed by an application that is independent from the specific storage technology used and thus works with a variety of online storage services. Experimental results show that the integrity verification method is efficient and that the overhead due to authentication is negligible. The talk ended with a demonstration of the authentication technology applied to Amazon's Simple Storage Service.

The afternoon session began with a talk from Steve Weis of Google entitled, "Competition & fraud in online advertising markets." Steve discussed advertising fraud, particularly how "click fraud," is a growing concern to the online advertising industry. His presentation provided an interesting look at an economic model of the online advertising market with a focus on the effect of ad fraud. Steve's central question was whether or not advertising networks have an incentive to combat fraud. The model answers this question in the affirmative and predicts that ad networks have an interest in fighting fraud and can obtain a competitive advantage with better filtering technology.

The second talk of the afternoon entitled, "On the evolution of authentication factors," was given by Moti Yung, of Columbia University and Google. In his talk, Moti described how the modern computing environment, its capabilities on the one hand and threats associated with it on the other hand, influence the basic notion of end-user authentication. In particular, he discussed how a social network can provide a fourth authentication factor beyond the traditional three factors, i.e., something you have (e.g., a hardware token), something you are (e.g., a fingerprint), and something you know (e.g., a password).

The day ended with a talk from Blair Semple of Network Appliance entitled, "Securing data with strong encryption and access controls." First, he discussed attacks on stored data, laws and regulations regarding the protection of personal information and the cost of privacy breaches for corporations. Next, he presented emerging industry standards for storage security, including a key management infrastructure for cryptographic protection of stored data. Blair concluded his talk by describing a storage security appliance that protects stored data with wire-speed encryption, strong access controls, authentication, and tamper-proof auditing. ■

Expressive Programming

By **John Cayley**
Visiting Professor of Literary Arts

According to Donald Knuth, Professor Emeritus at Stanford University, programming is an art. It is becoming clear, however, that in our age of ubiquitous computation, programming *is* art. So, it is timely and exciting that—thanks to matching support from RISD and from institutions within Brown—the department of computer science at Brown has been able to run an innovative course this spring entitled, "Advanced programming for digital art and literature" (CSC1950C, CRN25138). The course is taught by Daniel Howe, Visiting Professor of computer science at Brown, who brings a unique combination of talents to bear in his teaching. Daniel is completing his Ph.D. thesis in computer science at NYU's Media Research Lab, has taught related courses at NYU and RISD, and is an MFA graduate from Brown's own Literary Arts Program. He's also a heavy-hitting programmer (with years of experience in both the software industry and the open source community) who is committed not only to 'expressive programming' in his own practice, but also to developing the requisite teaching resources to make it clear to all of us what this emerging term actually means.

"In a world where net.art, conceptual art, and audiovisual art using computation is already often well-regarded and well-funded, as well as hyped, it is important to remember that text processing is close to the heart of computing and needs to be closer to the heart of literary practice."

Personality Explorer Project by Master's student Andrew Bragdon

The course is well underway and was quite heavily oversubscribed. It brings together an interesting, not to say creatively volatile, group of students. There are graduates from the Digital + Media program at RISD, graduates from the literary arts M.F.A., Ph.D. candidates from the MEME and MCM programs, senior undergraduates (including one doing an independent concentration on literary systems), and CS students of various shapes and sizes. There is also at least one faculty auditor, myself, a visiting professor (for five years) in Literary Arts with a brief for 'Writing Digital Media.' I am an amateur programmer and literal artist, a maker of literary objects in programmable media. As one of the sponsors of this course, I'm now enjoying every minute as Professor Howe opens up the world of Processing (http://www.processing.org), a development environment specifically designed for programming-as-art.

Professor Howe has a special interest in the literary practices associated with expressive programming and is a keen practitioner of natural language processing. He knows the existing tools and is busy building some of his own, which he then generously makes available to us all (particularly a text processing library called RiTa). In a world where net.art, conceptual art, and audiovisual art using computation is already often well-regarded and well-funded, as well as hyped, it is important to remember that text processing is close to the heart of computing and needs to be closer to the heart of literary practice. Professor Howe's emphasis in this respect is highly important and gives this course a very special quality. ■

New Faces – Rachel Reisner

Early in February, Rachel Reisner joined the graphics group as Professor Andy van Dam's executive assistant. Previously, she was executive assistant to the CEO of Gary's Wine & Marketplace, a multi-million dollar retail business in New Jersey. Ironically enough, she rarely partakes. Rachel received her bachelor's degree in English from Rutgers University in New Brunswick, New Jersey, where she also served as coordinator for Scarlet Listeners, a volunteer peer counseling organization. She traveled extensively while in school, visiting twenty countries and living temporarily in China, Switzerland, and Saudi Arabia. She enjoys fine dining, travel, films, and photography. Rachel is very enthusiastic about joining the graphics team and encourages foot traffic through her office where a well-stocked jar of M&Ms is strategically placed on her desk. ■

Seventh Annual Paris C. Kanellakis Memorial Lecture

On February 14, 2008, Arvind of the computer science and artificial intelligence laboratory at MIT gave the Seventh Annual Paris C. Kanellakis Memorial Lecture entitled, "A hardware-design inspired methodology for parallel programming."

This lecture series honors Paris Kanellakis, a distinguished computer scientist who was an esteemed and beloved member of the department of computer science at Brown. Paris joined the department in 1981 and became a full professor in 1990. His research area was theoretical computer science with emphasis on the principles of database systems, logic in computer science, the principles of distributed computing, and combinatorial optimization. Paris died in an airplane crash on December 20, 1995, along with his wife, Maria Teresa Otoya, and their two young children, Alexandra and Stephanos Kanellakis.

In addition to the lecture series, Brown University offers two special graduate fellowships that were established in memory of Paris. The Kanellakis fellowships are the result of a generous donation from General and Mrs. Kanellakis, Paris' father and mother. The fellowships are awarded to students accepted into the Ph.D. program in computer science. In keeping with the wishes of General and Mrs. Kanellakis, we prefer to award these fellowships to students from Greece whenever possible. The Kanellakis family also made a donation to MIT, where Paris received his Ph.D. in computer science, to support graduate student fellowships. The 2008 lecture was especially meaningful as Kanellakis fellowship recipients from both Brown and MIT attended and had the opportunity to meet each other for the first time. ■

The Kanellakis Fellows from Brown and MIT with Speaker Arvind and Roberto Tamassia

Parenthetically Speaking

"Parenthetically Speaking" is a feature column by Associate Professor **Shriram Krishnamurthi**.

Shriram with Dewey

Scribd or Cribd?

Scribd is a new document-sharing Web site.

Does that immediately remind you of something? Where did the content for the music-sharing networks come from?

I found Scribd because I was searching on a phrase, found it on Scribd, and realized it was in an uploaded copy of my own programming languages book. I didn't upload it, nor did I authorize it.

You would think the site would take real precautions to validate uploaded content. But they don't seem to (I pretty quickly found other copyrighted content), and perhaps that's to reduce their exposure (curtailing nothing is better than curtailing some and being held responsible for whatever slips through). Nevertheless, this has to be a lawsuit waiting to happen.

What really curdles my cream is Scribd's statement on how they will handle messages about copyrighted content:

"Please note that Scribd may, at our discretion, send a copy of such notices to a third-party for publication. As such, your letter (with personal information removed) may be forwarded to Chilling Effects (`www.chillingeffects.org`) for publication."

How's that again? Chilling Effects (a phrase from a famous Supreme Court ruling) was created to protect fair use, fan fiction, parodies, and the like. Of course, some of the people writing Scribd surely are stupid lawyers (more on that below). But these are hardly the people who care about Chilling Effects. So the effect of this statement can only be to intimidate the innocent with the subtle message that if you complain about Scribd, you're effectively chilling free speech.

Which brings me to the lawyers.

Legal Beagles

It was 1997 and I was the webmaster for the Rice computer science department. One day I received a nasty, threatening cease-and-desist message. The design of these messages is, of course, to intimidate the recipient into submission; lacking guts, I froze.

On closer examination, I found that it was from lawyers representing Figaro's Pizza trying to protect their trademark, which they accused us of abusing. Well, I thought (my innards warming), this was surely at best a misunderstanding: why would a computer science department abuse a pizzeria's copyright? So I asked them to provide a URL (they had, of course, failed to do so in their original message).

The URL they sent was to a page owned by one of our former undergraduates (who is now a computer science professor at a leading research university). I knew him well as he had worked with our research group; he was smart, funny, and a prankster. He lacked malice, but I could just see him involved in a parody. After all, the URL ended in `figaro.html`. With much trepidation, I pasted the URL into my browser.

It was the home page of his cat, Figaro, and somewhere on the page he happened to mention that the cat enjoyed pizza.

Curiously, for a company so eager to protect its trademark (they had an application pending about eight months at that time, which probably explains the adrenaline rush), they pulled a Bill Gates, i.e., completely missed the Internet. Their current domain name was unregistered at the time. Should have bought it, given that they have expanded into such world-class pizza destinations as Birmingham, Memphis, and Abu Dhabi.

Returning to the story: Containing my annoyance and anger, I wrote a brief reply to the law firm explaining that there was no violation on said page, so I was considering the matter closed. Suddenly my correspondent — who had previously used crisp, articulate, legal language — slid into poorly-punctuated, malformed sentences, riddled with "u" for "you" and similar contractions. Maxie, the writer, found the episode very amusing, and had the audacity to ask me to teach how to perform better Web searches (missing the point that the problem was reading, not searching). When I told him to shove it (politely, of course: nothing is worse than a lawyer with bad aim), he responded (and here I'm translating into regular English), "Why won't you help me? I was told the Internet is full of helpful people!"

Just Say Slavery

Speaking of regulations and the word of the law:

When I began to do research involving human subjects, I had to complete Brown's Institutional Review Board (IRB) certification. The certification course and exam is conducted by CITI, an organization that runs these services for a host of institutions. Presumably they charge a reasonable sum for their service.

I think IRB is a valuable practice. Studies with human subjects are fraught with difficulty; not only can even seemingly innocent projects expose subjects to risks, the very act of forcing experimenters to think about these issues is valuable and can help them re-think their study to be less intrusive, risky, or harmful. Of course, there is still a slightly surreal air to this kind of training, where one size is meant to fit all: studies with children, studies with prison subjects, the lot.

Setting aside such diluting generality, the issue I have is with the reductionist tests that accompany such training. I went into the online course hoping for an interesting educational experience; what I got was a quick return to high school history class, an absurd exercise in rote memorization and the recitation of slogans. Surely this could be tested in an interesting way, even on the Web (more on that in a bit), but I got the sense they weren't even trying.

The tests reminded me not only of high school history but also of driving tests. Every driving test has a de rigueur question about blood alcohol or about drunk driving penalties (but not—and this is a pet peeve—about the rights of bicyclists). But the answers are not instructive; instead, they're petty. Suppose the penalty for drunk driving is three months in jail; you, being the kind of person who is too sensible to drive drunk in the first place, probably read that and thought, "Okay, so the penalty is some number of months." But the options are never (1) three days, (2) three months, and (3) three years, answers with an order-of-magnitude difference. They will, instead, be (1) one month, (2) two months, or (3) three months. In short, instead of recording the high-order bit, you'd only captured the low-order one.

You could design a smart test. You could put people in situations and ask them what course of action they would take. Sometimes, the reasonable course of action would prove to be the wrong one according to the law, and understanding that difference would be instructive. But designing such a test requires the designer to actually understand testing, which is (guess what) a subtle and rare talent. A good tester, for instance, understands that most questions should be meaningful enough to administer even in an open-book exam. And so on.

Well, the CITI test was a lot like a typical computerized driving test. I had to work very hard at memorizing key phrases on the assumption that they might show up later (and some did). Only one question that I got wrong was actually instructive. And then I got to a question along these lines (actual wording not reproduced, so that CITI's lawyers don't come after me):

The purpose of SSL is to secure data:

- True
- False

Well, I thought! After all this talk about experiments with children and prisoners and drugs, finally a question right in my wheelhouse! Here was an eminently debatable proposition...and then I remembered this exchange from one of my favorite *Simpsons* episodes (cribbed from the Web):

Proctor: What was the cause of the Civil War?

Apu: Actually, there were numerous causes. Aside from the obvious schism between abolitionists and anti-abolitionists, economic factors both domestic and inter—

Proctor: Hey, hey... just say slavery.

Apu: Slavery it is, sir.

So I played it straight.

And now I'm certified.

Oh yeah, the Web. Nothing in their testing infrastructure precludes using multiple tabs or the Back button. Not that I'd know anything about that.

Speaking of CITI reminded me of this:

The What in the Where?

I was watching (with subtitles) Godard and Gorin's amusing but cartoonish Marxist rant, *Tout Va Bien*. In it is this remarkable sequence of

lines, as two voices conjure up a movie:

There'll be a country.

In the country, there will be a countryside.

In the countryside, there will be cities.

In most of human history, this last line probably seemed entirely natural. The great secular and spiritual centers, such as castles and temples, were built in part to dominate their surroundings, serving as an overpowering beacon to the visitor from the countryside. And yet, to an urban creature like me, cities are what there are; the countryside is what you obtain by subtraction. To hear of cities as the passive agents planted into the countryside was startling.

When I'm in Paris, I imagine what it must have been like to float down the Seine, pass the exurbs of huts and fields, and then come upon the towering majesty of the Île de Cité. (Likewise for Madern Gerthener's great cathedral alongside the Main in Frankfurt, or any number of other such monuments.) That's why the view of the Notre Dame that most impresses me is from the waterside on the embankment—from down below. Then we see the cathedral as its builders actually intended it to be seen.

Coda: The Monuments of State

Finally, I'm going to interject a rare political comment into this periodical. I don't usually get my news from TV, and in general avoid the klieg lights of frenzied CNN coverage. Yet during winter break I was transfixed by the news of the assassination of Benazir Bhutto. It may have been work-avoidance, but I think it was something more.

Sub-continentals of a certain age—mine—will remember the heady days of the mid-1980s, when two young technocrats came to power in India and Pakistan. In India, we joked that we'd gotten the raw end of the deal: while their new leader had chaired the Oxford Debating Union (at a time when such things still meant something in the sub-continent), ours seemed to have spent his time at Cambridge wooing a girl and not much else. But ours had then worked as a pilot and nothing seemed a better metaphor for the flight to modernity that we were promised. We truly believed these leaders would create better societies within our countries, and that their education and exposure would quell the fires that raged between India and Pakistan. It was a powerful kool-aid.

In the end, of course, it all came crashing down. Rajiv Gandhi was quickly engulfed in a major scandal; his modernizers ran into walls of orthodoxy and venality; and eventually, on the road back to power during an election campaign, he was the target of an early, high-profile suicide bomb. Benazir Bhutto, for her part, similarly mired in the muck of politics and corruption and lost, won, and lost again in dizzying succession. Exactly why Western powers had so much vested in her return is unclear; no political realist could have looked on her regency with much hope.

And yet, today, India at least is a booming economy, her considerable social troubles at least slightly counterweighed by her achievement and hope in some arenas. And none of this growth has come in ways that Rajiv Gandhi imagined. His vision was ultimately still one of top-down, government-led development (though he did listen to people smart enough to appreciate the need for telecoms infrastructure). The companies that dominate the headlines today were shabby regional outfits at that time. Though they have attracted new sparks, to a considerable extent they are led by the same people as they were before, suggesting that the problem was not one of talent, but of freedom to innovate. (As *The Economist* put it recently, India's vast licensing regime was, fortunately, simply not attuned to software, so it got free before they could clamp their hands on it.)

And so, a chapter of sub-continental politics that began with so much hope in my youth, and had already sputtered to a halt a few years later, formally ended with Benazir's tragic passing (which had an eerie parallel to Rajiv Gandhi's own end). With it, I hope, also died a chapter in the economics of development. While the centralized, top-down push for innovation that these leaders represented failed dismally, decentralized, bottom-up forces have used their freedom to forge a remarkable industry. I only hope now that Pakistan will find in itself innovation to parallel India. And as for the world powers, as in technology, so in politics: instead of trying to find the leader who represents your views and promises to thrust it upon her people, work on empowering the people at the bottom. ■

Named UTRA supports CS-Music Collaboration

By **Jocelyn Adams** and **Ian Sherman**

Ian Sherman and Jocelyn Adams with Wiimotes.

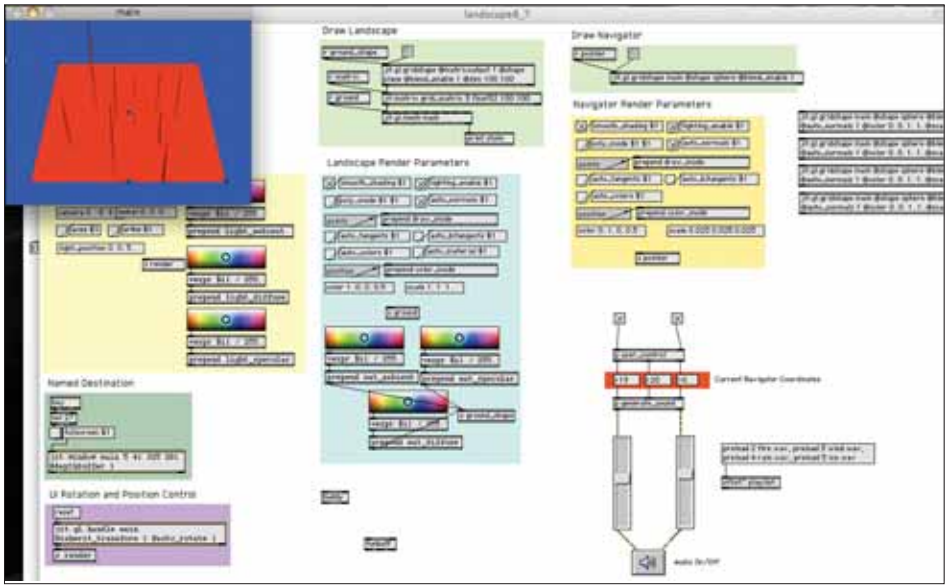
Last spring, a team composed of Jocelyn Adams, a composer / musician and music concentrator, and Ian Sherman, a musician and computer science concentrator, received a named UTRA earmarked for research in media and production. They pursued their project entitled, "Wearable sensor networks as an interface to interactive media," under the guidance of Professor Ugur Cetintemel.

As aspiring musicians and scientists, Ian and Jocelyn were drawn to this project as a chance to bridge their interests in art and technology. Interactive media is an active research area at Brown in the electronic music and modern culture and media departments, as well as in the RISD digital media program. Ian and Jocelyn began their work with visits to these departments, as well as a field trip to the MIT media lab. Since they were newcomers to this world, their initial goal was to learn its landscape.

Ian and Jocelyn first set their sights on developing software that could act as an abstraction over wireless hardware for artists. They quickly found, however, that a good solution to this problem already exists in the programming environment Max / MSP / Jitter. Max is a graphical data-flow language, which, when combined with packages to support audio synthesis (MSP) and video processing (Jitter), offers the artist a powerful tool for manipulating data streams and mapping them to audiovisual output. Its active user community supports objects to interface with sensors of all shapes and sizes. Following the advice of professor Chad Jenkins, who has had success using Nintendo Wiimotes to control Sony AIBO robots, they focused their attention on these familiar and inexpensive wireless controllers.

After growing comfortable with Max and successfully interfacing with the sensors, Ian and Jocelyn set to work implementing some algorithms to interpret the data streams coming in from the accelerometers on the Wiimotes. For example, they hoped to identify, in real time, when two Wiimotes were moving in sync. They found that some previously developed variants of the dynamic time-warping algorithm worked quite well. Though they didn't have time to realize an artistic piece on any large scale, they were able to create some proof-of-concept pieces. In one piece, two users navigate around an aural landscape with their Wiimotes. When their movements are synchronized, they can move more quickly through this 3D environment populated with sounds.

Since the summer, Jocelyn has incorporated this work into performances with her band The Low Anthem, and Ian has been building more interactive media in a class in RISD's digital media department. They are grateful to Ugur, Chad, the computer science department, the UTRA program, and NSF for their support in this project. ■



Data-flow program for the "Aural Landscape" application

New Ph.D.s

Recent Ph.D. Thesis Defenses included Mira Belenkiy, Melissa Chase, Guy Eddon, Lucia Draque Penso, and Danfeng Yao

Mira Belenky

Melissa Chase

Guy Eddon

Lucia Draque Penso

Danfeng Yao

Andy van Dam Cha Chas in Dancing with the Profs

Andy van Dam was one of seven professors who took to the stage in a packed Alumnae Hall for "Dancing with the Profs" on February 8, 2008. He and his dance partner, Patra Jongjitirat (class of '08), performed a fun dance routine for the three hundred students and staff in attendance, as well as for the competition's three judges.

The event was created by the Brown Ballroom Dance Team, who practiced with the seven professors for months, and then competed with a 90-second routine, each choosing a different dance: the fox trot; jive; rumba; salsa; swing; and the Viennese waltz, salsa. Andy chose the Cha Cha.

An internet search reveals that the Cha Cha is "a cheeky, lively, and flirtatious dance. It has a catch-me-if-you-can atmosphere, and is light and bubbly." Andy definitely brought the cheeky element to his performance, wearing a loose-fitting, chili pepper-printed shirt with the top two buttons undone. His most unforgettable moment involved combing his hair while Jongjitirat slinked around him. If you'd like to see Andy's performance, please visit mms://anything.cs.brown.edu/avd_DWP.

"Andy definitely brought the cheeky element to his performance, wearing a loose-fitting, chili pepper-printed shirt with the top two buttons undone."

Andy van Dam with President Ruth Simmons and Patra Jongjitirat.

Comments?

Send your views to: Conduit,
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or e-mail conduit@cs.brown.edu

Alumni Update

Brown Alums receive Academy certificate for the development of a fluid-simulation system.

Jonathan Cohen '00, Jerry Tessendorf '84, and Michael Kowalski '99

Three Brown alumni—Jonathan Cohen (B.Sc. CS and Mathematics, 2000), Jerry Tessendorf (Ph.D. Physics, 1984), and Michael Kowalski (M.Sc. CS, 1999)—were recently honored with an Academy of Motion Picture Arts and Sciences Technical Achievement Award for their work on fluid simulation technology for computer-generated film visual effects. The three were co-recipients of an academy certificate, along with Jeroen Molemaker, for developing the fluid-simulation system at Rhythm & Hues Studios. This technology was used for creating a variety of water, fire, smoke, and gas effects for several films, including The Chronicles of Narnia, Superman Returns, Happy Feet, and most recently The Golden Compass. The award was presented on February 9, 2008 at a black-tie ceremony hosted by actress Jessica Alba at the Beverly Wilshire Hotel in Los Angeles. Highlights of the evening were broadcast during the Oscars ceremony on February 24, 2008. Jonathan (jcohen@jcohen.name) is currently a research scientist at NVIDIA and resides in Ann Arbor, Michigan. Jerry (jerryt@rhythm.com) and Michael (mak@rhythm.com)both live in Los Angeles, where they continue their work at Rhythm & Hues studios.

Garrett Fitzgerald '90

After living for seven years in Seattle, part of which was spent working in Microsoft Product Support and then as a contractor to the Visual FoxPro Test Team, I've returned to New England. For the past year, I have been working as the developer for a large medical practice in Bangor, Maine, working with tools such as VFP, Visual Form Editor, and Crystal Reports to support the clinical and administration sides of the practice. In my career with databases, I have found that my Brown class work has been very helpful. The grounding in relational algebra that I developed in CS52, in particular, has served me well.

That's the rosy part of the update. The reason I left Microsoft Product Support is that I was let go for not meeting my metrics. A year or two later, I finally went to see my doctor and was diagnosed with ADD and severe sleep apnea—basically, even if I was awake enough to pay attention to my job, I wasn't able to. After the contracting gig ended with the release of VFP9, I wasn't able to get another job that paid as well, so I took a full-time programming/DP job with a pay cut of more than the cost of my annual rent. Some months later, my landlord had had enough of my late payments and asked my family and I to leave.

With a 13-year-old dog that had been with us since he was weaned, a non-running car, and two daughters in a dual-language program at their school, we were severely limited in where we could look for apartments. We ended up in the Hopelink Family Shelters for several months before one of our friends found us a place to live while we got back on our feet. After that, we decided that we needed to be close to our families, and moved back to Maine. I'm telling you this in the hopes that if you find yourself in a similar situation, you'll know that you're not alone and that you can come out the other end in one piece, no matter how much it hurts.

Olga Karpenko Ph.D. '07

Olga Karpenko was recently chosen for an American Associate of University Women Educational Foundation American Fellowship. She was among 97 Fellows selected from 1,116 applications submitted for the 2008-2009 class. The selected fellows are a group of exceptional women whose work promises to enhance such diverse disciplines as biology, philosophy, and anthropology. Congratulations Olga!

Ping!

Where are you and what are you doing?

Let us know what's happening in your life! New job? Received an award? Recently engaged or married? Use this form to submit your news or e-mail conduit@cs.brown.edu.

First Name

Last Name

Class Year

Address

City

State

Zip

E-Mail

My news:

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