conduit!

Volume 7, Number 2 | Department of Computer Science, Brown University | Fall, 1998

NETWORK DATA MANAGEMENT: INFORMATION HIGHWAYS WITHOUT TRAFFIC JAMS

Stan Zdonik

Prelude

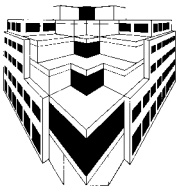
Once upon a time, in a land far, far away, managing data (entire gigabytes of it!) meant buying a mainframe and installing that magical black box called a database. Queries went in and answers came out. Simple, reliable, predictable, and fast... it was the stuff that multibillion-dollar empires were made of.

But the underlying technology—the chips, networks, and hard drives—for which databases were conceived and specialized is now in the midst of a revolutionary change. Chips are smaller, networks are faster, hard drives are larger ... and everywhere we look, the information we want seems to be creeping further away.

Digital wireless connectivity is exploding (annual sales of US digital wireless handsets nearly quadrupled between 1996 and 1997); the world fiber-optic market is expanding (worldwide annual demand for fiber optic cable has been increasing by more than 30% per year since 1993), and communications satellites are being launched faster than you can say "Space Jam." In days of yore, data was no further away than the local disk in the local mainframe where a local installation of a database engine resided. Now and increasingly in the future, the information is "out there," somewhere in the network cloud, residing in anything from a supercomputing cluster to a handheld computer. This increased access to geographically distributed data has been accompanied by unbounded growth in Internet traffic. The popularity of multimedia applications, the large number of businesses taking to the Web, and burgeoning Internet commerce are all contributing to the information glut on the Internet.

Microchips and hard drives just can't keep up. As hard drives get larger—growing by some estimates to 200 GB in 2003—the data they store becomes harder to access. Simply put, the increase in hard-drive capacity is outpacing improvements in the mechanisms responsible for positioning the read-head. As microchips currently double in efficiency every 18 months in accordance with Moore's Law, optical and wireless bandwidth doubles every 9 months: processors get faster, but our ability to flood them with data grows much faster. Moreover, Moore's Law is widely expected to fail early in the next century.

> *"the world fiber-optic market is expanding... and communications satellites are being launched faster than you can say 'Space Jam.'"*



The vaster the Internet, the longer valuable information seems to take to get from "there" to here. The larger the hard drive we put in our servers, the slower our servers are to react. Some might throw up their hands and exclaim, "The end is nigh!" (or more likely: "Smithers, that top-of-the-line server you bought last week isn't cutting it! The boss is at my throat! We need to get control of the situation! Get *this* week's top-of-the-line server and let's pray no heads roll for this!") We prefer instead to study this burly menacing beast—learn how it behaves, discover where it lurks—preparing for the day when we'll boldly step up to it, stare it in the eye, and whisper, "Game over."

Until then, for the people and applications that want to spin this worldwide tapestry of technologies into one, giant information system, there is *nothing*. In the meantime, we believe it is crucial to study the behavior of this complex information space, as we did with DBMSs.

Dissemination Studies

The stunning proliferation of wide-area, heterogeneous data networks is sweeping the databases of old into an environment for which they were never intended. Online databases are limited by a fundamental information management problem which exists in the archetypal client-asks/server-responds model: no matter the capability of a particular server, even the most well-intentioned large client population can inadvertently overwhelm it with too much work. Some have called this the "World Wide Wait."

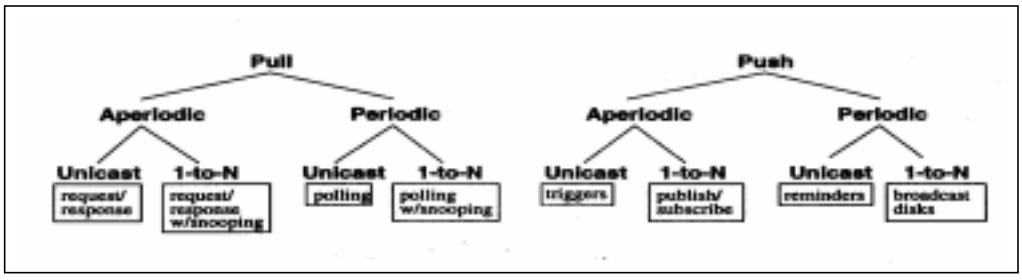


Figure 1: Data delivery options

As it turns out, our current unicast, pull-based delivery option most widely supported by the Internet today is just one of eight methods in our taxonomy of data-dissemination techniques, as shown in Figure 1.

The Broadcast Disk Project

This project was one of our initial forays into the world of push-based data delivery. By "push-based" we mean systems where transfer of data from server to client is initiated by the server. We focused on a relatively little-investigated branch of the dissemination framework tree we call "periodic push." In this scenario, data is broadcast by the server to all the clients following a well-known schedule.

Like TV viewers with a copy of *TV Guide*, clients listen to the broadcast when data they are interested in is scheduled to come around. Since the broadcast schedule is repetitive, a client that misses data this time simply waits for it to be broadcast again. This is especially important for mobile wireless users whose network connections are susceptible to unexpected interruptions. Furthermore, the performance of the system is invariant with the number of users listening for data—like a TV broadcast and *unlike* the one-to-one pull of the Internet.

Simply broadcasting every bit of data over and over again isn't enough, of course. That burly, menacing beast commonly called *latency* still lurks. The techniques we've learned to combat latency here include constructing a broadcast schedule by looking at the client interests and trying to group data items together according to demand.

Since the server sticks with a well-known schedule, clients can further reduce the latency of the system by managing their local cache in clever ways. This is analogous to viewers reading their *TV Guide*s and then setting their VCRs to record their favorite show so they can watch it later. The people who program their VCRs can watch the show as soon as they get home, instead of waiting for the rerun.

The Publish-Subscribe Simulator

Moving to another box in Figure 1's taxonomy of data-dissemination techniques, our current research focuses on a simulation study of "aperiodic broadcast" —the publish-subscribe model. In this architec-

ture, there are data sources that publish information, clients that consume information and *information brokers* in the middle. Sources register with a broker, agreeing to send that broker all the information they generate. Brokers accept subscription requests from clients, guaranteeing to deliver all relevant information to the client.

The operation of the system is deceptively simple. The servers generate data without regard to possible client interest. The clients patiently listen, comfortable in the knowledge that if some information they're interested in is generated, they'll get it. All the broker has to do is direct the flow of information from the sources to the clients according to their stated interests.

Beyond the scientific interest of a system like this (it scales up to massive client populations, like TV but unlike the Internet), beyond the media buzz extolling "push technology" as the savior of our souls, it is interesting to note that some existing applications use this mode of data-dissemination—for example, Usenet newsgroups. Of course, since these applications operate over the Internet (where broadcasting is still an experimental art), they usually rely on one-to-one connections between brokers and clients. Since the broker must service each client on an individual basis, it becomes the bottleneck. Nevertheless, this works reasonably well for things like newsgroup postings where our surly companion, latency, is not an overly important factor. However, for a publish-subscribe application with quality-of-service constraints (for example, a minimum framerate for a multimedia news feed), latency looms large.

The database guys: from l to r Donald Carney, Rahul Bose, Kerry Kurian

A better approach starts with broadcast channels from broker to client. However, this brings up a couple of interesting issues: how do we assign clients to channels, and how do we make run-time decisions about distributing data between the channels?

Simulations and Prototypes

We conduct our studies of data-management systems through simulation and measurement of prototypes. To this end, we are implementing a prototype toolkit of components (in collaboration with researchers at the University of Maryland) for building data-management systems that will eventually support all eight data-dissemination methods. Our basic prototype system, running on a network of PCs, can handle a hierarchy of brokers and dynamically changing client and server populations. We have also completed the first phase of a simulation toolkit designed to help in the rapid construction and study of proposed data-management systems.

Conclusion

Latency is everywhere. Brute-force attacks on it (that is, buying more and increasingly exotic hardware) do nothing to address the underlying data-delivery methods upon which latency feeds. Indeed, the faster networks, smaller chips, and larger hard drives thrown at the problem are themselves ever more susceptible to the very latency they are intended to root out.

By looking at the data streams on networks as more than raw bits, we are able to take advantage of higher level-structures inherent in the semantics of a given application.

Some people will try to power their way past latency. Others will surrender and sit idly by their computers as data dribbles in. But when you think you have a network data-management problem, you'll come to the people who know data management better than anyone. We're database guys; we will not let you down.

l to r: Danah Beard and Ilana Frankel. Danah's trip to SIGGRAPH was sponsored by the Industrial Partners Program. Danah's experiences are in italics, Ilana's in regular print.

SIGGRAPH 98²

7:00 am — The phone rings. Hotel wake-up service.
The phone rings; I put the pillow over my head.

7:09 am — The phone receiver is on the floor. I trip over it on my way to the shower. I am the only one moving. Danah Beard ('00), Mike LeGrand ('99.5) and Scott Klemmer ('99) sleep. This side of morning is really painful. One would think that SIGGRAPH—open to the world(s) of computers and art—would take our schedules into consideration ...

7:20 am — The shower is awesome. Thank you for the accommodations, Paul Allen.

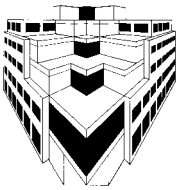
7:25 am — Danah and Mike and Scott still sleep.

7:40 am — The bus to the Convention Center is MIA. It is ridiculously hot and muggy out. Orlando is a pit. Or rather: a pit with (very successful) aspirations to Theme City status. Upside-down museums compete with restaurants from whose ceilings hang the twisted metal remnants of car crashes. A 10-foot Barbie shoe stands outside Barbie World (unfortunately, "math is hard"-School-Girl-Barbie is unavailable). A flock of large fake birds hangs over the entrance to the Castle Hotel where many Brown Graphics Groupies are staying. The birds chirp. I walk by THE NATION'S BEST STEAK and THE COUNTRY'S BEST RIBS and BARGAIN SPORTS WORLD and JEANS JEANS JEANS. And McDonald's. And everywhere, of course, billboards and fliers and neon proclaiming the greatness that is Disney (or 49 square miles of reasons for Europeans to hate Americans).

8:10 am — The concrete walkway outside the Convention Center appears through the haze as the frigid air from inside meets the heat at the doorways held open by black-clad Euros and artists trying to get their nic-fix without passing out from the heat.

8:11 am — C O F F E E

8:30 am — Jim Blinn's keynote address. His account of the 25 years of SIGGRAPH makes me laugh even though it is a) way too early and b) way too cold; his anecdotes remind me that some things really don't change. Ever.



"... San Jose, 1977: The two-day tutorial we presented was primarily about 3D polygon rendering and some frame buffer techniques. At the tutorial reception Monday evening Andy came up to me and complained vociferously about how bad the tutorial was and why weren't we describing the "fundamental principles of raster graphics." I apologized, but actually we didn't know what the fundamental principles of raster graphics were yet. Maybe we still don't..."

9:00 am *Jet lag makes miserable mornings worse. Ilana is gone; the rest of us convince each other that getting out of bed is necessary. We prepare for the day and leave the hotel room; our intention of walking is forgotten the minute we encounter the Orlando heat.*

9:40 am *Where is that bus? Finally a bus arrives—it has obviously come from the North Pole. We get our sweaters from our bags. Mike opens his chess book while I deal with the generic "Where are you from? What do you study?" from the guy next to me. Another passenger turns around and asks if I still go to Brown ... SMALL WORLD! It is Brook Conner ('91, ScM '96, of CS11/CS15 fame).*

10:00 am *Ravenous, I aim through the mess of people for the overpriced, overgreased food. I hear my name being called but cannot locate the source. There must be more people out here than in the auditoriums. From the crowds, two women approach me; I don't recognize them at all. One remarks that my purple-braided hair certainly makes me easy to find in a crowd. Great. But who are they? They introduce themselves; they know me by name—and purple-braided-hair description—from an email list. We talk. One of the best things about SIGGRAPH is the people. Everyone is interesting and willing to talk... Most of the mental stimulation achieved at SIGGRAPH is from communicating with random people about cool topics, some relating to computer graphics, others relating to other aspects of life... such as artificial intelligence.*

Crowds of folks in the hallways and anterooms belie the fact that courses are now in session. Tables with bins of Evian and Pepsi are mobbed.

A BASIC GUIDE TO GLOBAL ILLUMINATION. I enter the auditorium and am plunged into subzero weather. Perhaps it is some ploy to ensure that at least some of us stay awake. But such a precaution is unnecessary; Holly Rushmeier speaks well. I like her: she teaches without insulting her audience and without pretension, and she reminds me that there are brilliant women in the very male world of computer graphics. ... But it is colder than the CIT in here. And there is no Mountain Dew.

See ***conduit!*** in COLOR on the CS website

l to r: Matthew Amdur ('01) and Keith Schmidt ('00) worked over the summer to upgrade the CS website—http://www.cs.brown.edu. Working closely with several faculty members and staff, they reorganized the content, added new areas and created a more pleasing look. In the process they learned how to develop and maintain a sizable website efficiently.

	IMAGE-BASED MODELING AND RENDERING. This course is neat. The temperature problem has NOT been resolved but Paul Debevec shows his really impressive Campanile video that uses image-based modeling and rendering techniques to create photorealistic model of the UC Berkeley campus. A lot of other big names speak; I am reminded of how little I know. APPLICATIONS OF VISUAL PERCEPTION IN COMPUTER GRAPHICS. This room is bigger. And colder. One would think that this many PhDs in one place could figure out how to adjust a dial on a box on the wall; or that this much cash in one place would have enough clout to prevent us from freezing. Victoria Interrante keeps me here. Her demonstrations of human perception of depth and shape are compelling, as is the audience's acknowledgement of the importance and relevance of her research.
10:30 am	*Two friends from last year's SIGGRAPH find me and persuade me that the morning papers/panels look a bit dull; we wander, instead, to the exhibition floor. After all, though the exhibitors are primarily "booth babes," there is free stuff and neat information to be obtained.*
10:35 am	*THE EXHIBITION FLOOR* *IBM: A woman is walking around on a stage; a larger (and more Lara Croft-like) version of her is projected onto a screen. The technical people explain the graphics system but the audience doesn't seem to care. I headed for Pixar to get this year's free movie—Geri's Game—Ken Lao ('97) worked on this (Geri is pictured).* *ART CLASS: Lots of women are drawing the image of a guy (naked plus Speedo) onto a T-shirt. I don't stay around long enough to figure out how exactly this relates to computer graphics.* *THE TELEPHONE BOOTH: A long line of people is waiting to enter a telephone booth where they see and virtually touch a "clothing-challenged" person on the other side.* *VISIBLE HUMAN PROJECT: A naked human is lying under plexiglass; the user of this system runs a scanner over the person and the screen displays the person's cross-section.*
11:30 am	*Perfect timing for the funnies. For some reason, animated penguins are really funny. As is violence. The first short animation has an annoyed momma penguin kick one of her three yelping babies into the water ...I am definitely laughing but I am not sure why ...*
12:01 pm	Cassidy Curtis ('92) and Doug DeCarlo abduct me. Convention Center food is a misnomer. But our choices are very limited and we end up at a Chinese restaurant whose pagoda and moat and view of Barbie World remind me, in case I had forgotten, that I am in Orlando. And that Orlando specializes in AMERICAN culture. Cassidy (whose SIGGRAPH 1998 contribution is a technical sketch on LOOSE AND SKETCHY ANIMATION) and Doug (whose contribution is a paper proposing AN ANTHROPOMETRIC FACE MODEL USING VARIATIONAL TECHNIQUES) completely ignore the subject of computers.
12:46 pm	I meet Dan Gould ('00) and we enter an auditorium. Attendance here is higher than it was for any of the morning sessions. It is, after all, SIGGRAPH BOWL III. We sit in a predominantly Brown section to rally on TEAM BROWN (David "Spoke" Laidlaw ('84; Sc.M.'86), Nancy "Spork" Pollard, John "Spike" Hughes); they compete against teams of the best minds in the world of computer graphics, fighting each other to the buzzer to answer challenges like "Name at least three SIGGRAPH98 speakers over 6 feet" and "How many polygons in the original teapot?" TEAM BROWN is desperately trying to figure out the complex interaction involved in hitting the huge red buzzer before the other teams—to no avail. GO BROWN GO! Brown is out. The final round begins: NAME THAT ALGORITHM. Peter Shirley cannot identify the authors of the Shirley-Tuchman algorithm. Enough said.
1:50 pm	COFFEE
2:00 pm	Everywhere there are exhibits celebrating the 25th SIGGRAPH Conference: A VISUAL TRIBUTE TO COMPUTER GRAPHICS LABORATORIES: 1971-1988. Kurt Fleischer ('82), Ronen Barzel ('83, ScM '84) and Lee Markosian (PhD '99) loiter in front of the Brown Grahics Group panel...we've come a long way since vector graphics, baby.

A plaque dedicating the graduate student lounge in honor of Paris Kanellakis was installed over the summer. The area is much appreciated and frequently used by faculty and staff as well as graduate students. A popular weekly event is afternoon tea held in the lounge on Mondays.

I attend two Bill Buxton talks (he is so much fun) on the topic of HCI (human-computer interaction). One focuses on new ideas for hands-on interfaces, and Ishii (MIT Media Lab) talks about their current work; the other panel focuses on ubiquitous computing. I speak with several people in the room about ideas for and problems with future research; this is the essence of SIGGRAPH.

2:15 pm

Either the crowds are oblivious to this whole paper-sessions thing or the auditoriums are just not where the cool kids hang out; I enter the (ridiculously cold) auditorium to figure that out.

RETARGETTING MOTION TO NEW CHARACTERS. The results are pretty. All graphics talks ought to have demos this visually compelling. And Michael Gleicher ought to guest-lecture at Brown.

LARGE STEPS IN CLOTH ANIMATION. More pretty results. Andrew Witkin and David Baraff convince me that they have indeed come up with a numerically stable physically based significantly faster cloth simulator. Of course, convincing a not-quite-undergrad of the numerical stability and computational efficiency of pretty pictures of moving cloth is most likely not a goal of this research.

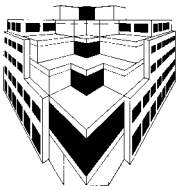
MULTIPLE-CENTER-OF-PROJECTION IMAGES. Looking to human perception and computer vision is neat. Multiple viewpoints encoded in a single image is neat. Differential sampling at multiple resolutions is neat. Image-based rendering is neat. Paul Rademacher's work nearly makes me forget that I am cold. And tired. And hungry.

4:00 pm

Electronic Theatre is one of the most enjoyed events at every SIGGRAPH: two hours of film excerpts and shorts. It is a chance for the artists to demonstrate what they have developed using the computer scientists' tools and a chance for the computer scientists to understand what their tools can and cannot do. As an attendee, it is a great opportunity to see where the world of computer graphics meets that of the visual arts. Even prior to the show, art and technology meet and the fun begins. PADDLES! Jill Huchital ('89) and I, and the entire audience, grab these ping-pong paddles with sensors in them and, laughing, attempt (poorly) to coordinate our movements to play games involving cows and mazes.

7:30 pm

The hostess at CHARLIE'S LOBSTER HOUSE quickly leads us to a room crowded with professors and students and filmmakers and venture capitalists and software engineers and entrepreneurs. Beside me, Scott Anderson ('87) tells those at the table about director Paul Verhoeven's rant against Hollywood's relationship with sex and violence; Paul Strauss ('81; PhD '88) jokes about East Coast versus West Coast and plays with his beautiful son; Ingrid Carlbom (Dept. Head of Visual Communications Research for Bell Labs),



SIGGRAPH 98

celebrating 25 years of discovery

The graphics groupies

one of Andy's early PhD students, confirms, laughing, that some things never change. A now-empty wine glass is struck. Andy speaks; we all shut up. Evidently this is one of those things that has remained the same. We congratulate Spike on his tenure and Nancy and David on their new faculty positions and Andy on his new role as grandfather. And we laugh at the one thing at which we can all laugh: Andy. He smiles and laughs with us.

One after another, former Andy students have come to dinner. It is amazing to be in a room filled with people whose names are echoed throughout the CIT: Cindy Grimm (PhD '96)—the parrot lady; Scott Anderson ('87)—Babe and Academy Award; Mary Lou Jepsen—MoonTV ideas. Everyone has such interesting stories (and funny ones about "back in the days" with Andy). I sit across from Steve Feiner (PhD '87), now a professor at Columbia. Along with Andy, he reminisces about the days when they needed punch cards and had to wait in long lines to get their printouts.

I appreciate my Suns. I appreciate my Suns.

10:00 pm — Thomas Crulli ('00), Scott, Mike, and I walk back to the hotel, narrowly avoiding the sprinklers, which manage to miss the lawns entirely. Orlando never ceases to amaze me.

10:45 pm — Danah returns from somewhere.

11:15 pm — Somehow we have become a posse. We decide to check out Downtown Orlando (as opposed to the closer but scarier Downtown Disney) and fit too many of us in a cab whose fare is covered by someone's company's expense account. We find a club whose bouncers seem oblivious to the multiple 26-year-old Scott Klemmers and whose outdoor bathrooms are accessed by a secret combination obtained by asking the intoxicated blond who leans against the bar; the drum and bass is phat and the crowded bar is cheap and somehow the heat isn't so bad anymore. And Orlando makes a small step toward redemption.

2:00 am — Bright lights kick us out of the club.

2:20 am — Bright lights greet us at the Peabody Hotel.

2:30 am — The hotel lobby is added to the list of SIGGRAPH hotspots; the hotel bar is still serving. Famous—and to-remain-nameless—professors and CEOs gather at the tables. Conversations are overheard: the state of academia; the state of industry; Microsoft; the human genome project; the global economy; Bill and Monica. We head toward the pool.

3:00 am — We lose the boys to the water and the free beer and the bikinis. We lose ourselves amongst the crowds of drinking and talking SIGGRAPH folks. I wish my MCM friends could see this.

4:00 am — Four hours until it begins again.

Symposium speakers from l to r: Martin Fowler, independent consultant; Jonathan Helfman, AT&T; John Vlissides, IBM; Steve Reiss, Brown. Richard Gabriel, Aspen Smallworks, Sun, is not pictured.

THE 21ST IPP SYMPOSIUM

Pascal Van Hentenryck

The 21st Industrial Partners Program technical symposium, held on May 7, 1998, was on **design patterns**, a topic of increasing interest both in industry and in academia. As in many artistic and scientific disciplines, skill in programming is acquired by a combination of experience and careful study of existing work. Patterns capture, abstract, and classify existing work so that it can be communicated widely and applied in other contexts. The symposium speakers discussed numerous pattern-related issues, from what they are and how to apply them to speculations on their future and the future of software development.

Steven Reiss (Brown University) and John Vlissides (IBM) were the morning speakers. John discussed the top ten misconceptions about patterns, which clarify where patterns came from, what they are and what they can do. Readers interested in these misconceptions can read John's book, *Pattern Hatching*. Let me just say that they convey insights when examined individually and also when examined together. Misconceptions 1 and 6 are particularly complementary. On the one hand, misconception 1, "a pattern is a solution to a problem in a context," overlooks relevance: a pattern should be applicable in other contexts. On the other, misconception 6, "patterns generate whole architectures," ensures that pattern users do not have unreasonable expectations: patterns do not by themselves create, they merely empower.

Steve Reiss talked about the role of patterns in software environments. He first discussed how patterns arise at different levels in software design. He then discussed Peyote, a tool provided in his Desert programming environment to identify, edit, and generate patterns. He also discussed implementation issues in terms of specification language and database requirements.

After lunch, **Martin Fowler**, an independent consultant, talked about analysis patterns, the topic of one of his recent books. Involving the audience early on, he carried us from a simple static model of medical data to a flexible, robust, and extensible model expressed in terms of quantities, measurements, and phenomena. He then showed how similar modeling patterns apply to finance.

Richard Gabriel (Aspen Smallworks, Sun Microsystems), the next speaker, first reviewed Alexander's recent work on "the nature of order," which describes a general theory of beauty, wholeness, and life in a 3D space. He then discussed how these aesthetic criteria apply to programs and speculated that the unfolding process of artistic design is based on principles similar to those involved in large system development in free software communities such as LINUX.

The last talk of the symposium, by **Jonathan Helfman** (AT&T) on textual similarity patterns, illustrated how large-scale visualizations often exhibit patterns

Background—A rendition of Escher's Circle Limit IV, by Doug Dunham, U. Minnesota, Duluth, who spent a brief sabbatical visit here this fall.

and how these patterns can be interpreted to reveal hidden structure in code, data, and text. This hidden structure, not apparent to the user of traditional text editors and other tools, can be helpful in reorganizing and improving software and software development.

More information, and many references, on patterns can be found online at *www.cs.brown.edu/memex/IPP_Resources.html*.

LETTERS & ALUMNI EMAIL

E. GORDON GEE, President

Suzi—I just read ***conduit!*** and want to congratulate you and your team on a first-rate effort. Thank you for placing me on your mailing list.

SWAMI MANOHAR, PhD '89

As threatened in last fall's issue of ***conduit!,*** and much to our delight, Swami dropped by with his family in June on their way back to India after a year's sabbatical at the University of Missouri at Columbia. He returns to his position at the Indian Institute of Science, Bangalore.

Sathya and Swami and their 8-year-old triplets (l to r) Yamini,

SCOTT MEYERS, PhD '93

Eugene's "Bad Trips" article in the spring ***conduit!*** reminded me of a trip I took near the end of my time at Brown. It included such Bad Trip staples as on-ground and in-air flight delays, missing luggage, and overbooked hotels, yet the overall experience was so pleasant, I thought you might find it interesting.

I had to fly to Dallas, but once we got on the plane in Providence, we were immediately hit with a flight delay due to traffic congestion near Chicago. I didn't care, however, because I'd used my frequent flyer miles to upgrade to first class. As a graduate student, this was a big deal. I didn't care how long we sat on the ground as long as I got to sit in the big leather seats normally reserved for avd *et al*. After a while we got under way, but when we approached Chicago, we had to circle for a time, because there was still too much congestion. I didn't care. I was still in first class. By this time I knew I'd missed my connection, but in first class, I wasn't about to let such pedestrian concerns ruin my trip.

I was moved to a different airline to make the flight to Dallas, and though I had to sit with the plebes in coach, more good news awaited me when we landed. My luggage hadn't made the flight. This was a good thing, as my luggage consisted of a very heavy box of paper materials that was frankly a pain to lug around. The airline promised to deliver the materials to me at my hotel the next day. Wonderful.

It was close to 2:00 a.m. by this time. I drove to the hotel, where I discovered that they were completely sold out. I held a reservation confirmed for late arrival, however, so they were obliged to honor it. There was one room left: the Presidential Suite. Normal daily rate? A cool $1200.

Now, I use the term 'room' loosely here, as the Presidential Suite consisted of a formal entryway, living room, and dining room (plus wet bar) on the *ground floor* of the 'room,' plus two enormous master suites in the upstairs part of the 'room.' Adorning the master bathroom counter were more little bottles of liquids than I've seen anywhere; no mere shampoo and conditioner for the President!

I had to move the next day, which was only a few hours later, but I didn't really mind. Presidential Suite or no, the water pressure in the shower of a room at the top of a skyscraper is lousy. Next time I'll shoot for the Vice Presidential Suite.

As long as I'm writing, I thought I'd mention my most recent undertaking, especially since it sounds like it might share

attributes with Peter Wegner's work on moving the ACM publications from paper to electronic form. The project itself sounds simple—supervising the publication of my two C++ books as a CD-ROM—but it has taken me as close to research as I've been in years. The material on the CD will be in HTML, so all we're really doing is producing a web site, but much to my surprise, there seem to be large gaps in the work done on such crucial issues as customizing presentation details for individual users. Most web sites offer fairly small fixed-size images, for example. These are fine for laptops, but they're often unusable when viewed on the higher-resolution monitors also employed by programmers. Book-length documents lead to interesting questions about how to break the material into files, the answers to which affect searching, indexing, bookmarking, and the creation of links into the material itself. Of course, the fact that the resulting CD must be portable across both browsers and operating systems leads to some interesting challenges, too, as does the constraint that this is a *publishing* problem, not a software development project. We can only hack our way out of trouble if the hacking occurs within the confines of HTML and its associated technologies (e.g., Javascript).

Scott and Persephone, "The Best Dog in the World"

I recently discovered that Brown PhDs Marc Brown and John Stasko are both on the Editorial Board of the journal *World Wide Web*, and I'm hopeful that when the CD project is done (near the end of this year), I may be able to justify submitting a paper for their review. We'll see. There's a lot to be done between now and then. *smeyers@aristeia.com*

JANNE SAHADY, ScM '79

No sooner had a small paragraph been published in ***conduit!*** with my company email address than it changed. As of November, 97, I am now employed at (and part owner of) Merrill Clark, Inc. a start-up company in Providence. The company is doing very well, lots of exciting contracts in healthcare and other commercial areas. The home page is *merrillclark.com*. My new e-mail address is *jsahady@merrillclark.com*.

FREDERICK THURBER, BA '83

Dear ***conduit!***, I have enjoyed reading of the exploits of fellow CS grads. For my part I have been working in beautiful Pawtucket, RI, for Hibbitt, Karlsson & Sorenson (HKS). HKS has a lot of fellow Brown grads, although most are mechanical engineering types. HKS made a name for itself with some high-end engineering software packages. Although these programs are very sophisticated, they were written years ago in FORTRAN and are batch-oriented. I, along with some 40 other UNIX programmers, are working on some modern, GUI-oriented products for HKS. We are using Python and that dreadful language known as C++, having missed the Java boat by a few years.

Right now we are struggling to move to the NT workstation. The old-time UNIX geeks despise the platform, seemingly on religious grounds, but I prefer it. I think that the program development environment on NT is much better than UNIX, but others think I am nuts! They could be right.

When not programming for HKS, I write a number of bird-watching and nature columns for local newspapers and conservation organizations. Am currently working on an article, and possible photo essay, about Monhegan Island, Maine, called something like, "All trucks go to Heaven, except the ones that end up on Monhegan." This summer I am also working on an atlas of the dragonflies of Rhode Island for the Nature Conservancy.

I would love to hear from other Brownsters. I can be reached at *thurber@hks.com*.

GRAPHICS GROUP
NEW FACES, NEW DIRECTIONS

Like the field of computer graphics, the Graphics Group at Brown is both growing in size and adding new research directions. We have two new faculty, Nancy Pollard and David Laidlaw, a major new research project—tele-immersion, a serious involvement in the DOE/ASCI DVC (Data Visualization Corridors) initiative, the beginnings of a new hardware in-stallation—a Cave that's the centerpiece of a new interdepartmental immersive computing facility, and growing ties with the visual arts community through research, ugrad joint majors in CS and Visual Arts, and a new textbook,—*The Computer in the Visual Arts* being published by Addison-Wesley this winter. Last but not least, the growing educational initiative includes that textbook, the Exploratories group's applets for CS123 and the start of work on a major revision of *Computer Graphics: Principles and Practice*, the 'Bible' of computer graphics.

Rosemary Michelle Simpson

New Faces

Nancy Pollard. Nancy arrived at Brown this fall with an intriguing background that includes a BS in electrical engineering (oil-well logging!), a PhD in robotics, and post-doctoral work in behavioral modeling and animation. She brings a deep understanding of the value and importance of interdisciplinary research to Brown—in fact, our strong supportive interdisciplinary culture was a factor in her decision to come here. When I asked her about why she chose Brown, she said: "1) good coverage of research areas related to my work (graphics, AI, robotics, applied math, cognitive science, and computational geometry), 2) a culture of interdisciplinary work/communication, and 3) the chance to work closely with undergraduates as well as graduate students."

Physically realistic animation of human motion

In her current research, she says, "I would like to make it possible for any user easily to program and use virtual human characters for research, education, sports training, communication, and medical/rehabilitation applications. For example, suppose you are a doctor wanting to design a prosthetic device for your patient. You explore several variations on a standard design, check how these variations affect comfort and dexterity for a set of common tasks, and create a variation that works well for this patient.

Achieving long-term goals like these will require understanding a great deal about:

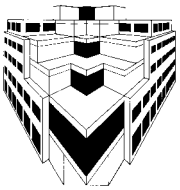
- UIs: how to provide an interface that users in many different areas will find intuitive
- Graphics: how to create convincing animations of human behavior
- Human motion/behavior itself !

One difficult question is: how will users interact with this type of application? Wonderfully intuitive UI techniques will be required to make a broad user base possible. Can users program their applications in a way that is completely intuitive to them? For my particular research area, using examples— teaching by showing—may be part of the answer, and my early research will focus on that aspect of the problem."

In addition to teaching CS 005 (Object-Oriented Programming Practice) and co-teaching (with David Laidlaw) CS 295-1 (Topics in Animation and Scientific Visualization), she has started an animation group that meets weekly to discuss computational animation issues.

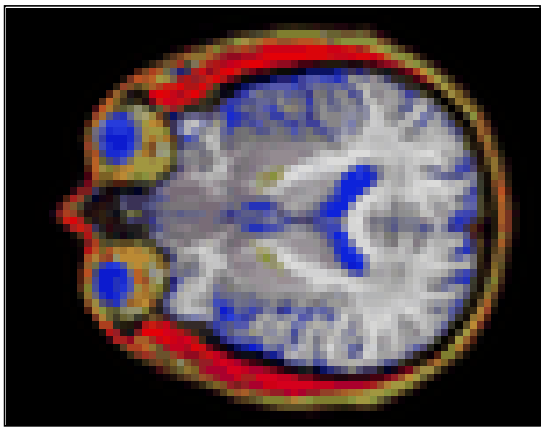
Interesting URLs: Grasp Planning for Articulated Robot Hands: *www.cs.brown.edu/~nsp/grasp.html*; Adapting Simulated Behaviors for New Characters: *www.cc.gatech.edu/gvu/animation/Areas/scaling/scaling.html*

David Laidlaw. David brings a love of art and a passion for science back to the school where he got his ScB and ScM in computer science. He describes his research approach as "scientific computer graphics—a cycle that includes:



(1) postulate model of physical phenomena, (2) collect/calculate data/images, (3) visualize results to validate or invalidate model, (4) repeat 1-3. The cycle leads to insight and predictive models of the physical phenomena and guides the search for new computational and visualization methods."

His previous research centered on medical/biological imaging applications, something he would like to continue here; the new computational biology concentration (***conduit!*** Vol. 6, No. 2) provides an interesting collaborative potential. He sees the Cave installation (see description below) as offering very interesting opportunities for exploring interactive multi-valued data visualization as well as the steering of computation, especially in fluid mechanics. In addition, he would like to explore the simulation and animation of biological systems and he strongly supports the DVC (Data Visualization Corridors) expression of the need for increasing visual bandwidth.



MRI data for geometric modeling and visualization

The Van Gogh prints on the wall outside his office reflect another passion—art. In October at IEEE VIS'98 David chaired a panel, which included Tom Banchoff of Brown's Mathematics Department (and won the Best Panel award), on "Art and Visualization: Oil and Water?" The statement of purpose clearly identifies issues at the intersection of art and visualization:

"Art and visualization have progressed on parallel paths, often visiting similar points in the space of imagery. This panel session brings together artists who have scientific interests with scientists who have artistic interests. Together, we hope to stimulate excitement about searching the collective experience of centuries of artists to find concepts salient to visualization. Each of the panelists will discuss some of their work, giving concrete examples of joint art/science endeavors. We have organized our statements around the following questions: 1) How can artistic experience benefit visualization? What artistic disciplines have the most to offer? 2) What are the dangers of mixing the two disciplines? 3) How should we proceed? What are the rich research areas to explore?"

He shares this interest with his wife, special effects designer Barb Meier (ScB '83, ScM '87), whose research has focused on painterly rendering algorithms (see the Cezanne research description below for new work in this area).

His first teaching experience was as a ugrad TA for CS224 (Interactive Computer Graphics); he returns to teaching as co-instructor of CS 295-1 (Topics in Animation and Scientific Visualization) and is gearing up to teach CS 190 (Software Systems Design) in the spring. Interesting URLs: Geometric Model Extraction from Magnetic Resonance Volume Data: *http://www.gg.caltech.edu/~dhl/phd/thesis.html*; Image Gallery: *http://www.gg.caltech.edu/~dhl/images.html*.

New Directions

ANS (Advanced Network & Services) National Tele-Immersion Initiative. The software infrastructure we are developing will form the basis for a standardized "telecubicle"—a networked cubicle that supports capture of real objects as well as the head-tracked 3D stereo display of synthetic 3D models. This framework will support the scanning and transmission (using Internet2 protocols) of environmentally scanned data, the display of stereo 3D graphics in a "telecubicle" environment, and interaction with synthetic objects and remote participants using a variety of input devices.

Jaron Lanier, a pioneer in virtual reality reseach, is the sponsor. We will be collaborating with the Naval Postgraduate School (Michael Zyda), Columbia (Steven Feiner, Brown PhD), CMU (Randy Pausch, Brown ScB), and UNC (Henry Fuchs, Graphics and Visualization STC colleague). URL:*http://www.advanced.org/teleimmersion.html*.

DOE ASCI/DVC (Accelerated Strategic Computing Initiative). The terabyte-sized datasets used in the ASCI program are too large for any existing visualization systems to handle. In addition, today's dominant visualization paradigm of a single user interpreting moderately large precomputed datasets

on desktop visualization systems driven with 2D input devices will not be adequate for collaborative efforts between geographically distributed groups. Furthermore, non-conventional display devices such as responsive workbenches and Caves (see description below) with higher-resolution immersive displays and 3D interaction promise to be better work environments for visualizing and interacting with the larger datasets.

Data and visualization corridors

The DVC report *Data and Visualization Corridors: Report on the 1998 DVC Workshop Series*, edited by Paul H. Smith and John van Rosendale, states a vision for research and development aimed at improving data handling, scientific visualization, and collaborative scientific environments. Andy van Dam and Andrew Forsberg (Graphics Group), Elaine Cohen (STC co-PI), and John van Rosendale (moving from NSF to DOE) contributed the section on 'Interaction, Shared Spaces, and Telecollaboration' and Jesse Kocher, one of our Visual Arts/CS students, contributed the remarkable illustration above.

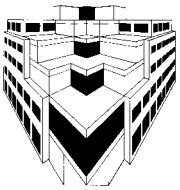
Cave. Brown's new NSF-supported Center for Scientific Computing and Visualization is an interdepartmental facility including Applied Math, Chemistry, Cognitive Science, Computer Science, Geology, and Physics. The Center will provide a state-of-the-art facility for supercomputing and visualization at Brown and will support a range of immersive visualization environments including a fully immersive four-walled Cave, a semi-immersive responsive workbench, and a conventional workstation. IBM will provide equipment for both computation (a large SP-2) and graphics for visualization.

The Brown Graphics Group will work with IBM in two capacities. First, in the coming year we and others at Brown will work with IBM to develop a scalable graphics system. Second, we will conduct research sponsored by IBM on user interfaces for immersive environments. Our primary driving applications will be large-scale scientific visualization and 3D modeling.

New User Interface Modalities

Haptic User Interfaces. The haptics project, led by Tim Miller, explores metaphors for haptic user interfaces rather than literal simulation of physical environments or a simplistic mirroring of the physical world. We are exploring ways to present and manipulate features that do not have a unique, intuitive mapping into a haptic form. Examples include guiding the user's motion, as in the physical snap-to-grid work done recently in collaboration between Brown and UNC (University of North Carolina), and providing gravity relief to alleviate the strain of keeping one's hand in the air for a long time; the second example illustrates the potential of haptics to alleviate some of the physical human-computer interface problems. Other possible outcomes include gains in performance, intuition, learnability, and enjoyment of the computer interface. The project uses the 3-DOF force-feedback PHANToM arm to investigate 2D GUI and fully 3D environments. URL: *http://www.cs.brown.edu/research/graphics/research/haptics/*

Multimodal User Interfaces. Multimodal interfaces unify multiple modes of input (e.g., gesture and speech) that complement one another to interpret the user's intentions more accurately. Gestural interfaces interpret application-



specific 2D or 3D gestures that convey more information than is possible with traditional windowing interfaces. For example, the SKETCH system (URL: *http://www.cs.brown.edu/research/graphics/research/sketch/*) can specify, position, and scale a primitive given several quickly drawn gestures. Speech interfaces provide additional dimensions that work effectively in combination with other interaction modes.

The current project, led by Joe LaViola, allows a user to lay out either a city block or house interior by gesturing and speaking. For example, a user can say, "Give me a rocking chair with arms this long and place it to the left of the fireplace" while gesturing with his or her hands to specify the length of the chair's arms.

CAD/CAM Interfaces. Extending the SKETCH system, Brown—led by Loring Holden and Bob Zeleznik—UNC and Utah have developed a prototype art-to-part system that allows users to quickly sketch non-trivial dimensioned metal and plastic prismatic parts. These parts can then be automatically manufactured on a machining center with the aid only of a technician who prepares and loads the stock and cutting tools. An important goal of this work is to provide a smooth pathway from original concept through finished machined part. Along this pathway, we want to allow the user to concentrate primarily on the geometric and parametric aspects of the design, with only minimal concern about manufacturing issues. The process plan, fixturing and machining operations necessary actually to manufacture the part are then generated automatically from the design.

Multiresolution Behavior. The goal of the multiresolution behavior project, led by Steve Dollins, is to build systems for the authoring and emulation of highly interactive, large-scale virtual narrative environments. In order to support very large worlds, we want to give the user an approximation of both the geometry and behaviors, computing only enough detail to emulate a plausible experience based on the limits of the user's time-varying perception, knowledge, and expectation of the environment. Our two approaches to this goal are procedural modeling and a multiresolution description of behaviors.

Our research testbed is a dense ballroom-dancing animation scene in which the dancers are defined by geometry, animation, and behavior. Whereas much work has been done in developing multiresolution representations of geometry, our research emphasizes developing similar such techniques for animation and behavior and integrating the three together.

Free-form Modeling. An artist can convey the clear impression of a field of grass with relatively few brush strokes. In contrast, the usual computer-graphics approach models every blade of grass, including distant ones, rendering them all, or it uses a texture map, sacrificing both realism and aesthetics. The free-form modeling project, led by Lee Markosian, seeks to replace these approaches with a modeling system that exploits centuries-old techniques used by artists and illustrators: drawing and painting are the primary means of both defining shapes and rendering them. With this system skilled artists should be able to apply their skills within the system to create distinctive 3D scenes. URL: *http://www.cs.brown.edu/research/graphics/research/npr/*

Arts Orientation

Music Notepad. **T**he Music Notepad project, led by Andy Forsberg, is a system for entering music notation using 2D gestural input that reflects the actions of a composer sketching music on paper. The system uses a stylus and tablet with a built-in LCD display that preserves the characteristics of paper and pencil and supports common music editing operations, automated playback, instrument selection, handwriting recognition, automatic formatting, and harmonic analysis. We are currently exploring the use of this system as a music education and jazz improvisation tool. Users will be able to write in a sequence of chords and then create contours that are interpreted into jazz lines. The system will analyze the chord changes harmonically and suggest appropriate scales. This will be a valuable educational tool for musicians and will give non-musicians an understanding of the mechanics of improvisation. URL: *http://www.cs.brown.edu/research/graphics/research/music/*

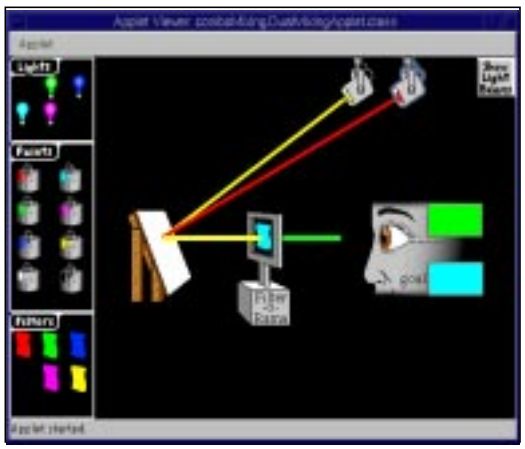
Painterly Rendering with a Cezanne Feeling. This project, led by Caroline Dahlloff, transforms 2D images into Cezanne-looking oil paintings. The algorithm used models Cezanne's method of painting, a significant digression from current painterly rendering algorithms, which try to emulate oil paintings without considering the various steps painters use to create their paintings.

Accessible Color. The project, led by Anne Morgan Spalter, is a combination research/education project to teach color concepts and make them easier to apply in graphics software. Current work includes development of a color web site for educational applets, designing new ways to choose color from perceptually-based color spaces, and integrating color theory and expert palettes into new ways of choosing and altering color schemes.

Visual Arts/CS Collaboration. Recognizing the growing importance of the artistic community at the SIGGRAPH conferences, an increasing number of graphics group student researchers are joint visual arts/CS majors. Two students did the cover for John Savage's recent book, *Theory of Computation*, while another student did an illustration for the "Data and Visualization Corridors" report shown above. In support of this growing trend, Andy van Dam has joined the RISD Board of Trustees. URL: *http://www.cs.brown.edu/~jes/book/book.html*

Educational Initiatives

CS123 Exploratories Applets. The Exploratories group has created several dozen applets for CS123 (Introduction to Graphics Programming) that are being used as demos in class, as the basis for interactive laboratory sessions, and as remedial and self-paced exercises. Current applet topics include: image processing, color theory, math for computer graphics (e.g., matrix math, commutativity of transformations and dot and cross products), scene graphs, and camera trackballs. URL: *http://www.cs.brown.edu/exploratory cs123applets*



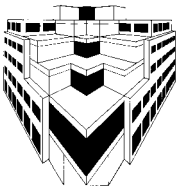
Color-mixing applet

The Computer in the Visual Arts. Exploratories project leader Anne Morgan Spalter's introductory textbook, which will be published by Addison-Wesley this winter, integrates history, theory, art examples, and explanations of the concepts underlying all the major types of computer graphics software. Chapters on input and output address a wide range of tools and techniques on art software for creating both screen-based and hard-copy works. Quotes from interviews with artists and computer scientists illuminate the origins of this dynamic field and suggest future directions. URL: *http://www.cs.brown.edu/people/ams*

New Edition of Graphics 'Bible.' The upcoming new edition of *Computer Graphics: Principles and Practice* will include an emphasis on mathematical principles (abstracted from sample uses), new 2D and 3D software packages (Java AWT and SCI/Microsoft/HP Fahrenheit Scene Graph, respectively), a new chapter on image-based rendering, more detail in the animation chapter, sections on new rendering techniques and new modeling techniques—including our gesture-based modeling—and will attempt not to rely too completely on any one package/language.

John Hughes and Andy van Dam—New Directions

John Hughes. Spike received tenure last year, an achievement underscoring his varied contributions to the field and to the department. Some of his current activities include being co-chair of Implicit Surfaces '99 (to be held in Bordeaux, France), serving as technical advisor for a series of math applets, collaborative work with Caltech, Disney, Microsoft, and Princeton, graduate and undergraduate student advising, and revising and extending the graphics 'Bible' (see above). He comments on the addition of David and Nancy to the department: "I am delighted to have David and Nancy as new colleagues, of course. But delighted only begins to hint at it—it changes my whole outlook to have a couple of new folks with whom to toss around ideas."



Andy van Dam. Andy has stepped down as Director for the NSF STC Graphics and Visualization Center, although Lisa Manekofsky and Anne Morgan Spalter will continue as Administrative Manager and STC Outreach Director respectively. He comments, "I found being the Director of a distributed research center to be a big challenge—dealing with five different corporate cultures and multiple creative and strong-willed PIs was, if anything, more challenging than being department chair of a cohesive and co-located department. In short, I have no regrets about taking the position and even fewer about relinquishing it." He hopes that the combination of new faculty and the reduction in STC management responsibilities will give him more time to devote to his long-term and deep interests—3D interaction and interactive educational microworlds (exploratories/interactive illustrations).

Graphics Group Research

How do these new approaches and projects fit into the existing research focus of the lab? Well, the hallmark of the Graphics Group over the years has been flexibility, the ability to remake itself as this remarkable field has grown and changed. For example, three years ago the research focus was on developing systems support for graphics research. Then Bob Zeleznik had a new idea for a graphics interface that much more closely reflects the way artists and architects actually work—a gestural interface that eliminates the need for menus. His project, SKETCH, and its progeny have evolved into a major focus of current work in the lab.

This flexibility can also be seen in that student researchers—both undergraduate and graduate—are encouraged to develop their own ideas. Sometimes these student projects become major research thrusts.

Sponsors

We gratefully acknowledge our continuing sponsors SGI-Alias|Wavefront, Advanced Network Services, IBM Corporation, Microsoft, NSF, Sun Microsystems and TACO, and welcome new sponsors Adobe and Intel.

SENIOR HONORS THESES '98

Natasha Gelfand

In the last few years there has been increasing interest in applications of software engineering concepts, such as object-oriented programming and design patterns, to the design and implementation of data structures and algorithms. Algorithm engineering is concerned with using these and other techniques to develop implementations of algorithms that are not only efficient but also generic and extensible. My thesis project was to develop an object-oriented design and implementation of the orthogonalization and compaction steps of the Giotto drawing algorithm, which constructs a planar orthogonal drawing of an embedded planar graph with the minimum number of bends. This work was done as a part of the GeomLib project (sponsored by the Army Research Office and by the NSF), aimed at creating an easy-to-use, open library for geometric computing. The project is described in the paper *Algorithmic Pattterns for Graph Drawing* (co-authored with my advisor Roberto Tamassia), which I presented at the Symposium on Graph Drawing in August.

Sharon Goldwater

My thesis work, which was done in conjunction with Eugene Charniak and Professor Mark Johnson of the Cognitive and Linguistic Sciences Department, involved modifying a natural-language parser to decrease parsing time without sacrificing accuracy. The parser is a statistical best-first parser, meaning it uses statistics collected from a large body of text to rank partial parses according to their likelihood, and preferentially works to expand the more likely subparses. We were able to make the parser about 20 times more efficient by modifying the ranking system to apply to smaller parts of the parse. This gave a finer-grained ranking, guiding the parser to a good parse more quickly. Our work is described in "Edge-Based Best-First Chart Parsing," which has been submitted to the Workshop in Very Large Corpora.

Sharon Goldwater

John Hale

Dimitris Mitsouras

John Hale

My project was in the area of natural language processing. Work in NLP attempts to develop software techniques for dealing with 'natural' language, as opposed to artificial computer languages. NLP has long been concerned with the phenomenon of pronoun anaphora—using such references seems to be such a fundamental part of understanding a sentence. In everyday English we are always careful to use the appropriately-gendered pronoun to refer to men, women and inanimate things. In my thesis I present a technique for using this conventionalized gender-synchrony to determine automatically the genders of the people and things mentioned in a large corpus of English from the *Wall Street Journal*.

Pronoun anaphora is the key to this technique. Since gender is not marked on proper names like "Kim" or "Sandy," the technique relies upon pronouns that are gender-marked referring back to proper names that aren't overtly marked. Using the assumption that 'he' always refers to masculine antecedents, 'she' always refers to feminine antecedents, and 'it' refers to non-human ones, the paper shows how even an unreliable pronoun-resolution method can extract useful gender information from a sufficiently large corpus of text.

Dan Price

Daniel Price

Many systems have implemented replay of parallel or sequential processes, but none have provided a robust set of debugger tools that take advantage of this power. We present new ideas about how software instruction counters can be used by programmers to facilitate debugging applications under replay, and suggest a new 'taxonomy of debugger events' that expands upon traditional breakpoint mechanisms. Finally, we present the implementation of our ideas in the RDB replay debugging framework.

Dimitris Mitsouras

My thesis, entitled "A Numerical Approach: Simulations and Statistics for Studying Large Scale Structure Formation in the Universe," was the outcome of work in collaboration with professors R.H. Brandenberger of the Physics Department and F.P. Preparata of our own Computer Science Department. In this work we have realized a number of goals we set out to achieve three years ago: given the latest results from deep space surveys that map thousands of galaxies to positions on nearly two-dimensional slices, is it possible to statistically differentiate between different theoretical models of how galaxies were seeded only billionths of a second after the Big Bang? If so, then what are the most important traits of the telescope that one should focus on in order to maximize the discriminatory power of the survey? Is it possible already to make an educated guess on which model is closer to the current observations? The answers we found

to these questions are, in short, yes, it is possible to differentiate between the currently prevailing models of structure formation in the universe, namely the *Cold Dark Matter* model, the two flavors of *Cosmic String* models and the *Global Texture* model. It is more important to increase the accuracy of the observed positions of galaxies in the survey than it is to increase the observational depth of a *Liquid Mirror Telescope*, which uses a fast rotating "bowl" filled with mercury as the primary lens, and in which the two above-mentioned traits are mutually exclusive. Finally, comparison of simulations for the four models with the deepest and most complete up-to-date survey, the *Las Campanas Redshift Survey* (with *N-26,000* mapped galaxies), is in almost excellent agreement with the CDM model and nowhere near the other models. The statistical measures we used were as simple as a *Counts In Cell* statistic, an *N-Galaxy Probability Function* and as complex as the *Minkowski Functionals* drawn from integral geometry, which provide a complete morphological analysis of the underlying iso-density surfaces of a distribution of galaxies. Due to the large data sets, the previously best-known algorithm for the calculation of the Minkowski functionals with a running time $O(n^4)$ has been modified to run in time $O((n^3 log(n))/p)$, where p is the number of available processors. This research was made possible by the Brown University Royce Fellowship ('96-'98) as well as a NASA Space Grant ('97-'98).

NEW CS FACULTY

The pictures of our new faculty were taken recently at the CS picnic

DAVID LAIDLAW
ScB '83, ScM '86

Before returning to Brown, David spent six years getting his PhD ('95) and three doing research at Caltech. His research included scientific vis-ualization, scientific computing and applications, developmental biology, medicine and fluid mechanics. He is excited to be back on the east coast and finds the prospect of raising his family in Barrington and Providence instead of LA very appealing. He, his wife Barbara Meier (AB '83, ScM '87) and their son Cassidy, now two, have just moved into a big old house which they're fixing up—one of their several avocations; he now has a very pleasant commute along the East Bay Bike Path and has been enjoying these crisp fall mornings. The commute is a longer one than in LA, but smogless.

Both David and his wife are delighted to be renewing old friendships that go way back in CS history. He and Barb met in Andy's intro course, then CS51! Barb's professional forte is in visual effects for feature films and she is excited at the prospect of new production opportunities in the northeast. Besides house renovating, they enjoy bicycle touring, gardening and cooking. Touring has taken them all over Europe as well as New Zealand, Alaska, Hawaii and British Columbia. "These were pre-Cassidy trips; we're still working on the logistics of the next one," said David. Their taste in cooking runs to ethnic cuisines from Thai to Mexican; however, their current focus is Northern Italian and French. A complete redesign of the new garden will have to wait until next year; in the meantime they are lamenting the loss of their roses and apricots in California, to say nothing of the tomatoes—the new owners of their CA house are reaping what the David and Barb hath sown.

This is David's first teaching assignment since TAing CS224. He is looking forward to interacting with Brown's creative and enthusiastic students.

NANCY POLLARD

Nancy joins the Department fresh from the animation lab at Georgia Tech, where she was mostly engaged in research. She received her PhD in robotics from MIT and worked at a small software company

for a couple of years before going to Georgia Tech. Her aim was to get back into academe in order to do more work in computer graphics.

Nancy grew up in a "one-traffic-light town" in Ohio. The next town housed the Neil Armstrong Space Museum—her school would take field trips to the museum. Says Nancy, "Ohioans are proud of their presidents (seven were from Ohio; who are they? see back page) and their astronauts." She earned her undergraduate degree at the University of Houston, initially suffering major culture shock at the scale of the place but discovering that among multitudes of people can come multitudes of friends.

David Laidlaw and Nancy are co-teaching CS295-1, the graphics seminar. Each brings his/her own focus to the course, Nancy's being animation and David's scientific visualization. They expect to learn much from the students as the course gets under way. Nancy is also covering CS5, Object-Oriented Programming Practice, an intro course she is continuing to develop that will ease the transition into a CS concentration.

For exercise Nancy runs long-distance. She finds the East Side of Providence a very pleasant place to run and is even considering running the Boston Marathon. She also likes to cook, specializing in creative vegetarian fare. It was gratifying to learn that Nancy, who had no prior knowledge of the Department, eased her pre-interview trepidation by reading several back issues of ***conduit!*** She gained insights into the activities and personalities here and declared it a very useful recruiting tool!

ELI UPFAL

Eli joined the department last January. Before coming to Brown he held two positions simultaneously, one at the Weizmann Institute in Israel and another at IBM Research in California. Consequently, he spent a lot of time in the air, which he came to dislike intensely. Weizmann is a research institute with only graduate students. Eli taught advanced courses there and conducted his own research in applications of probability theory and combinatorics in computer science, in particular in randomized algorithms and probabilistic analysis of algorithms. While doing similar theoretical research at IBM, he also participated in IBM-related work. His inventions, patented by IBM, are mainly in the area of communication networks.

Leaving California and the overcrowded Silicon Valley was not difficult, but he does miss San Francisco. However, he has found at least one coffee shop on the

Eli and Tamara

East Side that rivals those in SF—Coffee Connection on Wickenden Street.

Although Eli had visited several institutions in the east, he had never been to Brown until his job interview. He was favorably impressed with both the campus and the CS department. His family is now settled on the East Side, enjoying city life, Providence's renaissance and the scale of Rhode Island. His Brazilian wife Liane was surprised to meet so many people who spoke Portuguese. Having recently enjoyed the glories of a New England fall, they now anticipate another Rhode Island winter.

Carved by the grad students at their Hallowe'en party, each pumpkin represents a faculty member!

Roger Blumberg. Roger, who taught CS92 last year and will do so again this year, has been appointed to the national Technology Advisory Panel for the state of Ohio, a group that evaluates technology initiatives in Ohio's schools.

Tom Dean. Tom was busy this summer gathering information in preparation for the 1999 International Joint Conference on AI (IJCAI'99) to be held in Stockholm next summer, for which he is program chair. Part of the planning process involved a site visit to Stockholm in June and a meeting of the IJCAI Inc. board of trustees in Paris during the World Cup Games.

John Hughes. Says Spike, "Over the summer I got tenure and swore I'd never work again. I've been working harder than ever ever since ... only went on my boat four weekends all summer."

Leslie Kaelbling. Leslie was plenary speaker to the freshman class at "Points on the Compass," an academic conference that was part of Brown's orientation. Also on the home front, she received the Philip Bray Award for Excellence in Teaching in the Physical Sciences. This is a monetary award, only four of which are awarded annually. She served on a thesis committee at Universitat Politecnica de Cataluña in Barcelona. The talk was in Catalan, but the thesis was written in English! She gave a talk at the International Conference on Machine Learning in Madison, WI, and gave an invited talk at CONALD (Conference on Automated Learning and Discovery) on robot learning at CMU. Leslie admits to having "worked like a dog on CS17/18, that'll be covered in the spring issue!"

Franco Preparata. Franco presented invited plenary lectures at two international symposia held in June, the first in Elba, Italy, the second in Zurich, Switzerland. In September he presented a keynote speech at the inauguration of the graduate program in informatics at Kansai University in Osaka, Japan.

John Savage. Last May John was elected President of the Faculty Club. With Roberta Gordon, Director of Human Resources at Brown, he is co-chairing Brown's annual Charities Drive this year. His 1976 book *The Complexity of Computing*, published by John Wiley, has just been published in translation by Factorial, a Russian press. John's appointment to the MIT Corporation visiting committee for EECS has been extended for another four years.

Roberto Tamassia. Roberto served on the program committees of the Symposium on Graph Drawing (Montreal, Canada) and of the Symposium on Algorithms and Computation (Taejon, Korea). He also gave invited lectures at the University of Konstanz, Germany, the Worcester Polytechnic Institute, and Washington University, St. Louis. He co-chaired the Dagstuhl Workshop on Graph Algorithms and Applications (Dagstuhl, Germany) and the CGC Workshop on Geometric Computing (held in this department on October 11-12). He was awarded NSF funding for his research project on geometric algorithm design and implementation. His book on graph drawing (with G. Di Battista, P. Eades, and I. G. Tollis) was published in August by Prentice Hall.

Eli Upfal. Eli was plenary speaker at the Sixth Annual European Symposium on Algorithms (ESA 98) in Venice and an invited speaker at the Warwick Random-

ized Algorithms and Stochastic Simulation Workshop (WRASS) at Warwick University in England and at the Workshop on Complexity Issues in Parallel and Distributed Computation at The Fields Institute in Toronto. He was a program committee member for the thirty-ninth Annual Symposium on Foundations of Computer Science (FOCS 1998).

Andy van Dam. In September Andy was a keynote speaker at Eurographics in Lisbon and IFIP in Budapest. He stepped down as Director of the NSF Science and Technology Center for Graphics and Visualization after three years. During his tenure he led the STC through a successful renewal process, ensuring another four years of funding. He is happy to report that his intro to graphics course, CS 123, has over 80 students for the first time.

Computer Science Department
DISTINGUISHED LECTURER SERIES
1998-1999

EVERYONE IS WELCOME!

November 5
Oren Etzioni, University of Washington
"From AI Methodology to Internet Startup: The Story of the Softbots Project"

December 10
Avi Silberschatz, Bell Labs
"Next-Generation Information Systems"

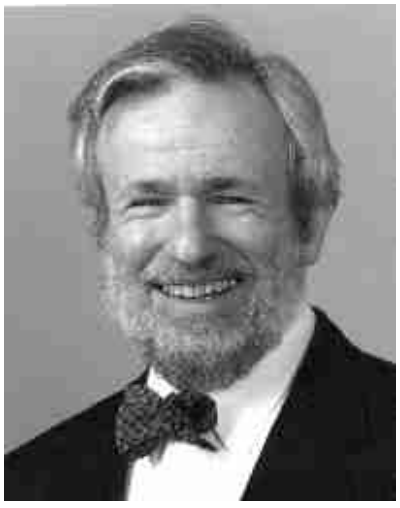
February 4, 1999
Barbara Simons, ACM
"Digital Library or Digital Store: Will There Be Free Libraries in the Digital Age?"

March 4
Przemek Prusinkiewicz, University of Calgary
"Modeling Plants and Plant Ecosystems"

May 6
Christos Papadimitriou, University of California, Berkeley
"Complexity as Metaphor"

All lectures start at 4:00 in the Lubrano conference room, 4th floor, refreshments at 3:45.

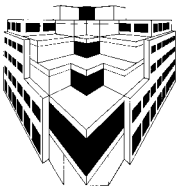
CHARNIAK UNPLUGGED



Eugene Charniak

Because of my research area (artificial intelligence) I often work with professors from other departments. For example, I currently have some joint grants with other Brown professors in Cognitive Science, Ap-plied Mathematics, and, of relevance to this tale, Neuroscience. Thus I find myself on the Neuroscience seminar mailing list, a list that also contains doctors (the medical kind, not PhDs) at the various local hospitals. About two months ago I re-ceived the first Neuroscience seminar announcement. One doctor at Miriam Hospital was on a trip and thus could not read the announcement, but his mail program was thoughtful enough to tell the person who sent the e-mail that he was out of town and for something important one should contact his administrative assistant. Actually, the mailer responded to everyone on the mailing list, not just the sender, so I got the response as well.

To this point there is nothing much new in this story—it has happened to me many times. But this time there was an extra twist. Since the doctor in question was himself on the mailing list, the mailer informed the doctor as well. Upon receiving this response the mailer then informed everyone on the mailing list a second time that the doctor was out of town. At this point we have what we in the trade call a non-terminating loop. By the end of the day I had received ten responses. Each time the mailer added



"Response" to the e-mail topic header and it was getting pretty long.

Now that this has occurred, it all seems so inevitable that I wonder why it never happened before. I also wonder why I got only 10 responses in the three hours before someone pulled the plug. Is the time for a message to go from the hospital to Brown and back really that long (i.e., on the order of 180 minutes/10 = 18 minutes)? Not that I am complaining, mind you.

Recently there has been a spate of columnists getting fired for putting invented people and quotes in their columns. We in Providence are probably slightly more aware of this than most people in the country, since two of the big cases occurred at the Boston Globe within a month or so of each other. One result of this is that Suzi Howe, our Editor-in-Chief, has been threatening to check my columns for accuracy. Thus I decided it would be better to do it myself. As our president has shown, it is better to get the dirt out early and get it out yourself. So, first, yes, it really is true that Ed Lazowska ('72 and now chair of Computer Science at University of Washington) said, "We think the department should be incredibly embarrassed that an old geezer like van Dam has the best-looking set of legs in the building." On the other hand, it is not the case that Tom Doeppner said of the workload in CS 169, "I think I am going to patent it as a cure for homosexuality, or heterosexuality for that matter."

You may remember Ramona, the department's robot (***conduit!*** Vol. 3, No. 2). You don't? Hosiery Corporation of America does. Last summer they sent "Ms. Romona D. Robot, Box 1910 Brown University, Providence RI 02912" a card for a free sample of "Silkies pantyhose." Suzi Howe got the same offer, sent in her card, and got the pantyhose. Ramona wasn't interested.

The other big mail event of the last few months was a very suspicious-looking package addressed to Andy van Dam from a company with the unusual name of "Nogruoy." The package was noticed by whoever was handling the mail that day and brought to Suzi Howe's attention. Suzi (I wonder how she can do it) observed that "Nogruoy" is "your gon" spelled backwards! This really made

people think. Suzi warned Andy, who eventually sent the following e-mail:

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Subject:  The mysterious package
did contain a Time Bomb
4 copies of the book ''Time Bomb
2000,'' in fact;
suzi - thx for being vigilant!
-a
```

To which Suzi responded:

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omigod!  what a hoot...or should
i say, a blast?!
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In the last issue of ***conduit!*** I mentioned that I was taking my sabbatical at Johns Hopkins and commuting back and forth every week to Baltimore on Southwest Airlines. On my very last trip back I picked up the airline magazine (usually I fall asleep before I descend to that level) and was greeted by an article about Providence mayor Vincent (Buddy) Cianci. A few ***conduit!***s ago I mentioned the mayor in the course of a paragraph on viewing Providence as a convention-goer, and I particularly noted the mayor's excellent marinara sauce. Thus I had no doubt about the topic of the article when I saw the title "The Mayor of Marinara." Most of the material was already familiar, but it is always interesting to get an outsider's view of something you know from the (relative) inside. Furthermore, I picked up a few tidbits, including: Buddy is now marketing his own brand of coffee "Mayor's Choice" (with, again, profits going to a scholarship fund); Buddy is the leader of a new movement with at least one follower—the mayor of Springfield, MA, has now marketed *his* brand of spaghetti sauce; finally, our mayor is not worried about going head to head with Paul Newman, saying, "Would you rather buy sauce from someone named Newman, or someone named Cianci?"

The 7 presidents born in Ohio: James Garfield, Ulysses S. Grant, Warren G. Harding, Benjamin Harrison, Rutherford B. Hayes, William McKinley, William H. Taft.

conduit!

A publication of
The Computer Science Department
Brown University

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U.S. Postage
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