

News & Notes

Winter/Spring 2014 ♦ Issue Fifty-One

CompSci @ Carolina



Dear Friends,

It has been a bit longer than usual since you last received the News & Notes. The department looks slightly different than it did then.

We will miss Donna Boggs, Andrea Bunn, Katrina Coble, and Tim Quigg, who retired from the department, as well as Kelli Gaskill and Cory Quammen, who left to pursue opportunities elsewhere. At the same time, we are excited for the new faces: Alex Berg, Tamara Berg, Bridgette Cyr, Chase Debnam, Megan Erlacher, Michael Fern, Jim Mahaney, Latasha Mingo, Kristen Palmer, Brett Piper, Alden Sharpe, Cynthia Sturton, and Jordan Wolf.

Despite some department personnel changes, our students, faculty, and staff continued to earn recognition from their peers. Among other honors, in this newsletter you can read about the IEEE Career Award earned by Henry Fuchs, Academy Awards given to Theodore Kim and Lawrence Kesteloot, and Björn Brandenburg's Distinguished Dissertation Award.

Finally, I would like to remind everyone that we are preparing for our celebrations of the 50th Anniversary of the Department and the 40th Anniversary of MIDAG during the 2014-2015 academic year. Starting on page 7, you will find a letter from Dr. Fred Brooks, a history of the department's early years, some of the ways we will be celebrating our 50th Anniversary, and how you can get involved right now.

Remember to stop by the department any time you are nearby. We would love to have you come visit!

Armando Lata
Chair of the Department

INTERESTING TIMES IN RNA SEQUENCING

"May you live in interesting times", the Chinese proverb goes. Or was it a curse? The rapid growth of experimental data is certainly creating interesting times for computer scientists. For instance, a modern DNA sequence analyzer can determine the nucleotide order of hundreds of millions of short DNA fragments simultaneously, completing the run in a single day. UNC operates eight such machines around the clock in support of research projects in genetics, molecular biology, and medicine. A multi-institution research group jointly led by Professor Jan Prins and UNC CS alumna Professor Jinze Liu at the University of Kentucky is developing algorithms and software to analyze RNA using high-throughput sequencers. The software is in use in multiple research efforts, including The Cancer Genome Atlas (TCGA) program. The TCGA is a national NIH-sponsored project

to characterize the genetic basis of different cancers and to classify the myriad ways in which changes in a cell's DNA can lead to cancer's defining characteristic of unregulated cell growth. While most participants in this program analyze the DNA sequence of thousands of different tumor samples, at UNC the focus is on analyzing the RNA.

To understand the UNC focus, a CS analogy might be helpful. The genome (DNA) is often described as the "program" controlling the cell. In "execution" of the program, short sequences of DNA are transcribed, creating RNA molecules that have regulatory effects in the cell, or are translated to proteins making up the basic machinery of the cell. In turn, small molecules produced in response to conditions throughout the cell regulate the locus and frequency of DNA transcription of the genome, controlling

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FUCHS RECEIVED IEEE VIRTUAL REALITY CAREER AWARD



Henry Fuchs was recognized by an international organization for his contributions to the field of virtual reality.

Fuchs, the Federico Gil Distinguished Professor of Computer Science and Adjunct Professor of Biomedical Engineering, received the 2013 Virtual Reality Career Award from the Institute for Electrical and Electronic Engineers (IEEE) at their annual Virtual Reality Conference. The Virtual Reality Conference is the premiere academic conference in the world on Immersive Virtual Environments. IEEE honored Fuchs for his lifetime effort and contributions to virtual and augmented reality.

Since the 1970s, Henry Fuchs has made pioneering contributions to many of the technologies needed to enable virtual and augmented reality. He came to UNC in 1978 and has worked on automatic construction of 3D models and scenes, fast rendering algorithms known as BSP Trees. Fuchs also created the graphics computer Pixel-Planes, the HiBall large-area tracking system, and video see-through head-mounted displays. Many of these advances were inspired by demanding applications such as augmenting visualization for surgical assistance (by merging real and virtual objects).

The IEEE Virtual Reality Career Award was established in 2005. It is given every year to an individual to honor that person's lifetime contributions to virtual & augmented reality.

BARUAH NAMED IEEE FELLOW



Sanjoy Baruah was recognized by an international institute for his contributions to the design of real-time embedded systems.

Baruah, a professor in the Department of Computer Science, has been named a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). IEEE is the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity.

Baruah was honored in recognition of his numerous contributions in real-time embedded systems through his research in creating advanced algorithms and models that work with applying scheduling theory to computer systems.

Real-time embedded systems are at the core of virtually

all modern technologies to control or monitor physical processes within stringent time constraints. People often encounter these systems every day in their cars and computers without ever realizing these systems exist. For instance, air bag deployment in cars is dependent on real time embedded systems because an airbag must trigger at exactly the right moment to be effective.

Baruah developed multiple types of new abstract algorithms and formal models for the sophisticated, modern devices that needed new techniques for designing and implementing real-time systems.

The distinction of IEEE Fellow is reserved for members whose extraordinary accomplishments in any of the IEEE fields of interest are deemed fitting of this prestigious grade elevation. IEEE Fellow is the highest grade of membership and is recognized by the technical community as a prestigious honor and an important career achievement.

WHITE RECOGNIZED WITH CAMPUS IT AWARD



UNC recognized Brian White's excellent support with an IT Award. White, who serves as IT director for the Department of Computer Science, joins nine other individual winners and three team winners for 2013.

The IT Awards, initiated in the spring of 1992 and first given in April 1993, were created in order to publicly encourage and acknowledge support efforts of information technology personnel. Nominated by their peers, winners of this award are recognized by upper

level management for their work in positions which rarely occupy the limelight.

Bill Graves, then associate provost for information technology, was quoted in the Chapel Hill Herald as saying of the first IT Awards, "The staff involved in information technology are tireless in their efforts to provide a state-of-the-art technical environment for this campus. Such dedication deserves public recognition since much of their work is behind the scenes and not always obvious to those who benefit from their efforts."

The IT Award comes with a plaque and a congratulatory letter from the chancellor.

ORDONEZ, BERG, BERG AWARDED MARR PRIZE



Clockwise from top: Vicente Ordonez, Alex Berg, Tamara Berg

Graduate student Vicente Ordonez and assistant professors Alex Berg and Tamara L. Berg were awarded the 2013 Marr Prize for Best Paper at the Fourteenth International Conference on Computer Vision (ICCV) in Sydney, Australia.

The award-winning paper, “From Large-Scale Image

Categorization to Entry-Level Categories,” was also co-authored by Jia Deng of Stanford University and Yejin Choi of Stony Brook University.

The Marr Prize, given biennially at each ICCV, is one of the most prestigious honors in computer vision research. It is named for British neuroscientist and psychologist David Courtnay Marr. This year’s prize is the twentieth to have been awarded since 1987.

The ICCV is sponsored by the Institute of Electrical and Electronic Engineers.

ANDERSON NAMED ACM FELLOW



Kenan Professor of Computer Science James H. Anderson was named to the 2013 Fellows of The Association for Computing Machinery (ACM), the world’s largest scientific and educational computing society.

Anderson was recognized for his contributions to the implementation and analysis of multiprocessor and multicore real-time systems.

The ACM Fellows Program began in 1993 with the goal of celebrating the exceptional contributions of leading members in the computing field. Those named as ACM fellows have helped to enlighten researchers, developers, practitioners and

end users of information technology throughout the world.

The 2013 ACM Fellows, who come from the world’s leading universities, corporations and research labs, have achieved advances in computing research and development that are accelerating the digital revolution and impacting every dimension of how we live, work and play worldwide.

In other honors, Anderson is a recipient of the U.S. Army Research Office Young Investigator Award, and in 1996, he was named an Alfred P. Sloan Research Fellow. He won the computer science department’s teaching award in 1995, 2002 and 2005. He is also a 2012 Fellow of the Institute of Electrical and Electronics Engineers (IEEE).

ACM will formally recognize the 2013 Fellows at its annual awards banquet, which falls this year on June 21, 2014, in San Francisco.

COBLE WON CATHERINE G. PERRY AWARD



Katrina Coble received the Catherine G. Perry Staff Excellence Award for 2013.

The award was established in 2011 and designed to honor a department staff member for excellence in performing his/her job duties.

Coble managed the needs for some 200 faculty, students, and staff in the department of computer science, where she worked for 31 years, including 21 years as administrative manager, before retiring from the department in June 2013.

“She could easily be called the backbone and heart of

the department,” said Tim Quigg. “Katrina helps keep the department running smoothly day after day and also cares deeply for the people (faculty, staff, and students alike) in the department. Her constant smile and positive attitude along with her tremendous wealth of University knowledge helps her to provide the department faculty, staff and students with sound advice and answers to questions or problems that arise. I heard her tell Gary Bishop that this wasn’t just a job for her but a career she chose.”

The award comes with an honorarium of \$1,000, placement of the honoree’s name on the permanent plaque in the Sitterson lobby, and recognition at the annual Department Awards luncheon.

ALUMNUS RECEIVES INTERNATIONAL RECOGNITION FOR DISSERTATION

Recent UNC alumnus Björn B. Brandenburg (Ph.D. 2011) won the Council of Graduate Schools/ProQuest Distinguished Dissertation Award, one of the nation's most prestigious awards for doctoral dissertations, for his work titled *Scheduling and Locking in Multiprocessor Real-Time Operating Systems*. Brandenburg is only the second UNC graduate to ever receive the CGS/ProQuest Distinguished Dissertation award. This award is given to only two individuals each year who, in the opinion of the award committee, have completed dissertations representing original work that makes an unusually significant contribution to the discipline. Brandenburg's dissertation won overall in a category that includes all of biological sciences, social sciences, mathematics, physical sciences, engineering and computer science.

The European Design and Automation Association Award (EDAA) also awarded Brandenburg with their Outstanding Dissertation Award in the category of New Directions in Embedded System Design and Embedded Software. Brandenburg is the first UNC graduate to ever win this award.

Brandenburg's response to winning these awards was, "Initially, complete disbelief. Also, there's so much great work being done in so many fields, it feels almost unjust to single out any one dissertation. But of course I was quite happy that it happened to be mine."

James Anderson, Professor and Director of Graduate Admissions, served as Brandenburg's doctoral advisor. He was less surprised by Brandenburg's success, especially regarding the award from the embedded systems community.

"Frankly, I would have been surprised if he hadn't won, because I cannot imagine within that field there was a better dissertation that came out at the same time as his."

"Björn's dissertation is a monumental piece of work," said Anderson. "It is filled with novel results that render large portions of existing real-time systems textbooks obsolete. In carrying out his research agenda, Björn was incredibly thorough. His dissertation is over 600 pages, and his experiments resulted in 100,000 graphs of performance data. This degree of thoroughness is so typical of Björn."

Brandenburg's dissertation makes novel contributions to real-time and embedded systems research. Real-time operating systems (RTOS) are the foundation on which dependable, certifiably correct real-time systems are built. In particular, an RTOS controls the execution of tasks such that isolation is ensured (e.g., a fault in the anti-lock brake controller should not spread to the airbag controller), which requires careful scheduling such that all timing constraints are met and predictable locking such that tasks can access shared resources without incurring unpredictable delays. A recent trend affecting RTOSs is the emergence of cheap, low-power multiprocessors, which can execute several tasks in parallel, but current RTOSs are ill-suited to multiprocessors as hardware



Brandenburg receiving the 2013 Council of Graduate Schools / Proquest Distinguished Dissertation Award.

parallelism requires fundamentally new designs. His dissertation addresses questions key to resource allocation for real-time operating systems (RTOSs), a project that allowed Brandenburg to develop a new multicore RTOS called the Linux Testbed for Multiprocessor Scheduling in Real-Time Systems, or LITMUS^{RT}.

If you are interested in learning more about LITMUS^{RT} or would like to try it, you can visit <http://www.litmus-rt.org>.

Brandenburg's dissertation produced 23 publications in top journals, conferences, and workshops related to real-time systems research. Two of these publications were honored with "best paper" awards, and he also won the 2012 UNC Dean's Distinguished Dissertation Award.

Currently, Brandenburg is a tenure-track faculty member and head of the Real-Time Systems Group at the Max Planck Institute for Software Systems.

"At MPI-SWS, I'm still looking into multiprocessor real-time operating systems," Brandenburg said. "But now I am increasingly looking from the point of view of OS design and robustness."

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execution. Most TCGA efforts analyze tumor genomes to identify mutations not found in healthy cells. In other words, they identify errors in the program that appear to be associated with uncontrolled cell growth. In contrast, UNC's project examines the transcriptome (RNA) harvested from tumor samples to understand how execution of the genomic program is changed in tumor cells.

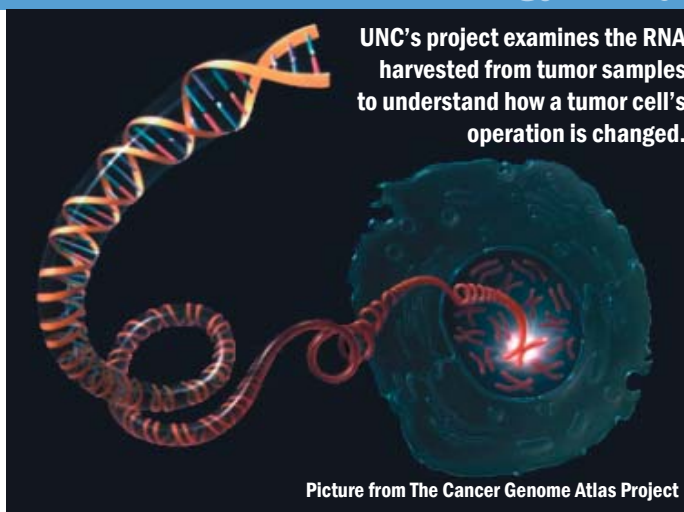
RNA molecules generally degrade quickly within the cell, so RNA transcripts extracted from a cell provide an execution snapshot. RNA transcripts are easily converted back to DNA molecules that are broken into short fragments, which are then sequenced using high-throughput DNA sequence analyzers, a process referred to as RNA-seq. For the TCGA RNA-seq protocol, fragments are around 200 nucleotides in length and 50 nucleotides are simultaneously sequenced from both ends of a fragment. For a given tumor sample, perhaps 100-150 million fragments might be sequenced, producing several hundred million sequences, or reads, of length 50. To obtain insight into transcriptome changes in cancer cells, we need to determine the genomic origin of all the reads and compare the locus and abundance of transcription, either between healthy and tumor cells or between different types of tumors.

Transcriptome analysis has seen intense activity over the past few years as RNA-seq enables unprecedented visibility into the transcriptome. The joint research group, funded by grants from NSF and NIH, has developed MapSplice, FDM, DiffSplice and other methods in daily use by the TCGA project and by other researchers around the world.

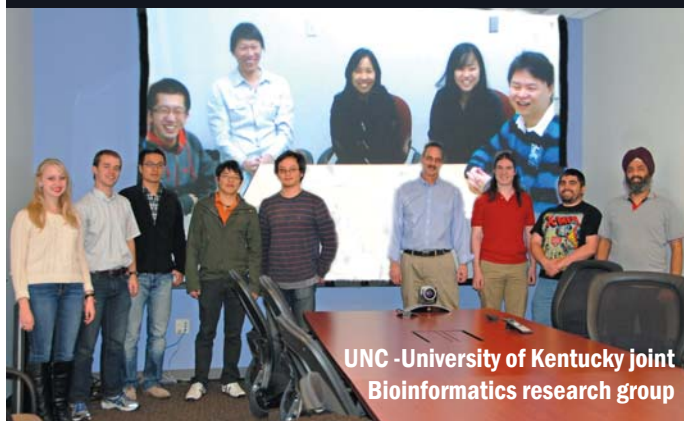
The MapSplice method determines the genomic origin of reads in an RNA-seq dataset. In principle, locating a sequence of length 50 in the 3.2 billion nucleotide reference genome can be accomplished very efficiently. However, the human reference genome will differ from any specific individual's genome in many ways, and the reads themselves may contain sequencing errors, so approximate matching techniques are needed. Second, the human genome is hardly a random sequence – it contains many similar sequences over and over, the result of ancient duplication events and evolution, giving rise to ambiguous matches. The final, and most difficult, challenge is that RNA transcripts may reflect “splicing” in which sections of the transcript are excised to yield the final observed RNA sequence. To identify the genomic origin of such sequences we require an alignment to the reference genome that can include gaps, reflecting splices. Taken together, these complications make it possible to align most any read in multiple ways. Biological cues and constraints can help, but the biggest help comes from the abundance of data itself. We can observe candidate alignments of all reads in the data simultaneously to discover splices and variations from the reference genome that are consistently supported, and use this information to determine the correct genomic origin.

Within the UNC TCGA project MapSplice has identified “gene fusions” that are the result of broken sections of DNA

UNC's project examines the RNA harvested from tumor samples to understand how a tumor cell's operation is changed.



Picture from The Cancer Genome Atlas Project



being re-incorporated in the wrong location. This may happen relatively often genome-wide, but the transcriptome view can detect whether such alterations may affect transcription in genes that control cell proliferation. MapSplice also predicted the presence of “circular RNA” in which splicing aberrations cause a transcript to link back to itself. Circular RNA does not degrade easily, and consequently affects regulation; its association with certain tumor suppressor genes suggests a role in cancer. The FDM and DiffSplice methods compare transcriptomes between samples using algorithms that observe differences in read alignments between RNA-seq datasets. Using FDM and DiffSplice to compare tumor and normal RNA-seq datasets, splicing and abundance changes in the transcription of key tumor suppressor genes were observed as a result of certain mutations in this area of the genome.

Uncovering the method by which specific DNA mutations can lead to uncontrolled cell growth suggests possible ways in which specific tumor cells may be identified and neutralized, as well as possible therapies to offset transcriptional changes. Meanwhile, sequencing technologies are advancing rapidly, promising more detailed insight. However, more data also presents additional challenges. Even with 99.5% alignment accuracy, given 100 million reads, half a million might be aligned incorrectly and could give rise to many incorrect conclusions. So boon or curse – these are interesting times for computer scientists, indeed.

TWO ALUMNI RECEIVE ACADEMY AWARDS IN SPECIAL EFFECTS

Not many computer scientists ever expect to win an Oscar, but this year two UNC alumni received Academy Awards, the film industry's highest honor, for technical achievement in special effects. Theodore Kim (Ph.D 2006) and Lawrence Kesteloot (M.S. 1995) were both part of teams that were recognized on February 9, in Beverly Hills, for their innovative work that has affected the film industry.

Kim and his fellow team members were recognized for their software algorithm known as Wavelet Turbulence, which expands on a former Oscar winning algorithm to generate realistic swirling smoke and fiery explosions on a larger scale and in a way that is easier to create and control. Their work has already been incorporated into more than two dozen movies, including "Avatar," "Sherlock Holmes," "Transformers: Revenge of the Fallen," "Hugo," as well as many others. Kim began

working on the project in 2007 during his post doctoral studies. "We applied and thought we had a shot, but at the same time we couldn't believe when we heard we won," Kim said. He is currently an assistant professor of media arts and technology at the University of California, Santa Barbara.

The other Oscar winning alumnus, Lawrence Kesteloot, worked with two others to create their integral Light system for computer graphics lighting at DreamWorks. Even though the original Light was created over 15 years ago, it is still continuously used because of its emphasis on interactive responsiveness, final-quality interactive render preview, and scalable architecture among other things. Kesteloot worked on



Theodore Kim (left) and Lawrence Kesteloot (right) giving their acceptance speeches at the Academy Awards. Photos courtesy of the Academy of Motion Pictures Arts and Sciences and Greg Harbaugh & Darren Decker/©A.M.P.A.S.

the program very soon after leaving UNC. He described the commitment required by the project, saying, "Working on this program is one of the greatest times of productivity in my career. It was hard work, but I look back on it with fond memories." He is currently working as an engineer at Tasty Labs in the San Francisco Bay Area.

UNDERGRADUATE STUDENTS DEVELOP UNC SPORTSYNC

Have you ever wished you could listen to radio announcers instead of the television commentators while watching a game? Many fans agree that radio play-by-play announcers provide more interesting and knowledgeable commentary for both pro and college sports events. The problem that prevents many fans from doing this is that the radio commentary and the images from the TV do not match, because radio signals almost always run 10-to-30 seconds ahead of TV broadcasts (which must pass through cable, satellite, or HDTV systems).

Three UNC computer science students have solved this problem and created a free way to sync your television and radio commentary. Michael Barlock, Patrick Waivers

and Kartik Sethuraman created UNC SportSync in a software engineering class. In the class, people present ideas for projects and the student groups choose which projects they want to help develop.

"I was naturally drawn to a project involving UNC basketball! I was very excited about creating an application that would benefit lots of people - Tar Heel radio enthusiasts in particular," said Sethuraman, one of the students who developed the project.

"I enjoy listening to radio commentators more because they are more knowledgeable about our team," Sethuraman said. "They cover every single UNC game all season, so naturally they know more about the team than a television commentator

who only covers a couple of Tar Heel games a year would."

Brian White, the information technology director of the computer science department, pitched the original idea for UNC Sportsync. He said that he has used it to listen to every basketball game this season and is very pleased with the final product.

Barlock, Waivers and Sethuraman created a free user-friendly program that could be downloaded through the internet. There are similar products you can buy online, but they cost \$60 or more. So far, UNC Sportsync has been downloaded 700+ times.

The latest version can be downloaded for free on the group's Google Code page. <http://code.google.com/p/sportsync/downloads/list>.



Dear Friends,

I am delighted to tell you that our department is celebrating our 50th anniversary! I'm proud of the students who have come through the program and now represent us as alumni throughout the world. To better connect you with your classmates and the department, we have a number of celebratory activities planned for the upcoming months. Please stay tuned for details.

Events planned so far are:

February 24th, 2014	San Francisco Bay Area Alumni Reception
February 26th, 2014	Seattle Area Alumni Reception
October 18th -19th, 2014	Anniversary Kick-off Weekend
May 2nd-3rd, 2015	50th Anniversary Gala

You are an important part of our department's history and we want to include your personal recollections in our celebration. Please do share your photos and memories of your time here via our 50th Anniversary webpage: <http://www.cs.unc.edu/50th>

We'll update this site as new events and activities are planned.

We look forward to reconnecting with you in the upcoming months. And save those dates so y'all can come.

Warm Regards,

Dr. Fred

Dr. Fred

P.S. We greatly appreciate the ongoing support our alumni community provides. Thank you!



HISTORY OF THE DEPARTMENT - 1962-1970: THE BEGINNING

Next year will mark the 50th anniversary of the Department of Computer Science at Carolina. To honor this tremendous occasion, we are presenting excerpts of the department's creation and growth from Peter Calingaert's personal history published in 1994.

1962

The first steps toward creating a computer science department began in 1962 when the University of North Carolina began looking for a new Computation Center Director. The committee was interested in Dr. Frederick P. Brooks Jr., a Chapel Hill native and Duke University graduate who had also studied at one of the nation's first computer science programs at Harvard. Brooks was not interested in the position, but he was interested in coming to the University. When he came to visit that spring, his lecture "Ten Research Problems in Computer Science," stirred the minds of several key figures at UNC. An assembly of senior professors suggested the creation of a study committee, which recommended the creation of a new academic department within the College of Arts and Sciences. The University offered the position of leading the fledgling department to Brooks, who accepted.

1963

As the head of a new Computer Science Department, Brooks worked closely with Hugh Holman, the Dean of Graduate Studies at UNC, to structure the department. Brooks strongly believed that the department could have the most effect on modernizing the computer culture of North Carolina by concentrating on educating teachers rather than practitioners. He immediately began the lengthy process of getting a Ph.D. program approved.

Brooks' coming full-time to the University of North Carolina was delayed while he stayed with IBM to help manage the System/360 software release effort, a product of which he had been instrumental in the development. The University, IBM and Brooks reached an agreement that he would remain another year at IBM while

spending one week per month in Chapel Hill to help launch the new department. In addition, IBM promised to help the school upgrade their computer system in the future. To teach courses and provide continuity, IBM agreed to dispatch George Cramer, who became the Department's first full-time faculty member.

J. W. ("Bill") Hanson, who had been appointed as director of the Computation Center and lecturer in mathematics, also agreed to help fill in the new department. Brooks, Cramer, Hanson and Sara Elizabeth ("Lib") Moore, the new secretary, set up the department in the tiny but attractive West House.

1964

Thanks to the help of Dean Holman and other UNC departments, who donated some of their own graduate research funding and budget money for a copier, mimeograph and other necessary items, the department was established and ready to go in the summer of 1964.

1965

During the first year, 1964-1965, Cramer and Hanson taught classes while Brooks taught seminar courses in bursts during his visits to Chapel Hill. By the 1965-1966 academic year the Master's Degree program was initiated and Brooks finally came to UNC full-time. While recruiting a faculty and managing a new academic unit, Brooks taught six courses in five subjects with average enrollment of 27, conducted seminars and tutorials, and supervised master's theses.

1966

Cramer returned to IBM, while Erwin Danziger, the newly appointed director of Administrative Data Processing, offered his services. With an academic appointment but no extra compensation, Danziger taught a business data processing laboratory course from 1966 -1985. The staff was also joined by Sylvia Hubbard, who taught programming.

Several significant milestones took place during the 1966-1967 academic year. The first M.S. degrees were awarded to Gail Woodward in December 1966 and to Hung-Ching Tao in May 1967. Akira Nakamura came from

1967



continued to teach in the department even after he became Dean of Library Science. Dick Brewer served the first of his two years as an instructor with a joint appointment in both computer science and the journalism department. Two visiting professors included Tom Gallie from Duke and John Sanderson from the University of Adelaide.

New assistant professor appointments went to Dave Benson, Steve Pizer, and Don Stanat. Pizer, like Brooks, was a Harvard Computation Lab alumnus. At

Harvard and at the Massachusetts General Hospital, he had begun research on processing medical images. Stanat came from the Communication Sciences program at the University of Michigan, where he researched programming paradigms. Benson, whose degree was from Caltech, returned after three years to his beloved Pacific Northwest. The other two remained here, both as full professors. Stanat has retired, but

Pizer is still a professor in the department. He was named a Kenan Professor in 1992.

In 1968 Peter Calingaert joined the department as the second full professor. Demetrius Koubourlis of the Slavic Languages department taught programming courses in the Spring of 1969, 1970 and 1971. In 1969, three more faculty members, Hal Hanes, Gerry Fisher, and Vic Wallace, joined the department. Hanes came from Earlham College as a one-year visitor. Fisher stayed for a year before resigning to go to the Illinois Institute of Technology. Wallace remained at the department for seven years.

Of course, it was not just the faculty that grew. From 1964-1970 student numbers soared. The number of graduate students in the department more than quadrupled from 15 students to 63 students. It would take another 20 years before the number would double from there. The total number of registrations in courses in the department, including thesis and dissertation research, rose from 306 to 1,214.



Above: Fred Brooks teaching a computer science class in 1972.
Left: The West House served as the first home for the department.
Right: West House "Garden Party" meeting for incoming graduate students in 1980.



Nihon University in Tokyo to begin two years as visiting assistant professor. Carl Page, newly minted Ph.D. and father of future Google Co-founder Larry Page, became the first full-time tenure-track appointment (other than Brooks) as an assistant professor. Page only remained at UNC for a year due to significant allergy problems. He left on friendly terms, and Brooks helped him secure a position at Michigan State University. Another important milestone took place in 1967: the Department began to enroll its first Ph.D. student officially and received the first terminal for computer aided instruction (CAI).

During the first decade, the Department used joint appointments to increase its breadth faster than its budget. The first two such appointments, Sally Sedelow with English and Walter Sedelow with Sociology, were the first senior faculty members to join Brooks. Walter Sedelow

1969

1970

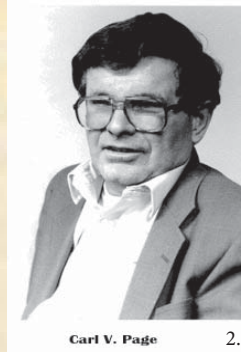
1968

The Founding of the UNC Department of Computer Science

In 1962 Fred Brooks gave the lecture “Ten Research Problems in Computer Science” which got the faculty thinking about creating a new department.



1963 UNC offered Fred Brooks the job of leading their brand new Computer Science Department.



Carl V. Page 2.

Carl Page was the first Assistant Professor in 1965. He held the first tenure-track position after the one Brooks held. Due to severe allergies, Page left UNC after his first year. Fred Brooks helped him secure a new position at Michigan State University, where he spent the rest of his career.

The 1st Home for the Department



In 1964 the department originally set up shop in West House, where it occupied all but the main front room.



Sara Elizabeth “Lib” Moore worked in the department as the first secretary. She stayed in the department for 16 years before moving to another position.

1965 The Masters Degree program was established in 1965.

The first two students to graduate with a Master’s in Computer Science from UNC were Gail Woodward in 1966 and Hung-Ching Tao in 1967.

1966-1967

1969
Paul Oliver was the 1st person to receive a Ph.D. in Computer Science from UNC.

Oliver served as the Computer Center Director, 1968-1970.

After leaving UNC he went on to hold several academic appointments and worked many years as a consultant for Booz Allen Hamilton.



Early research was supported chiefly from grants from **IBM and the Atomic Energy Commission.**

IBM 6.



DEPARTMENT NEWS

WELCOME

New Faculty Appointments

Alex Berg is an Assistant Professor whose research involves computer vision. Prior to joining the department, Alex was on the faculty at Stony Brook University.

Tamara L. Berg is an Assistant Professor working in computer vision. She also joins us from the faculty at Stony Brook University.

Michael J. Fern is the Associate Chairman for Administration, Finance, and Entrepreneurship. Before joining the department, he earned a Ph.D. in Strategic Management from the Kenan-Flagler Business School.

Ashok Krishnamurthy, Deputy Director at RENCI, was appointed an Adjunct Professor in Computer Science in March 2013.

Cynthia Sturton is an Assistant Professor and Peter Thacher Grauer Fellow who specializes in computer and hardware security. Cynthia joined the department after obtaining a Ph.D. from the University of California, Berkeley.

New Staff

Bridgette Cyr joined us as Human Resources/Student Services Assistant in June 2013.

Chase Debnam joined the department in August 2013 as an Accounting Technician. Prior to joining, he worked for UNC-Chapel Hill Disbursement Services.

Megan Erlacher joined the department in May 2013 as a Travel Coordinator from UNC-Chapel Hill Disbursement Services.

Latasha Mingo joined the department in June 2013 as Business Manager. She was previously at Auburn University.

Kristen Palmer joined the department as a Proposal and Outreach Coordinator in January 2013. She works with the Research Support and Communications team.

Brett Piper joined the department in October 2013 as a Communication and Publication Specialist working with the Research Support and Communications team.

Alden Sharpe joined the department as a Faculty Support and Outreach Coordinator in May 2013. She works with the Research Support and Communications team.

Jim Mahaney re-joined the department in February 2013 as a Senior Research Associate.

Jordan Wolf joined the department as Human Resources Manager in August 2013 from the UNC Equal Opportunity Office.

Thanks and Farewell

Donna Boggs, Human Resources Coordinator, retired from the department at the end of July 2013 after 28.5 years of service.

Andrea Bunn, an Accounting Assistant, retired from the department on July 31 after 13.5 years of service to the department (nearly 24 years at UNC).

Katrina Coble, Administrative Manager, retired from the department on June 30, 2013 after 31 years of service.

Kelli Gaskill, the News & Notes editor and Communications Manager, left the department in January 2013 after 10 years of service to study nursing at UNC-Chapel Hill. She will graduate in May 2014 with a nursing degree.

Cory Quammen left the department on November 1, 2013 for a position at Kitware, Inc. Cory received a degree in the department and worked here for three years as a Senior Software Engineer.

Timothy Quigg, Lecturer and Associate Chairman for Administration, Finance, and Entrepreneurship, retired on May 31, 2013 after being with the department for 22 years.

CONGRATULATIONS

Faculty and Staff

Henry Fuchs received the 2013 IEEE Virtual Reality Career Award. For more details see the story on page 2.

Sanjoy Baruah was named one of the IEEE Fellows of 2013. Story available on page 2.

Katrina Coble won the 2012 Catherine G. Perry Staff Excellence award. You can read about the award on page 2.

James Anderson received a Kenan Professorship and was named an ACM Fellow for 2013. See page 3 for a story.

Jan-Michael Frahm and **Marc Niethammer** were elevated to Associate Professors as of January 1, 2014.

Adjunct Professor **Greg Welch** has been named Florida Hospital Endowed Chair in Healthcare Simulation at the University of Central Florida.

2013 SIGGRAPH Awards were given to **Mary Whittom** (Outstanding Service Award) and **Turner Whitted** (Steve Anson Coons Award for Outstanding Creative Contributions to Computer Graphics).

Frederick P. Brooks, Jr. won the 2013 UNC General Alumni Association Faculty Service Award.

Brian White received an IT Award. Read about his award on page 3.

Graduate Students

Ravish Mehra won a Link Foundation Fellowship in Advanced Simulation and Training for 2013-2014. The Link Foundation awards up to five fellowships to qualified doctoral students in academic institutions for research in advanced simulation and training. The grants, totaling \$26,000 each, are to support students while they complete their dissertation research.

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Graduate students **Andrew Maimone, Xubo Yang, Nate Dierk, Andrei State, Mingsong Dou,** and **Henry Fuchs** won Best Short Paper Award at the IEEE Virtual Reality Conference for their paper, “General-Purpose Telepresence with Head-Worn Optical See-Through Displays and Projector-Based Lighting.”

Graduate students **Zhimin Ren, Hengchin Yeh,** and professor **Ming C. Lin** received Honorable Mention for their paper “Auditory Perception of Geometry-Invariant Material Properties” at the IEEE Virtual Reality Conference.

Björn B. Brandenburg received the Council of Graduate Schools/ProQuest Distinguished Dissertation Award for his dissertation “Scheduling and Locking in Multiprocessor Real-Time Operating Systems.” For more details, see page 4.

Graduate student **Vicente Ordonez** and professors **Alex Berg** and **Tamara L. Berg** won the 2013 Marr Prize for Best Paper for their paper “From large scale image categorization to entry-Level categories” at the 14th International Convention on Computer Vision. For more on the 2013 Marr Prize, see page 3.

Undergraduate Students

Preeti Arunapuram, junior computer science major, was the recipient of the 2012-2013 Charles H. Dunham Scholarship. As a part of her scholarship, she will intern at SAS.

Michael J. Guarino, Patrick Lee Waivers, Ian Sang-June Kim, and **Zachary Taylor Cross** were initiated into the Alpha of North Carolina Chapter of Phi Beta Kappa in the Fall of 2012.

Willem Wyndham received the 2013 Stephen F. Weiss Award for Outstanding Achievement in Computer Science.

SPONSORED RESEARCH

Adaptive and Scalable Network Policy Enforcement. PI: Michael Reiter. U.S. Office of Naval Research

Aggregate Formation Under Turbulence: Small-scale Biophysical Interactions Driving Carbon Flux in the Ocean. Co-PI: Leandra Vicci. National Science Foundation

CC-NIE Network Infrastructure: Enabling Data-driven Research. PI: Jay Aikat. National Science Foundation

CGV: Small: Interactive Sound Rendering for Virtual Environments. PI: Ming Lin. National Science Foundation

Clarity Evaluation. PI: Russell Taylor. Molecular Devices LLC

Collaborative Research: CyberSEES: Type 2: A New Framework for Crowd-Sourced Green Infrastructure Design. Co-PI: Jack Snoeyink. National Science Foundation

CPS: Breakthrough: Collaborative Research: Bringing the Multicore Revolution to Safety-Critical Cyber-Physical Systems. PI: James Anderson. National Science Foundation

CSR: Small: Real-time Computing Using GPUs. PI: Sanjoy Baruah, Co-PI: James Anderson. National Science Foundation

Dense Crowd Simulation and Applications. PI: Dinesh Manocha, Co-PI: Ming Lin. The Boeing Corporation

DURIP: High-Performance Clusters for Computational Acoustics and Sound Simulation. PI: Ming Lin, Co-PI: Dinesh Manocha. U.S. Army Research Office

EAGER: Automatic Classification of Programming Difficulties by Mining Programming Events. PI: Prasun Dewan. National Science Foundation

EAGER: Data Association and Exploitation for Large Scale 3-D Modeling from Visual Imagery. PI: Jan-Michael Frahm, Co-PI: Enrique Dunn. National Science Foundation

EAGER: Interactive Reconstruction and Visualization of Metropolitan-Scale Traffic. PI: Ming Lin. National Science Foundation

EAGER: Leveraging 3D Structure Estimates for Photo Collection Based Geo-localization and Semantic Indexing. PI: Jan-Michael Frahm, Co-PI: Enrique Dunn. National Science Foundation

Efficient Tracking, Logging, and Blocking of Accesses to Digital Objects. PI: Fabian Monrose. Department of Homeland Security Advanced Projects Research Agency

GENI in the Classroom: Course Modules for Teaching Networking Concepts. PI: Jay Aikat. Raytheon BBN Technologies Corporation (Prime: National Science Foundation)

HCC: CGV: Small: Eyeglass-Style Multi-Layer Optical See-Through Displays for Augmented Reality. PI: Henry Fuchs. National Science Foundation

II-NEW: A Robot Testbed for Real-time Motion Strategies and Autonomous Personal Assistants. PI: Dinesh Manocha, Co-Inv: Ron Alterovitz, Jan-Michael Frahm, Henry Fuchs, Ming Lin. National Science Foundation

Integration of Endoscopic and CT data for Radiation Therapy Treatment Planning. PI: Julian Rosenman, Co-PI: Stephen Pizer, Ron Alterovitz, Jan-Michael Frahm. NIH National Cancer Institute

Mechanisms of Risk and Resilience in ASD: Ontogeny, Phylogeny and Gene Disruption. PI: Martin Styner, Co-Inv: Marc Niethammer. Emory University (Prime: National Institute of Mental Health)

MRI: Development of Pneumatic Water Wave Genesis: A Versatile Wavemaking Instrument for the UNC Joint Fluids Lab. Co-PI: Leandra Vicci. National Science Foundation

Multi-lumen Steerable Needles for Transoral Access to Lung Nodules. PI: Ron Alterovitz. NIH National Institute of Biomedical Imaging and Bioengineering

NSF Support for the 2014 USENIX Security Symposium. PI: Fabian Monrose. National Science Foundation

Poisson. PI: Dinesh Manocha. Sandia National Laboratory

Privacy on the Line: Next-Generation Defenses for Securing VoIP Communications. PI: Fabian Monrose. U.S. Army Research Office

REU Supplement for UNC GENI. PI: Kevin Jeffay, Co-Inv: Jay Aikat. Raytheon Co. (Prime: National Science Foundation)

Robotic Natural Orifice Skull Base Surgery. PI: Ron Alterovitz. Vanderbilt University (Prime: National Institutes of Health)

SBIR-Approach-Specific, Multi-GPU, Multi-tool, High-realism Neurosurgery Simulation. PI: Dinesh Manocha. Kitware Inc. (Prime: National Institutes of Health)

STTR-Interactive Acoustic Simulation in Urban and Complex Environments (Phase II). PI: Dinesh Manocha. Impulsonic, Inc. (U.S. Army Research Office)

STTR-Image-Based Quantification and Analysis of Longitudinal Lung Nodule Deformations. PI: Marc Niethammer. Kitware, Inc. (Prime: National Institutes of Health)

STTR-Multimodal Image Based Assessment System For Traumatic Brain Injury. PI: Marc Nitethammer. Kitware (Prime: National Institutes of Health)

STTR-Scalable Communication and Scheduling for Many-Core Systems. PI: James Anderson. Real-time Innovations (Prime: Department of Defense)

Travel Subsidies for 2013 CPS PI Meeting. PI: James Anderson. National Science Foundation

TWC SBES: Medium: Collaborative: Crowdsourcing Security. PI: Michael Reiter. National Science Foundation

TWC: Frontier: Collaborative: Rethinking Security in the Era of Cloud Computing. PI: Michael Reiter, Co-PI: Jay Aikat. National Science Foundation

TWC: Small: Toward Pronounceable Authentication Strings. PI: Fabian Monrose.

ALUMNI NEWS

M.S. and Ph.D. Alumni

Francis Roncagli (M.S. 1983) left the software industry to switch careers after over 30 years working for companies like Digital Equipment Corporation, Rockwell Automation and Hyland Software. He completed the requirements of the Doctor of Business Administration degree at Cleveland State University in December 2012. Since August 2011 he has held the position of College Lecturer in the Department of Finance in the Monte Ahuja College of Business at Cleveland State, where he teaches graduate and undergraduate classes in Corporate and International Finance. (Blaise.Roncagli@hyland.com)

IN MEMORIUM

Philip Koltun passed away on Oct. 26, 2012. He earned a Ph. D. in computer science from UNC in 1982. During his career, Phil taught computer science at NC State and Sangamon State (now UI-Springfield), before leaving for an industry job at Harris Corporation in the software operations, where he met his wife and began a family. Phil was always a tremendous UNC Tarheels and Fighting Illini fan.

Thom Haynes (M.S. 1989) started working at Fujifilm Medical Systems USA in June (in RTP, NC) as the User Experience Lead. He owns Usability Guidelines for the division, and the UI Specification for the next version of Synapse, a software PACS radiology solution for workflow, image manipulation and analysis for common modalities such as CT, MR, MG (mammography), etc. (thomhaynes1@gmail.com)

Debu Chatterjee (M.S. 1990) is now Founder and CEO of a Data Analytics startup DxContinuum. The company is actively recruiting additional beta customers. (debu.chatterjee@gmail.com)

Ross Whitaker (M.S. 1991, Ph.D. 1994) was appointed Director of the School of Computing at the University of Utah as of January 1, 2014. (whitaker@cs.utah.edu)

Ronald Azuma (Ph.D. 1995) was invited by the National Academy of Engineering to give a Gilbreth Lecture, covering Augmented Reality. The Gilbreth Lectures are named in honor of Lillian Gilbreth, the first woman elected to the NAE. (ronald.azuma@gmail.com)

Dan Palmer (Ph.D. 1995), professor of Computer Science at John Carroll University (JCU) is on a research sabbatical for the Spring 2013 semester at the Cleveland Clinic Foundation. He and Dr. David Piraino, MD are investigating collaborative diagnosis of digital medical images using algorithmic and social consensus techniques. They are using software developed by JCU undergraduates in a semester-long Software Engineering course. (dpalmer@jcu.edu)

Theodore Kim (Ph.D. 2006) and **Lawrence Kesteloot** (M.S. 1995) were both part of teams that were recognized in February in Beverly Hills, for their innovative computer science work in the film industry. More information is available on page 6.

Paul Yushkevich (Ph. D. 2003) received tenure at the Department of Radiology, University of Pennsylvania. (pauly2@mail.med.upenn.edu)

Doug Hoffman (Ph. D. 1996) has announced his latest book, his first work of science fiction, titled Parker's Folly. The book is available as a paperback and eBook from Amazon.com. Hoffman is living in Conway, Arkansas, working at Acxiom Corporation and teaching at Hendrix College on occasion. (hoffman@dlhoffman.com)

Vicki Interrante (Ph. D. 1996) is serving as the general co-chair for IEEE Virtual Reality 2014 (along with her colleague from UMN Dan Keefe). It will be the third time in three years that a UNC alum has served in the co-chair role for this conference. Last year the conference was chaired by Ben Lok and Greg Welch and the year before it was chaired by Aditi Majumder. (interran@cs.umn.edu)

Greg Coombe (Ph. D. 2007) left Google after six years and joined Matterport. Matterport does 3D scanning of interior spaces for real estate. The company recently closed a funding round of \$5.6 million dollars to create immersive experiences with interior spaces, starting within homes. (greg.coombe@gmail.com)

Marc Macenko (M.S. 2009) graduated from UNC Law School in Spring 2013, passed the NC bar, and started working at a local patent boutique law firm, Withrow & Terranova. (macenko@gmail.com)

Stephen Olivier (Ph.D. 2012) won the Best Student Paper Award at the Supercomputing Conference, the top conference in high performance computing with over 10,000 attendees. Stephen presented the paper "Characterizing and Mitigating Work-Time Inflation in Task Parallel Programs," a part of his dissertation research. Stephen is now a senior member of the technical staff at the Sandia National Laboratories in Albuquerque. (olivier at cs.unc.edu)

Undergraduate Alumni

After 12 years of living in The Netherlands, **Sam Brodtkin** (B.S. 1997) has returned to Silicon Valley for a job at Apple, Inc. as an iOS Engineer. (sam@brodtkin.com)

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Ian Yuan (B.S. 2001) moved to Seattle to complete a pediatric anesthesiology fellowship in 2013. (iyuan02@gmail.com)

Aaron Fulkerson (B.S. 2004), CEO of Mindtouch, announced the launch of the HTC Global Product Help Experience in April. Mindtouch powers the support website, the in call center, in support ticketing and in product (on handset) product knowledge. He wanted to let others know that Mindtouch is hiring. (aaronf@mindtouch.com)

Ryan Niedzialek (B.S. 2005) is now a manager in the Strategic Analytics group at Electronic Arts. (ryan.niedzialek@gmail.com)

FAMILY MATTERS

Eric Burns (Ph. D. 2007) was married on April 6, 2013. (eric.burns@lmco.com)

Amy (Henderson) Squillacote (M.S. 2000) and her husband, Michael, welcomed Rachel Grace in October 2012. (amy.squillacote@gmail.com)

David Gotz (Ph. D. 2005) and his wife Anne welcomed their new child, Adina Ester. She joins big sister, Sarah and big brother, Isaac. (dgotz@us.ibm.com)

Roger Rice (B.S. 1998) and his wife welcomed their new child, Carrington Justice Rice, in May 2013. (roger_rice@unc.edu)

Jeff Terrell (Ph. D. 2009) and his wife Emily welcomed their first child, Henry Nolan, in August 2013. (jeff.terrell@acm.org)

Graduate student **Christian F. Orellana** married his partner of six years, Edward Marlowe, on October 26, 2013 in Biddeford, Maine. (cfo@cs.unc.edu)

Andrew Zaferakis (M.S. 2001) and his wife Zemina welcomed their second child, Jaxon Alexander Zaferakis, in October 2013. (andrew.zaferakis@gmail.com)

Assistant Professor **Ron Alterovitz** and his wife Sheyna welcomed their new son Seth in October 2013. (ron@cs.unc.edu)

Jaime Vega (B.S. 2005) is now a Software Development Manager at Jazz Wireless Data. (jxvega@gmail.com)

Michael Stewart (B.S. 2007) earned an M.S. degree in May 2013 (as well as an Engineering Education graduate certificate and Future Professoriate graduate certificate). He is continuing in VT's Ph.D. program in Human-Computer Interaction and expects to graduate in May of 2016. (tgm@vt.edu)

Friends of the Department

Liyun Yu, postdoctoral fellow with Steve Pizer in 1994-1996, was elected chair for IEEE EMBS ENC Chapter and as a board member and Conference Director for ISSA Raleigh Chapter. Yun has also recently won several photography awards including: PPNC 2nd Place in Commercial Group 2012, PPA International Competition Award 2012, Black White Spider Award Nominee 2012 and Light Space and Time All Photograph Special Recognition, 2012.

RECENT PUBLICATIONS

Antani L., A. Chandak, M. Wilkinson, A. Bassuet, and D. Manocha. "Validation of adaptive rectangular decomposition for three-dimensional wave-based acoustic simulation in architectural models," International Congress on Acoustics, 2013.

Antani L., and D. Manocha "Aural Proxies and Directionally-Varying Reverberation for Interactive Sound Propagation in Virtual Environments" IEEE Virtual Reality, 2013.

Brandenburg, B., and J. Anderson. "The OMLP Family of Optimal Multiprocessor Real-Time Locking Protocols," Design Automation for Embedded Systems, special issue on selected papers from the 2011 ACM International Conference on Embedded Software, 2012.

Curtis, S., B. Zafar, A. Gutub, and D. Manocha. "Right of Way: Asymmetric Agent Interactions in Crowds," The Visual Computer, 2013.

Elliott, G., and J. Anderson, "An Optimal k-Exclusion Real-Time Locking Protocol Motivated by Multi-GPU Systems," Real-Time Systems, Volume 49, Issue 2, pages 140-170, March 2013.

Elliott, G. and J. Anderson. "The Limitations of Fixed-Priority Interrupt Handling in PREEMPT_RT and Alternative Approaches," Proceedings of the 14th Real-Time Linux Workshop, pp. 149-155, October 2012.

Elliott, G., B. Ward, and J. Anderson, "GPUSync: A Framework for Real-Time GPU Management," Proceedings of the 34th IEEE Real-Time Systems Symposium, Vancouver, Canada, IEEE Computer Society Press, December 2013.

Erickson, J., and J. Anderson, "Reducing Tardiness Under Global Scheduling by Splitting Jobs," Proceedings of the 25th Euromicro Conference on Real-Time Systems, Paris, France, IEEE Computer Society Press, pages 14-24, July 2013.

Erickson, J., J. Anderson, and B. Ward, "Fair Lateness Scheduling: Reducing Maximum Lateness in G-EDF-like Scheduling," Real-Time Systems.

Gao Y., S. Liao, and D. Shen. "Prostate Segmentation by Sparse Representation based Classification," Medical Physics 39(10):6372-6387, 2012.

Golas, A., R. Narain, and M. Lin. "Hybrid Long-Range Collision Avoidance for Crowd Simulation," ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games (I3D), 2013.

Guy, S. "Geometric Collision Avoidance for Heterogeneous Crowd Simulation," Ph.D. Dissertation, University of North Carolina at Chapel Hill, 2012.

Haase, J., P. Mishra, A. Stephens, R. Haggerty, C. Quammen, R. Taylor, E. Yeh, M. Basrai, and K. Bloom, "A 3D map of the yeast kinetochore reveals the presence of core and accessory centromere specific histone," Current Biology 23: 1939-1944. 2013.

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Ichnowski, J., and R. Alterovitz, "Parallel Sampling-Based Motion Planning with Superlinear Speedup," in Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Oct. 2012, pp. 1206-1212.

Ilie, A., and G. Welch, "Automated camera selection and control for better training support," in Foundations of Augmented Cognition (D. Schmorrow and C. Fidopiastis, eds.), vol. 8027 of Lecture Notes in Computer Science, pp. 50-59, Springer Berlin Heidelberg, 2013.

- Ilie, A., and G. Welch, "On-line control of active camera networks for computer vision tasks," to appear in *Transactions on Sensor Networks*, tentatively scheduled for vol. 10, no. 2, May 2014.
- Krajcevski, P., A. Lake, and D. Manocha. "FasTC: Accelerated Fixed-Rate Texture Encoding," *ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, 2013.
- Lobaton, E., J. Fu, L. Torres, and R. Alterovitz, "Continuous Shape Estimation of Continuum Robots Using X-ray Images," in *Proc. IEEE/RSJ International Conference on Robotics and Automation (ICRA)*, May 2013, pp. 717-724.
- Liu, C., and J. Anderson, "Supporting Soft Real-Time Parallel Applications on Multiprocessors," *Journal of Systems Architecture*, to appear.
- Liu, C., and J. Anderson, "Suspension-Aware Analysis for Hard Real-Time Multiprocessor Scheduling," *Proceedings of the 25th Euromicro Conference on Real-Time Systems*, Paris, France, IEEE Computer Society Press, pages 271-281, July 2013.
- Liu W., R. Lau, and D. Manocha. "Crowd Simulation Using Discrete Choice Model," *IEEE Virtual Reality (VR)*, pp. 3-6, 2012.
- Lyu I., S. Hyung Kim, J.K. Seong, S. W. Yoo, A. Evans, Y. Shi, M. Sanchez, M. Niethammer, and M. Styner. "Cortical Correspondence via Sulcal Curve-Constrained Spherical Registration with Application to Macaque Studies," *Medical Imaging 2013: Image Processing*, vol. 8669, pp. 86692X-1-7. SPIE (2013).
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- Maimone, A., G. Wetzstein, M. Hirsch, D. Lanman, R. Raskar, and H. Fuchs, 2013. *Focus 3D: Compressive accommodation display*. *ACM Transactions on Graphics* 32, 5. Article 153 (September 2013)
- Maimone, A., X. Yang, N. Dierk, A. State, M. Dou, and H. Fuchs. "General-Purpose Telepresence with Head-Worn Optical See-Through Displays and Projector-Based Lighting," *IEEE Virtual Reality 2013* (Orlando, FL, USA, March 16-23, 2013)
- Mehra R., N. Raghuvanshi, L. Antani, A. Chandak, S. Curtis, and D. Manocha. "Wave-Based Sound Propagation in Large Open Scenes using an Equivalent Source Formulation," *ACM Transactions on Graphics*, 2013.
- Mehra R., N. Raghuvanshi, L. Antani, and D. Manocha. "A Real-Time Sound Propagation System for Noise Prediction in Outdoor Spaces," *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*, vol. 2012, pp. 7026-7035, 2012.
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- Pan, J., I. Sucan, S. Chitta, and D. Manocha. "Real-time Collision Detection and Distance Computation on Point Cloud Sensor Data," *ICRA*, 2013.
- Park, C., J. Pan, and D. Manocha. "Real-time Optimization-based Planning in Dynamic Environments using GPUs," *IEEE International Conference on Robotics and Automation (ICRA)*, 2013.
- Perrin N., O. Stasse, F. Lamiraux, Y. Kim, and D. Manocha. "Real-Time Footstep Planning for Humanoid Robots Among 3D Obstacles Using a Hybrid Bounding Box," *IEEE International Conference on Robotics and Automation (ICRA)*, pp. 977-982, 2012.
- Ren Z., H. Yeh, and M. Lin. "Example-guided Physically Based Modal Sound Synthesis," *ACM Transactions on Graphics*, 2012.
- Snape J., S. Guy, J. van den Berg, and D. Manocha. "Smooth Coordination and Navigation for Multiple Differential-Drive Robots," *Experimental Robotics: The 12th International Symposium (ISER)*, Springer Tracts in Advanced Robotics (STAR), vol. 79, pp. 601-613, 2013.
- Stephens, A., R. Haggerty, P. Vasquez, L. Vicci, C. Snider, F. Shih, C. Quammen, C. Mullins, J. Haase, R. Taylor II, J. Verdaasdonk, M. Falvo, Y. Jin, M. Forest, and K. Bloom, "Pericentric Chromatin Loops Function as a Non-linear Spring in Mitotic Force Balance," *J. Cell Bio.*, 200 (6). pp. 757-772. 2013.
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- Taylor R., and K. Bloom. "Intersecting Art and Computer Graphics," in *Visual Strategies* by Felice Frankel and Angela H. DePace. ISBN 978-0-300-17644-5. pp. 102-107.
- Torres, L., R. Webster III, and R. Alterovitz, "Task-oriented Design of Concentric Tube Robots using Mechanics-based Models," in *Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Oct. 2012, pp. 4449-4455.
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- van den Berg, J., D. Wilkie, S. Guy, M. Niethammer, and D. Manocha. "LQG-Obstacles: Feedback Control with Collision Avoidance for Mobile Robots Under Uncertainty," *IEEE International Conference on Robotics and Automation (ICRA)*, pp. 346-353, 2012.
- Wang C., and D. Manocha. "GPU-based Offset Surface Computation Using Point Samples," *ACM Solid and Physical Modeling*, 2012.
- Ward, B., and J. Anderson, "Fine-Grained Multiprocessor Real-Time Locking with Improved Blocking," *Proceedings of the 21st International Conference on Real-Time Networks and Systems*, Sophia Antipolis, France, ACM Press, pages 67-76, October 2013.
- Ward, B., J. Erickson, and J. Anderson, "A Linear Model for Setting Priority Points in Soft Real-Time Systems," *Proceedings of Real-Time Systems: The Past, the Present, and the Future - A Conference Organized in Celebration of Alan Burns' Sixtieth Birthday*, York, U.K., pages 192-205, March 2013.
- Ward, B., J. Herman, C. Kenna, and J. Anderson, "Making Shared Caches More Predictable on Multicore Platforms," *Proceedings of the 25th Euromicro Conference on Real-Time Systems*, Paris, France, IEEE Computer Society Press, pages 157-167, July 2013.
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News&Notes

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Throughout News & Notes, we list degree information for all our B.S., M.S., and Ph.D. Computer Science and Math Sciences alumni.

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UNC alumnus Ron Azuma spoke on the topic of augmented reality at the The National of Academy of Engineering (NAE) in February 2013 as a part of the Gilbreth Lectures. This picture shows Azuma (middle) receiving a certificate in recognition from Chad Holliday (left), the Chair of NAE, and Maxine Savitz (right), the Vice President of NAE.



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