Department of
Computer Science
University of Illinois
at Urbana-Champaign

Alumni News

Winter 1996 Vol. 1, No. 7 *Computer Science Alumni Association* • A Constituent group of the University of Illinois Alumni Association

Are you ready for Cyberfest? *aka Hal's Birthday*

Cyberfest will soon be upon us. We hope you've been tracking the developments by visiting the Cyberfest home page. For those of you in the dark, Cyberfest is a campus-wide celebration of the computer on the occasion of HAL's birthday. HAL, the errant computer from the movie *2001: A Space Odyssey*, was born in Urbana in 1997, and we would like to claim the Department of Computer Science as his cradle. All kinds of events, including Engineering Open House, will be taking place across the campus during the week of festivities. And of course, Computer Science has its own events—three reunions and a forum—which we hope you'll attend. The most special guests will be YOU!

Most events will be held from Wednesday through Saturday, March 12-15. ***Your support, in every form, is needed! Feel free to contact me, or any of the event chairs below.***

—Judy Tolliver, editor

BIG IRON

A reunion of ILLIAC and Cedar folk

If you are an ex-user, designer, or builder of any of the ILLIACs or Cedar, please plan to attend the Big Iron reunion.

The liquid plan calls for an anecdotes and memories hour, an updating on various friends and coworkers, as well as other activities.

You'll even get another chance to burn your finger on a soldering iron!

To help, contact Sylvian Ray, Big Iron reunion chair, ray@cs.uiuc.edu or 217-333-0806.

To get on the mailing list, send e-mail to bigiron@cs.uiuc.edu.

PLATO

A reunion of developers and programmers

Come join us for a day of food and festivities! There will be talks by Important PLATO FOLK, and you'll get to log on and look at some of your favorite lessons, notesfiles, and games. Plans are still being made, so your suggestions for speakers or activities (and offers of help!) are most welcome. This event will be sponsored in part by NovaNET.

To help, contact Michael Walker, PLATO reunion chair, mwwalker@uiuc.edu or 217-333-7316.

To get on the mailing list, send e-mail to mwwalker@uiuc.edu.

ACM

HALapalooza: ACM alumni reunion

This reunion for past ACM (Association for Computing Machinery) members will start with a tour of current day ACM facilities as well as information about a number of current ACM projects. The group will then move on to socializing over an old-fashioned ACM meal. After dinner, there will be a number of activities and presentations including "Techno-Jeopardy."

To help, contact Alex Bratton, ACM reunion chair, bratton@mcs.com or 708-575-8200.

To get on the mailing list, send e-mail to halapalooza-request@acm.uiuc.edu.

1997 CYBERFEST

All reunions will take place on
SATURDAY, MARCH 15, 1997,
in the Digital Computer Lab.

http://www.cyberfest.uiuc.edu for campus events
http://www.cs.uiuc.edu/cyberfest for department events

University of Illinois
Computer Science
Alumni News

Editor: Judy Tolliver

Computer Science Alumni News deadlines for submissions: March 1 for the spring issue, October 1 for the winter issue. Your input is needed and welcome!

All ideas expressed in the *CS Alumni News* are those of the authors or editor and do not necessarily reflect the official position of either the alumni or the Department of Computer Science.

Printed by University of Illinois Printing Services on recycled paper.

Correspondence concerning the CS Alumni News should be sent c/o the editor, Department of Computer Science, 1304 West Springfield Avenue, Urbana, IL 61801, or to alumni@cs.uiuc.edu.

http://www.cs.uiuc.edu

Happy Birthday, HAL: A campus-wide celebration

Some exciting things are happening at the campus level. Here are some of the confirmed ones:

Roger Ebert will host a showing of *2001: A Space Odyssey* at Krannert. A program, also hosted by Ebert, of conversations with futurist film makers and high tech luminaries will be shown for the first time. **Arthur C. Clarke** will be among Ebert's guests. Mar 13.

HAL's Birthday Celebration will also be held at Krannert. The cast of 2001 and other Hollywood personalities are invited. Mar 14.

Disembodied Creativity, a day-long symposium on the social and aesthetic implications of intelligent machines, will be hosted by the English department. Speakers include: **N. Katherine Hayles**, professor of English at UCLA, a literary scholar with special interest in chaos theory and the social and artistic implications of development in AI. Her latest book is *Virtual Bodies: Evolving Materialities in Cybernetics*. **Bruno Latour**, leading French sociologist of science and philosophy with special interest in the social construction of machines. His latest book is *Aramis, or the Love of Technology*. **Hans Moravec**, director of the Mobile Robot Laboratory at CMU. His latest book is *Mind Age: Transcendence Through Robots*. **Brad Leithauser**, chair of the humanities at Mt. Holyoke, whose most recent book is *Penchants and Places*, a book of essays on the theme of intelligent machines. **Richard Powers**, UI English professor and science fiction author, of *Goldbug Variations* and *Galatea 2.2*. Moderator will be **Michael Berube**, English professor and author of the book *Public Access: Literary Theory and American Cultural Politics*, which includes a chapter called "Paranoia in a Vacuum: *2001* and the National Security State." Mar 13.

Piers Bizony, author of the definitive book on the subject, book *2001 Filming the Future*, will be a Guest-in-Residence at Unit One on campus March 8-14. His newest book is *Island in the Sky: Building the International Space Station*. Mar 8-16.

Cyberfest Showcase: A two-day futuristic technology fair including vendor presentations and faculty/staff presentations. (Contact mshiff@uiuc.edu for tech fair info.) Mar 13-14.

Musical Works appropriate to the Cyberfest theme will be written and performed by the UI's Department of Composition and Theory. UIUC was the site of the nation's first electronic music studio. Mar 12.

American Society for Cybernetics will host its biennial national meeting with evening performances and conversations open to the public. Mar 8-12.

1997 Great Lakes Symposium on VLSI, an IEEE conference. Mar 13-15.

Engineering Open House hosts thousands of visitors for student project displays and competitions (see p. 9). Mar 13-15. ■

Lodging & Transportation

See Champaign-Urbana Convention & Visitors Bureau home page:

http://www.prairienet.org/community/convention/home.html

Computer Science Cyberfest Forum

A group of scientists will gather in DCL on the evening of March 12 to wrestle with the computational and philosophical issues raised by the movie *2001: A Space Odyssey*. Our special guest will be **Frederick I. Ordway III**, scientific and technical consultant to the film. Ordway worked with Clarke and Kubrick on the film and was closely involved with IBM on the computer scenes. He is a NASA veteran and author of a chapter, "2001: A Space Odyssey in Retrospect," in the book *Science Fiction and Space Futures*, edited by Eugene M. Emme (Univelt, 1982).

Other scheduled guest scientists include:

- David Kuck, supercomputer development leader;
- Stephen Wolfram, physicist and developer of Mathematica;
- Tom Mitchell, leading researcher in machine learning and AI at Carnegie-Mellon University;
- Dave Waltz, senior researcher in AI and massively parallel computation networks and director of computer research at NEC Laboratory;
- Murray Campbell, researcher for IBM's Deep Blue chess computer;
- Joe Hoane, researcher for IBM's Deep Blue chess computer.

Professor Jerry DeJong, who is organizing the event, will moderate the discussion. The film will be shown in conjunction with the forum either that afternoon or the night before. ■

http://www.cs.uiuc.edu/cyberfest

HAL's birth celebrated on special envelope

The Champaign-Urbana Stamp Club is celebrating the birth of HAL with a special commemorative envelope and cancellation. Allan Tuchman, BS'76, MS'91, is president of the club and head of the project. The envelope will include a 4-color cachet and a special cancellation approved by the United States Postal Service. The cachet shows the Sun, Earth, Moon, and Saturn, four bodies that figure prominently in the novel *2001: A Space Odyssey*.

The text on the envelope reads:

The future begins in Urbana...
At the dawn of the third millennium.

and also includes the text

"I am a HAL Nine Thousand computer, Production Number 3. I became operational at the Hal Plant in Urbana, Illinois on January 12, 1997."

(This quote is used with permission of Arthur C. Clarke.)

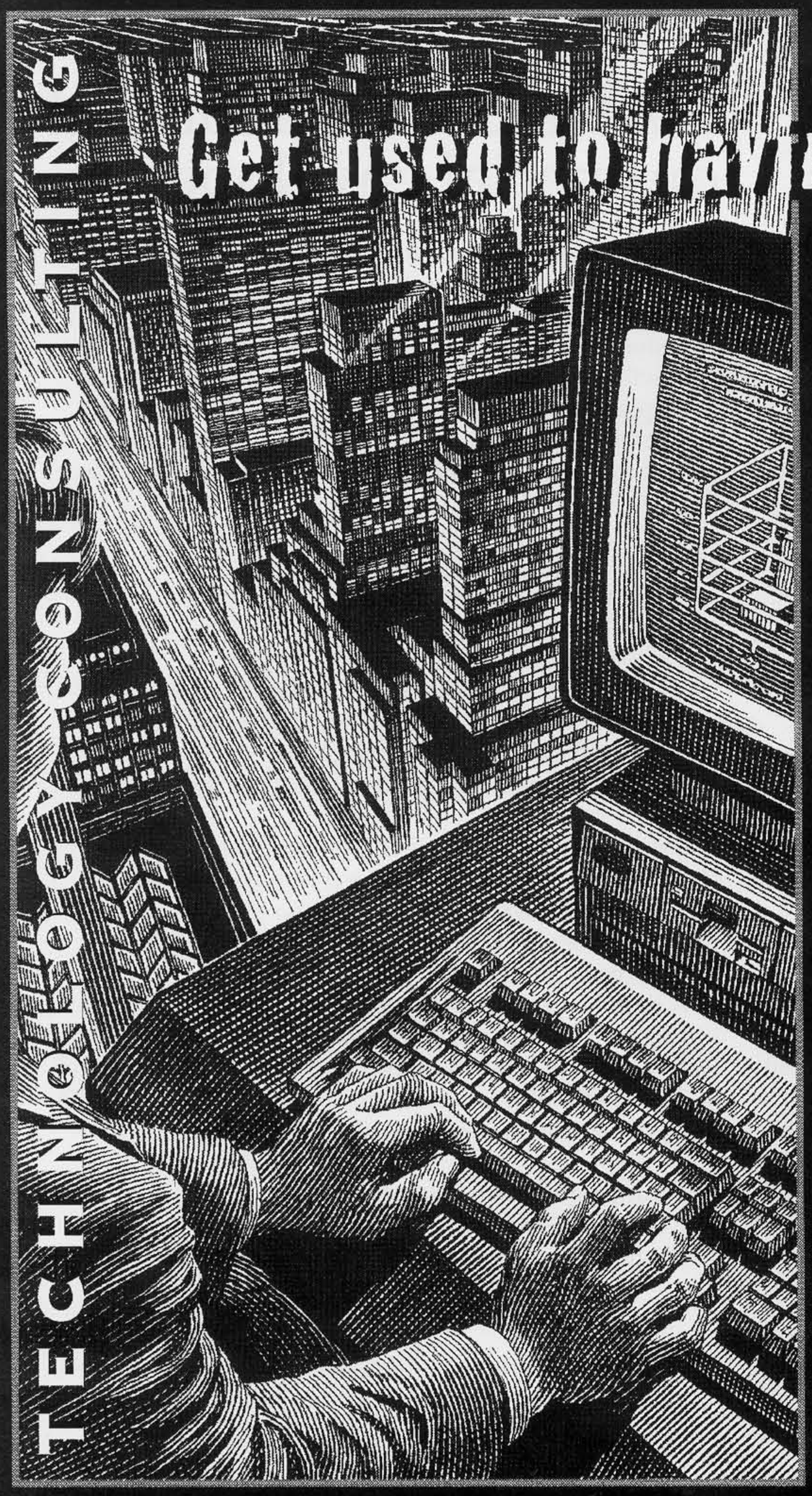
The stamp on the envelope is the Computer Technology stamp issued October 8, 1996, and the special pictorial cancellation shows planets of the solar system out to Saturn and reads "Computer Genesis Station, Jan 12, 1997, Urbana, IL, 61801".

A limited quantity of the envelopes will be made and available only until the supply is exhausted. Mail orders will be filled in January. Envelopes are $2 each and must include a self-addressed, stamped #10 envelope (include $.52 postage for 3 or more). Address orders to:

Champaign-Urbana Stamp Club
P.O. Box 11266,
Champaign, IL 61826

CS professors write about HAL

Three Illinois professors are featured in a new book edited by David Stork called *HAL's Legacy: 2001's Computer as Dream and Reality*. The book, published by MIT Press, explores the relationship between science fantasy and technological fact using HAL as a point of departure. Professor emeritus David Kuck wrote a chapter called, "Could We Build HAL? Supercomputer Design," adjunct professor Stephen Wolfram wrote, "HAL, Computer Languages, and Images: Using Computers," and ECE professor and computer science department affiliate Ravishankar Iyer wrote, "Foolproof and Incapable of Error? Computer Reliability." ■



Get used to having your fingers on the pulse of technology

Deloitte & Touche Consulting Group, one of the world's leading consulting firms, has fast-track opportunities reserved exclusively for Illinois' top students.

Systems Analyst Program

By joining us you'll be entering the challenging and rewarding world of information technology consulting. You will apply the latest technologies to our clients' most challenging business and technical initiatives. We provide opportunities to expand your skills through formal training, teamwork with our senior staff and education programs. You'll gain skills in planning, building, testing and implementing systems by actually doing the work -- which we believe is the best way to learn.

Deloitte & Touche Consulting Group

change that produces results

Of course opportunities like these will disappear faster than your student e-mail account. To qualify, you need to have a superior academic record, demonstrated leadership ability and boundless initiative. Plan now to meet with Deloitte & Touche Consulting Group when we visit Illinois. Sign up in the placement office for our campus interviewing. Deloitte & Touche Consulting Group is an equal opportunity firm. We recruit, train, compensate and promote without regard to race, creed, color, national origin, age, veteran status or disabilities. Web browsers are encouraged to visit our web page @ http://www.dttus.com

From the Corner Office

Dan Reed

Exciting things are happening in DCL, many of which are described in other parts of this newsletter. With the opening of the Grainger Engineering Library across the street from DCL, we shifted the contents of the DCL library to the Grainger library and are remodeling the DCL library space for two new uses. A portion of the library space will form our new departmental lounge, a meeting point for faculty, staff, and graduate students. The remainder of the space will house graduate students, research staff, and faculty, including our newest faculty member, Professor Andreas Nowatzyk.

Professor Nowatzyk comes to us from Sun Laboratories, where he led a group developing an exciting new parallel computer system. Dr. Nowatzyk's expertise complements our world class research group in high-performance computing. Please join me in welcoming him to the department.

In another important development, Professor Michael Heath has assumed the directorship of the College of Engineering's Computational Science and Engineering (CSE) program, and the CSE offices have relocated to the second floor of DCL. The CSE program creates exciting possibilities for multidisciplinary education and collaboration. As one example, we are leveraging the opportunities provided via the CSE program, our departmental multimedia infrastructure project, and the work of Professor Campbell and his students on Vosaic, we are planning a new initiative in distance learning.

Finally, we have created a departmental strategic planning committee that is working with the faculty to create a long term plan for the department's research, education, and service foci. If you have ideas or suggestions, I am confident the committee would love to hear from you. The committee can be reached at stratplan@cs.uiuc.edu.

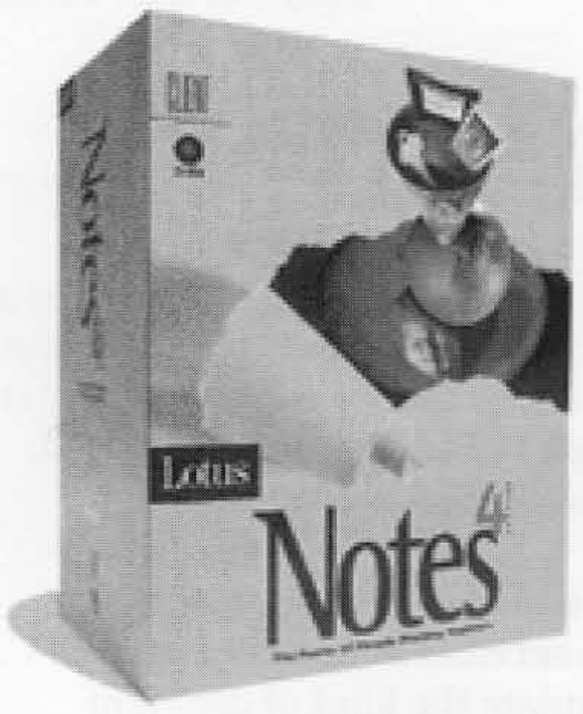
—Dan Reed
Head of Department
reed@cs.uiuc.edu

Lotus Notes comes to campus in a big way

Alumnus Ray Ozzie, BS'82, has helped arrange for IBM to provide the university with a site licence to use Lotus Notes on all three campuses. Every faculty member, student, and staff member will be able to use this leading groupware product. This may have a tremendous impact not only on administrative management, but on the educational side as well.

Brian Levine, a former PLATO programmer with a background in psychology and education, was hired last fall by the Communication and Computing Services Office (CCSO) to manage the Notes deployment. "Notes is hard to define," Levine stated. "A verbal definition does not give it justice. Working with it is the best way to figure out what it is. It will mean different things to different people depending on how they use it. It helps facilitate business processes, the movement or flow of information, it can do e-mail, access Usenet or the Web. What isn't currently known is how it can be used for education. That's my focus: How can we exploit Notes for instructional gain?"

CCSO is shooting for fall deployment, but it is not known yet how wide the initial deployment will be. CCSO has received some assistance from Andersen Consulting through Newenka DuMont, BS'83, who arranged for several Notes deployment consultants to help in the strategy and rollout definition. Training, support and initial applications are CCSO's major tasks at hand. Notes will enter a lot of competition, from products like Microsoft's Exhange and SoftArc's First Class, for use by university units. "Word of mouth will be really important for wide use of Notes," said Levine.



He concluded, "We're a leading research institution of higher education in the country, and we have a history of innovative computer uses, and if anyone ought to be able to make innovative instructional use of Notes, we ought to. We have an opportunity to explore instructional uses of the leading group product in industry, and Lotus has the opportunity to open their product to a wider, higher education market." ■

An conversation with Bjarne Stroustrup, Gillies lecturer and inventor of C++

Bjarne Stroustrup, creator of C++, delivered the 20th Donald B. Gillies Memorial Lecture on March 25. After first giving a technical talk on the standard C++ library, Stroustrup presented "Programming Languages—Why Should We Care" to a packed house of over 200 people. Stroustrup discussed the role of programmers and programming languages, the origins, aims, and design rules for C++, and the key language features of C++ and the design and programming techniques they support.

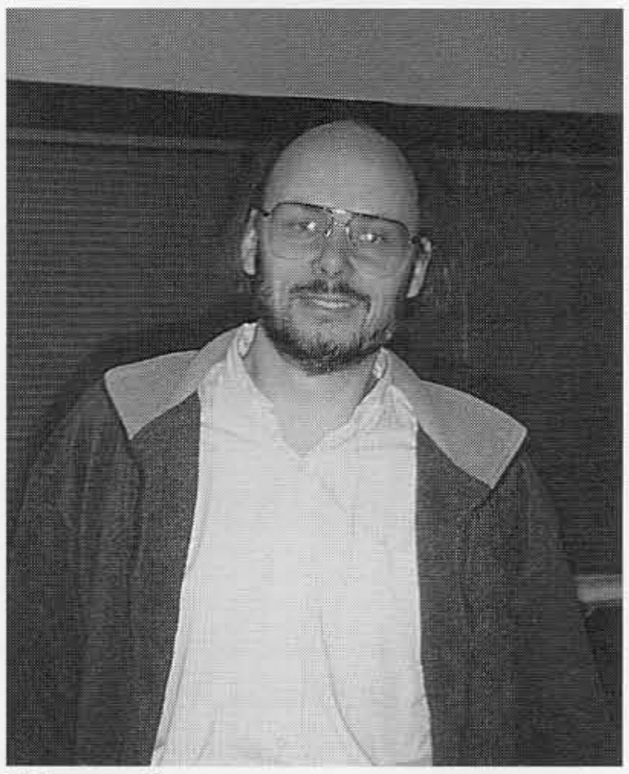
Stroustrup is the designer and original implementer of C++ and the author of several books on the subject. He received his Cand. Scient. in mathematics and CS in 1975 from University of Aarhus, Denmark, and his PhD in computer science in 1979 from Cambridge University. His adviser was David Wheeler, who was on the DCL faculty at Illinois from 1951-53 and was a programmer for ILLIAC I.

Stroustrup currently heads AT&T Bell Labs Large-scale Programming Research department and is a Bell Laboratories Fellow. In 1993, he received the ACM Grace Hopper award and is a Fellow of ACM as well. He lives in Watchung, New Jersey, with his wife and two children.

This was Stroustrup's second visit to Illinois. The first was five years ago when he spoke to the Choices research group headed by Professor Roy Campbell. Choices is an object-oriented operating system developed by that group and written in C++.

I had the following conversation with Bjarne Stroustrup shortly before he gave his talk on programming languages.

—Judy Tolliver, editor



Bjarne Stroustrup

Did your involvement with object-oriented programming start in Aarhus?

Sort of. I mean, I went to university in Aarhus, which was also my hometown, so that's nice. I tried Simula for a couple of weeks at Aarhus when I was an undergraduate. Then several years later, I was in Cambridge trying to get a PhD. And I recognized that I needed a tool and Simula was a good tool for it, so there I then learned Simula properly.

I was trying to simulate a distributed operating system, trying to distribute services over a network of computers. I wanted to simulate the kind of different performances and different strategies for composing systems, different kinds of networking, and shared memory kind of architectures, trying to figure out how high-level systems could be supported by lower level architectural things. And those simulations could be very well designed and implemented in Simula, or so I thought. My early education in Aarhus taught me what a plausible tool was, and then I just picked up the tool and in the end it helped with the design, but it couldn't do the implementation. It was too expensive, so I had to translate it to a lower level language.

Then when I came to Bell Labs in 1979 and I needed to build some systems. I knew both the strengths of the Simula approach—strongly typed, object-oriented programming and design. I also knew the weaknesses of the Simula approach which were that it simply ran too slow, it was too cumbersome, it couldn't interact well with other software, and it wasn't effective for systems level programming. And so I tried to take the strength of Simula in terms of type system and object-oriented programming and object-oriented design and marry it with the strengths of C which was that it could interact with lots of other software, it was open, and it was good for systems level work. And it was efficient, and that was the origin of the thing.

Aarhus gave me some idea of what Simula could do, and Cambridge gave me the experience and the real learning of those ideas and what were the weaknesses of the approach. And the next step was to actually use that experience to build the first version of C++.

Was the first version built for something specifically within Bell Labs?

Basically, yes. I was in the business of helping people design various things: network protocols, board layout, things that require simulation. And so the early uses—my bread and butter for years—were simulation programs for help with designs: Trying to figure out buffering capacities in networks, trying to figure out the behavior of certain networks under saturation conditions, trying to symbolize board layout by minimizing communication courses, things like that. That was the call. Then

there were lots of other things because, as it turns out, C++, or C with Classes as it was called in the early days, was useful for lots more things than its original purpose.

Why did you call it C++?

C with Classes was quite descriptive because it was C and it had the Class concept from Simula. The point was, however, that people dropped the word classes because it was such a long name, so they called it C, which was all right with me. But then they started calling C Old C or Straight C or Plain C, so I had to find another name, not to be insulting. And I had a little competition, with me as judge and jury, and I picked C++, because ++ is the increment operator in C, so in C, C++ means Next Successor Add 1, things like that, so it's just a programmer's joke.

Since new languages are so hard for people to accept, how come C++ became accepted as readily as it did, and what did you do to try to get people to use it?

It's hard to say, really. It's sort of culturally compatible with C. You can go relatively easy from C to do some of the less radical parts of C++, and that helps. It is also much more efficient than anything that can do similar things much better. It's used very simply: If you want to write object-oriented code, if you want to write highly abstract code, you can use C++ or you can run ten times slower. That was very important. So were the compatibility with C and the efficiency. Also, it wasn't specialized. It was just a language, it could fit in on any computer, you didn't have to use any particular Windows system, or database system. If you wanted to write system level code, you could do it! And what I did was I explained to people what it was, I didn't hype it. I also explained what it couldn't do. I explained very carefully to people what I *didn't* promise people, and I think that was important.

So first it was accepted within Bell Labs, and then...

And then it spread. It spread rather fast. It was worldwide in very small pockets well before it was called C++. I was asked by the ACM to write a paper on the history of C++ a couple of years ago and so I researched it again. It spread rather fast and rather wide. People liked it. It was easy to prove you could get some benefits from it, and if you worked a bit harder at it, you could get more benefits. It can be learned incrementally, it can be used incrementally, and basically your benefits are at least proportional to the effort, as opposed to having to understand everything first before you can start.

Are you still developing C++?

No, we're just finishing the international standard for it. That's sort of the end of it as far as I'm concerned.

There's no next big thing then?

No, I don't want to. It's been too much and too long. But I think one thing I would like to emphasize here. There are two theories for how C++ succeeded which are just plain false. The first is that it succeeded simply because it was first. And it wasn't. Simula was there. Smalltalk was there. Objective C was there. Eiffel was there, and so was the Object-Oriented Pascal. It was one of a group, and there were actually several that were before that. It was not because I was first. Secondly, it is not because of the marketing might of AT&T. We spent $3,000 popularizing it and marketing for the first three years when it was commercially available.

I've never seen TV commercials for it.

No, no. I have seen a magazine ad for it, but that came four years after it was commercially marketed. We literally only spent three or four thousand dollars in three years! The hype came when somebody else actually bought the idea and then started trying to make money off it. It was a grass roots thing.

With the AT&T break up, are projects like this going to go on?

A lot of things will go on. It's a difficult times for fundamental research anywhere, from the universities to software engineering. So these are rough times in general, but research will go on, and what I'm doing here has always been research with a small "r." Always trying to serve a user community well. Trying to get fundamental ideas—which I don't claim to be mine. I borrowed most of my great ideas from Simula with acknowledgment. Trying to actually engineer them and popularize them and get them into real use. There never was a C++ project. It was just me building some tools and helping some people design networks and things like that. It just grew up out of a need and out of some ideas for fulfilling that need. It was only much later that there was a project. C++ was not the result of a planned, large, budgeted project. The first commercial C++ release also was by an order of magnitude the cheapest product ever produced by Bell Labs.

Do you have any opinion on Java?

Not really. I have one severe problem. Each time I try to run it on my Sun, it freezes my X server, and I cannot execute it. It that's security, then it's very secure, because no one can do anything to my machine when it's using Java.

Java is being hyped as the next generation of—

The next generation of what?

—Of C++.
Well they claim it to be better than all other languages in all possible ways, and it's plainly not. It may have a role in the Web and networking, but that depends on whether they can keep it secure. And as it looks now, it doesn't look all that secure to me. But we'll see. I think it is not a language issue or a language design issue, it is a systems and security issue. And my feeling is that most people up till now just pretend there are no security problems.

I wanted to ask you about the software crisis. With millions and millions of lines of code, how can you write a bug-free program and be able to prove that it's bug-free?
First of all you can't.

Should you even bother?
Well you should try. You try the best you can. I mean, you can't prove that a car won't crash either, but it doesn't stop us from having cars. But what you want to do with the software crisis is not eliminate it because you can't. You'd have the whole earth's population trying to make error free programs. What you want is to make them more and more error free and spend disproportional effort on life-critical things. You can write very reliable programs. When I hear about people programming pacemakers in C++ I get sort of nervous, but on the other hand, I'd get sort of nervous independently of which language they were programming in. The idea of pacemakers and heart monitors and wing tips of airplanes being controlled by processors *should* make anybody a bit uneasy, and it should increase the effort of verification and all the techniques we've got. I mean, we're not helpless. It's just difficult and expensive.

The Denver airport is a big example of a failed plan...
Well, the way I've heard it, they had two companies bidding. One said it would take x years and y dollars, and the other said it would take 2x years and 2.something dollars, that is, twice the time and more than twice the cost, and they decided to go with the first company. Not only were they cheaper and faster, but they were also American. The other company, however, had built such a system before, and it did take slightly more than 2x times and cost slightly more than 2y dollars. I think what we saw here was the effect of the procurement process and the effect of politics. If you want something cheap and fast, you'll get something cheap and fast. And I think they got exactly what they asked for. They just didn't want to believe that the problem was as hard as it was.

If you have hundreds of programmers working on one big program, how do you manage that?
With great difficulty. First of all, we do it and it works. Two it's too cumbersome, unpleasant and expensive. I think we need a combination of better design techniques, better languages and better management. There are several ideas for the language parts, C++ is one of them. There are better ways of designing programs: object-oriented programming in the more general sense is part of that problems, and I think management is too prone to oversimplify solutions.

Take the movie industry, for example. They don't pretend everyone's the same. Actors act. Cameramen run cameras. Lighting specialists do lighting. I think within the design and programming, we actually probably need more specialization and more cooperation. There's too much emphasis on fitting people into a few rigid categories. Programmers are like *this*, and you want to get an ANSI standard programmer. And you want to pay him an ANSI standard wage. And you get an analyst who wears a tie and does specifically *that*. You need to have a much more flexible set of roles, and you have to realize that even within the programming area, people vary. And people measure productivity of programmers and it varies by a factor of ten within a small group very regularly and sometimes by a factor of 100.

The people who manage programmers—are they themselves programmers?
Sometimes they are, but when they are they quite often did their programming fifteen years ago and are a bit out of touch. It is very hard. It is a very immature discipline, and it has to not only mature, but it has to mature on its own conditions, not in simple imitation of, say, hardware design. Software is different and difficult. So we need to look into it. I mean, my job title is head of large-scale programming research, and if I thought we knew how to do it, that wouldn't be a research topic, right? So, I'm looking into it; I think I have some ideas. But I know full well that this is not a mature engineering discipline. This is difficult—difficult like in research.

How do we teach all this stuff? This field has spread out into so many different areas, it's impossible to teach everything to every student.
We do not know how to specialize yet. A lot of attempts to specialize have left out critical parts that are needed to do a job well.

It probably needs to be a five- or six-year program or something. But then by the time you graduate, the stuff you learned early on would probably be obsolete.

Of course it would, but the observation in Denmark was that the traditional degrees took 5.5 to 6.5 years. They would not let you out; they would not consider you a functioning professional in less than 5.5 years. My master's degree took 6.5 years. I was the youngest computer scientist ever in Denmark for about two weeks, until all my friends graduated. But it took that long. And they tried to introduce a bachelor's program and it completely flopped. I think they abandoned the bachelor degree again. This was a novelty. They were trying to use the Anglo-Saxon system, and they just couldn't produce people with sufficient knowledge and skills to be used in industry.

What was your bachelor's in?

I don't have one. This is standard Danish practice. No bachelors. It is not a useful concept in the science and engineering disciplines. I have a Candidate of Science—it's like a rather massive master's degree. But tradition there was that you couldn't build an engineer or a scientist or good functioning professional in the sciences in less than 5.5 years. And they did a serious experiment—I mean serious meaning that the government didn't want to pay for it and all the power of the government and all the pressure of the European Union and all the Presidents from the U.S. and England—they tried to build a four-year program to produce something useful in those fields. It worked more or less in the arts, but it didn't work in the sciences. It had withered.

So you feel that the Danish system is better?

I think that trying to produce a good engineer or good scientist in four years is a loser. All the good ones have to have a master's anyway, and it's going to take them two years more. Why not realize it? It's probably not feasible bureaucratically here, but that's as long as it takes, so you find everyone takes a master's that actually wants to stay in the field.

So getting a PhD in Denmark is not very common?

It's getting more common now, but it used to be very unusual. I could not have gotten a PhD in Denmark, it was unheard of. That's why I went to Cambridge. There are a lot of computer professionals—good ones—for the population. It is very competitive. There are lots of Danes abroad for that reason. But the system runs at a profit. If you look at it, the country is doing well. It cannot absorb all the people it educates, but it ends up exporting some people for that reason. The system works—we're running a full welfare state at a profit and the current account surplus per person is roughly equal to that of Japan.

Are you ever tempted to go back?

Yes. I get homesick a lot. I've lived in Denmark, I've lived in England, I've lived in the States. I can get homesick for several places at once. It's very confusing. My wife and kids don't speak Danish. My wife's English and it's very hard to learn a language that's not your mother's.

Thanks.

After the interview, Stroustrup told me a funny story about Greg Chesson, PhD'77. (Chesson, who brought UNIX to Illinois while he was a student, is chief scientist at SGI.) About ten years ago, during a Usenix conference, Chesson was chair of a session, and in that capacity was responsible for chasing people off the stage when their time was up. He did this by playing some notes on the grand piano in the back. "There was a speaker who was running badly over time," related Stroustrup, "and he was going on and on about how wonderful the world was going to be with something or another. Chesson started playing 'Beautiful Dreamer,' and the hall collapsed!" ■

EOH: "Imagine That!"

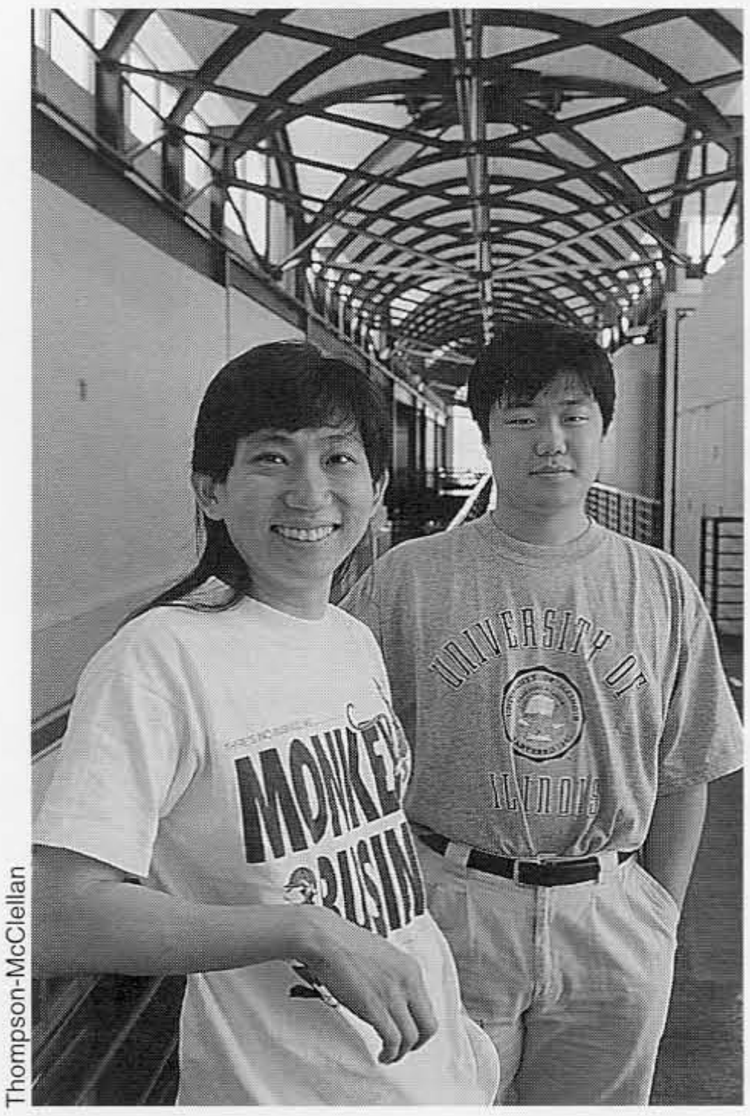
The College of Engineering proudly presents Engineering Open House 1997: "Imagine That!" EOH '97 promises to be a celebration of engineering principles and our professions, drawing tens of thousands of visitors to our campus. This year's EOH is held in conjunction with the campus-wide Cyberfest, a celebration of the birth of the HAL 9000, the (in)famous computer from Arthur C. Clarke's *2001: A Space Odyssey.*

We would like to take this opportunity to invite you and your family to become involved with EOH, as a visitor or judge. As in years past, all EOH exhibits are judged by a panel of professors and alumni. If you'd like to judge exhibits, or if you'd like to receive information on attending EOH, send e-mail to eoh@uiuc.edu or call (217) 244-3828.

—Jeremy Knopow, EOH Director

For campus EOH, http://stimpy.cen.uiuc.edu/comm/eoh. For ACM's EOH activities, http://www.acm.uiuc.edu/events/eoh.

*V*osaic: With a *V* for *V*ideo — *V*ery amazing!



Thompson-McClellan

See-Mong Tan and Zhigang Chen, the minds behind Vosaic, new software for real-time video streaming over the Internet. Using a revolutionary protocol, called VDP, Vosaic takes the pain and angst out of watching video on the Web and makes it what it should be: fun!

Real-time video streaming over the net has been a pipedream until very recently. The "download and play" model currently used by most Web surfers may soon be history. It goes without saying that no one likes to wait 30 minutes to download a 3-minute video clip. Furthermore your average computer is not hooked up to a T1 line, nor does it have the gargantuan amount of disk space required store video. Now, with new software created by students in the computer science department at Illinois (sound familiar?), a person can watch a video on their computer which plays smoothly even if the network is clogged, doesn't take up any disk space, and gives the kind of "time-to-gratification" that most people can live with. It is called Vosaic, derived from the name "Video Mosaic," and it is based on a new protocol, also invented by a computer science student, called Video Datagram Protocol, or VDP. VDP is a breakthrough improvement for video delivery which leaves TCP (Transmission Control Protocol) in the dust. Video can be delivered using Vosaic at an impressive 6 frames per second over a 28.8 modem, almost twice the rate of competing software. And for the first time in its history, the university is taking a direct role in the commercialization of a product invented here by becoming an equity partner in a venture it formed with two entrepreneurs called Vosaic Corporation. The Holy Grail of Web TV may be right around the corner—stay tuned.

Vosaic began in spring 1994 when graduate student See-Mong Tan was looking for an information systems design class project (CS 497, taught by library and information science professor Bruce Schatz). Because he had been fooling around with video at the time, Tan decided to hack some video into the Mosaic Web browser. David Putzolu, MS'95, joined him and it worked: they had a proof of concept. In the spring, another graduate student, Zhigang Chen, was fishing around for an operating systems class project (CS 323, taught by Professor Roy Campbell). Tan suggested that Chen follow up on the video work he started, so Chen did a workstation implementation of Tan's project and during the process, invented a new video standard called Video Datagram Protocol (VDP). "Stan and David came and talked to me about their project, and I thought it was neat," recalled Campbell. "But it wasn't a really big deal. It was when Zhigang was able to get video across the network without using TCP that I knew we had something important."

In spring 1995, VDP became Chen's PhD thesis research. An old friend and former classmate from China, then at the University of Oslo in Norway, Dong Xie, also took an interest. Collaboration over the network with Xie was essential for the VDP development and the video hyperlink work. Another Illinois CS grad student, Yongcheng Li, joined the collaboration, and together they presented "Real Time Video and Audio in the World Wide Web," which won the Best Paper award at the World Wide Web 4 Conference in Boston that fall. Suddenly, the world's attention focused on their work.

Right before they gave the paper, during the heady days of Netscape IPO fever, it occurred to the developers that their software may have commercial potential. So they rushed it to the patent attorneys before releasing Vosaic over the Web (free, of course). The paper caught the eyes of Digital Video Communications entrepreneurs Charles Colby and Stuart Johnstone who were looking for technology to improve video conferencing. When they saw Vosaic demoed, they switched gears and started working out a deal with the university's Research and Technology Management Office. This office, headed by Mel DeGeeter, was established after the need became evident in light of the university's painful learning experience with Mosaic and Netscape. This time, the university would

have an equity stake in Vosaic's commercial development. In April 1996, Vosaic Corporation was formed as a joint venture between Digital Video Communications and the University of Illinois.

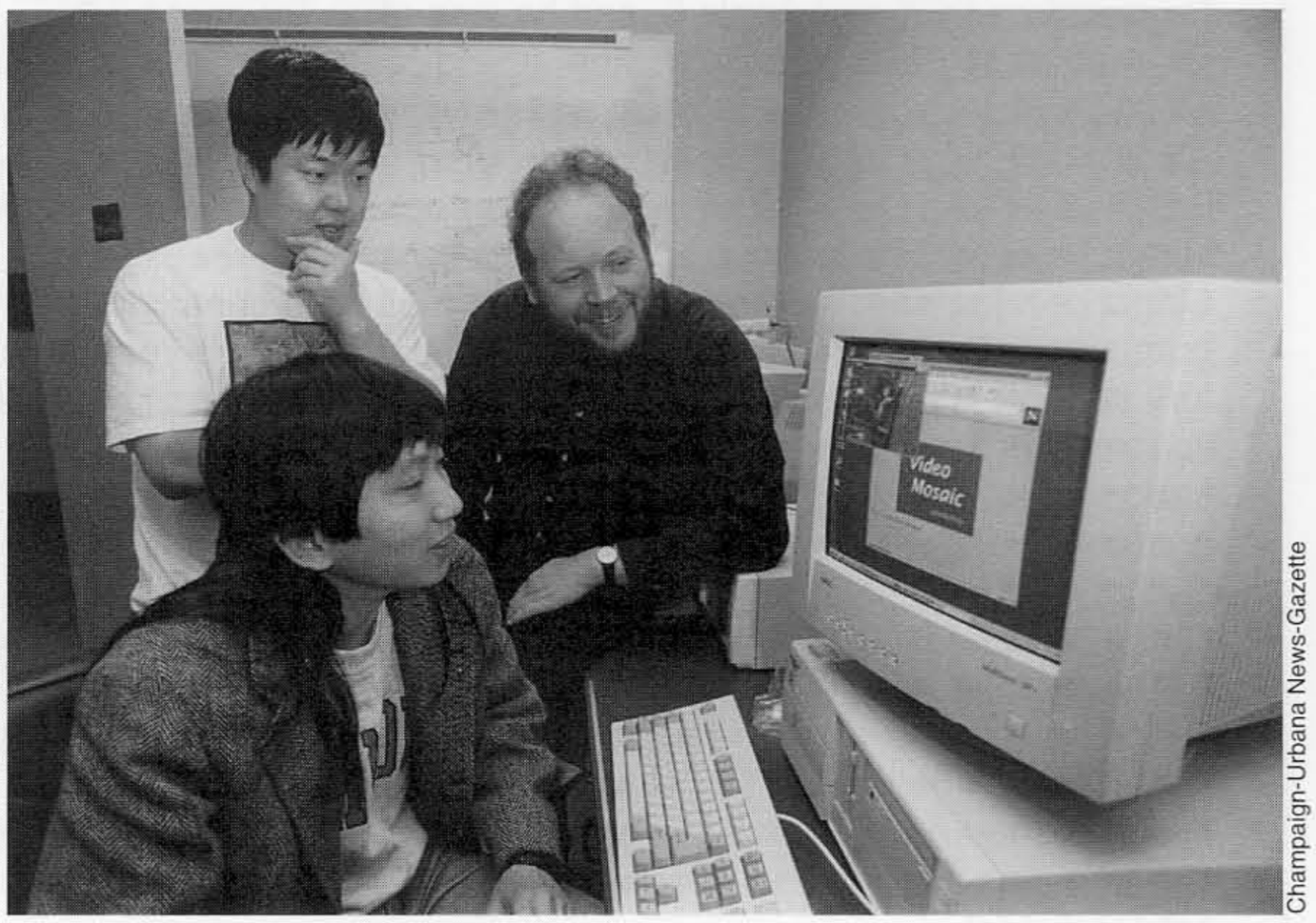
At the beginning, the only copy of Vosaic was sitting in Tan's computer at his house. On April 20, Urbana experienced its first tornado touchdown in memory. Scared that his hard work would be swept up to Oz, Tan had to make a tough decision: to go upstairs and get the code onto a floppy or to remain in the safety of the basement. He decided to save the code, but changed his mind when he actually saw the funnel cloud. Luckily, the tornado did not touch down where he was. (It hit the southeast corner of Urbana where about 100 homes were damaged.)

Stuart Johnstone, president and CEO of Vosaic Corporation, is an entrepreneur who, over the years, has headed ventures from yachting to video. He teamed up with Charles Colby in 1995 to market a software-based video telephony product. It was Johnstone's search on the Web for new video technology that, "through persistence and serendipity," led him to Professor Campbell's group. When Johnstone saw their work, he recognized its potential and e-mailed the developers, as is the style these days. "There's no reason why a university can't participate in a win-win scenario," said Johnson, "meaning that if a technology or idea has been developed that could be commercialized, then it could be marketed to the real world through a corporate vehicle. This is the first instance that I'm aware of that a university itself has an equity position and also derives a royalty benefit and a *de facto* R&D relationship." He pointed out that the beauty and benefit of the university environment is the combination of teaching and learning, with students going off and working with a professor on a problem and brainstorming ways in which to address it. The environment lends itself to the kind of random thinking and creative impulse critical for the long-term growth of a company. This does not usually happen in a corporate environment, he noted. "So the corporate vehicle can help fuel some of that R&D work," he said, "and then can pull out any stuff that looks promising and commercialize it. On top of that, the company itself can still go out and acquire technologies from other places. We've created a relationship that's helping the university with pure cash flow, for starters. It's helping generate what we believe and hope to be significantly greater prestige for the university and for what it's doing in this leading edge field of systems research."

http://
www.vosaic.com

"The alternative," said Campbell, "would be a separate organization, and the developers would leave. That pulls you away from the university, and the ties would get tenuous after a while. A lot of organizations that have spun off from the university have left and gone to other places. If the university owns a bit of the company and has more direct participation, there's more motive to keep it here and make it successful." Most of the developers, including Campbell who has been here for 20 years, have grown fond of living in Champaign-Urbana. No one really wanted to leave. "There are also the problems," he continued, "of how a company continues to be viable, how it refreshes what it's doing, and so on. Locally we don't have much industry, so to get a company that would be closely related to the university, where it can get fresh ideas, is a good thing."

http://
choices.cs.uiuc.edu/
Vosaic/Vosaic.html



Champaign-Urbana News-Gazette

See-Mong Tan, seated, Zhigang Chen, and Roy Campbell contemplate an early version of Vosaic.

What is Vosaic, and what does it do? Simply put, Vosaic is software for video streaming over the Internet. It involves taking a video or audio data stream, compressing it, and sending it over the net to a client that decompresses the stream and plays the result. Vosaic also enables users to insert hot links directly into video streams, making possible dynamic video presentations that connect these hot links directly to other video streams, data, databases, audio streams and graphic images. The program is a new way to utilize video streams with fully integrated HTML links embedded within the stream itself.

Although Vosaic capitalized on the Mosaic name, it is a completely different animal. "Vosaic is a little different because there is a lot of computer science behind streaming video over the network," explained Tan. "Unlike Mosaic, which is pretty much straightforward programming, we have to actually solve some very difficult problems in computer science involving compression, how you handle loss, how you detect varying bandwidth, how you lower the rate of data delivery."

Vosaic currently works as a plug-in to Netscape Navigator and Internet Explorer. Clients are Windows 95/NT, MacOS, Sun Solaris, and Linux; servers are Windows 95/NT, MacOS, and all flavors of UNIX. Servers contain video databases and souped-up Web servers. The Vosaic Video Server allows users to store massive amounts of video and audio and send them out over any IP network using VDP as an underlying transmission protocol. Vosaic Corporation also offers Secure MPEG, a process of encrypting MPEG video for things like secure videoconferencing.

"Downloading video files on the Web, because they're so huge, is a real pain, but watching videos on a Web page is cool," said Tan. "Video on the Web is fraught with technical problems. Users demand instant gratification. They want to view the file as it's downloaded. They want fast forward/rewind/stop/play, hyperlinks, and all that kind of stuff." But to provide these requires overcoming messy technical hurdles like bandwidth, bandwidth variance, packet loss, and synchronization.

The Internet has widely variable bandwidth as data is transmitted via phone lines (28.8 Kbps), ISDN (128 Kbps), Ethernet (10 Kbps) and other means. And it further varies according to the network load and the client's CPU load. To combat bandwidth variance, Vosaic dynamically adapts to the bandwidth conditions by feeding back the observed network and CPU conditions to the video server.

Adaptation, or how you sense how much bandwidth is available, was one of the first big hurdles that the developers overcame. Video data comes in from the server to the client over the network. First, you are limited to the amount of bandwidth, say 28.8 Kbps. This can go up or down depending on the network load. The bandwidth can also go up or down according to the amount of motion in the video. How do you detect the bandwidth variance? How do you find out if there is enough bandwidth to send the video? And how much of the video do you send at a time? Here is how Vosaic answers these questions, in a nutshell. First, audio has absolute priority over video. This is because the eye

See-Mong Tan

See-Mong Tan, who also goes by the nickname Stan, grew up in Singapore, where his Chinese parents fled during World War II from the Japanese. Like many other computer scientists, he was drawn to the common denominator of science fiction and fantasy and devoured works of Assimov and Tolkein. But it was really his sister, who gave him a science encyclopedia as a kid, who deserves credit for his pursuit of science. In seventh grade, Tan's school got a Commodore PET and Apple II, and he was off to the races. His parents finally gave in to his pestering and bought him an Apple II so he could play games like Firebird and Odyssey: The Complete Adventure. But once he discovered programming, his game playing days were over. Determined to study computer science, he took and failed the computer science aptitude test for college, required in Singapore. Instead, he took a regimen of math and chemistry, graduated, and went to the army for the first year of two-year mandatory service. After that, he went to Berkeley on a scholarship for a BS in computer science and worked part-time at Lawrence Berkeley Laboratories. In 1989 he was bound for the cornfields of Illinois for graduate work. After completing his MS with Professor Roy Campbell, he was forced to return to Singapore for a year to complete his mandatory army service. He returned in 1993 to finish his PhD, which he is almost done with. During his free time (what free time?), Tan brews his own delicious beer, a hobby he was introduced to by Thomas Skibo, MS'92, now at SGI. Tan's wife, Yong-kian, is an accomplished ceramic artist who hopes to open her own studio this fall. She also developed a Chinese culture curriculum for the Urbana school district.

compensates better than the ear does, so you can degrade the video in favor of the audio. You can use the audio as a barometer of what is happening in the network because it comes at very constant rates. So, you take a chunk of time and see how much audio has come in. If the audio comes in just fine, you send the video and sustain both the audio and video rates. If the audio doesn't come in at the expected rate, then you know something is wrong. At that point, you feed this information back to the server and tell it to resend the video, but to send less than last time. This feedback loop is extremely complicated, but it works very well. The Vosaic developers call this technique "tail adaptation," because the adaptation is done at the tail.

The next hurdle was synchronization between the video and audio, and another complicated scheme was developed. There is a queue at the client end that stores the video and audio packets as they come in. For comparison, here's how TCP handles synchronization: a video or audio packet is resent over and over again until it is received by the client. Sometimes it takes a while to detect that a packet is lost and the result is stop-start behavior. For video, the lost packet is simply not shown—"the show must go on." With audio, however, you notice missing packets. It sounds like this (read the following aloud): "Th is a pac t miss g." Vosaic employs audio masking, by interpolating between pitches, to combat this effect. For synchronization, audio and video packets are sent from the server to the client into a queue. The client pulls things off from the front of a queue. Because each packet is constant, you can determine if something is missing at the tail. If so, then you send back a request for the server to resend it. A round-trip path is established from server to client and back to the server. The size of the queue is some $\rho \times$ round-trip time, where ρ is some engineering factor, usually 2. The missing packet is slowly advancing to the head of the queue, so the size of the queue must be at least one round-trip time. The goal is to make sure the packet is received before the missing part gets to the head of the queue. The danger, also present with TCP, is something called the cascade effect. That is, if you request that a packet be resent, that creates extra load on the network. And the extra load on the network creates more loss. And the loss results in the need to request another packet, and so on. Then the system comes to a grinding halt. The Vosaic team came up with some "cool" algorithms to handle this situation as well.

One approach to the problem of bandwidth and video transmission is to use a sophisticated compression scheme, such a the proprietary video standard called Wavelets. (Wavelet compression filters out things which the eye can't see and sends only the components which are perceptually dominant. The result can be somewhat jerky.) The idea is to compress the video until it's so small it can be sent over a standard phone line. Other compression schemes include MPEG and H.263 for video, and MPEG, GSM, G.723.1, and VoxWare for audio. The compression schemes in Vosaic are all standards-based so that any decoder, hardware, and software may be used.

The Vosaic developers took a different approach to the bandwidth problem. They used standard compression algorithms but used a very fancy protocol, invented by Chen, called Video Datagram Protocol (VDP). VDP senses how much bandwidth there is and how the bandwidth is varying, and then varies the amount of data sent and prioritizes the packets. It is VDP that is the heart of Vosaic. It is the first protocol of its kind to completely adapt a video stream to the condition of any IP network, thus optimizing its transmission, making it 40 times faster than any other protocol for handling video.

"What I did at first," Chen explained, "was combine Mosaic with

Zhigang Chen

Zhigang Chen had no computer access at his home in the coastal city of Yantai, China, and it wasn't until he attended Tianjin University, the oldest modern university in the country, that he got to work with one. This was after he reasoned, based on what he'd been reading in the press, that studying computer science was a good idea. "I was so fortunate that I made that decision," he reflected. After he graduated in 1991, he went to the University of Southwestern Louisiana, for a master's degree, where he specialized in parallelizing compilers. He decided to pursue the PhD at Illinois on the strength of its parallel processing research. After a year, he changed course from the theoretical to the applied, and his desire to do system software and software engineering led him to Campbell's research group. After he gets the PhD, which is his number one focus at the moment, he predicts that he will eventually return to China, where he see a lot of opportunity. Chen enjoys traditional Chinese literature (a favorite is author Lin Yu-tang) and he's an avid tennis player and swimmer. His wife, Jun Liu, is a graduate student at Illinois in the leisure studies department.

some Mbone tools so that the Mbone information could be accessed from Mosaic." The Mbone is the multicast backbone on the Internet (Virtual Internet Backbone for Multicast), a collection of routers which can pass multimedia packets. In the Mbone model, a single server sends a copy of its on-line broadcast to a special group address that people can "tune in" to. Vosaic, on the other hand, works point-to-point, from one server to one client. "It's more like video on demand," said Chen. "And Vosaic is off-line, rather than live, so if you watch a video, it can stop when you click on something. VDP applies the client server-model, rather than the traditional, multicasting model."

For a video signal, there are consecutive frames, and these frames are treated differently by the compression algorithm. Some frames are independent, and some are dependent upon the other frames, like the frame before or after. If you have two similar frames, for instance, you can save the information from one of the frames and have the other frame point to it. VDP, in a sense, can handle this. Given a sequence of frames, it can decide which frames are more important than others, which are the focus of the transmission, and find the frames that other frames depend on. Then, according to the available bandwidth it has detected, VDP can pick out which frames to send and when. TCP, on the other hand, retransmits for data integrity, which not only takes too much time but also leads to synchronization problems. There is no timing information and no priority between audio and video. You can get away with using TCP for video only if you have enough bandwidth and low loss. If you don't, then you'll get stop and start behavior or slow motion video. "VDP can transmit the compressed images and video signals better than other protocols because it has knowledge of which kind of compression is used, how it works, and how to effectively use the available bandwidth for that particular compression," Chen explained. Vosaic displays video at 6 frames per second, enough for most applications. Full motion video, which takes at least a T1 line, uses 30 frames per second.

The Vosaic program, which is huge by most standards, is written in C++, some Java, and Choices. C++ was particularly attractive because it features object orientation and code reuse and the group was already adept at object-oriented techniques. It was also very good for making the code portable. Choices, a product of the department's Systems Software Research Group headed by Campbell, is an object-oriented operating system written in C++ (see http://choices/cs.uiuc.edu.)

Although faced with tough competition from companies like VDOLive, Xing Tech, Vivo, and Precept Software, Vosaic has an impressive list of heavy-hitting clients including Geffen Records, Dreamworks, NBC, CNN, the Associated Press,British Telecom, the BBC, SGI, as well as some more eclectic organizations. One of these, for instance, is the Shakespeare Globe Project, which intends to use Vosaic for video tours through the Globe Theater. Another, the Center for Tourism in South Carolina, plans to use it for on-line auctions. A major potential is for educational use, including distance learning. Vosaic will be included as an Internet Explorer module on the new Windows/NT CD-ROM from Microsoft,

Roy Campbell

Professor Roy Campbell hails from South London and has been with the department for 20 years. Originally a mathematician, with an MS from the University of Sussex, he was unable to avoid working with computers to make a living. He went to work as a systems analyst for Burroughs Corporation in London. "I was supposed to go around and fix the problems with the very expensive and extravagant systems the salesman had sold," he said, pointing out that most of the machines weren't designed to do what the users wanted them to do. "That was kind of fun, I liked that, and I read about all the Burroughs's machines, including the ILLIAC IV. I thought that was neat, so I decided to go back to school." (The ILLIAC IV was built under a contract developed by Burroughs, Texas Instruments, and the university.) After completing his PhD from the University of Newcastle-upon-Tyne, Campbell accepted a faculty position in the department in 1976. A year later, he developed PATH Pascal, a language for expressing concurrency.

His current research projects include the integration of video with the World Wide Web and its applications, high-performance networks, digital library system software, dynamically adaptable operating systems that support continuous media, mobile computer security, and performance issues of distributed shared memory multiprocessors.

Campbell skis, camps, is an assistant scoutmaster, and enjoys electronic Scottish folk music. He and his wife Ann, who is Scottish, have three boys and a girl at home.

and the public is already using it as a Netscape plug-in for PCs and Macs. A UNIX version (Sun, SGI, HP) for academic and corporate customers is also available. Vosaic will also have a centralized, physical space, at the "pig farm," a facility near the university's Swine Research Farm. So far, everyone has been working from home or from their student offices.

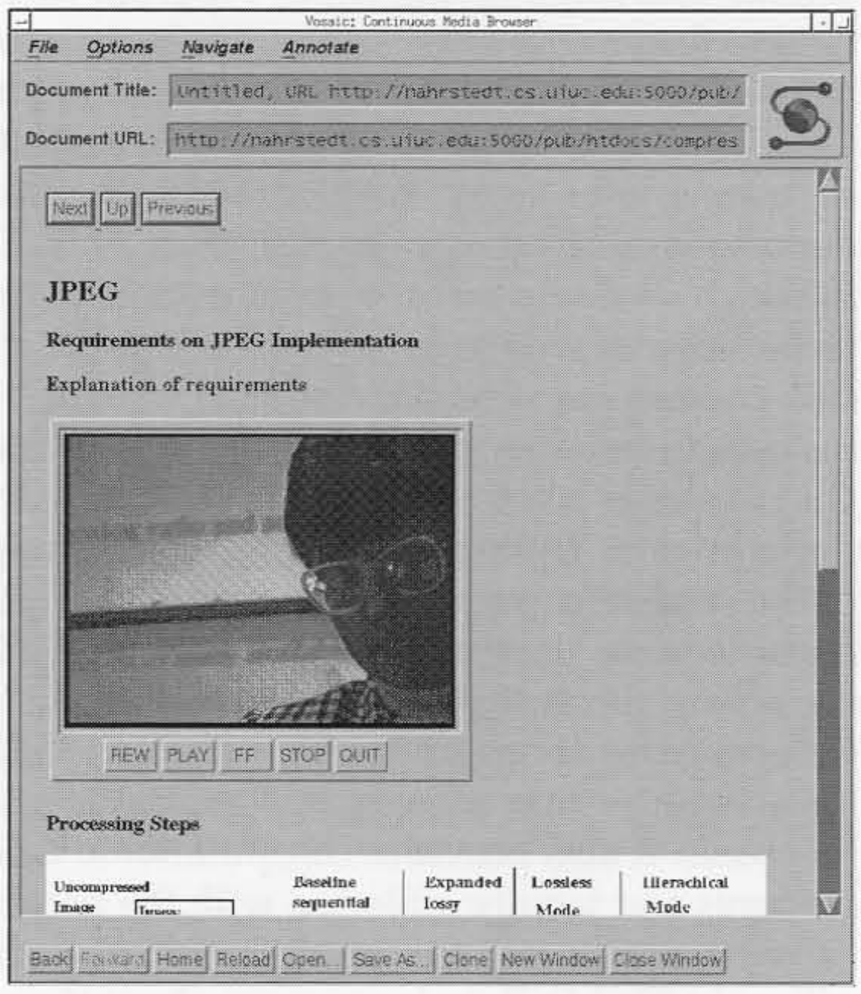
The complimentary personalities of the three co-inventors, Tan, Chen, and Campbell, is evident when you meet them, and that is exactly why the collaboration works so well. According to Tan, Campbell is the ideas person, the one who gives the group direction. "That's what I like doing. Sometimes the idea is a bit off the wall, but that's for them to sort out," Campbell said referring to his students. Tan deals with the PC side and the software architecture of the system, making sure the pieces fit together and work. Chen handles the compression schemes and protocols.

New faces have since entered the scene. Vosaic development can really be broken into three phases so far. Phase 1 involved Tan and Putzolu. Phase 2 introduced Chen, Xie, and Li. Phase 3, which began after when Vosaic Corporation was formed, brought in Dave Raila, BS ECE'88, MS'92, who did the video capture and compression with MPEG for streaming video in real time, and computer science graduate student Willy Liao, who ported Vosaic to the Macintosh.

"A chance like this doesn't come around very often," Tan said, speaking on behalf of the others. "I think it's wonderful having a job like this. I like the academic environment, the group dynamics, the freedom. We hope the R&D core will remain at Illinois, drawing from the department and the university, so that whatever creativity comes out will be visible. We want the same thing to happen here that happened in Silicon Valley, with Stanford for instance. There's so much talent here. Everybody's really smart, and we all stand to benefit. Best of all," he continued, "it's home-brewed software right here in Illinois." ■

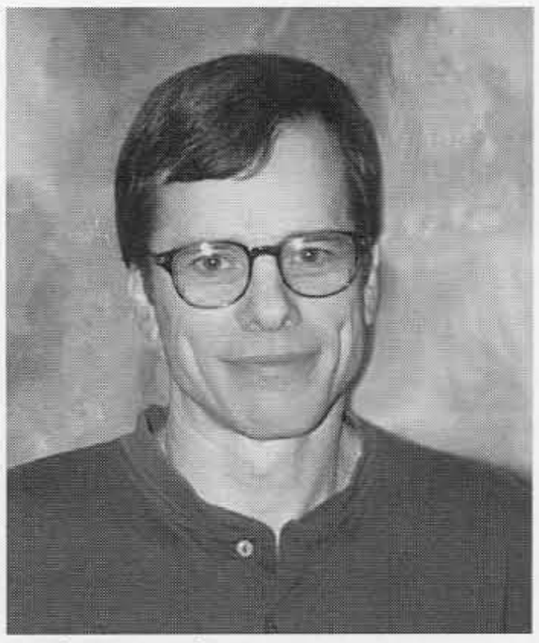
Using Vosaic in the classroom

Vosaic will be used next spring's Multimedia Systems Class (CS 397), taught by Professor Klara Nahrstedt. The class material will come from last spring's and this fall's Operating Systems (CS 323) and Data Structures and Software Principles (CS 225), whose lectures were videotaped. The spring 1997 multimedia class will be the first to psychologically examine how valuable audio-visual information is for educational material and how valuable this information is when integrated with text and graphics. HTML multimedia documents will be prepared from the taped lectures for use as an experimental learning environment. One major challenge is in the editing process. Decisions regarding which pieces should be used in which format, and there they should go—text, slides, animation, graphics, audio, video—must be made. The next challenge is how to go from taping the lecture to digitizing, editing, compressing the file, preparing it for the server, and then integrating with the other parts. Nahrstedt and Professor Roy Campbell are pushing the technology to provide a smoother line from input of the video to HTML format. One improvement from last spring to this fall has been the move from the workstation to the PC environment. The work is now being done on Hewlett-Packard PCs equipped with hardware cards with MPEG compression, an HP server, and MPEG video editor. "Every semester, we learn how to make it easier," commented Nahrstedt. "The ultimate goal is to easily input the information and then output and automate it." "What I'd like to see," said Campbell, "is to get course video from the department so that all the lectures and activities are all video and broadcast, so you can listen in to them wherever you are. Not just courses either, but ACM meetings, and other department activities." ■



A screen image for CS 397 using Vosaic. Pressing the play button in the window will activate a video clip of Professor Nahrstedt explaining something about JPEG.

Michael Heath heads CSE program



Mike Heath

Computation is an increasingly vital component in the advance of scientific knowledge and engineering practice. Numerical simulation enables the study of complex systems and natural phenomena that would be too expensive or dangerous, or even impossible, to study by direct experimentation. The quest for ever higher levels of detail and realism in such simulations requires enormous computational capacity and has provided the impetus for dramatic breakthroughs in computer algorithms and architectures. Because of these advances, computational scientists and engineers can now solve large-scale problems that were once thought intractable, such as modeling entire aircraft or automobiles.

The University of Illinois has long been a leader in exploiting computation in all areas of science and engineering. Such work is inherently interdisciplinary; for example, the Digital Computer Laboratory originally grew out of a collaborative effort among several departments, including computer science, electrical and computer engineering, and mathematics. The Computational Science and Engineering (CSE) Program was initiated in 1994 to foster interdisciplinary, computationally-oriented research among all fields of science and engineering at UIUC, and to prepare students to work effectively in such an environment. Each of the twelve participating departments offers a graduate (MS or PhD) CSE Option in which students become proficient in computing technology as well as in one or more applied disciplines. CSE courses are specially designed to reduce the usual barriers to interdisciplinary work. Thesis research by CSE students is actively advised by faculty from multiple departments. Upon satisfying the degree requirements of the student's graduate department and the CSE requirements, the student is awarded a CSE Certificate signifying successful completion of the CSE Option. The CSE program sponsors several interdisciplinary research assistantships that are awarded annually on a competitive basis. It also provides computational facilities for students and faculty affiliated with the program.

We invite alumni to visit the new CSE administrative offices in 2262 DCL to learn more about the program and tour its facilities.

—Michael Heath,
Professor and Director of CSE

http://www.cse.uiuc.edu

Michael Heath (PhD, Stanford, 1978) has been in the department since 1991. In July, he was appointed director of CSE by Dean Schowalter to succeed Prith Banerjee who left the university to assume a chaired professorship at Northwestern University. Heath conducts research in scientific computing and parallel computing. In scientific computing (also known as numerical analysis), his interests are in numerical linear algebra and optimization. He is particularly interested in sparse matrix computations, such as direct methods for solving sparse systems of linear equations and least squares problems. He is also interested in the design of mathematical software. He has a DARPA-funded research project for the development of scalable libraries for numerical linear algebra. ■

Instructional labs upgraded

The student instructional laboratories were all upgraded this summer. We extend special thanks to Sun Microsystems, Intel, Microsoft, and Silicon Graphics for their contributions to this effort.

The software design and software development laboratories underwent dramatic change. Through a Sun Microsystems grant/purchase program, the department was able to trade in old Sun workstations and obtain 48 Sun Ultra 1/140 clients for the lab. Each client has 64 MB of memory, its own copy of the local software distribution, and locally installed Sun software tools (C, C++, and SparcWorks). The Common Desktop Environment (CDE) has also been installed. The CDE Display Manager replaced the X Display Manager (XDM). The laboratory servers were upgraded to two Sun Ultra 2/170 servers, which replaced the three Sun Sparc20 servers. The operating systems have been upgraded to Solaris 2.5.1 for all clients and servers.

The networking was also dramatically improved by putting each client on an individually switched 10BaseT port to a Fore Systems switch that is connected to the servers by a 100BaseT line.

The two SGI Indigo2s serving the database, AI, and multimedia laboratories have been upgraded to Solid Impacts, running IRIX 6.2, and all 15 multimedia HPs now have video cameras installed. In addition, all multimedia computers are now connected to the HP video server using ATM technology.

The embedded systems laboratory has been upgraded with current HP embedded controller design software, a networking system which allows shared emulation, and the addition of five PCs, donated by Intel, used to support our courses in interfacing PCs to real-world devices. ■

Illinois Summer Software School educates and stimulates

The Illinois Summer Software School (ISSS) was a hit with attendees once again. In its sixth year, about 100 computer professionals attended.

"It went well," said Professor Mehdi Harandi, co-director of the program. "It was well-attended, but could facilitate more." He would really like to hear alumni suggestions for the types of courses they want because they have found industrial surveys to be inadequate. The most popular courses this year, he said, were those that dealt with newer technologies such as object-oriented programming, tools and techniques, and network oriented courses. They are also thinking of offering not only 3-5 day short courses, but perhaps expanding the program to include courses several weeks, or perhaps even a month, long.

The following courses were offered:

Programming in C++
Advanced Programming in C++
Information Superhighway
Using ATM Technology
World Wide Web
Cryptography, Security, and Privacy for Networks and Distributed Systems
Design of Multimedia Systems
Introduction to Java Programming
Java for C++ Programmers
Advanced Java Programming
Software Design Techniques
Object-Oriented Design with Design Patterns

About 15 alumni attended the school and their comments were overwhelmingly positive. Here are some of them:

Sally Wilkins, MS '69, PhD '75, a member of the first class of computer science graduate students at Illinois, has been at Los Alamos National Laboratory for the last 19 years. "I've been in management for four and a half years, and I really wanted to get back into technical work. It doesn't take long in computer science to get behind technically," she said, "so when I got the ISSS brochure, I really wanted to attend." She took the C++ programming classes. "The people who taught them were excellent, and the lecturing and computing facilities were very adequate. They served lunches which allowed the attendees to become acquainted and maintained the continuity of the class. The atmosphere was relaxing, but the class was really no-nonsense. I liked the pace." She noted that she couldn't find a similar university program anywhere else. Wilkins works in the Distributed Computing Environments group of the Computing, Information, and Communication Division at Los Alamos. sfw@lanl.gov

Jeff Slovin, BS'89, is a software engineer at GTE in Waltham, Massachusetts, working on a planning tool for cellular telephone networks. He thought the C++ classes he took were "fantastic." The program enabled him to get away from work for a week and concentrate on learning C++ without the distractions of the office, he said. jhs0@gte.com

Scott Renner, BS'81, MS'84, PhD'90, works for MITRE at Langley AFB in Virginia on data management issues for the Department of Defense. "I love the opportunity to come back and visit faculty," he said of ISSS. "Dr. Mickunas was one of the best lecturers in the department; I figured his Java course would be worthwhile; and I was right." Renner is getting ready to move to corporate headquarters in Bedford, Massachussetts, and is looking forward to winters again. sar@mitre.org

Chris Maxson, BS Math/CS'90, is an information systems programmer for Direct Marketing Technology, a direct mail firm in Schaumburg, Illinois. He took the Object-Oriented Design with Design Patterns Class. "It was nice to get back into the academic world," he said. "We had many discussions that you wouldn't have in the real world, and that was very pleasant," he said using as an example a discussion comparing code to a genetic structure. Having people from so many different backgrounds in addition to the academics teaching the classes provided a stimulating environment, he said. chrism@dmti.com

Lee Bennett, BS'89, has attended ISSS for three years. At first he used it as a way of extending his degree, by taking some of the beginning level classes. Now he takes the more advanced classes on topical, current issues. "I like attending," he said, "because it's nice to get away from work for a while and pretend you're a college student. At work you're banging out things, trying to get business results. To get back into the academic environment and be a little theoretical is a nice change of pace." Bennett works for Omron Electronics in Schaumburg, Illinois, a manufacturer of PLC microprocessors for factory automation. His work involves developing support tools for customers who buy their products. lbennett@oei.omron.com

If you'd like to get on the mailing list for next year's Illinois Software Summer School, contact Kendra Reasor of the Office of Continuing Engineering Education, 217-244-2037 or kreasor@uiuc.edu. ■

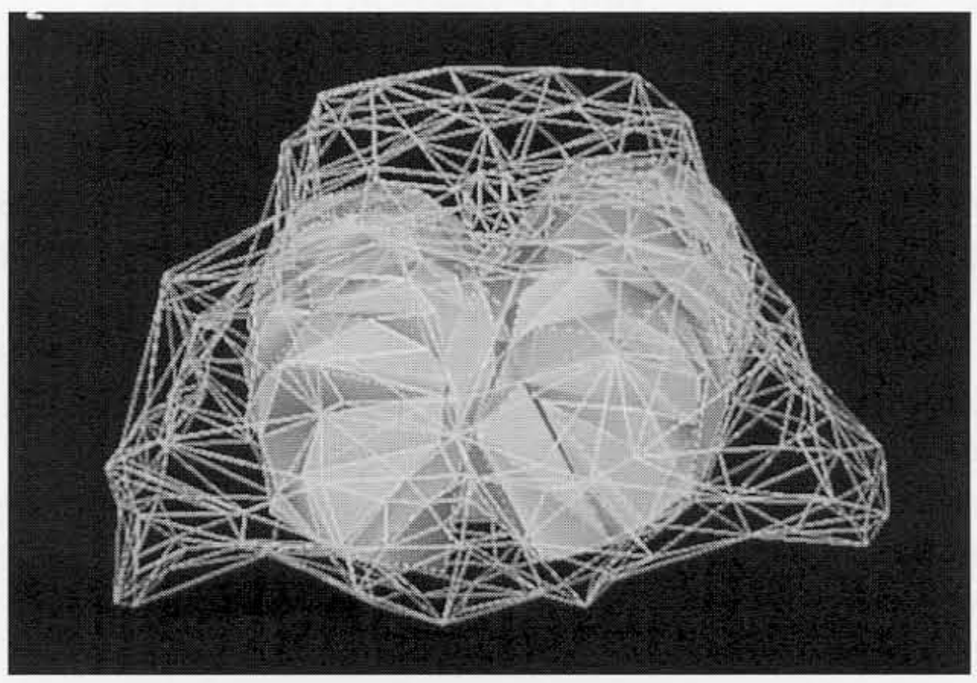
Alpha Shapes

Herbert Edelsbrunner and Ping Fu open visual doors to the unknown

Professor Herbert Edelsbrunner and NCSA researcher Ping Fu, MS'90, developed a novel way to study scientific data through mathematically constructing stunning 3D shapes that researchers can explore by literally going inside them.

Herbert Edelsbrunner and Ping Fu make a powerful team as a collaboration between their two research groups produced the hit 3D modeling program Alpha Shapes and its virtual reality version, Virtual Alpha Shapes Visualizer. Edelsbrunner, a professor of computer science at Illinois since 1985, and Ping Fu, MS'90, technical program manager at the National Center for Supercomputing Applications (NCSA), are also married. Together they founded a company last April called Raindrop Geomagic, which will take their work into the commercial realm.

The ideas and technology behind Alpha Shapes represent a breakthrough in computational geometry and scientific visualization. Indeed, they are exploiting the underlying technology in new and unexpected directions, building software with unparalleled quality and creative power. The software allows scientists to explore shapes and to use this as a tool for research. It does this by manipulating the geometric data common to many branches of science and engineering. The combination of the software with virtual reality devices takes the concept one step further by constructing 3D objects with detailed and often complicated features and allowing the user to inspect them from both the outside and inside. This is achieved in the CAVE, NCSA's VR laboratory which incorporates three projection-based modes of VR. For instance, a biologist can visually enter hidden regions within a protein, which is relevant in the study of inaccessible voids and protein folding.

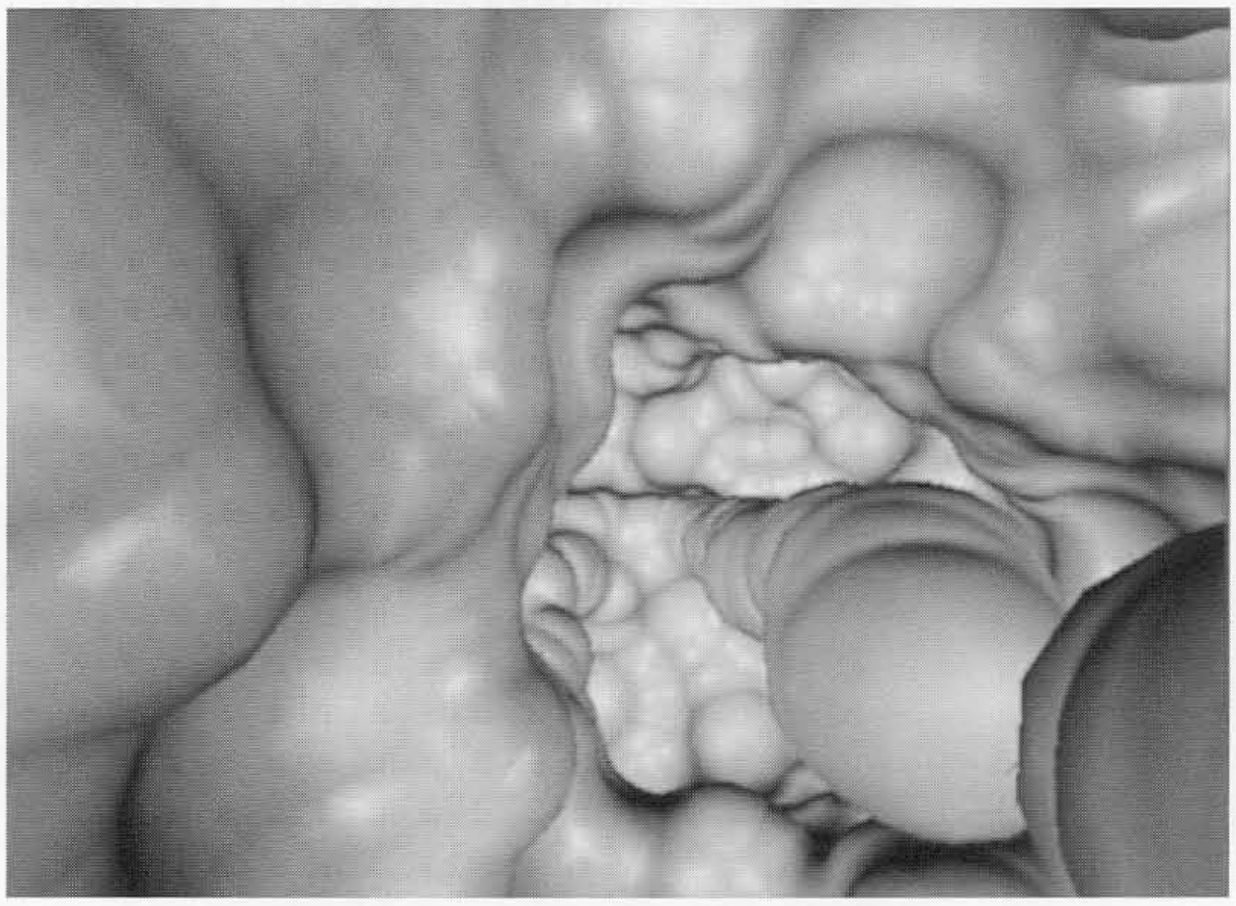


A model of the lungs derived from scanning the rib cage. The lines represent the rib cage, plus noise. The shape inside is the lungs, the space surrounded by the rib cage.

The first mathematically rigorous definition of alpha shapes was introduced by Edelsbrunner in 1983. An alpha shape is a mathematical definition of the shape of a finite set of points. A more technical description of an alpha shape is that it represents a finite set of points in 3D space and a real parameter alpha which uniquely defines a simplicial complex, such as a Delaunay triangulation, consisting of vertices, edges, triangles, and tetrahedra embedded in space. This is called the alpha complex of the points. The alpha shape is the geometric object defined as the union of the elements in the complex. Important applications of alpha shapes include the construction of 3D models of proteins in which holes and tunnels can be identified so that biologists can determine the possible location and volume of water molecules. Chemists and physicists can use it to define the volume of atom clusters. Astronomers can explore the global cosmological structure of the universe. A host of other areas await application of the alpha shape concept: cluster analysis, geometric modeling, mesh generation, and feature computation and recognition.

Biologists are currently the largest users of the alpha shapes software. For instance, at Illinois they are using it to investigate the shapes of proteins and to look at fluid flow in the brain. Shankar Subramaniam and Eric

Jakobsson and, both professors of biophysics, have found alpha shapes to be a good tool for defining molecular shapes. Jakobsson and postdoc Sudhakar Pamidingantham have been working with alpha shapes to understand protein docking with toxins. Specifically, they are examining a protein, called a potassium channel, and its interaction with scorpion toxin. Here's what happens when a scorpion bites you: The scorpion toxin molecule sits around in the blood, bouncing around with Brownian motion but guided to the potassium channel by electrostatic charges. Finally, it locks into place, fitting into the channel like a glove. The shapes of both the toxin molecule and the channel are both irregular, so alpha shapes is a good tool for defining them. The structure of this protein is very difficult to obtain by traditional means (x-ray crystallographic or nuclear magnetic spectroscopy), but by modeling the potassium channel as the reciprocal shape of the scorpion venom molecule, it can be done. So why is this important? Because now pharmaceutical companies can better design drugs to interact with the potassium channel. In other words, scientists can use the shape of the toxin to determine the shape of the potassium channel and use that shape to design small molecule drugs, drugs that can be taken as a pill rather than injected because their molecules are small enough to be absorbed across membranes.



Inside view of a molecular surface model of Gamicidin protein.

Edelsbrunner is among the world's leading researchers and practitioners of computational geometry. In 1983 he and two colleagues devised the alpha shape theory for creating 2D shapes from scattered point data. For the next eight years, Edelsbrunner's theories lay waiting for scientists to pick up and exploit. In 1987, his landmark book *Algorithms in Combinatorial Geometry* came out. It is still considered by many to be the best textbook and reference source on computational geometry.

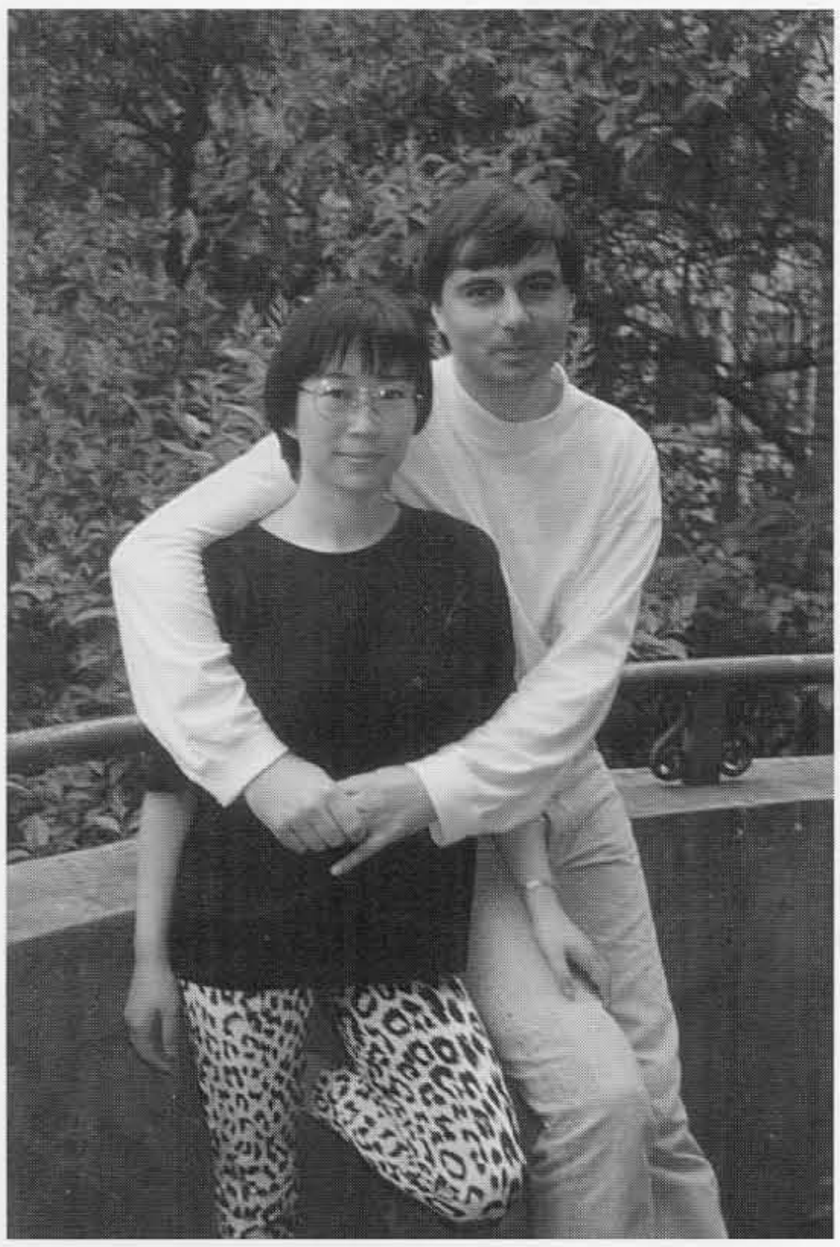
In 1991, at age 33, Edelsbrunner became the first computer scientist to win the prestigious Alan T. Waterman Award from the National Science Foundation. "Coping with real-world objects requires taking into consideration their real geometries rather than treating them as idealized, oversimplified shapes," reads the citation. "Computational geometry is thus going to be of utmost importance in computational science and computer-aided design . . . There is no question that Dr. Edelsbrunner's work is of the highest research quality and is having far-reaching impact." The $500,000 grant that came with the award changed his research outlook. "This is a big award in the sciences," explained Edelsbrunner. "CS people don't know about it, but it's known by people in mathematics, chemistry, physics, and biology." Edelsbrunner explained one of the general difficulties of interdisciplinary work: Two parties cannot really judge the quality of their partners. Thus, people are happy to rely on "official stamps," like awards. Winning the Waterman Award opened doors for Edelsbrunner, and it became easier to discuss his work with other scientists. "The impact was that my research became more outward looking—more applied. The question of what's relevant and what's not became more important." At the same time Ping Fu came to NCSA, and because she interacted with those "other scientists" all the time, she was

http://
fiaker.ncsa.uiuc.edu/
alpha/index.html

able to throw the door open wider. The two of them started their fruitful collaboration.

A native of Austria's second largest city, Graz, Edelsbrunner has always had a love for mathematics. He was attracted to computer science because it sounded like a more modern, interesting type of math. Part of the real story, he confessed, was that he wanted to get out of taking over the family farm. "It was quite a big farm, with corn and potatoes and other things, so it would have been a good trade, but I didn't really like the farm work." He studied computer science at the Technical University of Graz, where he became one of the department's first PhDs, in 1982. His research was on data structures and algorithms, and through his publications and journal articles, he began to achieve world recognition.

In 1985, Edelsbrunner came to the U.S. as part of an exchange program to teach computer science at Denver University in Colorado. Upon his discovery that because he was paid in foreign currency his TAs made more than he did, he made an overnight decision to remain in the U.S. With a job offer from IBM in hand, colleague Franco Preparata arranged an interview with University of Illinois and in three weeks, he was bound for Urbana-Champaign.



Ping Fu and Herbert Edelsbrunner

Why did Edelsbrunner opt for an academic career over a lucrative industry position? Actually, if you've had the pleasure of meeting with Edelsbrunner or hearing him speak, you would instantly know that he was born to be a teacher. Mathematical research requires engaging in long periods of mental journeys, Edelsbrunner explained. And the journeys occasionally contain depressing segments. So, although the long-term reward at the end can be great, the short-term rewards of teaching makes it easier to get through the difficult periods. "Every day," he said of teaching, "you have a sense of achievement—you taught someone something." This satisfaction, derived from teaching students, would be missing in an industrial research setting.

Ping Fu took a more winding path to Illinois. A Chinese literature graduate from Nanjing, Fu came to the U.S. in 1984 to pursue an advanced degree. She entered the linguistics department at the University of New Mexico in Albuquerque, but a year later, she decided to find a more marketable skill. With very little computer science knowledge and a sympathetic adviser, she switched to the undergraduate program in computer science. "I was even afraid to hit the keyboard," she confessed. Fu felt that programming was something she could pick up quickly because it is a man-made language, something one could learn at a later stage in life. Programming was something that she could overlay upon and integrate with her literature background and writing experience. Some of her works, including poetry, novels, essays, and short stories, were published in China. This was a distinct advantage she felt she had over students trained in traditional engineering curricula. "Programming is much of an art as well as a science," she explained. "If you have to write a novel, you have to really understand the overall picture and the structure of how you want to put things together, and how they're connected. I was trained in that, for I was a writer before I was a computer scientist."

Fu's desire to attend a school with a stronger CS program led her to the University of California at San Diego. During her studies there, she took a job as a consultant doing database work for a company called Research Systems Group, an NCR spin-off. After graduating with an BS from UCSD, she went to Bell Laboratories where she became involved with networking. She was particularly

attracted by their off-campus masters program, and that's what led her to the University of Illinois. Edelsbrunner was one of the professors in that program, and when he mentioned that he was going to visit Nanjing for the first time, Fu volunteered to help him out by connecting him with her English-speaking family there. That marked the beginning of their relationship. After commuting from Urbana-Champaign to Naperville for over three years, they were married in 1991.

It was a challenge for Fu to find something interesting and suitable to do professionally in the Urbana-Champaign area. NCSA offered her work in both database and networking, but she said no. Instead, she accepted a position in the Software Development Group and is responsible for visualization software. Because of her liberal arts roots, the idea of something artistic, as well as technical, was attractive. The daughter of two professors, she was once again going to live in a university environment.

How does the collaboration work so well? According to Edelsbrunner, "Ping and I work on different aspects and levels. I worry about the mathematics, the geometry, and the algorithms, and she worries about the implementation, the graphics, and the interface with science and industry." Fu explains the success of their collaboration in a similar way. "The perfect match really comes from the fact that he's a theoretician, and I'm a software engineer. So I do a lot of practical work, and he does a lot of theoretical thinking." A typical project might work something like this: Fu finds a problem (say, in molecular biology). She presents it to Edelsbrunner, who finds a mathematical and algorithmic solution. Then she implements the algorithms for presentation to the scientist, adding a graphics interface. The work underneath is mostly done in the Department of Computer Science and the part peoples' eyes can see is done at NCSA. Working with Edelsbrunner are Ernst Mücke, MS'88, PhD'94, (ANSYS), Nataraj Akkiraju (Mentor Graphics), and Michael Facello, MS'93, and with Fu are Jiang Qian, MS'96, Damrong Guoy, and Dmitry Nekhajev. The software is a way to bridge the gap between computer scientists on the one side and scientists and engineers on the other. Fu points to Illinois's strong interdisciplinary research infrastructure, embodied in places like NCSA and the Beckman Institute, as making this kind of collaboration possible.

Edelsbrunner and Fu founded Raindrop Geomagic, an Illinois incorporation, last April to commercialize some of their work. Fu serves as president and Edelsbrunner as consultant. "We have some good innovations," said Edelsbrunner, "but we still have to show that those are applicable to problems that people really want to solve and also spend money on. Somehow that requires another level of creativity. We used to always about two things: What else can we do with it and how else can we explain it? In other words, the academic world trains us to be oriented towards methods. We don't think in terms of what would people use it for—how can I model a game character, or how can I design a plane? But we can start doing this because we're assembling so much more knowledge that gets close to those applications." Edelsbrunner's current work extends the topological ideas and methods for reconstructing differential surfaces that can be manipulated with a computer, such as deformation and changing of the topology. He believes that the result of this work will generate software that will be able to do new things—things that were unreachable before—and it will do it fast and accurately.

When he's not reading math books, Edelsbrunner can be found listening to rock and jazz music or playing guitar, while Fu continues her literary pursuits, including writing. Two-year old daughter Xixi, their most important collaborative effort, keeps both of them on their toes at home. ■

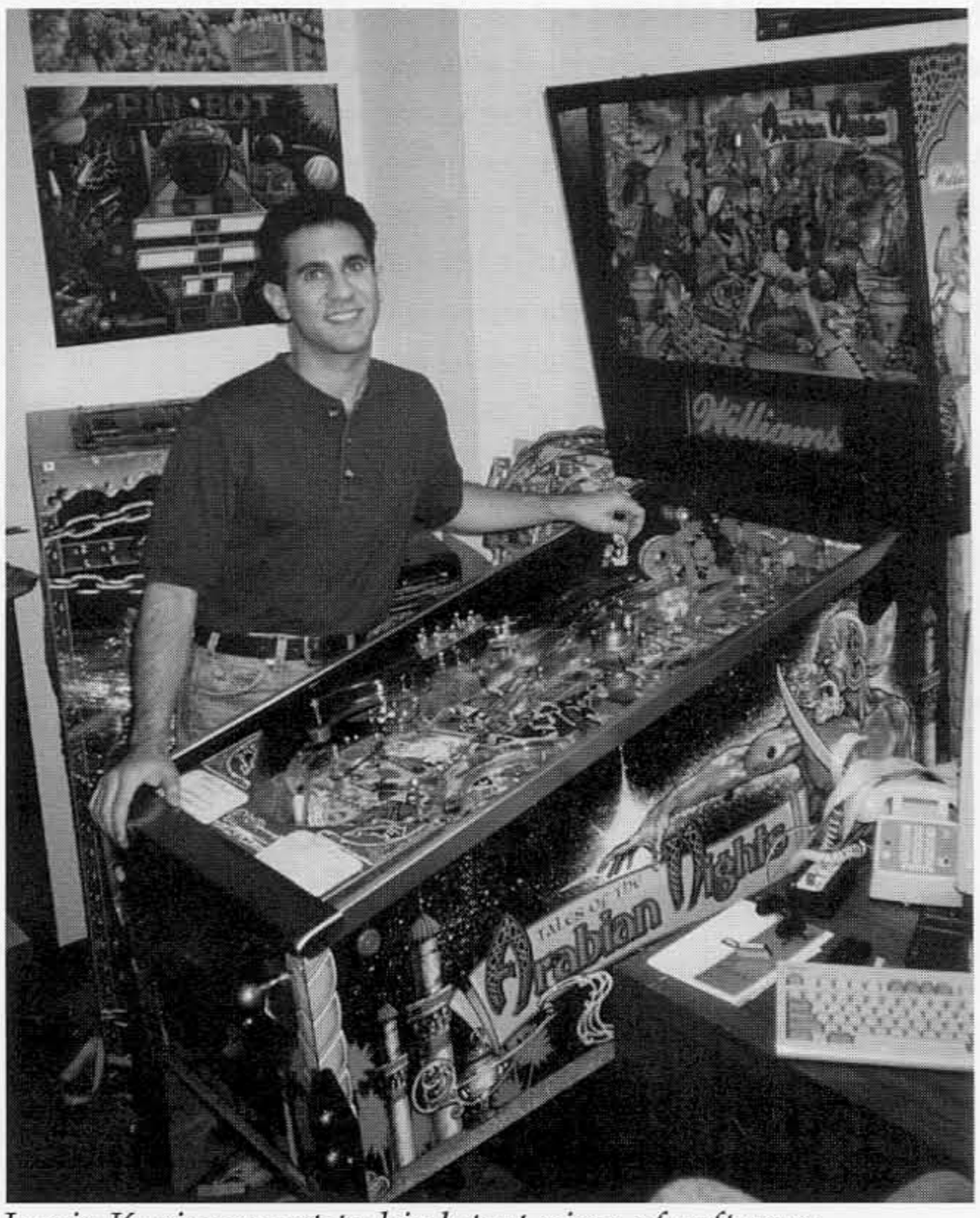
Bit, bytes, buzzers and bells:
Louis Koziarz takes pinball into the 21st century

Louis Koziarz, BS'91, is helping pinball make it in a digital world with a boggling array of options for your entertainment dollar. But as history has shown us, pinball comes and goes but never goes away, thanks to innovative programmers like Koziarz.

"I thought I was
The Bally table king
but I just handed
My pinball crown to him."
—Pinball Wizard
Pete Townshend
1969

Its popularity rising and falling with the economy, as it has for the last two hundred years or so, pinball is still a part of the American entertainment landscape, and the place to be if you're a pinball enthusiast is Chicago. That is where Louis Koziarz, BS'91, designs and programs pinball games for Williams/Bally Pinball. Koziarz's latest creation is a game called Tales of the Arabian Nights.

Koziarz has been programming since fourth grade when he was part of a Glenview grade school experiment in which students were turned loose on Apple IIs. His exposure to computers was furthered by watching over his father's shoulder as he ran SPSS programs while earning an MBA. It was in high school that Koziarz learned Pascal and C, and when college time rolled around, he knew he wanted to study computer science. Because of the public attention focused on NCSA and the Beckman Institute at Illinois, and tempted by the possibility of working on a Cray, Koziarz chose to come to the University of Illinois. He never did get to work on a supercomputer, but instead, he entered the happening world of the Illini Union basement and the games therein. In fact, Bally has used the Union basement as a test site for some of its new designs. "College students are the ideal pinball customer. They have free time, free change, and they're interested," said Koziarz. He went on to describe his educational experience as straightforward. He concentrated on operating systems, and his goal directed sequence was in human factors in psychology.



Louis Koziarz next to his latest piece of software, which drives Tales of the Arabian Nights.

http://
www.wms.com

When Koziarz graduated, still not really thinking of making pinball his livelihood, he went to work for Abbott Labs in the Chicago area where he did software validation in the transfusion diagnostics division. If you've ever donated blood at a blood bank, your blood was probably run through one of Abbott's devices for detecting diseases, such as HIV. He spent three years there during which he began to collect and restore old pinball machines, lugging 300-lb boxes up the stairs and stuffing them into his apartment. Koziarz began to meet other kindred souls, through collectors groups and through the Usenet group rec.games.pinball. Eventually, he became acquainted with people who worked for the pinball manufacturers, and he landed a job at the pinball mothership: Williams/Bally-Midway.

"Chicago is the pinball capital of the world," Koziarz said. "Ninety-nine percent of the games are made here, and all three major manufacturers are here: Williams/Bally, Gottlieb, and Sega. No one really knows why, but pinball has always been centered in Chicago." Several companies have tried to get started elsewhere, like California and Florida,

but failed. As a result, pinball enthusiasts use Chicago as their primo gathering spot, and major events such as Pinball Expo, are held in Chicago. "Maybe it's the central location of Chicago or the location of [parts] vendors," Koziarz speculated, "but pinball has been a central part of the city's history."

Computerwise, Koziarz's work revolves around operating systems and embedded programming. "A pinball game is basically a real-time system," he explained. "The machine must react to where the ball goes and how it's moving. It really has no idea where the ball is going to go." All pinball machine programming is done in assembly language, although programmers are beginning to explore C. "It's a very rich atmosphere," said Koziarz, "with mechanical designers, artists, composers and musicians. On a design team, you have about six or seven different disciplines working together. The programmer represents just one facet of the project."

Pinball has a long and fascinating history. It is believed to have evolved from a game played in 18th century France called Bagatelle. In those times the word bagatelle was used to mean trivial amusement or trifle but later referred to any game involving the rolling of balls into scoring areas. In this ancestor of modern pinball, played in parlors and homes, a player shot a marble with a little cue. Eventually, a coin operated version was invented that used a plunger to shoot the marble. Historians speculate that a French soldier brought the game to America when the French arrived to help the colonists with their revolution. The game sat around until the 1920s, when it took off as a cheap diversion during the Depression. A lot of the features in the 1920s and 1930s, like the plunger, are still with us, Koziarz pointed out. After World War II, the game exploded again. People had more recreational time, and the game became electric. Many new features were invented, such as the flippers and tilt mechanism.

Although pinball is now recognized as a distinctly American game, during the 1920s it somehow made its way to Japan and became Pachinko, "the lost cousin of American pinball." Pachinko became a huge industry in Japan, and even now it is larger than the Japanese car industry.

Of course, there is a darker side to pinball. In the 1930s, it became inextricably associated with gambling. Pinball machines became a regular feature in bars, pool halls, and bowling alleys. Core pinball players, as they do today, tended to be males between ages 18 and 30. The games were designed by males for males and often contained macho themes with violent content.

In 1976, the microprocessor found its way into its first pinball machine, a game from Bally called Freedom. Up until then, games were driven by relays, switches, mechanical reels and solenoids, and there were lots of moving parts. A typical pinball machine would have 30 to 40 solenoids that popped and fired and did different things to a ball. "All that stuff was eliminated," said Koziarz. "The microprocessor made the machines simple mechanically." Everything, including visual and sound effects and scoring, is now driven by microprocessors. The microprocessors found in pinball machines are no more powerful than the 2 MHz microprocessors found in old Nintendo machines. "There's a lot of work to do with that little processing power," explained Koziarz. "The CPU is designed to be low cost, so we've got the technical constraints of processor speed and code size. We try to put all the money into the game itself and keep the electronics cost low." But a lot of extra code is required for self diagnostics. "Let's face it, when a pinball machine breaks, everybody knows it. We don't want the user to feel cheated."

The challenges for pinball manufacturers are not strictly technical, which is why they seek out employees with imagination and enthusiasm in addition to raw technical skill.

The video game revolution in the 1980s was a watershed for pinball. The first wave hit in the late 1970s and early 1980s with games like PacMan and Defender. "Pinball pretty much died," said Koziarz. "—killed off by video games." Many pinball

http://home.navisoft.com/planet/pgpinb.html *for some pinball history*

http://www.wms.com/williams/ww/uw6.html *to learn about pinball game development*

http://www.resultsdirect.com/pachinko.htm *for some pachinko history*

companies went under. The video revolution changed the nature of pinball. Pinball companies had to keep up with the "twitch factor" —the fast, hyperactive action that kids had come to expect from a game. Pinball games had to score faster, play faster, have better sound effects, and offer a host of other gimmicks to keep up with video games.

Pinball made a slow comeback around 1985 when the video game market went bust and pinball companies started to consolidate. Bally Manufacturing, the company responsible for PacMan and other hit video games, decided to spin off its less profitable businesses, such as the video/pinball division, the slot machine business, and the Life Fitness exercise machine group. Williams electronics, Bally's biggest competitor in the pinball business, bought the remains of Bally/Midway in 1988 and assumed the Bally trademark for pinball machines. The Williams/Bally-Midway factory now turns out pinballs under both the Williams and Bally trademarks and video games under the Midway label. Williams has also recently acquired Atari Games as well, Koziarz added, "so the name is changing again!"

The biggest seller for Bally until The Addams Family overtook it in 1992 was the 1978 game called Eight Ball (a sequel called Eight Ball Deluxe was released in 1982). Another hit for the company was Star Trek The Next Generation, one of three Star Trek pinball games. Koziarz personally worked on Jack*Bot, before working on Tales of the Arabian Nights, which just went into production.

Recent technical innovations in pinball include the dot matrix display and digital sound. But the game is still true to its physical roots. "There's an invisible channel between the player and the machine with the sense of touch. You can feel the game through your fingertips," said Koziarz. Expert pinball players refer to a Zen-like state in which a player feels what the ball is doing without consciously thinking about it. When you take pinball into the video world, it simply does not feel the same. There's no manipulating the machine with your hands, nudging it, feeling it. Pinball tries to explore more senses than video games, especially with sound and lights, and it's more social. "When you're playing," said Koziarz, "it's a very visible thing. When a player does well, the game goes nuts, and friends come over from the other side of the bar to see what's going on." Simulations of this, such as the computer pinball game Crystal Caliburn, don't even come close, according to many pinball players, because it lacks the "touch environment."

Koziarz benefits from his psychology and human factors background when trying to design the interface between pinball machine and player. The pinball machine of today has become like a small movie in a box. It has a plot and characters, and as you play, a story unfolds. But because players aren't always looking at the screen, which displays their status in the game, the pinball designer must create redundancy in the system. There must be several ways to let players know how they are doing and to reward good play. This is typically done with lights and sound. Unlike the early gambling games that motivated players with a possible cash reward at the end, players now play for fun. "We have to entertain and motivate the player by making the games flashier, with more tricks and toys." Toys are the things in the game that do different things to the ball, such as grabbing it.

The pinball industry, although no longer in decline, is in a period of flat growth. A lot of things are competing for the entertainment dollar, such as home VCRs, the Internet, home video games, computer games, and satellite TV. People have become very fussy, but Koziarz is optimistic. When the economy has been in the doldrums, people have played more pinball. It's very cyclical. "Pinball has always been part of America, and it will always be around in one form of another," he predicts. "It takes a second to learn and a lifetime to master. The hardest thing in designing a new game is achieving that balance where the game is good for both novices and experts." And in his office a mile west of Wrigley Field, Koziarz is busy doing just that. ■

Pinball memories . . .

Professor Mike Heath, pictured on p. 8, grew up with pinball. After serving in WWII, his father took a job with a novelty company that supplied pinball games and jukeboxes to restaurants, bowling alleys, and other businesses in the Atlanta area, where Mike was born. When the family returned to its roots in western Kentucky, Mike's father took some pinball machines and jukeboxes with him to start his own operation there. As a child, Mike remembers accompanying his father to service the machines and collect the nickels (yes, nickels) that had accumulated. He always watched with fascination as his father manually sorted, counted, and wrapped the coins at incredible speed. He also remembers accompanying his father to the Melody Mart in Paducah to buy records (78 rpm, made of shellac) in boxes of 50 at a time (a habit he still indulges to this day, though now they are CDs). You can imagine the popularity of Mike and his sister given that there were always pinball machines and jukeboxes around the house with unlimited free plays. Alas, when 45 rpm records came along, Mike's father opted to get out of the novelty business rather than upgrade his machines, and all those beautiful classic Wurlitzer jukeboxes, which would now be worth a small fortune each, were tossed into a dump (the same dump that also received Mike's comic books and baseball cards). ■

Good old days of pinball in Champaign-Urbana

Wouldn't you know it? The first pinball arcade in Champaign-Urbana was cofounded by a CS alum. Dale Jurich, BS EE/CS'71, MS'72, and Andy Dobronsky (better known as Andy Dallas who owns Dallas & Co., the magic and costume shop on University Avenue) started the Apple Duck arcade on Green Street.

Jurich, from Chicago, had a lot of distractions during his studies, especially during graduate school. For example, he started the computer section for a calculator store called the Numbers Racket, where he sold S100 bus computers. "Remember, these were the days when HP calculators were $300-400 and engineers would come over and drool over the new programmable HP calculators," he recalled. Then he and Professor Denny Mickunas founded Small Systems Services, a company which sold Fortran systems for the early PCs. (The systems were distributed by a company founded by Rick Balocca, MS'80, and Herb Schildt, MCS'81, called Supersoft.) Balocca became president of SECS (Students for Environmental Concerns) and was involved in setting up the first Earth Day at UIUC. He was also the director for the NSF/SOS (Student Oriented Studies) grant to study the environmental impacts of food and beverage packaging, one of only about 20 groups to win the award and a first for undergraduate research through NSF. The project occupied the whole top floor of CSL. By this time, he had faded from the PhD program.

Jurich began playing pinball when he went out for beers at places like Treno's and Murphy's. He bought a few machines and installed them at the University YMCA on Wright Street, where SECS used to hold its meetings. During this time, he met Dobronsky, who collected old machines—not just pinballs, but other arcade games like bowling and baseball. So the two teams up and opened an arcade near Mahomet in 1973. A year or two later, with experience in hand, they opened Apple Duck ("A for Andy and D for Dale," he explained, "It was the first thing that came to me.") They didn't make any money, but they had a great time and met a lot of people. In 1978, he felt like he needed a change, so he went to the west coast to a marketing position at Intel, first in California and later in Oregon. After three years at Intel, he left to become a consultant. Interestingly, he did some work with a company associated with Bally and he wrote two video games. One, Dark Planet, was for Stern Electronics and had limited distribution. Another, PC Pool Challenges, distributed around 1982 by IBM for the PC Jr., is still played to this day. Three months ago, Jurich joined Chromatic Research, in Sunnyvale, as an engineer working on multimedia processors and software.

Another hotbed of pinball activity was the Illini Union basement. Since 1970, Steve Lawson, ChemE'76, has managed the games there. The Union got its first pinball machines in the very early 1970s. During these days, the Union would get a new game once every three or four months. Now, it's every other month and Lawson has trouble keeping up with them.

"Because of computerization," said Lawson, who collects old pinball machines and video games, "the games are artificially pretty intelligent. They can create scenarios based on what you've done. Before computerization, a whole sequence of things had to happen so that, for example, when you popped a target, a relay closed and held, and when all five relays were held, something else would happen. Now that stuff is stored in memory so that possibilities are endless with regard to the routes you can take." Lawson's favorites are Out of Sight, Eight Ball Deluxe ("It talked!"), and Centaur (Bally's first machine that had a stereo reverberating effect).

Todd Satterthwaite, mayor of Urbana since 1993, was in the pinball business from 1974 until the early 1980s. He got his start working at the Illini Union, while he was a student, where he was responsible for cleaning and repairing pinball machines, learning as he went. After three years, he became quite good at both fixing and playing pinball, and he organized pinball tournaments there. After that, he and his brother Mark took over Apple Duck and then opened Treetop.

"All pinball games are variations on themes," he said. "It used to be you'd shoot targets, put the ball into the hole. Now you have to know the 43-button combination that will rip someone's head off!" He believes that undocumented ways to do things have become a cult in itself and that part of the game manufacturer's marketing strategy is leaking that kind of information.

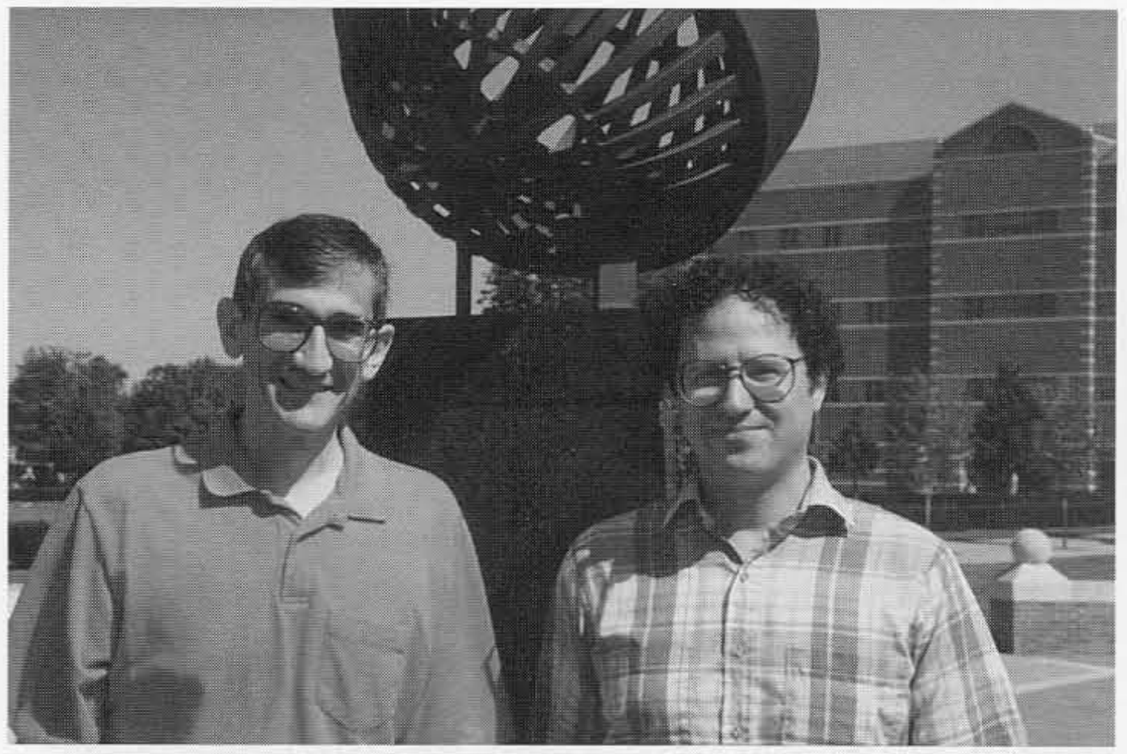
"The games are geometrically progressing," said Lawson. "The games take more time to learn. There's not enough time in my life to learn everything I need to know to learn it competently. My talent for hitting the ball right where it need to go should not be overshadowed by the distractions of the complexity of the game. The games should be simple," he said, "but life is no longer simple."

Satterthwaite concurs. "When I started at the Union, all the machines were electromechanical. Computers were in the early stages of development. My favorites were 2001 and Drop a Card. They were pretty simple—knock down targets, hit the special." Now, Satterthwaite lamented, "you have to take an undergraduate course to play! They're basically like a computer. The boards are taller, you've got ramps, double-decker fields. You have to read a lot of instructions and spend ten bucks in the machine before you figure it out!" ■

Reingold and Dershowitz create a Digital Calendar Library

Professors Nachum Dershowitz and Ed Reingold share their work and fascination with calendars in a new book which explores the cultural, historical , and mathematical facets of the world's most important calendars, "reworking and rephrasing them into the algorithmic language of the computer age."

An obsession that has lasted over ten years is now embodied in a book called *Calendrical Calculations,* published by Cambridge University Press in 1996. The book describes how to do calendar implementations for computers. Using fourteen calendars of current and historical interest, precise descriptions are given and accurate calendrical algorithms are presented. Its authors, computer science professors Nachum Dershowitz and Edward M. Reingold, hope that "in the process of reworking classical calendrical calculations and rephrasing them in the algorithmic language of the computer age, we have also succeeded in affording the reader a glimpse of the beauty and individuality of diverse cultures, past and present."



Ed Reingold and Nachum Dershowitz on the Beckman quad in front of a sculpture, by Stephen Luecking, which represents a solar calendar that marks the changing seasons.

When you want to know in advance whether a particular date is a holiday, or whether a particular date is a Monday or Tuesday (for example, to find out when election day is), Ed Reingold explained, the calculations can be very intricate. What he and Dershowitz did was to describe for a dozen or so major calendar groups exactly the way the calendar works and exactly how they can be computed.

For most calendars, before the use of computers, the average person relied on experts who published books of tables and all kinds of shorthand calculations and methods for converting one calendar to another. And for most calendars, there are published documents that show how to convert to the Gregorian calendar, the dominant calendar in use today. Books were written to make things simpler for the experts, using logarithms, for example, instead of multiplication, employing shorthand tables so that negative numbers would not cause problems. A calendar would be printed based on these calculations, with holidays marked, and people would accept them.

There are probably hundreds of calendars in use in the world today. There are at least thirty in India alone, and not all are based on astronomical phenomena. Some, like our Gregorian calendar, are based on the year, some are based on the lunar cycle, and some are entirely artificial. "The calendar is really at the crux of ethnicity," said Dershowitz. "Without an ethnic calendar, ethnicity is hard to maintain. All you have is food or something." Reingold pointed out that in a relatively small area like southeast Asia there are over 100 calendars. Each country may have its own variation of a similar underlying calendar, but the calculations do differ from one another. "In India," Reingold explained, "any location has its own calendar because it's location dependent. That is, the date depends on the sunrise in that particular location and where the moon was at sunrise."

Calendrical problems are notorious for plaguing software. Here are just two examples:

> The COBOL programming language usually allocates only two decimal digits for internal storage of years, so untold numbers of programs are expected to go awry on New Year's Eve of the coming millennium.

Many programs err in, or simply ignore, the century rule for leap years on the Gregorian calendar (every 4th year is a leap year, except every 100th year which is not, except every 400th year which is). For example, early releases of the popular spreadsheet program Lotus 1-2-3 treated 2000 as a non-leap year, a problem eventually fixed. But, all releases of Lotus 1-2-3 take 1900 as a leap year. By the time this error was recognized, the company deemed it too late to correct: "The decision was made at some point that a change now would disrupt formulas which were written to accommodate this anomaly. Excel has the same flaw."

The algorithmic nature of calendars and how to do the computations are the focus of the book, although some of the history and astronomical connections are talked about because of their interesting nature.

The initial motivation for what was to become Reingold's calendrical quest was to create Emacs-Lisp code that would provide calendar features for GNU Emacs, which would include the Gregorian, Islamic, and Hebrew calendars. Then it grew from there. "This is such an obsession; it's kind of like malaria. That is, it goes into a quiescent state for a while, but then all of a sudden it'll erupt, and you'll be bothered with fever and aches and pains." For Dershowitz, the fascination with calendars stemmed from his childhood love of planets and star. "I just got interested calendars ten or twelve years ago as something to play with," he said.

One of the things that Reingold wanted to do for Emacs was to implement the Jewish calendar. He talked to Dershowitz about this problem, and Dershowitz implemented it in a form that Reingold could translate for use in Emacs. A lot of people expressed interest in the code, so together they wrote a paper about it. More interest generated a second paper. "We probably had 500 requests for reprints of those papers," recalled Reingold, "and I doubt that the rest of my papers combined generated this number of reprint requests." The two papers together, which constitute about 80 pages, blossomed into a 350-page tome.

Calendar conversion is a finite problem in the sense that computer arithmetic is finite, but there is much more to be done. (Dershowitz and Reingold keep a file of calendars for future work.) The first step, they explained, is to find authoritative sources for a particular calendar. This is a big problem in itself, especially because not only are the resources in another language, but they are often out-of-print. Dershowitz explained: "When you find some sources and track down most of the references on them, you have to read it, understand it, learn the jargon, translate it. That takes a while. I find that for many of these calendars, you have to reverse engineer a lot of things you read, because they're all geared to hand calculation rather than computers. What's easy for a computer is hard for a person, and vice versa. A computer has no trouble multiplying big numbers—it doesn't need logarithms, for example. Most of the things you find written are wrong or don't have enough detail to apply an algorithm at all. To figure out those details are sometimes next to impossible. Sometimes it seems a little experimental. You get a date and then you don't know what the rule is exactly, and you try out different possibilities and see which matches the data better. Then you have to find data to compare it to. Also, you may have to find people to translate. Then you have to find data in tables to compare it with. Then we get our whole family to help compare the dates that the computer produced with the printed source. Then we find discrepancies and have to figure out who's right and who's wrong. Is it just a typo? Is it systematic error? It goes on and on and on."

http://emr.cs.uiuc.edu/home/reingold/calendar-book/index.html

"I have perhaps 50 different sets of tables for different calendars," Reingold added. "There's not one of them that doesn't have typos, which means you go look at a particular date that disagrees with your algorithm, and you may be wrong or the table may be wrong. Most people look at published tables and take them as somehow chipped in stone at Mt. Sinai, but it's not so. The tables are often wrong. Every table I have has got typos in them that are serious typos. Even the computer produced ones, because somebody went in and edited them by hand!"

Experts on each calendar, and there usually only one or two people in the world who really know it, must be consulted. Many of these

continued on p. 31

The man with *all* the Mortal Kombat secrets: Ed Boon (and he's not telling!)

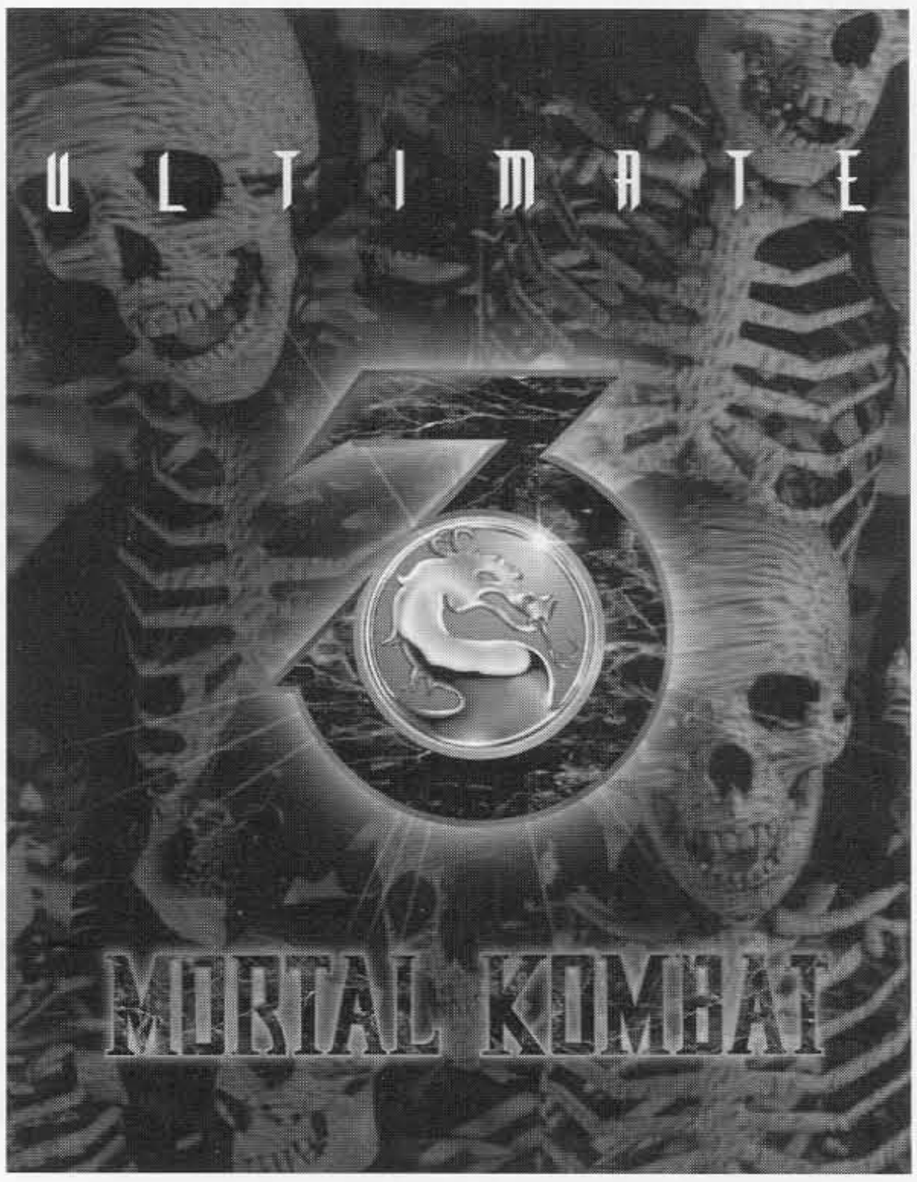
Programmer Ed Boon, BS'86, turned his passion for gaming into a career. He and graphic artist John Tobias changed the face of video gaming by creating Mortal Kombat. With each release of the game, Boon pushes the technology, dazzles the public, and raises the standards of all video games.

Ed Boon, Math/CS'86, is doing the job he was born to do, say his friends. He is co-creator and programmer for the most popular video game of all time: Mortal Kombat, an intergalactic martial-arts tournament set on a mythical Asian island. The fact that combatants could actually be killed, and very graphically, really caught people's attention, whether they played or not. Riding the wave of the game's success, he is now hard at work on Mortal Kombat 4.

Here's how big Mortal Kombat (MK) is: The first MK game sold over 6 million copies worldwide. When MK2 came out, it made more in its first weekend than *Forrest Gump* or *Jurassic Park*, with over $50 million in retail revenues its first week. MK3 sold more than 250,000 copies in its first day of release. A feature film based on the game came out August 1995 and became the top grossing picture in the country at the time, netting $23 million its first weekend. It was followed by a martial-arts stage show called Mortal Kombat: The Live Tour that premiered at Radio City Music Hall. And there are at least a hundred licensed MK products including Hasbro action figures, an animated video, music albums, comic books, and novelizations. MK4 is due to hit the arcades and shelves early next year. Boon receives thousands of letters and e-mails from players wanting to know some of the tricks on how to play to games and from would-be developers who want advice on how to get started. Although he won't reveal any secrets, he does advise future developers to study computer science or art in school.

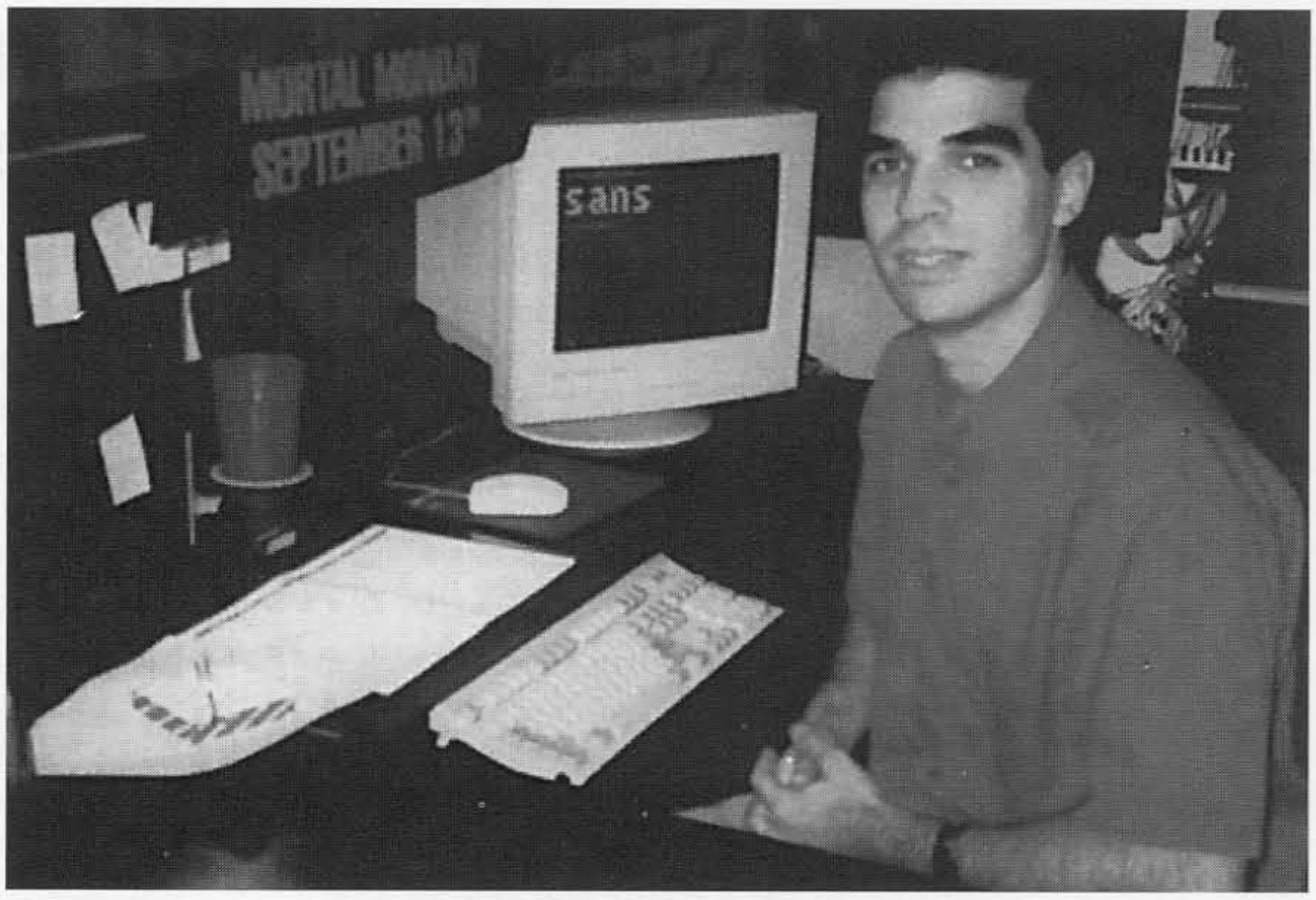
In high school, proud owner of an Atari 800, Boon was sure he wanted to study computer science in college. In 1980, when the first arcade video games came out—games like PacMan, Defender, and Missile Command—Boon became firmly hooked. Boon came to the U of I because he wanted to be near his home in the Chicago area and because he knew the university had a top CS program. He enrolled in the usual math and CS classes, but it wasn't until he learned 8086 assembler in Professor Faiman's CS 221 class that he became passionate about CS. "Doing MPs [machine problems] was interesting," he recalled, "but they told you what to write. I always thought the fun part was thinking up what to write and that writing it was more of a common skill. I looked at the program as a tool rather than the accomplishment." To further hone his programming skills, Boon worked with mathematics professor Robert Kaufman on a mathematical graphics program that he wrote in both BASIC and FORTRAN for the Atari.

When he wasn't in class, studying, or playing basketball at IMPE, Boon could be found inside the dark reaches of the Spaceport arcade. "I structured my schedule to play Robotron at Spaceport," he confessed. "I remember my freshman year, I always ended up at Spaceport or Alladin's Castle." (Spaceport, still a going concern, is on Green Street in the building formerly occupied by the Five and Dime store. Alladin's Castle used to be in



Johnstown Center but folded.) Boon lived in Snyder Hall, and when he walked to class, he would take the odd path so that he could pass by Alladin's Castle and sneak in a few games. "My friends were growing out of it. We'd all go out, walk around campus, go to Kam's, O'Malley's, or Murphy's, but I'd always go toward Spaceport."

Although he had a strong interest in computer graphics and video games, he never applied to Williams Electronics. Williams was the premiere video game producer and was conveniently located in Chicago. Boon graduated in May 1986 and spent the summer living with his parents in a semi-panicky state, wondering if he should have more aggressively sought out a job earlier. Somehow, his resume floated over to Williams, and they called him about a pinball programming job. A little intimidated and starstruck, Boon was interviewed by the game designers he admired. "I didn't even know that people programmed pinball games," he said. His first job was writing in 6800 assembler for a game called Joust. After two and a half years of pinball programming, he joined the fledgling video department that was just forming. There, he did two popular video football games, High Impact and its successor Super High Impact.



Ed Boon

The idea for MK stemmed from memories Boon had of playing Karate Champ, a video fighting game that involved maneuvering characters that punched and kicked each other. That was in 1984-85, he said, noting that he is able to chronologically mark his life according to which game he was playing at the time. "Then I saw Street Fighter (a Capcom game) and thought we could do it better," he said. That was what sparked him to act on the idea. "What set Mortal Kombat apart from any other fighting game at the time was that it was digitized. Images were created from a video signal and turned into pixel form. That way you get a much more realistic look, as opposed to someone drawing from scratch like a cartoonist would do. In having the realistic look, we wanted to make the images do something that no other game had done before. With more detailed graphics, we could introduce levels of humor and shock the public," he explained. Some of the public were indeed shocked by the level of realism and violence in MK, and it led to its condemnation by some politicians. "I don't know how many people caught on, but the whole idea was to make fun of the karate movies that were out. If you see it in a movie people say, okay, movies do that. Then you'd see it in cartoons. But people weren't used to seeing such violence in a game. It wasn't expected, so we knew that it would get attention. When the politicians jumped on it, they didn't realize that that drew even more people to the game. Its popularity escalated and when people were told it was bad for them, they liked it even more." When MK moved from arcades to home-video, parents' hackles were raised leading to in an industry-approved ratings systems and parental guide on game box covers. Prior to the controversy, MK had a cult following of "bad boys." The original target group for the game was 17-year old males, but as their younger siblings looked over their shoulders, the numbers of MK players mushroomed and the game was played by a broader range of ages. And of course, the parental ire made playing the game even more cool. Women were not part of the target audience, however. "It's harder to get women into video games," he said, "so either you swing for a home run or strike out." Recalling the PacMan phenomenon, Boon thinks that a video game geared toward women would be commercially huge.

In spring 1992, Boon and Midway artist/designer John Tobias started working on MK.

http://www.wms.com

Boon wrote the code and came up with most of the special moves and hidden tricks, and Tobias did the graphics and stories for the characters. The game was released in October of that year to arcades. The following year, it is released for home video (Sega's Genesis and Game Gear and Nintendo's NES and Game Boy). MK2 was released October 1993 to arcades, again followed by a home version in September 1994. MK3, where we are now, was introduced in March 1995 followed several months later by an upgraded version called Ultimate MK3. Home versions of MK3 came out in October with a home version of UMK3 to follow.

Practically guaranteed to have another blockbuster on his hands, Boon is hard at work on MK 4. Its release will be early 1997. Already, prospective players have been hounding him about what lies in store. Boon has been the only programmer on all three MKs, which is not common. A development team for a game the size of MK would typically have about three programmers, three video artists, and a sound technician. This time, however, because of MK4's sheer size, Boon won't be the project's sole programmer. He will be joined by another alum, Todd Allen, Math/CS'86, whom Boon actually recognized from a CS 264 class but did not know as a student.

All game coding at Williams is currently done in assembler, but C is probably the language of the future for video games. "As good as C compilers go," said Boon, "they're not as efficient as writing in assembler. But the development time would be faster, so maybe the trade-off would be good." Every time there has been an attempt to program a video game in something else, according to Allen, the game failed. "We do a lot of custom design of hardware," Allen explained. "In general, we don't use mainstream chips because we're trying to be cheap, and it's so hard to find good quality compilers. So, it's always back to assembler." He also pointed out that the code is easier to debug and that it allows the precise control of timing of all events that is necessary in a real-time video system. (Assembler language is still taught in the CS department as a means of teaching about computer architecture rather than as a programming tool in CS 232, a required course called Computer Architecture II.)

The highly anticipated MK4 will be radically different from MK3. New hardware, most of it custom designed, will be used to produce 3D graphics, the major trend in today's video games. (Previous MK games have been in 2D.) MK4 will use RISC architecture, DSP software, and with multiple ALUs, will employ parallel processing for the first time. "But the biggest challenge," said Boon, "is coming up with the concept. What is the public going to want?"

Just one last question: Why is Mortal Kombat spelled with a K? "Just to be weird," Boon replied. ■

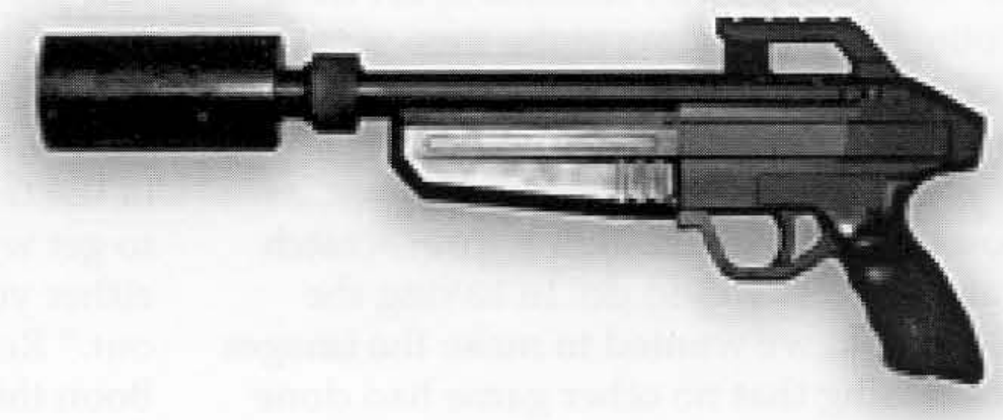
Richard Cheng invents Tracerball

Richard Cheng, PhD'71, chairman and founder of ECI Systems and Engineering in Virginia Beach, went from the corporate boardroom to a closet filled with electronic equipment and came out with an invention that has rocked the paintball world. It is the paintgun Tracer Unit, a muzzle attachment that illuminates a special paintball, dubbed Tracerball by Cheng. This allows players to see their trajectories and basically brings a daytime sport into the nighttime realm.

Paintball is a 15-year old sport, invented in England, and currently played by over a million people worldwide. It involves shooting targets with guns, but instead of regular bullets, paintballs are fired. These little balls splatter paint on their targets upon impact. Paintball is not only played recreationally, but is used for combat training by the military, police, and government agencies. Cheng's Tracer Unit will be used by these units for close quarter combat training at night.

Cheng's involvement with paintball started in 1995 when his son lamented that he was unable to play paintball in the dark. One of ECI's areas of expertise is weapons simulation using laser beams. Cheng was amazed to find that no one had come up with a way to play paintball at night. He made a prototype himself, patented the idea, and spun off a new company, RTC International, to market the invention. Executing the idea for Tracerball was really quite simple, Cheng explained. He first had to find materials for the special gel-filled, phosphorescent paintballs, making sure they were water soluble, nontoxic, biodegradable, and would explode on the proper amount of impact. Then he had to make the Tracer Unit, a strobe that would excite the balls and the proper time so that they glow while traveling at speeds around 300 ft/sec. "I just tinkered around," Cheng said, "doing old grad student's work." ■

http://www.tracerball.com



A paintball gun equipped with Cheng's Tracer Unit which illuminates paintballs for nighttime play.

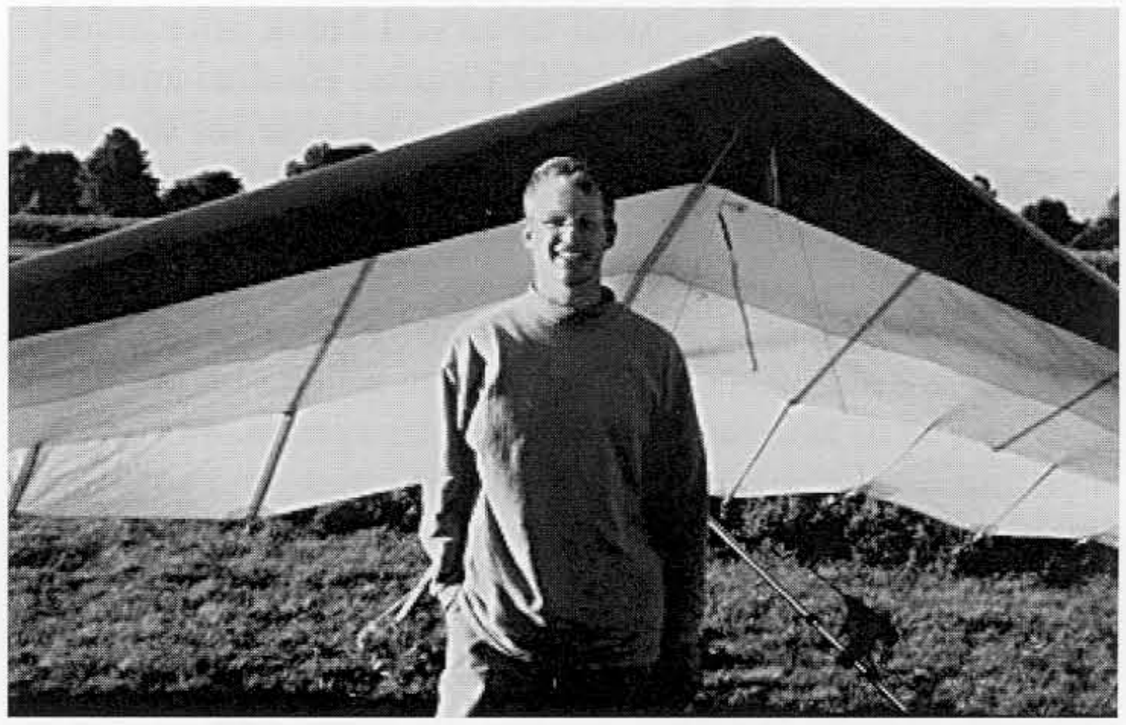
Todd Allen joins Ed Boon for MK4

Todd Allen, Math/CS'86, is new to the Mortal Kombat scene. He recently joined fellow alum Ed Boon to program Mortal Kombat 4, due out early next year. Allen hails from Loda, a small town north of Urbana. His father, an employee of Chanute AFB in Rantoul, was a computer hobbyist who, in 1975, built an Altair computer from a kit. It was on this machine that Allen first started writing games. He came to Illinois because of its strong computer science program.

Allen spent a lot of time gaming as a student. His favorite haunt was the basement of the Illini Union. He also did a little programming on PLATO as well as play some of its popular games like Empire, Avatar, and Airfight. "I've done a fair bit of programming, and doing arcade video games is my favorite," he said. "Everyone understands the excitement and reward that comes from working on fun products that get mass produced and played worldwide. Most programmers can also appreciate how interesting it is to work on a program that gives feedback in a very direct and visceral way."

Allen enjoyed programming in assembly language, and he wanted to apply his computer science knowledge to something with direct feedback, like gaming, rather than to go into research. When it was time to graduate, Allen wanted to work for the company that made his favorite video game, Defender. That was Williams Electronics. He talked to the game's designer and wound up with a job. The first game he worked on was Narc. Allen got a lot of satisfaction from seeing the final climax of Narc during an arcade scene in the Teenage Mutant Ninja Turtles movie. "It was my claim to fame for a few seconds!" he said.

Allen is excited to be working on MK4. "But one of the best parts," he said, "is something that most who haven't worked on something similar don't understand. It's that we start from scratch. No operating system, no runtime library, and no compiler. On MK4 this has gone one step further. I got to do a fair amount of coding for our newest, designed totally in house, 3D graphics chip without even an assembler to get in the way. It's the first time I've ever been able to optimize a piece of code by asking the chip's designer to change what the instructions do. That's about as close as a coder can get to feeling like a king." He continued: "The biggest appeal, though, is that there are few surprises. There's no one else to blame for our wasted CPU cycles. And all the bugs are *our* bugs. That makes me sleep better at night. The closest thing I can think of to compare is Linux. All the source is there at your fingertips. You have total control. Except video games are small enough to be comprehensible!" ■



Todd Allen, ready to engage in his favorite pastime, hang gliding.

Calendar, continued from p. 27

experts are long retired and don't have fax machines or e-mail. (If anyone knows a Japanese calendar expert, by the way, let them know!) It's the little details that seem to take the most effort. Eventually, the stage is reached where the code is written, simplified and refined in an elegant way. Then it is written out and the history and details are added. It requires that you be a mathematician, a programmer, an anthropologist, and good with languages. "And generally obsessive," added Reingold.

Calendars control ours lives in ways that most of us don't even think of. Furthermore, we human beings are used to a certain cyclic structure in our lives. If a calendar is inaccurate with respect to the seasons, as a result of dates which continuously drift in a certain direction, then we can run into doctrinal problems, for instance if Easter or Passover no longer occurs in the spring.

And did Dershowitz and Reingold figure out how *Star Trek*'s calendar worked? Actually, they did give it a shot but were unable to find detailed rules, other than that the bigger the stardate, the later it is. Or something like that. ■

Trudy Chapman at the Olympics

Trudy Chapman, BS'85, is taking a well-deserved break after a very busy Olympics. As Assistant Venue Technology Manager for Results, Chapman has spent the last year and a half away from her Lexington, Kentucky, home, in preparation for the 1996 Olympic games. During the games themselves, she was on the volleyball results team.

A native of Murrayville, Illinois, Chapman started working as a programmer after graduating and migrated later to project management of software development. For the last eleven years, she has been working for Integrated Systems Solutions Corp. (ISSC), an IBM service subsidiary. For the Atlanta Committee for the Olympic Games (ACOG), host of the games, Chapman managed the software testing effort, making sure that the software written by IBM was properly integrated. She was one of at least 500 IBM personnel at the games.

ACOG was able to reuse some of the software developed for the Barcelona games, but in four years, the technology had changed significantly. Software was developed for three main areas: Accreditation, Results, and a kiosk system called Info'96. Competition information, statistics, and results are stored on a mainframe, then sent to the outside, including the kiosk and press agencies. There were approximately 2,000 touch screen PCs driven by networked AS/400s with links to S/390 mainframes, and over 3.5 billion people viewed the games worldwide.

Accreditation starts when an athlete arrives at the airport or the village and gets a badge. The badge authorizes him or her to compete in specific events and grants individual access to restricted areas. This software, which had to track some 10,700 athletes competing in 37 sporting events at more than 27 venues, ran on a combination of venue RS6000s and the ES/9000 mainframe.

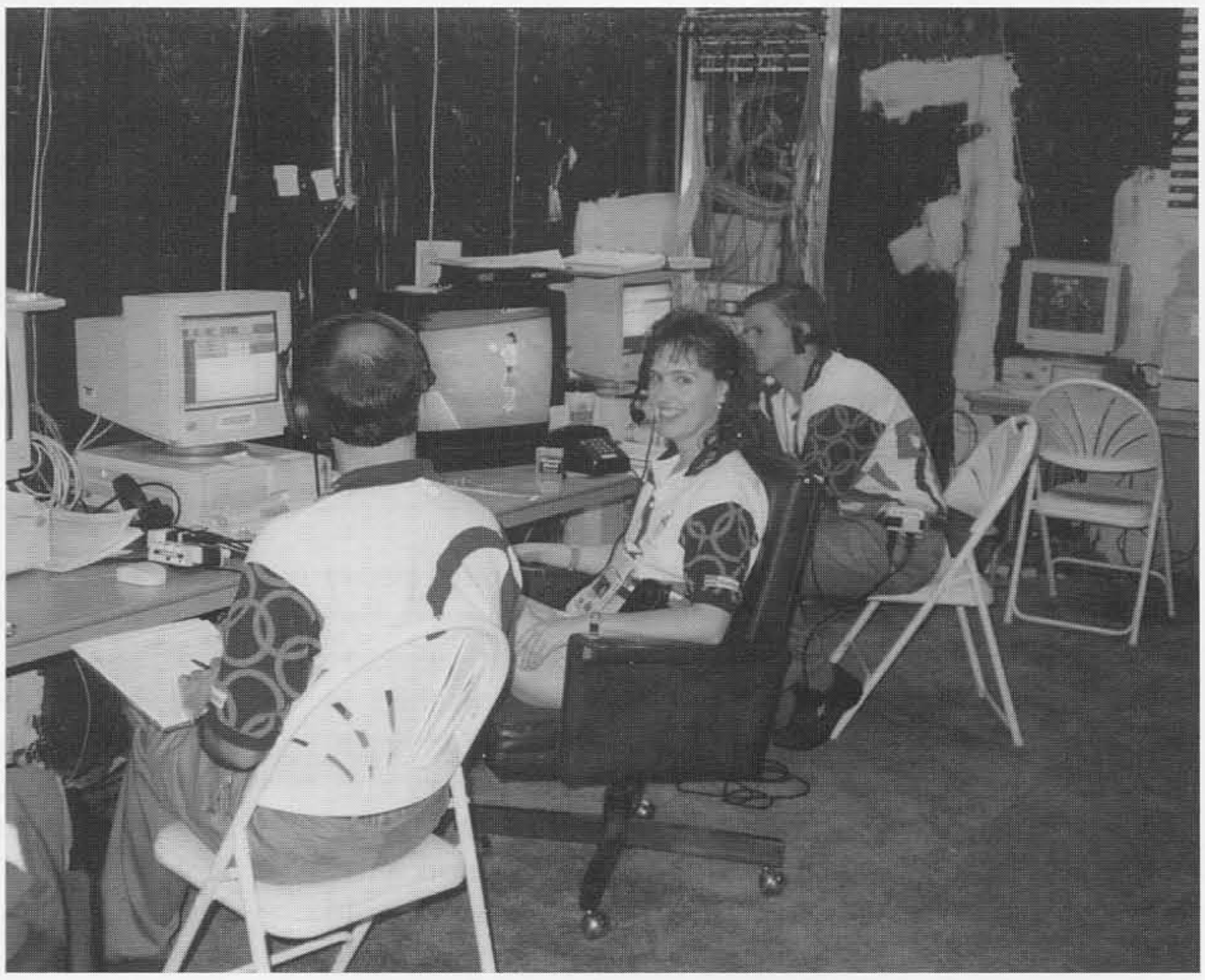
Results involved much more than keeping track of who won which competition. For volleyball, Chapman's venue, this meant tracking every serve, spike, dig, card and so forth, and generating statistics to be fed to Atlanta Olympic Broadcasting, the venue scoreboard, the Internet, WNPA (World News Press Agencies), and Info'96. The results application was client-server based; each athletic venue fed data electronically to a mainframe.

Info'96 was the name for the electronic kiosk system inside the Olympic village. About 150,000 credited individuals, including athletes, media, and judges, could use this touch screen system for things like sending and viewing e-mail, competition schedules, and competition results. The results were available approximately two minutes after the real thing. ACOG also supplied data for Internet consumption. The results application was written in Smalltalk on an AS400.

"It was a deployment nightmare," said Chapman. "In most cases we had less than two weeks to set up the sports venue, install the equipment, install the software, and test out the whole operation." She explained that one of the biggest challenges was trying to integrate platforms. IBM wanted to use as many different platforms and applications as it could, in spite of their complexities, to showcase the company's skills. For the most part, they accomplished this.

After the Olympics, Chapman was happy to get home to her flower garden and, as an avid movie watcher, get caught up. A little travel weary, she doubts she will be in Sydney for the next summer Olympics, but she looks forward to possibly working her first winter Olympics in Salt Lake City. ■

http://www.atlanta.olympic.org
http://www.issc.ibm.com

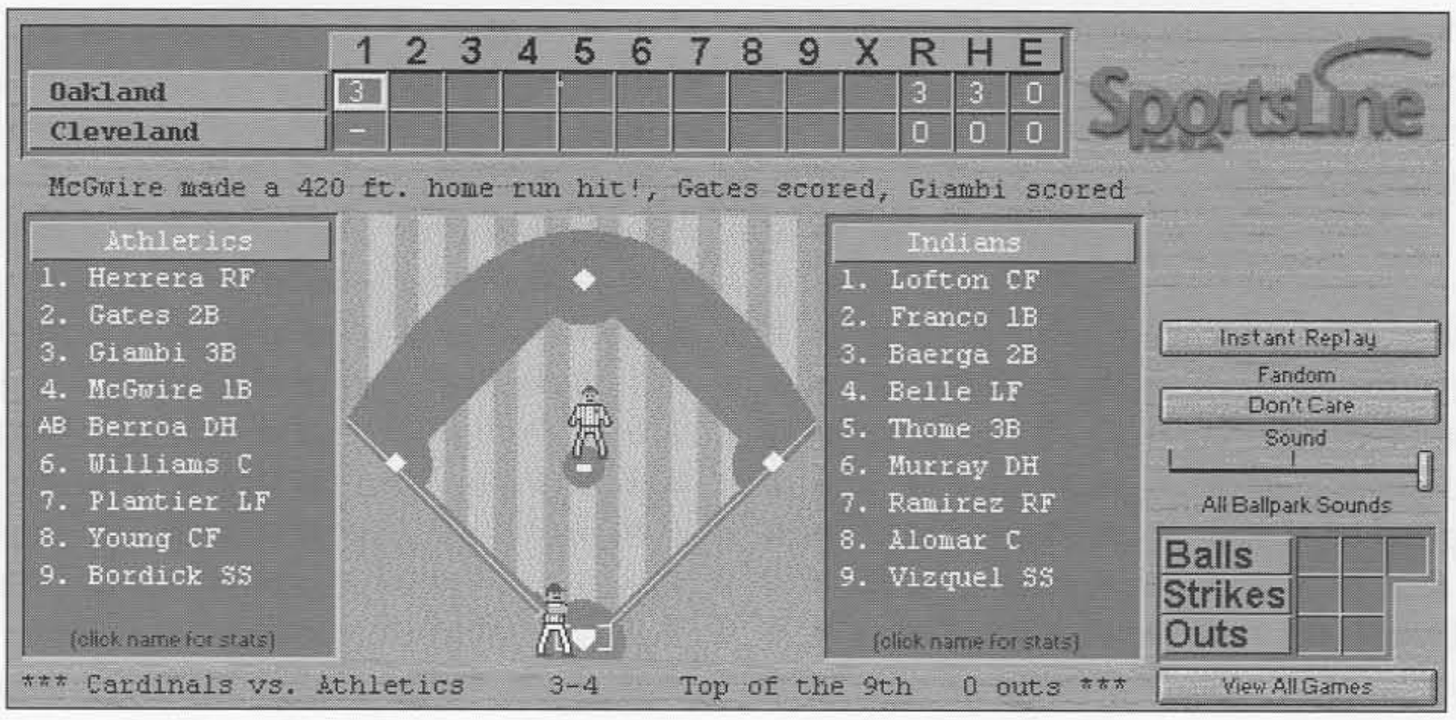


Trudy Chapman working on volleyball results, in the results control room, beneath the spectator seating in the OMNI arena.

Can't make it to the ballpark? No problem

Let Victor Tavernini bring the ballpark to you

Would you like to watch a Cubs game while you're sitting at your PC in Timbuktu? Thanks to companies like Sportsline USA, you can. Victor Tavernini, MS'87, is a programmer for the Ft. Lauderdale company that produces Baseball Live!, an animated play-by-play simulator that allows you to watch any baseball game, as it's being played or after it's been played, on the Web. The program even provides optional stadium noises, like crowd cheers and organ music, as well as the umpire voices ("Strike!"). The "live" games are about 15-30 seconds behind the real thing.



Tavernini, a native of south Florida with a BS in CS from U Texas-Austin, came to Illinois in 1986 for a masters degree thanks to his employer, Bell Laboratories in Andover, MA. At Bell Labs, he was part of a software tools group that helped developers create transmission products. At Illinois, he worked on compiler-type stuff with adviser Simon Kaplan and received his MS in 1987. He later returned Florida to take a position at Racal-Datacom, a computer networking systems and services company. He spent seven years there until a little start-up company made him a offer he couldn't refuse, and he became employee number 14 at Sportsline USA. There are now about 100.

Tavernini wanted to do innovative work and liked the idea of publishing something with no delay from publishing to delivery. A Marlins fan up until the 1994 baseball strike, Tavernini thought it would be neat to see what was happening at all the ballparks in the country at any one time. So, last April his company teamed up with STATS Inc., out of Chicago. STATS Inc. is a sports statistics company that compiles stats for all major sporting events, Tavernini explained. They have reporters at these events who transmit coverage to their headquarters in Skokie, Illinois. They then resell this information to news and sports organizations, publish books, and even have their own computer service (albeit text-based and primitive). Sportsline USA leased a line to its Ft. Lauderdale facility and, with Macromedia's Shockwave, put the action on its Baseball Live! Web site. Doing this required using a low-level baseball protocol, formatting, substituting names, and generating hyperlinks to other relevant information. "It involves a little bit of parsing, a little bit of data communications stuff," Tavernini explained. "It's almost real-time so you have to get a lot of cycles on an SGI box."

Baseball Live! gets over 10,000 users per day, including many from Japan. Tavernini wonders how many of those people actually get any work done while tuned to the Cubs or Giants, who both play afternoon games. In addition to the interface work and achieving the look and feel of the game, the biggest challenge Tavernini faces is how deal with navigating through some 65,000 pages of content.

Tavernini has been hard at work on Football Live!, which debuted in September to over 150,000 page views (and it was mentioned in the September 16 issue of *Newsweek*). Sportsline is also working on Golf Live! "There's a big potential in golf because there are a lot of sponsors," Tavernini pointed out. "Plus the first round games played on Thursdays and Fridays are almost never televised." Don't look for basketball, hockey, or soccer, though. Those games are too fast for the Web right now. ■

http://www.sportsline.com

Eric Bina catches us up on his life at Netscape

In July, I caught up with a very busy Eric Bina, BS'86, MS'88, the coauthor of the original Mosaic. Bina lives in Champaign, where he and CS professor Marianne Winslett tend to their new daughter Natalie. He telecomutes to Netscape, in Mountain View, California, where he works as a programmer along with over a dozen other Illinois CS graduates. My last conversation with Eric was for the Winter 1994 issue of this newsletter, when he was working for the newly formed Mosaic Communications Corp. Obviously, things have changed in a very big way since then. I asked him to step us through some of these changes.

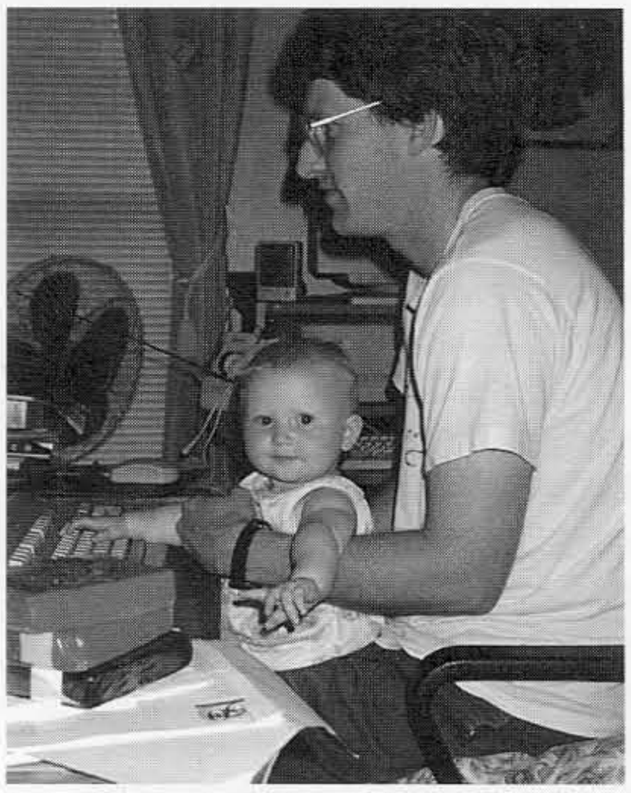
—Judy Tolliver, editor

Since the fall of 1994 and up until Netscape Navigator 2.0, the Illinois programmers at Netscape, most of whom comprised the Mosaic team at NCSA, had been working on Navigator, Netscape's Web browser. "Then, it was a steep up curve," explained Bina. "Everyone was becoming famous quicker and quicker, and we were in the press all the time." During this time Jon Mittelhauser, BS'92, thought of by Netscape management as having a natural talent for marketing, was snatched up by the marketing folks. Chris Houck, MS'92, Aleks Totic, MCS'94, and several new people were left to work with Bina on Navigator 2.0. Rob and Mike McCool, both BS'95, worked on the server. Marc Andreessen, BS'93, had already moved out of the engineering sphere and into the corporate vision realm. "Marc always had the intent to get out of programming," said Bina, "which was funny because he was so good at it." Later, Houck and Totic left to work on something else, though Totic eventually returned to the Navigator group. Mittelhauser, eager to get back to programming, joined the Tiger Team, a small group that wrote special versions of Navigator for corporations like SGI. "For a while, it was just Lou and me," said Bina, referring to Lou Montulli one of the initial Netscape programmer who came from Kansas State U, where he wrote Lynx.

Bina is still stunned at how quickly and how large Netscape grew. They have already outgrown two facilities in Mountain View, and there are now over 1,000 employees. Netscape's product line also expanded and they now offer a host of products aimed at business intranets. "It boggles the mind," said Bina, shaking his head. "Every time I see an ad that has a URL in it, I think, it was only three or four years ago that anyone in the U.S. even heard of the Web. It's nuts." Bina is also amazed at how much information can be found on the Web. About the only thing he hasn't found is how to get a pocket knife that's *not* a Swiss Army knife.

What about the Microsoft threat? "It's amusing and interesting," replied Bina. "[Netscape president] Barksdale is really into the team-player concept and that you should never say anything bad about the competition." However, not all people within Netscape agree with or practice that philosophy. "Microsoft has said that Netscape is their number one competitor and that it's simply good business practice for them to crush us. They have quite openly declared war on us. So how are we supposed to react when someone says, 'Nothing personal, but for the sake of my business I have to put you out of business?' The reactions of people are so different throughout the company," he continued. "For a while, it was kind of universal that we were growing and growing and we didn't have any real competition. Everyone was all super psyched up. You get people from all sides—people who like to ridicule Microsoft at every turn, with all the jokes, and people who work for Netscape but are Microsoft groupies: 'Microsoft is doing this, *we* have to do this.' I say, 'No, calm down. Competing with Microsoft doesn't mean we have to do everything Microsoft does. There are many areas where we won't even intersect. It's okay. We're not trying to become the evil twin of Microsoft.' And we get people everywhere in between." As an example, Bina told of a big PC tradeshow in which Microsoft unveiled their ActiveX strategy and demonstrated the beta version of their new browser. The Netscape people who attended came back and e-mailed their trip reports to the rest of engineering. "They were completely different flavors. One person says we're in deep trouble, another says it's all just hot air. And they both saw the same thing!" He continued, "I think it's good for the company to have real competition. Based on unofficial rumors, Microsoft has more people working on their Internet Explorer than we have in our entire company. So, from a manpower and money standpoint, they have us beat hands down. But I like a picture that I saw in some magazine of this truck driving toward a rabbit in the road with Marc's face. What do we do? We can always jump over the hedge. So the idea is not to go head on with this Mack truck. There are some groups within Netscape that push the line that Microsoft is trying to take the food from the mouths of your children, but it doesn't come from the top." According to Bina, Netscape founder Jim Clark had told everyone to expect this kind of competition—that Netscape was like an ant on an elephant's foot.

Netscape has acquired several smaller companies. I asked Bina about the Netscape corporate culture in view of the fact that there are so many people coming from other companies. Apparently, it has worked out very



Eric Bina at work with daughter Natalie.

well. "It's kind of weird," he said. "You don't see it every day, but underneath there are cliques of people who tend to band together. For instance, at lunch there's an Oracle table." Netscape is trying hard to form a corporate culture to assimilate all those groups. "When we were small, we even hired someone whose job it was to establish a corporate culture. She did things like organize events. One still happens: we have a beer bust every Friday hosted by a group who is responsible for the theme."

Netscape employs a lot of young people, but like most companies, the management is composed of older, more seasoned people with years of experience in other companies. "I used to be the oldest one," Bina said of the programmers, "but not any more." As one of the first to bring a baby to work, Bina paved the way for others to come to the office with babies in Snuglis.

There have been countless studies on whether telecommuting results in higher or lower productivity. Bina thinks telecommuting is wonderful. "We do more of it at Netscape now that we're a big company," he explained. "Originally when we were smaller, we were definitely influenced by the fact that Jim Clark didn't think telecommuting worked very well . . . It's true that I work less since Natalie was born than before, but the same thing would be true even if I wasn't telecommuting. I was putting in 80-hour weeks before. We recently had to update all the ISDN stuff at work because of all the telecommuters. There are a lot of people in California who do it because the commute is so awful." Bina described a Web site, internal to Netscape, that daily describes the traffic conditions on the commute in. A Netscape employee can get up in the morning, turn their computer on, and find out from people who already drove in where the accidents were and so forth.

I asked Bina to predict what Netscape would be like in two years. Of course, this was an impossible task, and he went on to describe how difficult it was to make plans for his wife's sabbatical, which is coming up. "We'd like to do something more exotic than the Bay area—perhaps Australia. But can I telecommute from Australia? The company might not even be there! Or the company may become completely rigid corporate—we're certainly heading that direction. In the original company policy, drafted by Jim Clark, a sabbatical was written in. But that may not be there. Considering how much we've changed in the past few years, the next few years we'll probably change less. I hope we won't continue this ridiculous rate of growth. In my opinion—as someone who doesn't know a lot about business—it seems that we need to start growing slower and consolidate what we have. We're acquiring people at a tremendous rate, and I'm sure we're acquiring a lot of good people, but when you acquire people that fast, you're going to acquire some bad people that we're going to have to let go. Right now Netscape is doing a lot of hiring, but if you start laying people off, then you get bad press, and the stock price goes down, and so on. We've spread out into so many products. We need to figure out, of those 15 products, which five are the ones we're going to focus on?" He concluded, "I hope that in two years we'll be calmer, more mature, and more focused as a company. I hope we haven't been crushed out of business by Microsoft. That's certainly possible if the company stubbornly insists on going head on with them."

Bina is still committed to programming. He see the big technical challenge for everyone as being: What is the next big thing that everyone is going to want? Right now everyone is adding things to what they've already got, like Javascript and ActiveX. These things are getting more and more technical and used by fewer and fewer people, explained Bina. "Everyone uses the basic point-and-click HTML. Maybe 10 percent of those people are ever going to write a Java script. And 10 percent of those 10 percent are ever going to write a Java program. So we're all devoting more and more time for technical solutions for fewer and fewer people. Up to a certain extent that's important because you have all these Web masters and mistresses out there now who all need that stuff, and you have to target them because they're the ones who make the buying decisions for companies nowadays. But the real technical question that we have to try and answer is: What's the next thing one of us, or anyone, can do that's going to bring everyone on board again the same way that the Web did originally?"

The future is a guessing game. Telecommunications is steadily improving. Deregulation will allow phone companies to give you television and cable companies to provide network service. What will it all mean? "By the time Natalie is in her 20s, there'll be a computer in every dang household in the world," laments Bina. "I'm leaning toward Natalie never having anything to do with computers."

And how did the big IPO affect the Illinois folks? Visibly, most of them bought houses. Other than that, they haven't slowed down a bit. ■

Mentor Program makes the grade

The CS Alumni Board's Mentor Program, introduced during the 1995-1996 school year received good marks from the participants based upon a survey administered after the first go around. In the program, students and alumni were paired together to help provide a "real world" spin on classwork. Participants found the program useful to further their networking, to get advice on interviewing and skill needs, and to discover what computer scientists and engineers do once they no longer have MPs. Alumni found it to be a great way to stay in touch with the department.

The program was not without some start-up pains, however. The most common one was getting the relationship between mentor and student started. The first communication was the big hurdle so this year we are providing addition information to all participants and stressing the necessity of e-mail as a communication vehicle. We're also opening up the program to more recent graduates because the first job experience was a major topic for the students.

If you're interested, drop an electronic dime to alumni@cs.uiuc.edu and join the fun. We're planning a get together over Homecoming, so sign up now.

—Jim Cupec, MS'77,
Mentor Program Chair

NOT A MEMBER OF THE UI ALUMNI ASSOCIATION?
CALL 1-800-355-ALUM
or
alumni@uiuc.edu

Faculty & Staff notes

Marianne Winslett was quoted in the June 26 issue of USA Today in the cover story called, "How girls get scared away from computers." In it she says, "We have programs where scientists and engineers go out and are connected with specific middle school classes and the girls there. You don't walk into a middle school and preach to them, but you make it implicitly obvious that girls at that age could grow up to become a scientist. That is a really important age for outreach."

David Padua and **Josep Torellas** moved back to DCL this fall from the Computer and Systems and Research Lab, a building between DCL and Beckman.

Paul Saylor is the principal investigator on a new Grand Challenge project funded by NASA, entitled "A Multipurpose 3D Code for Relativistic Astrophysics and Gravitational Wave Astronomy." The objective is a general purpose, parallel and scalable code for computing gravitational waves. Project members are from NCSA and the astronomy department at UIUC, Argonne National Lab, and the physics departments at Washington U, St. Louis and SUNY-Stony Brook. The principal goal is the study of the collision of two neutron stars. This cataclysmic event is estimated to occur several times a year within the observable universe. A collision would produce gravity waves that radiate away through space. These waves can be detected by a gravitational observatory, the very first of which will become operational in the year 2000: the Laser Interferometric Gravitational Observatory (LIGO). The high performance numerical software must solve some of the most complicated mathematical descriptions of nature in all of science. "Our era is similar to that of Galileo when he first turned a telescope skyward to observe the universe using light," said Saylor. "LIGO will be the first to observe the universe using gravitational waves. An important reason for our project is to find out what a gravitational wave looks like so that an observer using LIGO can recognize one when she 'sees' it."

Steven Wolfram was featured in the September 15 Wall Street Journal as "an inventor who makes complex calculus simple." The article highlights Wolfram and the new, souped-up Mathematica 3.0, software recently released by his company, Wolfram Research Inc.

Dick Canaday, director of budget and resource planning in the department from 1988-96, died at age 58 on June 16, 1996. He worked at the university for 35 years before retiring in January, 1996. ■

BOARD MEMBERS NEEDED

THE CS ALUMNI BOARD helps the department stay current with trends in industry and build stronger ties to the alumni. The board has recently been involved with the mentor program, curriculum surveys, newsletter, Web page, mousepads, and screensavers.

WE ARE LOOKING for people from a variety of backgrounds who are willing to serve on the board or help out with its activities. The board meets three Saturdays a year in Urbana and Chicago, and board members serve two-year terms. If interested, please contact alumni@cs.uiuc.edu.

Two more ACM presidents found!

The last issue of the CS alumni newsletter uncovered two more past presidents of the student chapter of ACM at Illinois. Any more out there?

Terry Shepard, PhD Math'69, served as ACM president sometime around 1965. "I have always felt as though I were more a CS grad than a math grad from Illinois, and I admire the courage that Fontaine Richardson and some others had in switching from math to CS." It was Richardson, PhD'68, who let us know where Shepard was. Shepard is now professor of electrical and computer engineering at the Royal Military College of Canada in Kingston, Ontario, where he does research in software engineering. Before that, he was executive director of the Cable Telecommunications Institute in Ottawa, manager of Computers, Communications and Controls for Canada Square Corp. in Toronto, and held various positions with the Department of Communications in Ottawa. shepard@ecesun.rmc.ca

Fred Stahl, BS Math'66, MS Math'68, PhD'74, was president in 1969-70. "What I remember most about the ACM chapter meetings," he wrote, "was the difficulty in getting people interested in attending meetings. I recall with great fondness my eleven years at the U of I and in particular the education I received there," he wrote. Stahl is president of Wellington Systems, an information technology consulting firm in Norwalk, Connecticut. Before that, he was professor of electrical engineering and computer science at Columbia U, Ohio State U, and UNESCO Professor of Computer Science and Mathematics at Simon Bolivar University in Caracas, Venezuela. wellngton@ix.netcom.com

Classnotes

The book, The Whole Internet, written by **Ed Krol, BS'73**, has been included in the New York Public Library's Books of the Century. Produced as part of the library's centennial celebration, Books of the Century lists the "most significant works from the last 100 years." Krol's 1992 book, is the only computer book included in the compilation. The guide states that with his book, Krol "reached out to a wide audience, writing not only with technical expertise, but also with enthusiasm for the subject and a genuine desire to open up to the curious the world of networking." Krol is assistant director of CCSO (Computing and Communications Services Office) at Illinois. e-krol@uiuc.edu

Steve Chen, PhD'75, became Sequent Computer Systems's Chief Technology Officer in June.

Curtis Steele, BS'76, MTCS'80, now works at Systems & Computer Technologies Corp. in Chicago. He will oversee computer operations for an off-campus educational facility of Roosevelt University.

Mark Tebbe, BS'83, attended the World Economic Forum in Davos, Switzerland this summer. His firm, Lante Corp., developed and ran the messaging system for this conference. Tebbe is founder and president of Lante. mtebbe@lante.com

1994 World Champion cyclist **Karen Brems Kurreck, BS'84**, narrowly missed qualifying for the Atlanta Olympics. Kurreck has been a member of the U.S. national team since 1993 and has been the highest placed American in the last three world championships. At this writing, she is preparing to compete in two events at the world championships in Lugano, Switzerland, October 9-12. Kurreck lives in Cupertino, California, with husband Tim. kkurreck@aol.com

Brendan Eich, MS'86, is Netscape's latest Illinois acquisition. Eich wrote the interpreter and compiler code for Javascript and he was featured on the front page of the New York Time's business section on September 9 in an article called "Tickling the Ivory and Tweaking the Javascript: Part Artist, Part Hacker and Only Partly Awake."

Robert E. McGrath, MS'86, is the coauthor of a new book, *Web Server Technology: The Advanced Guide for World Wide Web Information Providers* (Morgan Kaufmann, 1996). McGrath is a senior system engineer at NCSA and Webmaster for NCSA's Web page. His research focuses on large-scale distributed systems. mcgrath@ncsa.uiuc.edu

Kimberly (Griffin) Binegar, BS'87, was married to William Binegar in June 1995. After she completed an MS in EE at U Iowa, she became product manager for Rockwell International in Anaheim, California. kabinegar@anet.rockwell.com

Daniel Bernstein, MCS'87, was featured in the June 1996 issue of Wired magazine in an article about his lawsuit against government cryptography controls. He is a professor in the Department of Mathematics, Statistics, and Computer Science at the University of Illinois at Chicago.

John K. Estell, MS'87, PhD'91, is associate professor of computer science at Bluffton College in Bluffton, Ohio, and responsible for the college computer science degree program. He is also Chair of the Western Lake Erie (northwest Ohio) Group of the Sierra Club and running for election to the Club's state executive committee this fall. Estell resides near Bluffton on a small farm with a cat named Furball. estell@bluffton.edu

Scott V. Heaton, BS'88, was married in September to Stacey A. Chapman. They live in Lakewood, Colorado, where he works as a software engineer for Electronic Data Systems. Good thing he lives in Colorado because he's a ski and mountain biking enthusiast. msusden2.sheaton@eds.com

Ping Fu, MS'90, Marc Andreessen, BS'94, and Tim Krauskopf, MS'87, graced the pages of the February 5 issue of U.S. News & World Report in an article entitled, "Diplomas and dollars: The University of Illinois churns out big-time software entrepreneurs."

Todd Biske, BS'91, MS'94, married Andrea Kish, BS Civil'94 in September. He works for the National Atmospheric Release Advisory Center at Lawrence Livermore National Lab in Livermore, California.

Vicki Jones, MS'92, was featured in a brochure called *Women in Computer Science*, produced by the Computing Research Association. The brochure is part of an effort of the CRA Committee on the Status of Women in Computing Research to increase the number of women in computer science and engineering research and education at all levels. The brochure and other CRA activities are available on-line at http://cra.org. **Mary Jane Irwin, MS'75, PhD'77**, is a committee cochair. Jones has accepted a faculty position in computer science at North Carolina State University, where she starts in January. She is currently finishing up her PhD. vjones@cs.uiuc.edu

Kenneth P. Smith, PhD'92, was married in December 1995 to Lynn Ricek. He works for MITRE Corp. in McLean, Virginia.

VLSI Symposium to be held at U of I

The 1997 Great Lakes Symposium on VLSI will take place March 13-15 on campus. GLS-VLSI'97 is the seventh in a series of symposia exploring the recent progress in VLSI circuits and systems design. The symposium addresses all aspects of design, test, and validation of microelectronics-based systems.

General cochairs are ECE department head Steve (Sung-Mo) Kang and CS professor C. L. (Dave) Liu. Sponsors are IEEE Computer Society, IEEE Circuits and Systems Society, and UIUC, in cooperation with IEEE Signal Processing Society and ACM SIGDA.

http://www.ece.uiuc.edu/~vlsi97

Roland Haring, MCS'95, is a technology consultant at TANDEM Chile and lives in Santiago, which involves keeping up to date on technology trends and hot products in the market. In addition, he recently became assistant professor in the Department of Computer Science at the University of Chile. "On weekends I usually run away from the capital, either into the mountains close by, or go sailing (fun-surfing) to the coast, which is about two hours driving from the capital." rharing@tandem.cl

Let us know . . .

What's been happening with you.

Here's how . . .

Send a note

to alumni@cs.uiuc.edu.

Add yourself

to our online directory: Link from www.cs.uiuc.edu. Find your Illinois CS friends, and let them find you!

Post

to our newsgroup, uiuc.cs.alumni. (Ask your site administrator to include this newsgroup.)

And the best way to keep in touch?

Come visit!

College of Engineering
Annual Fund
Department of Computer Science

Yes, I want to support high-quality education with my gift of:

❒ $1000 ❒ $250
❒ $500 ❒ $100
❒ Other:_____

I have enclosed my check in the above amount made payable to:

❒ UIF/Computer Science Dept., unrestricted
❒ UIF/Computer Science Dept., _____ _____Fund.

I authorize the U of I Foundation to collect my gift in the amount above through the credit card checked:

❒ Visa
❒ MasterCard
Card no:_____
Expiration date:_____
Signature:
_____

My company
_____
will match my gift with $_____. I am enclosing my employer's Matching Gift form.

Name _____
Home address
_____
City_____
State____ Zip_____

I understand that this gift is tax deductible as allowed by law.

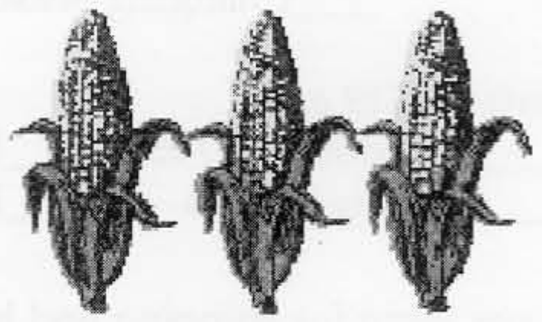
Return this form and your check to:

U of I Foundation
Harker Hall
1305 West Green Street
Urbana, IL 61801

W4A

For your holiday giving . . .

T-shirts!



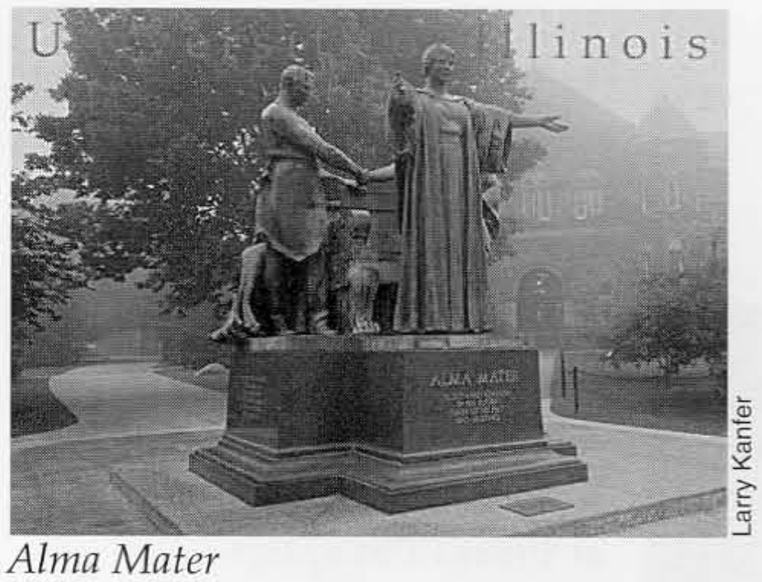
Digital **C**ornputer **L**ab
Department of Computer Science • University of Illinois at Urbana-Champaign

Our ever popular digital corn t-shirts are all-cotton, in vivid white, with festive green and yellow corn.

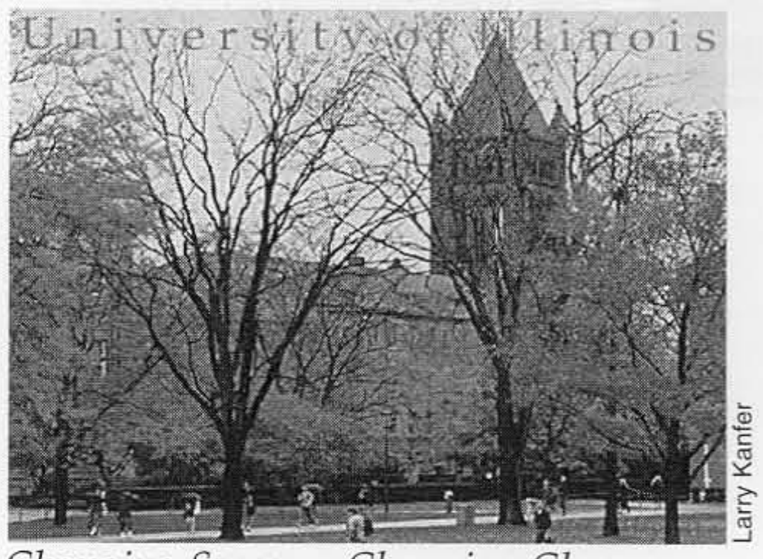
Mousepads and Screensavers!

Our exclusive mousepads feature the work of acclaimed photographer Larry Kanfer, BS Arch'79. One features the stately Alma Mater statue in summer's mist. The other features the Quad in autumn splendor.

We also offer two screensavers. The first, called *Illinois Images,* is a collection of nine Larry Kanfer photos of some of campus's most beloved spots. The second, called *Illinois Ironworks,* is a collection of vintage photos, mostly black-and-white, of ILLIAC-related things and people. The PC versions are stand-alone screensavers and run on Windows 3.1 or 95 (NT not available yet). The Mac versions are slides to go with Berkeley Systems After Dark.



Alma Mater



Changing Seasons, Changing Classes

See back page to order.

CSAA Gift Order Form

Name _____
Address _____
City _____ State _____ Zip _____

T-shirts and mousepads can be seen in color on the Web! Link to the CS alumni Web pages from http://www.cs.uiuc.edu.

- I would like t-shirt(s) at $14 each.
  ____small ____medium ____large ____x-large ____xx-large
  (put quantity next to each size)

- I would like mousepad(s) at $12 each.
  ____Alma Mater ____Changing Seasons, Changing Classes

- I would like screensaver(s) at $19 each.
  Version: ____Windows 3.2/95 ____Macintosh *(must have After Dark to run)*
  Screensaver: ____Illinois Images ____Illinois Ironworks

Add $2 per order (not per item) for shipping and handling.
❖ Illinois residents, add 7.25% tax first.

- I have enclosed a check for _____ made out to the Computer Science Alumni Association.

Send to Judy Tolliver, Department of Computer Science, 1304 West Springfield Avenue, Urbana, IL 61801.

Questions? Call 217–333–1621.

Department of
Computer Science
University of Illinois
at Urbana-Champaign
1304 West Springfield Avenue
Urbana, IL 61801