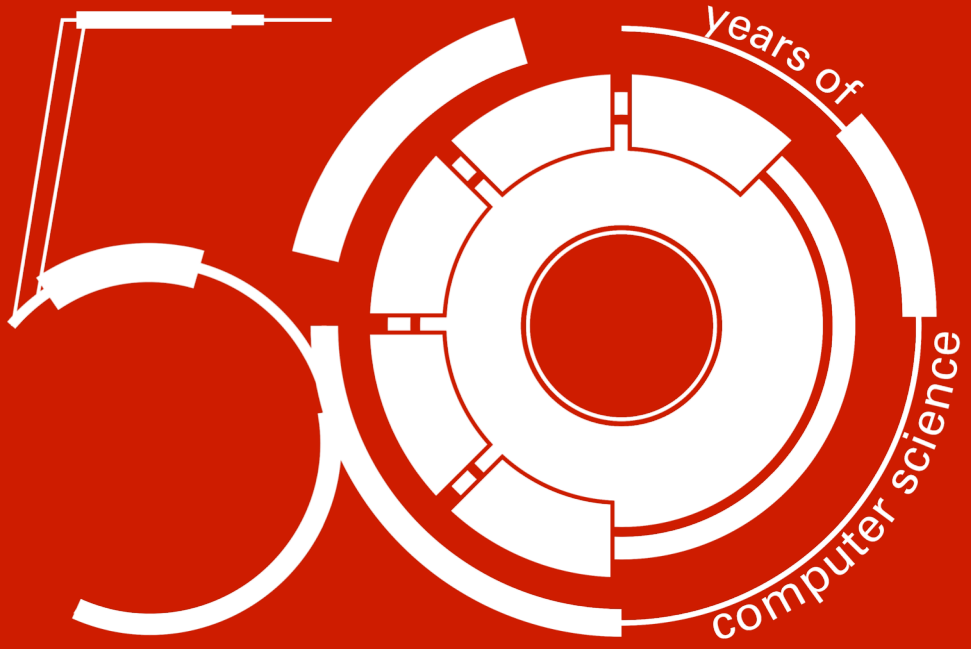
A HISTORY OF THE
NORTH CAROLINA STATE UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE
2007-2017



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Preface

It was November 7, 2016, and we were looking for the Computer Science Corporate & Career Services Suite located in the Computer Science (CSC) wing of Engineering Building 2 (EB2) on Centennial Campus (CC). "We" were Carol Miller, retired Lecturer who taught in the department from 1985 to her retirement in 2009, and Carol Lee, retired technical writer and graphic artist.

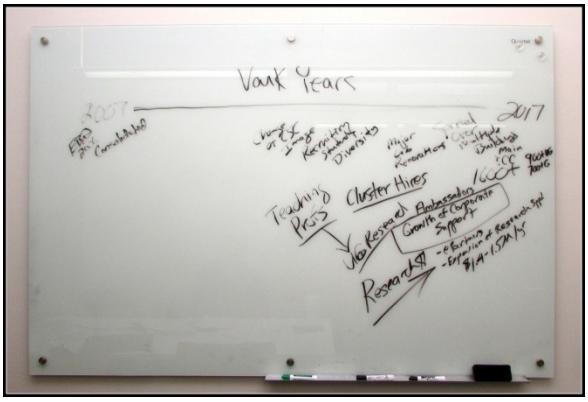
Engineering Building 2 on Centennial Campus
Home of the Computer Science Department

November 7 was the start of our mission to document the history of the Department of Computer Science from 2007-2017. The first 40 years had been documented as part of the 40th Anniversary and we had been hired to bring the history documentation up to date for the 50th Anniversary celebration in the fall of 2017.

When we were asked to document the 2007-2017 history of the department we had no idea where to begin. We knew the history was a story of numbers; growth in enrollments, research dollars, and other data. And we knew there were many research advances reflected by changes in technology and the needs of society. But we also recognized that the history of the department was a story of people, the people in the department who made it all happen. So we decided the history we would document would be the story of the department as told through the numbers *and* through the voices of some of those people who made it happen. We chose to collect voices and memories of a sample of faculty, staff, and students who participated in the decade's events.

In addition to office space, the CCS suite contains two interview rooms. We were ushered to one of the interview rooms and using a digital recorder we began collecting conversations with 12 faculty, staff, and students. We interviewed one at a time, asking a couple of common questions but mostly allowing the conversation to flow so each could tell his or her story of their experience in the department during the decade.

We Find our Space…



Ken Tate Begins the Conversations

We recorded more than 16 hours of interviews over two days on this first visit. We returned Feb. 2 and 3, 2017, and recorded four more hours of interviews. On the second visit, we toured classrooms, the Center for Education Informatics, the Senior Design Lab, and the Hunt Library.

In all we recorded more than 20 hours of interviews. We transcribed all of these interviews and asked the interviewees to review them for accuracy. This collection provides an oral history of the department over the decade; a collection of memories of people who participated in the decade's events. The transcriptions are available online in *Conversations A History of the N. C. State University Department of Computer Science 2007-2017*.

After we transcribed the conversations, we perused them and identified themes. Next, we took the stories we heard, along with numbers and important facts, and wove them into this document.

There was a remarkable consistency running through all the conversations; a sense of pride in the university and the department; a view of how students find opportunities for themselves and how faculty members create these opportunities; a feeling of security on the part of faculty and staff; and, a sense of excitement and energy at all levels.

It was a joy and a pleasure to listen and to compile the history. We hope you enjoy the story.

Carol Miller and Carol Lee

Acknowledgements

We would like to acknowledge the following members of the department who graciously took the time to be interviewed and to review the transcriptions for accuracy. We wish we had had time and energy to talk with all 105 members of the department!

Dennis Bahler, *Associate Professor and Director of Undergraduate Programs*

Lina Battestilli, *Teaching Assistant Professor*

Mark DeMaria, *Undergraduate Student, Park Scholar*

Christopher Healey, *Professor, Department of Computer Science and Goodnight Distinguished Professor, Institute for Advanced Analytics*

Sarah Heckman, *Teaching Associate Professor and Assistant Director of Undergraduate Programs*

Margaret Heil, *Director, Senior Design Center*

James Lester, *Distinguished Professor and Director, Center for Educational Informatics*

Sean Mealin, *Doctoral Student*

Brad Mott, *Senior Research Scientist, Center for Educational Informatics*

Melissa Novitsky, *Undergraduate Student, University Scholar, Science Technology Engineering and Mathematics (STEM) Scholar, President of Women in Computer Science (WiCS), Computer Science Student Ambassador*

Douglas Reeves, *Professor of Computer Science and Electrical and Computer Engineering, Associate Dean for Graduate Programs in the College of Engineering*

George Rouskas, *Professor and Director of Graduate Programs*

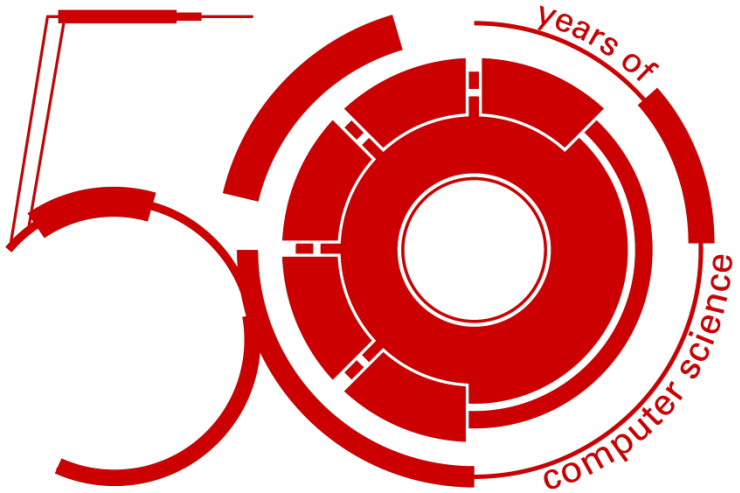
John Streck, *Research Faculty*

Ken Tate, *Director of Engagement and External Relations, Corporate & Alumni Relations*

Mladen Vouk, *Department Head (2004-2016), Distinguished Professor and Associate Vice Chancellor for Research and Development, and Director of the NC State Data Sciences Initiative*

Laurie Williams, *Professor and Interim Department Head*

We also wish to thank **Tammy Coates***, Public Communications Specialist. We think of Tammy as a true First Responder, and we appreciate her prompt response to all our requests for information or photographs.*



A History of the North Carolina State University Department of Computer Science 2007-2017

This fall, 2017, NC State University's Department of Computer Science celebrates its 50th anniversary. From its inception in 1967 until today, the department has grown and prospered to be among the top computer science departments in the nation.

The history of the first four decades was compiled for the 40th anniversary celebration. As planning began for the 50th anniversary, we were commissioned to bring the history up to date. "We" are Carol Miller, a retired Lecturer who taught in the department from 1985 to 2009 and Carol Lee, a writer and graphic artist.

To document the history we chose not to focus exclusively on numbers such as growth in enrollments and research dollars nor on simply cataloguing the accomplishments of the faculty and students, but to share numbers and accomplishments to enhance the history shared by faculty, staff, and students. We interviewed sixteen members the department, recorded their thoughts and experiences, and – best of all – their stories, creating the following history of the past decade.

"Meredith College has a total undergraduate enrollment of 1,679." (2016-2017)

That may seem an unusual way to introduce this document, but the fact is interesting because the 2017 fall enrollment of the computer science department is more than 1650 students. The department's student enrollment is the same as this nearby college, an entire college.

Of these 1650 students, more than 500 are studying to earn a master's degree and 80% of them are from India. Of the 950 undergraduates, only about 100 are from outside North Carolina. As the department celebrates its 50th anniversary, there are now more than 200 PhD candidates doing research.

To run this vast enterprise, the department has moved forward in developing new ways to perform research, deliver education, and organize interdisciplinary work within the university.

A few of the department's more significant advances in the last decade, along with related stories that are shared in this history, are:

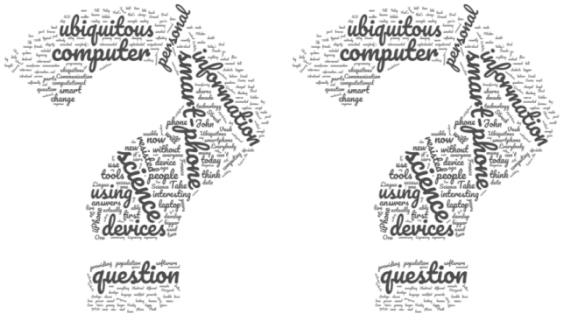
- The department has shifted from a primarily undergraduate education institution to a world-renowned research facility. Departmental research now focuses on artificial intelligence, gaming, security, systems, software engineering, and other exciting areas. This history includes a faculty member explaining his research using artificial intelligence and gaming to develop personalized learning systems for K-12 students, and a graduate student talking of collaborating with FEMA to research equipping and training dogs for disaster rescues.

- The department has moved towards interdisciplinary research and education. The university and the department now organize scholars from multiple disciplines to solve society's problems. We include a story of a professor using social media for wildfire mitigation. This same professor describes various topics he teaches in the study of data analytics ("big data").

- A professional teaching faculty is now in place to focus 100% on designing and delivering quality education to the undergraduates. A member of the teaching faculty shares her story about providing undergraduate research opportunities through "lightning talks." Another teaching faculty member talks about making students aware of how their "mindset" (how they perceive their abilities) affects their performance.

- The department has forged and cultivated relationships with partners outside the university in business, industry, and governmental agencies. These relationships - combined with NC State's proximity to the Research Triangle Park – allow the department to offer students the opportunity for internships, research, and an introduction to potential employers. This sets the department apart from schools that can provide only classroom experiences.

This history documents the story of a remarkable department as told through the numbers, the accomplishments, *and* through the voices of some of those special people who made it happen.



Two Questions

We included two questions for all interviews.

First, we were curious about what personal computing devices were being used today. We were surprised at how consistent the answers were and we think the answers will be very interesting reading at the 100th anniversary.

The second question was, **"What is computer science in 2017?"** Christopher Healey said in his response, **"Computer science is no longer a man, a boy, alone in a room, with no friends, programming a computer."** Perhaps it never was but that is what many of us think of when reflecting on computer science in 1967. All of the answers were different and all were interesting.

Question 1: What personal computing devices do you have?

"I resisted and resisted, and now I can't live without it."

Responses to the first question were very similar. Margaret Heil's comment was typical. "I have a smart phone… I love my smart phone. I resisted and resisted, and now I can't live without it." All of those interviewed had a smartphone. Most had a laptop. And a few had other devices such as tablets or gaming devices.

Dennis Bahler commented, "I teach a course where I hold up an iPhone and tell the students that someday, we will laugh at how crude this device is – but it will happen!" The iPhone made the smartphone a ubiquitous device, and it was announced just a decade ago on January 9, 2007.

John Streck gave us a catchphrase when he declared, "In the past 10 years – the Vouk Years – the ubiquitous communication device is the Smart Phone – without a doubt; as a matter of fact, sometimes to a flaw!" Ever after our conversation with John, the smart phone became The Ubiquitous Communication Device of the Past Decade!

BTW

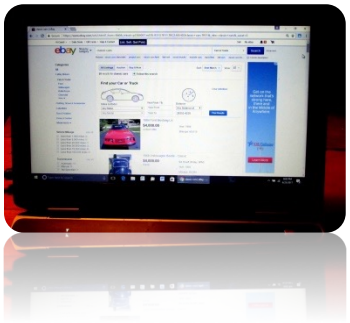
The very famous Ubiquitous Communication Device, the iPhone – was introduced a decade ago – in 2007.

Happy Birthday, iPhone!

Question 2: What is Computer Science Today?

"Everybody is using computers and computers have to be usable by everyone."

Brad Mott shares a story:



> When I was growing up, it was not common to use computers or for people to know that much about computers, but today everybody's life is changed, and modified because we are using computers on a daily basis. I bought my father his first laptop recently for his 69th birthday. I told him you are 69, it is time you had a laptop. My mom has had one for many years, but he is happy to have his own. He uses it to browse classic cars on eBay and to shop for parts for cars he fixes up.
>
> The ubiquity of computers and how they are used in almost every moment of our lives today is a big change and that is causing a change in how we think about computer science and what it means to be a computer scientist. Everybody is using computers and computers have to be usable by everyone. That is changing the way we develop systems. We now have sophisticated software one needs to be able to control, to use, to even program or script. So more and more people are needing to understand computational concepts and computational thinking to survive in today's world.

"Franca Lingua *for Science*"

John Streck shares an interesting idea:

> I would say first that computer science has become the *Franca Lingua* for Science…the language for all science and technology.
>
> Take ECE (Electrical and Computer Engineering), in my humble opinion it's more computer science than it is anything else. Take materials engineering, you're looking at how you evaluate information and data. Take aeronautics, it's now all computerized for doing modeling or simulations. Almost everything you touch – that's all software.

"Using information and providing tools for using that information"

Mladen Vouk was asked, *What do you believe computer science was in 1967 and what it is in 2017?*

> In the beginning computer science was all about transferring information, and it still is. There are actually two parts. One part is using information, and the other is providing tools for using that information.
>
> In the 1960s to 70s we had mainframes. In the late '70's and early '80's we had personal computers. Around 1983-1984 those personal computers were sufficiently widespread and affordable enough that you had an entirely new population of people being able to generate information, use that information, and actually have the need to develop tools to manage that information.

Devices are becoming more personal. Devices and people are more interconnected. Social media, etc., connects a new bigger population seeking information. Each change in technology has enabled new, bigger populations to be in contact with information, to exchange information, etc.

Computer science has *always* been about enabling access to information either as a user or as a person who develops tools to access the data.

Mission and Vision of the Computer Science Department

Mission

We create and disseminate knowledge through research and education in the theory and application of computing, to better the state and nation, and to equip our students to succeed and contribute to society.

Vision

The department will be a leader in computer science education and at the forefront of educational innovation and disseminating new knowledge. Our graduates will be leaders and innovators in industry, education, and government for the state, nation and world. The faculty will be recognized for the quality of their research and will influence the national and international agenda. We will engage in inter-disciplinary pursuits that reinforce the impact of computation in other disciplines. Our outreach activities will fuel economic development and contribute to the health and well-being of society.

-Approved by the Computer Science Faculty, April 2, 2012

The Vouk Years

The organizing principle in the past 40 years of history has been the service of the department head; for example, it begins in 1967 with The Lewis Years. In July 2004, Dr. Mladen Vouk became Interim Head of the Computer Science Department. He became head of the department in July 2006, and he stepped down from that position on Jan. 1, 2017 to become Associate Vice Chancellor for Research Development and Administration. Dr. Vouk led the department for almost the entire decade we are documenting. He was the department's leader and the department's accomplishments and advances for that decade are his legacy.

Dr. Vouk received his B.S. and a Ph.D. in solid state physics from the King's College, University of London, U.K. and an M.S. in computer science from N. C. State. He joined the faculty at N.C. State in 1985. **Currently Dr. Vouk is a Distinguished Professor of Computer Science, Associate Vice Chancellor for Research Development and Administration, and is the Director of the NC State Data Science Initiative.**

Dr. Vouk has extensive experience in both commercial software production and academic computing. He has been referred to as "The Father of VCL" (the Virtual Computing Lab) and he is the author/co-author of more than 300 publications.

Reflections on Dr. Vouk's Years as Department Head

Toward the end of his term as department head, Dr. Vouk was asked how he would like to be remembered. He answered, "We did no evil. We had no scandals. We have a collegial department with strong faculty and a strong student body."

Associates of Dr. Vouk had much more to say about his impact on the growth and development of the department during his 13 years of leadership.

Ken Tate, Director of Engagement and External Affairs, Corporate & Alumni Relations, made these remarks on the occasion of Dr. Vouk's retirement as department head.

> I think history will show that the decade that Mladen guided us as department head will go down as one of our most successful ever. During this period, our research levels have hit all-time highs, we have built the strongest corporate partnership program on campus, and we've hired some incredibly bright and productive faculty.

Key labs and centers have been upgraded, new academic tracks have been launched, and student services have been enhanced significantly. All these things take money, so the success we have achieved during a period of prolonged budget cuts and restrictions is a true statement of Mladen's leadership abilities!

Mladen is a rare leader who can soar at the 50,000 foot level, and then take a deep dive into the weeds when necessary. If he has a fault, it might just be the inability to push back and say 'enough is enough'.

My grandfather always told me, "if you want to get something done, give the job to a busy person!" Well, I think a lot of folks at NC State must have felt that way about Mladen, because I've never known a time when he didn't have three to four different titles and a corresponding number of duties. Despite having so many plates spinning in the air at all times, they never came crashing. Maybe that was because he was up 24/7 making them spin. All I know is that I have never had a leader I've respected and admired any more than Mladen Vouk.

John Streck, Dr.Vouk's long-time associate and research partner had this to say:

…Mladen and Don (Bitzer) are the same way: they're more concerned about the students than themselves. Mladen goes the extra mile. Even as the department head, he does things well beyond what you would ever think a department head would do. He's that much involved. He still has his own graduate students.

Another notable thing about Mladen is that some people double book their calendars – he triple and quadruple books his! And you try to figure out if you're the one who is lucky enough to get to see him but you always eventually do. He somehow violates the time/space continuum! He was very much into not only computer science, but into how we can grow the Centennial Campus – because this is his playground! I've done a lot of projects with him over time 'cause it's fun - and I consider him as the mentor for all computer science.

"The Centennial Campus – this is his playground!"

J.Streck

James Lester, Distinguished Professor and Director of the Center for Educational Informatics, describes the significance of Dr. Vouk's leadership of the Computer Science Department.

In most computer science departments, it would be nearly impossible to be able to work on education research. This department, under Alan Tharp and Mladen Vouk, was very supportive of this kind of research. They allowed this kind of work to blossom here. There are less than a

handful of places like this. This Center is a very nice side effect of his inviting this interdisciplinary work. There are many computer science departments that say they do interdisciplinary work, but this department really does it.

The department now has a really phenomenal research group developed over the last decade with Mladen's leadership. The research expenditures speak for themselves: it is a very clear story and he completely made that happen.

Laurie Williams, Professor and Interim Department Head (effective January 2017) was asked, **"What are some of the things worth remembering - things that weren't here 10 years earlier?"** She replied:

More females in the faculty, major research centers, teaching faculty – this is all part of Mladen's legacy. We have the largest number of female faculty in the country. That's pretty amazing! That didn't happen by accident. Mladen focused on that. And yet there is not a single female faculty here that is 'lesser'. He did not allow us or advocate so that we got lesser faculty. They are all great. They are here. It is important to have these role models for women but also for the diversity of perspective.

Another change is now we have bigger research centers versus ten years ago. We used to have several small groups, maybe two faculty working on something together. Smaller projects, but now we have some big efforts.

In 2009 we hired the first Teaching Faculty. It has been an amazing positive change to the department in every respect. It provides stability for the students and for the faculty. I have some views into other institutions that have the teaching faculty model with feelings of the teaching faculty being lesser. For example, questions of "do the teaching faculty attend faculty meetings, etc..." There is none of that here. They are not second-class citizens.

And Mladen kept us afloat during the difficult days of the financial downturn. We would read in the newspaper about this cut and that cut, but as a faculty we kept going. The department did not lose faculty. He protected the faculty and the department. He created the culture where financing was not a day-to-day concern.

Education

The department will be a leader in computer science education and at the forefront of educational innovation and disseminating new knowledge.

Vision of Computer Science Department

We heard several themes in the interviews that emphasized the department's commitment to this core purpose. Themes included the tremendous growth in enrollment, especially the graduate program, the addition of a professional Teaching Faculty, the hiring of more women faculty, and adding new courses and graduate tracks that reflect the computer science of today.

Conversations with students were quite entertaining and showed that the life of a computer science student is both similar and different from the early days of punched cards and mainframes. We included some of their stories.

Enrollment in 2007 and in 2017

Enrollment over the last decade grew dramatically. The enrollment chart below provides the undergraduate and graduate enrollments for the fall semester 2007 and the anticipated enrollment for fall 2017. Enrollment grew steadily over the decade.

	Fall 2007	In 2017
Undergraduate Enrollment	**586**	**950+**
Graduate Enrollment	**452**	**700+**

The undergraduate enrollment for spring 1968 was 49.

2007

In the fall of 2007, 586 students were enrolled as undergraduate computer science majors. There were five CSC graduate degree programs in 2007 (MSCN, MCS-DE, MCS, MS, and PhD). The total enrollment for all five programs was 452. Of these, 160 were PhD students.

CSC Annual Report Sept-08.

2017

What is the current enrollment (fall 2016)?

> We have more than 950 undergraduates today. Our enrollment has been cyclical with peaks in late 80s and again around 2000. Today we have 700 plus graduate students including more than 200 PhD students.
>
> Dennis Bahler

> We are the **largest computer science graduate program** (PhD and Masters) in the country. This school year (2016-17) we will probably graduate 30 PhDs and about 240 – 250 Master's students. I have to have two bottles of water to call all the names at graduation!
>
> George Rouskas

More than 250 from the Graduate School turned their tassels this year – a two water-bottle ceremony!

Is NC State required to have a certain percentage of undergraduate students from North Carolina?

"We are one of about four states that have a cap on the percentage of out-of-state students we are permitted to admit. The number is 18% and we are nowhere close to that number. We are closer to **12% out-of-state students."**

Dennis Bahler

Most undergraduates are from North Carolina. Tell us about the graduate students.

The graduate program is 85–90 percent international.

By far, the highest numbers of graduate students are Indian, then Chinese. The third highest number is from the United States. The Master's program is made of nearly 80 percent Indian. The PhD program has most students from China and the United States; a few are from Europe and from South America.

Most international students do not go back to their country. They stay here. They know the opportunities are here.

George Rouskas

Graduation Spring 2017

2017 Graduates

The spring 2017 graduating class included **2 Ph.D.**, **140 M.S**., and **114 B.S**. degrees, expanding the department's alumni base to more than **9,000.**

The average starting salary in spring 2017 was **$72,000** for B.S. graduates and **$102,000** for M.S. graduates. The top 3 employers for these graduates were **Amazon, SAS,** and **IBM**.

The Teaching Faculty

We explored educational innovation by asking, "*What is the single biggest innovation in undergraduate education in the department in the last decade?"*

"The teaching faculty. We now have six teaching faculty."

Dennis Bahler

One of the most important changes in the last 10 years is the teaching faculty. That happened in 2009 with the first teaching faculty hire. It has been an amazing positive change to the department in every respect. It provides stability for the students and for the faculty. Everyone so values their attitude and how they prepare the students, how they innovate the curriculum.

Mladen Vouk made the teaching faculty happen.

Laurie Williams

I was the first professional teaching faculty hired in our department with the professorial rank associated with the teaching modifier. The teaching faculty ranks follow the same professional development path of Assistant, Associate, and Full – it just has the teaching modifier associated with it.

In the responsibilities of the standard teaching, research and service the percentages are different. It's very, very high teaching, but there is research and there is service associated with it.

Sarah Heckman

There are six of us teaching faculty. I was the third teaching faculty hired. I love my job. I do believe the teaching faculty has its place here.

I have been teaching four years. That first year was full of mistakes. Four years later with experience I am focused on teaching and on how to make things more understandable. My priorities are all on teaching with focus on CS Education research.

We, the teaching faculty, talk about how to do things better. We share with each other. For example, in our introductory course we are now making the students aware of something called the 'growth mindset.' "Just because you didn't do well on the first test, does that mean you are just not good at computer science?" Growth mindset focuses on the underlying beliefs people have about learning and intelligence. When students believe they can get smarter, they understand that effort makes them stronger.

Lina Battestilli

More Women Faculty

"We are **#1 in number of tenure-track female faculty** among all departments of computer science within colleges of engineering. Counting teaching and tenure-track faculty at all levels, we are almost 35% women."

Dennis Bahler

What other changes do you see in last 10 years here in the department? What are some of the things worth remembering - things that weren't here 10 years earlier?

One is many more women faculty. We have the largest number of female faculty in the country. That didn't happen by accident. Mladen focused on that. And yet there is not a single female faculty here that is 'lesser'. He did not allow us or advocate so that we got lesser faculty. They are all great.

Laurie Williams

The Undergraduate Curriculum

What changes have you seen in courses at the undergraduate level in the last 10 years?

We now have two regular undergraduate security courses, one in computer security and one in network security. Both are senior level electives.

We have an undergraduate course in compilers, a course in social computing, and a course in cloud computing. These are pilots.

We "piggy back" (combined 400 undergraduate and 500 level graduate) courses. For example, we have a data mining course that was piggybacked until it got too large. This also serves as an undergraduate introduction to machine learning. We now have artificial intelligence courses at the undergraduate level. We have database courses, mostly the relational model.

Dennis Bahler

Senior Design Requirement

"Accreditation requires communication and teamwork, so Senior Design is now a required course. There are now multiple sections and a Senior Design Lab."

Margaret Heil

I think what our Senior Design course looks like now reflects what computer science is today. What the department is doing with the Senior Design course is awesome. All schools have capstone courses but ours is unique. What is unique about our capstone? The projects come from industry. The projects are real. The industries throw these problems at us. They say, "Look at these technologies and solve this problem."

I am amazed at the students. They write code, but not from the ground up. The students must figure out how to integrate all these different frameworks. They are given multiple technologies and have to make them work together. They are given a puzzle of technologies and 15 weeks to learn the frameworks and make them work together to solve the problem and complete the project. I think piecing together multiple technologies to solve a problem is the most valuable skill for a computer scientist leaving school today.

Lina Battestilli

One of my roles in the Senior Design experience is to help students form as a team. I coach them on what it means to be a team, how each of them is expected to be proactive leaders and participants in the project, and how each of them is expected to be accountable to their team.

I developed a project management activity by accident in the early years. A team lead by one of our top students came to me asking for help because his team wasn't coming together at all. I sat down with the team and facilitated the identification of system components, how the components interacted, and timelines of related tasks/responsibilities. That team had the most effective process that semester (and the highest quality project)!

Tell us about Posters & Pies.

Posters and Pies is our end-of-semester exposition which is now held over at the Hunt Library because we're too big for here and because it's really nice over there – such a fantastic venue! We have one presenter from each team give a two-minute presentation – that's how we start the show.

You mentioned that you have 29 projects this spring. How many total projects have you had in Senior Design?

Including the spring 2017 class, Senior Design has had **590** project teams (approximately four students per team) since 2001. The program was established in 1994; 2001 was the year we started keeping records.

Margaret Heil

Undergraduate Research

Are there other recent innovations in the undergraduate program?

We now have undergraduate research projects. The students are paired with faculty. Some are Research Experiences for Undergraduates (sponsored as part of National Science Foundation (NSF) grants). Some are paired following "lightning talks" given by faculty. Students can pair with this faculty and work on the professor's research. Then the students give 'elevator talks' on their work. We want to give them the opportunity to be a part of research.

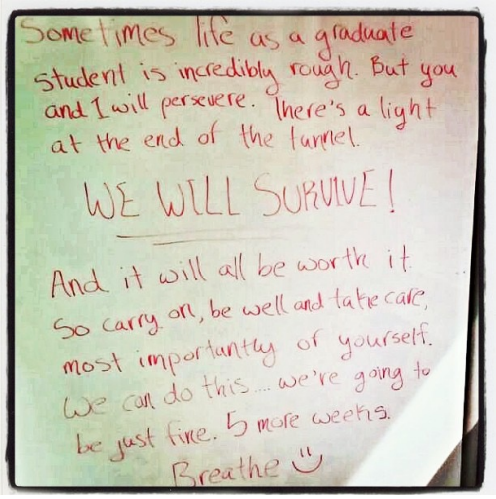
Dennis Bahler

We have 'lightning talks' with each faculty member giving a five-minute presentation about their specific area of research or a project they want an Undergraduate to work on.

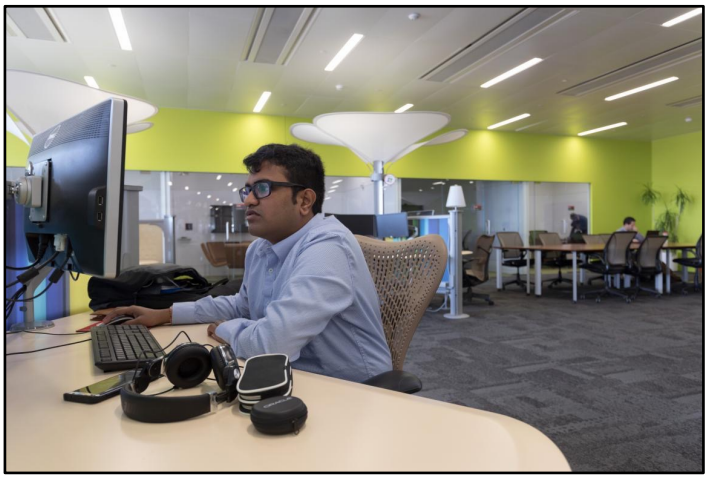
So this is Research speed dating…

Exactly! Sarah Heckman

Graduate Curriculum



Encouragement for graduate students found on a whiteboard at the Hunt Library – from the My#HuntLibrary photo collection.



Graduate students have their own spaces to gather and to study in the Hunt Library. This is the Graduate Student Commons.

Are there new tracks /concentrations within the Master's program?

In the past 10 years, we have added three new tracks, three concentrations: Software Engineering, Security and Data Science. We also have a graduate certificate in data science that started fall 2016. It is a joint program with the Statistics department.

Describe changes to the graduate curricula during the past 10 years.

Many new courses are related to data science and analytics. This has become extremely popular, not just in computer science but in other disciplines.

There are a lot of students who want to take our courses from other disciplines; for example, take gaming courses. North Carolina School of Arts has a film study program. They want to create a joint Master's Program with us. Film studies majors there want to know how to develop the technical part with gaming.

Software Engineering has been very important over last 10 years. The code base has become so large that finding bugs and managing code is very important. Educational Informatics is another major area of the curriculum.

Security started with security of networks and it has now moved to security of devices, specifically, to smart phones. There are many areas of security: malware, privacy, and advanced crypto algorithms.

George Rouskas

The Wolfline transports students around NC State's ever-expanding campus.

Student Stories

Here are some stories from students we interviewed. Some things never change. Some do!

A Day in the Life of a Computer Science Student

I live off campus in a house located four blocks from Centennial. It's my second year there. Would you like me to walk you through a typical day?

- wake up
- skip breakfast (usually) – I recently started drinking coffee because I needed to. I was going to try to get through college without drinking coffee, but I realized that senior year was going to kill me if I didn't!
- get a coffee
- go to class for most of the day
- go home, eat dinner
- work on homework
- occasional free time with friends
- repeat

I'm an interesting case in that most computer science seniors only have computer science classes. I intentionally spread out my electives so that my senior year I was taking about half and half. On Monday/Wednesday/Friday I'm on Centennial doing engineering stuff and Tuesday/Thursday I'm on Main Campus doing design. I'm a design minor – art and design.

Mark DeMaria, Undergraduate and Park Scholar

Undergraduate Life

What is it like to be an undergraduate today? What's your day like?

I now live off campus. My freshman year I lived in the Scholars Village – that was a cool community to be part of.

I wake up at 7:00 a.m. every day because I like to have my classes early and then I drive in, park, sometimes I'll take a bus to Main Campus, have some classes, do some peer projects, and come

back to Centennial Campus or go home for the night.

Are your classes mostly on main campus with a few over here? What kind of mix do you get?

It's mostly on Centennial because I'm in the core of the degree now. There are some elective classes and humanities courses and stuff that are still on Main Campus, but for the most part my classes are over here.

What are you taking?

I just came from Interactive Game Design – that's an elective for us – and it's really fun! We have group projects and we work in Daniels Hall (building on Main Campus). I'm also taking Operating Systems and Network Security. Network Security is my favorite class I've had so far in CSC; I learned how to make a server and a secure chat IM (Instant Message) system for my first project and that's just so cool to me.

Melissa Novitsky, Undergraduate

Finding N. C. State

What attracted you to computer science?

I'm from Cary, NC, and I went to Athens Drive High School. It's just down the road from NC State. My junior year I was taking AP (Advanced Placement) Calculus and my teacher for that course asked me, "Hey, can you join this AP Computer Science class starting for next year because we need more girls to be involved in it? We got a grant from Duke Energy and they needed a certain percentage of females in the classroom."

So I threw him a bone and said, "Okay, I'll try it." I wasn't really looking forward to it. I thought it was going to be really hard and for my senior year I just wanted to relax a little. But I really loved it! It was just so unique and an entirely different experience from anything else I'd taken.

We programmed robots and stuff and just random little things that were really cool and entertaining. And then I decided, "Okay. I don't know what else I'm going to do with my life, so I might as well do something that I can probably have a pretty good future with."

I applied to NC State with the intent of computer science, and I was still kind of unsure about it. Ken Tate emailed me and said, "There's an award you can win if you apply – it's called Aspirations in Computing." So I applied. I did not think I was going to get it – but I won! From there it was just "Okay. I'm going to do computer science" and it's been a great decision so far!

Melissa Novitsky, Undergraduate

The James B. Hunt Library

One of the most visible events of the past decade was the opening of the James B. Hunt Library on Centennial Campus in 2013. This landmark building was met with excitement, anticipation, admiration – and even the usual amount of skepticism generated by innovative design.

The library was designed by Snøhetta, an integrated landscape, interior, and architectural practice based in Oslo and New York that was selected to reconceive and design the famed Library of Alexandria.

Douglas Reeves comments on the Hunt Library:

> It's interesting that you should ask about that. I had a little bit to do with that. For many years I was on the library committee, then I was chair of that committee. When we were in the ramp-up period to get support for designing the library and to talk to all the constituencies about what they wanted, I was chair. The library was Susan Nutter's vision. Her vision was that the library of the future was not a repository for information, but a place for collaboration. And she has made that happen.

NC State has a great web-site for the library (https://www.lib.ncsu.edu/huntlibrary) which includes this part of the Vision:

> A great research library is more than collections, technologies, and comfortable workspaces – a great library inspires. Its architecture and technology create spaces that encourage collaboration, reflection, creativity, and awe. At the core of the vision for the Hunt Library is the ability for our students, faculty, and partners to immerse themselves in interactive computing, multimedia creation, and large-scale visualization—tools that are enabling revolutionary ways to see and use information.

In a real-world application of this vision, undergraduate student Melissa Novitsky shared how she and her fellow students study at Hunt.

For classes like the Network Security class, I have a study group – and every time there's a test we spend seven hours at least in the Hunt Library the weekend before the test.

That's how most of the classes go once you get into the core of your major – you find a group of people who have the same study habits as you and you stick with them, helping each other understand concepts and ideas in your shared classes...and spending the entire weekend with them before the tests.

The Hunt Library has nice rooms and big study areas and we can connect our laptops to big screens so we can all collaborate on things together. We usually use Google Docs to compile notes from the class and then edit them to help each other understand the information better. This has changed the way we study and collaborate.

In our conversation with Christopher Healey, we asked if he had been involved in any of the displays at the Hunt Library. He replied:

The one at the entry, the Micro Tile display, is one that my PhD student is working on. He is working on how one interacts with the display. There is no keyboard, no mouse. But there is a Microsoft Kinect right above it so we are hooked into that and we are using voice and natural gestures as the interface.

Prominently located to catch the eye of everyone entering the library, the Immersion Theater is Hunt's premiere digital exhibit space. This is where Dr. Healey's students work.

The right side of the video wall inside the Theater has a gentle curve, which gives content an immersive quality. Visitors can walk up closely to examine details or have a seat to let the experience soak in. Audio capabilities make this the ideal video wall for communicating with voiceovers and soundtracks.

There is also a Teaching and Visualization Lab at the Hunt Library. It is a black-box room that offers 270-degree immersive projection on three walls. I work in there but it is very popular space and is booked most of the time. Preparing a presentation for that space is very time-consuming. There are 10 projectors so you have 10X the content to design and develop the narrative.

Teaching and Visualization Lab

But where are the books?

On my tour yesterday, I saw the beauty, the quiet, the rooms for students to work together….and the bookBot was saved for last. Carol Lee

"One Word: bookBot."
-The Hunt Library in
The Paris Review

Many articles have been written about the Hunt Library, both here and abroad. In North Carolina's *Our State* magazine, Scott Huler wrote an article called *Raleigh's 50 Foot Librarian: Hunt Library.* Here's how he introduces it:

> When you talk about libraries, you begin with books, right?
>
> So, meet the bookBot, which takes most of the 1.5 million books in the James B. Hunt Jr. Library – the Jetsons-modern building on the main oval of North Carolina State University's Centennial Campus – and buries them. It stuffs the books into metal boxes and stacks those boxes 50 feet high down vast, narrow aisles you can't get to. Think of the enormous warehouse scene at the end of *Raiders of the Lost Ark* and you'll have the idea. If you want the books, you ask a robot to get them for you.

Viewing Area for the bookBots

View of the bookBots at Work

Douglas Reeves adds his thoughts about the bookBot:

> The bookBot was a massive hole in the ground when construction began. The emphasis for the bookBot was a need for space. The space that was affordable (approximately $150 million) was not as much as was required. The answer was to stack the books in a very concentrated way to make space for people.
>
> There is a robot that retrieves the book and brings it back to the patron. The books are randomized. My fantasy is a dead body could be stored in one of those bins. Only the computer would know where it is stored! No one would think about why that bin is never accessed!

And a closing comment from Douglas, "There was one thing Susan Nutter wanted for the library that she didn't get – a bar on rooftop! "

But the students got a beautiful Skyline Terrace!

Research

The faculty will be recognized for the quality of their research and will influence the national and international agenda.

Vision of Computer Science Department

Over the last decade the department has experienced a major shift from a teaching department to a research department. This is arguably the biggest change for the department over the last decade.

Mladen Vouk had this to say:

> For the last 10-15 years we have actively moved from being a teaching department to a research department. And now we are a prominent research department.
>
> If you look at our graduate program, it starts growing a lot around 2000 when we consciously grew enrollment. Today we have more than 700 graduate students including 200 PhD students. We have been consciously growing the research side.

Numbers Tell the Story

Significant (research) digits: 62, 45, 28. The department currently has 62 research faculty including 45 tenure/tenure-track faculty. And the *department* boasts 28 *faculty* who have been awarded the NSF's prestigious *CAREER Awards.*

Mladen remarked, "the research budget has been growing at 7-10% over last 10-15 years". Research expenditures exceeded $8 million in 2007 and doubled to more than $16.5 million in 2017. Active research grants were more than $28 million in 2007 and are more than $64 million in 2017**.**

Research Budget	**$ 8+ Million**	**$16.5+ Million**
Active Research Grants	**$28+ Million**	**$64+ Million**

Growth in CSC Research Dollars

2007 **2017**

This ranks the department in the **top 10** *departments for sponsored research funding among computer science departments in colleges of engineering in the United States.*

Research Direction

The department has faculty doing research in dozens of key areas, many that were just emerging a decade or two ago. Some of these areas can be traced back to the mid/late 90s when Dr. Alan Tharp, then department head, hired faculty doing research in *emerging* areas of computer science. Those areas included human-computer interaction, scientific visualization, networking, gaming, and artificial intelligence. Many of those researchers are now departmental leaders and their work is world-renowned.

The department now has a really phenomenal research group developed over the last decade with Mladen's leadership. The research expenditures speak for themselves: it is a very clear story and he completely made that happen.

James Lester

A change is now (2017) we have bigger research centers versus ten years ago. We used to have several small groups, maybe two faculty working on something together. Smaller projects. But now we have some big efforts.

Laurie Williams

"The big winners in research are games and security."

Mladen Vouk summarized the focus of research areas today:

Software engineering, systems, AI (part of educational informatics, games), and security. For the past 10 years, the big "winners" in research are games and security. More recently we have data science and data analytics. We have been doing it all along but now it has become explicitly highlighted. Networking is another area. The networking degree has been around since 2000. Security used to be a networking exercise – now it is a primarily a data exercise. Theory has been around all the time.

We are prominent in: software engineering, educational informatics, security, and networking. Networking is coming back…the research focus now depends on devices.

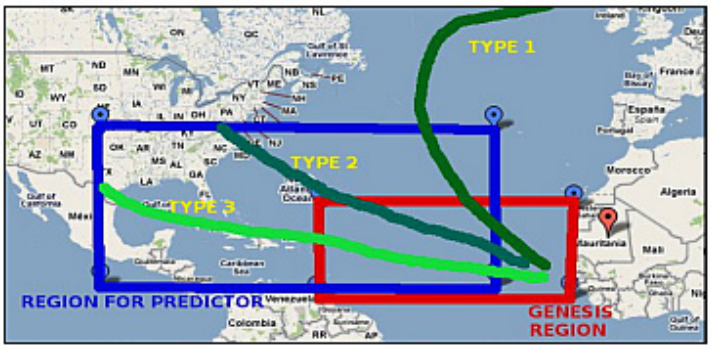
Areas of Research in 2017

Research with impact on health and well-being of society

We thought you would like to read about a few departmental research projects from the 2007-2017 decade that may have impacted your or your family's life.

(The samples below are excerpts from the Computer Science Research publication which is produced each school year.)

> ***Crystal Island*** *is an adventure-style video game. It leverages artificial intelligence and commercial game technologies to create engaging interactive learning experiences. The Crystal Island game* ***targets 8th graders studying microbiology****, and features a science mystery in which the student plays a detective tracking down the source of a disease.*
>
> Computer Science Research 2007-08



Predictions of North American hurricane paths based on spatio-temporal data at the region of origin, off the coast of North Africa.

Researchers from NC State have developed a ***new method for forecasting seasonal hurricane activity*** *that is 15 percent more accurate than previous techniques. Now researchers have developed a model that evaluates historical data for all of the variables--such as temperature and humidity-- in all of the places at all of the times in order to identify those combinations of factors that are most predictive of hurricane activity.*

Computer Science Research 2011-12

> ***Faster Downloads for Smart Phones.*** *Tired of waiting around for your smart phone to play that video? N C State computer scientists have good news. They have developed a new algorithm that significantly reduces data retrieval time for smart phones and tablets.*
>
> Computer Science Research 2012-13

The Laboratory for Analytic Sciences (LAS)

August 15, 2013, NC State News Release by Mick Kulikowski

North Carolina State University Chancellor Randy Woodson today announced a new partnership with the National Security Agency (NSA) to create the Laboratory for Analytic Sciences (LAS) on NC State's Centennial Campus. The lab will bring together some of the brightest minds from government, academia and industry to address the most challenging big-data problems and will be a cornerstone of the emerging advanced data innovation hub at NC State.

From the Laboratory for Analytic Sciences webpage:

The geographic proximity to the "big data" cluster economy in the Research Triangle and a land-grant culture driving faculty to conduct "use-inspired" research across colleges and domains solidified NC State as the ideal host for the LAS.

Conversations about Research

Faculty and students talked about their research in our informal conversations. They provided wonderful insight to the academic research world.

"There is an economic and social need to have people learn better, whether that is K-12 with new assessments and standards, or a captain of a submarine or a general in the army deeply interested in training people to do their jobs."

James Lester talked about changes in personalized learning technologies over the last decade,

> Ten years ago there was very little recognition that learning technologies could do much for anybody. For 50 or 60 years there has been a succession of technologies that people have looked at but, in general, people outside education have not been interested.
>
> In the last five or so years, there have been multiple policy pronouncements by the National Academy of Engineering and by research associations. These research associations are groups of engineers and computer scientists, not education focused. There are grand challenges to deliver personalized learning technologies. There is an economic and a social need to have people learn better, whether that is K-12 with new assessments and standards, or a captain of a submarine or a general in the army deeply interested in training people to do their job, to think effectively and to solve problems. That is very different than it was ten years ago.

Leonardo hangs out at CEI and helps to teach 4th and 5th Graders.

Tell us more about the funding of this research.

Much of our work is supported by National Science Foundation, but within that organization much is supported by the Computer Science Directorate and another segment by the Education Directorate. That is certainly a change.

The Army also supports our work. Private foundations support our work as well. The Gates Foundation, the Hewlett Foundation – all these are very, very interested in how personalized learning and learning analytics and educational data mining can be used to solve large-scale education problems. This is a very positive development. If we were in this same business ten years ago we would have to work much harder to get funding to support our research.

"You can't take it back."

Laurie Williams commented on the importance of security in healthcare:

Healthcare is such an important domain in which to apply security. If you lose your credit card number, you can get a new one. But you can't change your medical history and if there's a breach, there's a breach. You can't take it back. Healthcare is a motivating domain for privacy and security.

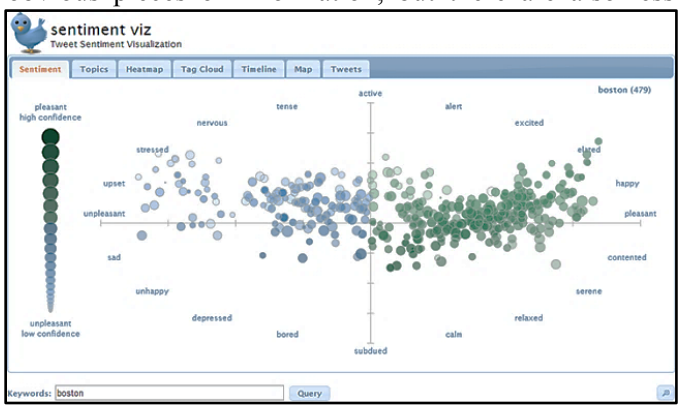
In the last 10 years we have had increased emphasis on security and cyber security. With all that is going on in the world, there is so much more emphasis now than in 2007. I personally feel very motivated because my research is helping our national security. Every day when I am doing the research I know there is a need. I feel a lot of passion around that.

Social Media and Wildfire Mitigation

"Concerns people are really emotional about"

Christopher Healey explained how visualization and analytics can be used to help with wildfire events:

Right now we are looking at risk communication and risk mitigation for wildfire events through social media. During a wildfire event, there are interesting focuses. One focus is the news cycle. In earlier times, people read about news events like wildfires in the newspaper. We now have a 24 hour news cycle and people expect answers to their questions and concerns in an hour. The public information officers (PIOs) need some way of understanding what needs to be communicated every hour. There are obvious pieces of information, but there are also less obvious things. For example, people often want to know which roads are closed. Someone who doesn't live in the area but who passes through the area such as a trucker may need this information.



We use social media, Twitter Visualizations in particular, to study how to do all this. For example, during an event, the PIOs can set up a

hashtag and say tweet to this hashtag if there is something you want to know or there is something that is bothering you. And our tool can capture and visualize all that information in ways that highlight the most frequent concerns and the concerns people are really emotional about. Then the PIOs can focus on the five or six things in the report that are most important to the public.

Election Visualizations Discussed on Election Day 2016

Our interview with Christopher Healey took place on November 8, 2016, Election Day. Below he describes a project developed for the previous presidential election in 2012.

Today is Election Day, 2016. Let's talk about tomorrow morning, those red states, and blue states maps.

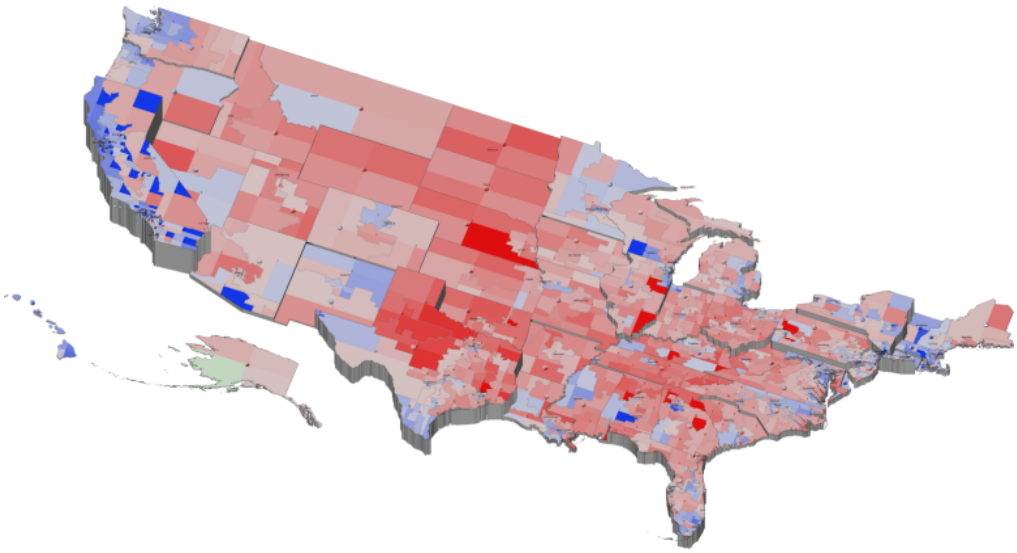
So we run election visualizations. This was initially prompted by an irritation on my part that people always call states red or blue. That is not what a state is. A state is composed of groups of people who vote in very different ways for very different reasons. Red or blue means for some election, for some office, for some geographical area, this party won. The media has standardized on red for Republican and blue for Democrat.

So we wanted to show results for some elections by geographic region and we chose Congressional districts. We chose four elections, Senate, House, President and Governor. We take a Congressional district and split it into four pieces. Each piece corresponds to one of the four elections and it is colored to show how the people voted for that election in that district. We color the piece red, blue or green (for Independent).

So you will take the results of today's election and tomorrow morning you will produce these maps. Who are the clients?

The general public. The election visualizations will be available for the entire country tomorrow on my university website.

District and State-wide Visualizations for all 50 United States
from Dr. Healey's Website – Nov. 8, 2016



Interdisciplinary Scholarship: Centers (with a capital C), clusters (with a lowercase c), and Institutes

We will engage in inter-disciplinary pursuits that reinforce the impact of computation in other disciplines.

Vision of Computer Science Department

Computers are everywhere and they touch everything. NC State and the department have met this challenge with new ways of organizing research and education. Three of these interdisciplinary organizations are Centers, Institutes, and clusters.

To illustrate these concepts, here are descriptions of the Center for Education Informatics, the Institute for Advanced Analytics, and some faculty clusters.

What is a Center (with a capital C)?

James Lester explains the Center for Educational Informatics:

> The mission of the Center for Educational Informatics (CEI) is to design, develop, and investigate next-generation learning technologies. With a focus on personalized learning for K-12 STEM (science, technology, engineering and math) education, CEI creates adaptive learning technologies for classrooms, homes, and museums.

What does it mean to be a Center?
It is an official designation that universities provide for academic units to fulfill some particular mission. So Centers are typically self-supporting. They are different from departments in that they often have special staffs, a collection of research staff that are full time employees. They typically have no teaching responsibilities; they are 100% research.

Is the Center wholly within the College of Engineering?
As Center Director, I report to the Dean of the College of Engineering. We are officially part of the College of Engineering. We have four faculty members and all of these faculty members are in the Computer Science department.

All of our projects have collaborations that are outside of engineering. All of our projects have educational psychologists and curriculum specialists and science education. We

have really tight ties with the College of Design, the College of Education, the Friday Institute, and many organizations outside NC State. Our collaborations are very interdisciplinary. They reflect the needs if you are building an educational technology. You need people included who understand learning and how it works in the classroom.

Institute for Advanced Analytics (IAA)

The Institute for Advanced Analytics is not affiliated with the department but it does share a prominent computer science faculty member, Christopher Healey. Chris explains the IAA for us.

Christopher, your titles, Professor, Department of Computer Science, and Goodnight Distinguished Professor, Institute for Advanced Analytics, indicate that you exist in two worlds at NC State. What is the Institute for Advanced Analytics?

The Institute is a unique organization dedicated to teaching individuals how to master complex methods and tools for large-scale data modeling. The Institute's flagship program is the nation's first Master of Science in Analytics (MSA) degree, an intensive 10-month learning experience with an innovative curriculum. The Institute exists outside any College and reports directly to the Provost. It was founded in 2007, and is located on Centennial Campus. Michael Rappa is the IAA Director.

Within the Institute, I teach visualization and something called visualization tools. I teach text analytics, Python, color theory, Geographic Information Systems, whatever is important for the students to know. The courses we teach provide both foundational theory and practical material. The students see a lot of different topics, maybe 30 to 40.

MSA students also learn about community service and how to dress for that sort of success! Photo from Class of 2017's toy drive for WakeMed.

Students in the Institute always work in teams. They receive communication training and presentation training. We even train them on how to eat at a formal meal. We take them out to dinner and a trainer explains the various forks, how to converse, how to conduct oneself…all this is planning for interviews.

Students are on campus 9-5, five days a week. Dress is business casual or higher. The male-female split is usually close to 50-50, and the vast majority of students are U.S. citizens.

clusters

What in the world is a cluster (lowercase c)?

Chancellor Randy Woodson tells us about this new idea for interdisciplinary innovation:

Society's grand challenges cross the boundaries between academic disciplines. Our faculty clusters program positions NC State to lead the search for solutions.

In 2011, we launched the Chancellor's Faculty Excellence Program (CFEP) to bring together the brightest minds in a range of academic disciplines and give them the support to tackle global issues. Our new faculty clusters are adding more than 75 new faculty members in 20 select fields.

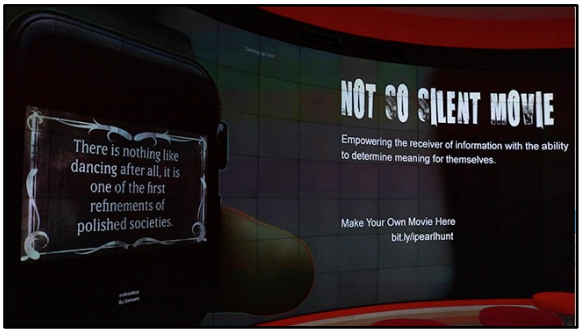
What is cluster hiring? George Rouskas tells us and explains, **"They cross pollinate!"**

When Chancellor Woodson came in he decided to build interdisciplinary faculty groups across departments and even colleges to tackle very challenging problems in society. So he came up with the idea of clusters where all the faculty hired in a cluster will be working on the specific theme or topic of that cluster, but looking at it from different points of view. They cross pollinate. We have about 15 or 20 clusters today and computer science is represented in most of them. Not all but most.

We have the Data Science cluster: It is a collaboration with Statistics and Mathematics, so we have faculty from these three departments. There is a cluster in Forensic Science. It pulls some of our gaming faculty. Clusters are not created top down. The way clusters are formed is that the university solicits proposals from departments. The faculty working with other faculty comes up with proposals. Bottom up vs top down. This is something that started in last 10 years.

And Mladen Vouk explains how, **"This is good for us!"**

Cluster hiring has been going on for the last five years. Cluster faculty is hired because of their interdisciplinary interest; for example, data sciences and gaming. A cluster might have someone from psychology, someone from English, and other disciplines. The way it works is a group of faculty gets together to research a topic. A cluster doesn't have a home in a single department. Cluster hiring was a conscious effort by the provost and the chancellor to inject interdisciplinary research into the university. We have benefitted because computer science has become a supporting science. Everybody needs it. This is good for us!



Showing in May 2017 at the iPearl Immersion theatre - a great example of clusters-in-action. The "Not So Silent Movie" is a collaborative exhibit that combines art, design, and computer science.

Today there are 20 faculty clusters. Here are three clusters with computer science faculty members. The clips are from the Chancellor's Faculty Excellence Program website (https://facultyclusters.ncsu.edu/).

Visual Narrative Cluster

Narrative is a central mode of understanding the world around us. As narrative has expanded into digital media, new possibilities arise for the creation and analysis of powerful visual narratives which increasingly pattern our world. Our work bridges the expertise of engineers, humanists and designers to establish next-generation applications in visual media.

Digital Transformation of Education Cluster

Our cluster represents an interdisciplinary effort to enhance information and communications technologies to support learning in formal and informal settings. Our work addresses issues related to foundational research, classroom practices and educational policy. We extend and advance the university's well-established, highly successful multidisciplinary collaborations involving faculty and students from the Friday Institute for Educational Innovation; the departments of Computer Science, Psychology, and Communications; and the College of Design.

Forensic Sciences

Our work ensures the safety and security of society, civil and criminal justice, and military activities. It provides core capabilities in research, academics, professional training and outreach in the fields of forensic chemistry, forensic evidence analysis, disaster preparedness, forensic human DNA and forensic statistics. We focus on human DNA, evidence standards and disaster preparedness, textile analytical chemistry and statistics.

A Dumpster Inspires a Career in Research

So, how do these fabulous researchers find their way into the field of computer science? Here is James Lester's story:

Wait! You were an undergraduate history major, right?

Yes, I went from history to computer science. I had a series of really awful jobs. I worked at a construction site in Austin (Texas) in the summer in a dumpster. It was over 100 degrees. I was a "classifier" – the construction crew threw pieces of lumber, into the dumpster and I sorted those pieces into those with nails and those without. This was after I had my history major. It was compelling.

But I got lucky! The summer following this experience I took Calculus III, and my teacher was a world famous AI researcher, Woody Bledsoe, who did automatic theorem proving. He was president of the Association for the Advancement of Artificial Intelligence (AAAI). AI was a weird thing at the time. AI was this obscure corner of computer science that most people thought was bogus and had no future. The field had no respect. That was 1986. So now skip forward to 2016. I go to the Bay Area a lot. Now there are billboards begging for employees with AI background.

In March of last year, there was an article in the *New York Times* that describes the incredible opportunity for those with AI background. One stat is that PhDs from really good schools are starting at $1M salary.

When I was a graduate student I spent eight years building a system that would automatically generate natural language stories/essays. And it was all manual engineering. Now the same problem would be solved by just feeding a bunch of stories like you want the system to generate into a machine learning system, and that system generates a story generation model and you apply that model at run time and off it goes. Machine learning is now its own field – same for natural language processing and planning – and robotics – and vision. AI is its own universe!

Opportunities

One theme that ran throughout our conversations was opportunity – both opportunity seized and opportunity created. Students conveyed a strong message of the importance of taking a chance on an opportunity when it presented itself. They discussed the ways in which their professors helped open the way to opportunities in research and education.

"Take the opportunities that come to you."

Melissa Novitsky told us that "seizing the opportunity" resulted in her choosing computer science at NC State. After a calculus class her junior year in high school, Melissa was asked to join a computer science class for her senior year. They needed a certain number of women to qualify for grant funding. That class is what led her to consider NC State and the computer science curriculum. "Take the opportunities that are presented to you…I just did it and it turned into this huge thing with so many opportunities for me. So, I would say **take the opportunities that come to you**!" Melissa had another opportunity she wanted to share – that of working for a North Carolina Congressman – in her words – "third from the Presidency!"

I was approached by the congressman's office over the summer about organizing a hackathon. Congressman David Price's people emailed me and said, "Hey, can you help us out?" and I said, "Okay," so I was in communication with them, got some great contacts in the congressional office, and helped them organize a hackathon.

There is a Congressional App Challenge that happens every year. I think this is the third year. This was the first year they were doing an actual hackathon for it. It's for high school students to just make an app or to encourage some sort of computer science interest in technology. They held an actual hackathon where they had industry professionals come and help out and then taught these high school students how to make an app for mobile phones.

He asked me to give a talk at the opening ceremony so I got to give a talk right after a Congressman. It was crazy! I got an accidental selfie with him. Before the ceremony started I

was just checking my makeup and he was sitting behind me – he hadn't met me officially at that point. I accidentally took a picture and he was drinking something and staring right at the camera. It looked really silly! And that's how I met the congressman!

Then I went to vote at the recent elections and he was on the ballot. First were the Presidential candidates, then the Senatorial, the Congressional. I thought, "I know that guy – third from the Presidency!"

"They made the time."

Sean Mealin tells us how his professors took the time to provide opportunities for him to do research.

The people here made the difference for me – people that were willing to sit down with this high-schooler who didn't know much about computer science. **They made the time**. As I grew and started going through the program, toward my sophomore year, there were professors that were willing to take undergrads into their labs to do research. For a number of years I worked with Suzanne Balik on her dissertation. I was in Suzanne Balik's class and we had to adapt one of the final projects in (CSC)116 to be accessible. We had a very positive experience working together. She said, "Well, I'm working on my dissertation which includes the topic of recruiting blind people to work with diagrams and graphs like flow charts. I've done some work, but I'm starting the final bit of my dissertation. Come work with me as a programmer. That way we have someone who would use the product involved in the product design."

"How do you do that differently?"

After doing that project with Ms. Balik and doing a study on blind software developers with Dr. Emerson Murphy-Hill, he asked, **"**How do you do this? No one has actually looked at how blind people think about software development differently from sighted people." That led to us doing interviews and eventually writing a paper. Once again it was a professor's curiosity and willingness to include an undergraduate which opened that door and eventually I thought, "Well, research is very interesting – I'm finding out new things." So it was Dr. Murphy-Hill saying, "**How do you do that differently**?" that led to that opportunity and eventually led to my traveling to a conference in Austria.

"The Work is Worth Doing"

Sean Mealin and his guide dog Simba are currently doing graduate research with Dr. David Roberts. Sean tells us:

When I received Simba I was between my undergrad and my graduate and at that point I didn't know I was going to be working with dogs as a research topic. I actually was interested in a very different area. Dr. Roberts taught a game class – he's one of the gaming professors – and I thought he was interesting so I kept in touch with him and he found out I was going to get a guide dog. He said, "Oh, I do research with dogs. I'd love to hear your experiences going through guide dog schools since I've never seen that before," so I said "Sure!"

I came back with Simba, chatted with him more, and my very first semester he said, "Well come do some research hours in my lab – do a trial – see if you like it." I said, "Sure, I'll try it 'til I find out if I like something else better," so I got in. I really enjoyed the work, **the work is worth doing** - and I never left!

What Sets Us Apart – Partnerships

Our outreach activities will fuel economic development and contribute to the health and well-being of society.

Computer Science Department Vision

A big thing that sets this department apart and that influenced me to come here is the partnership with companies. There are not that many places in the country or in the world that have such collaborations. Those collaborations change the way we do work. Places that do not have this give students a more theoretical, a more textbook view of the world. Because we have all these companies, these great collaborations, we are set apart.

Laurie Williams

Durham

Chapel Hill

Raleigh

Location, Location, Location

NC State University finds itself in the enviable position of being one of the anchors of the technology-rich Research Triangle Park (RTP). It is bounded by three Tier 1 Universities – NC State University in Raleigh, Duke University in Durham, and the University of North Carolina in Chapel Hill.

This park contains 7,000 acres and now (in 2017) it has a population of 260 companies. RTP is within 10 miles of the NC State Campus, and many of the companies there are research partners with the department. RTP and the surrounding Triangle area provide the top employers of department graduates.

"We also have biopharmaceuticals, education, government, and *finance.*"

Dr. Douglas Reeves, Professor and Associate Dean for Graduate Programs in the College of Engineering

Is our proximity to the Research Triangle Park important?

Absolutely. We have some industry supporters like IBM that have been involved since I have been here and they are here because of the location. The Triangle is still going great guns!

Now we've got another 'leg' (tripod, chair, whatever): Finance. Fifteen years ago I would not have thought about finance. They have very sharp people. Finance for the Triangle is really the back office…not customer service…not the investment segment. Deutsche Bank, Credit Suisse, MetLife, Fidelity and several others are here. The area is substantial. Commercial banking is very technology driven…very advanced. There is a tremendous amount of data processing to determine trends, products, and risk analysis.

So, for us, it is a boon. It means we have the high tech computing industry and communications. We also have biopharmaceuticals, education, government, and finance. The Triangle has a very diverse and very robust economy.

Internships

Companies in the Triangle provide valuable internships for most of the department's undergraduate students.

Melissa Novitsky, Undergraduate, Develops Special Interest in Cybersecurity Through an Internship at Cisco in Research Triangle Park

Melissa tells us how she feels about the importance of cybersecurity:

I would say my specialty is security. I've been working at Cisco, interning there in the Security & Trust Organization. I've been taking the security courses this year. I think the department is trying to make it an official concentration – I'm hoping they are!

Cybersecurity should be at the forefront of everyone's minds, especially developers making new applications and products. Hackers and malicious users are always a step ahead of developers, as soon as a developer announces some way they're creating a project, a hacker will know exactly how to exploit vulnerability. If we could get developers to think about adding in security measures before the products are released, and not as patches afterwards, then society would be much better off.

BTW

The Girl Scouts of the USA agree with Melissa about the importance of cybersecurity! They announced in June, 2017, that they had collaborated with Palo Alto Networks to introduce a series of 18 cybersecurity badges beginning in September 2018. The badges will help Scouts explore opportunities in STEM (science, technology, engineering and math).

Senior Design Collaborations

Lina Battestilli says it best, "All schools have capstone courses but ours is unique. What is unique about our capstone? The projects come from industry. The projects are real."

590 Projects! That is the number of senior design projects that student teams (three-five students per team) have completed since 2001. (We're not positive but we suspect that is more *wins* than any of the NC State athletic teams over the same period.) Each project has a corporate sponsor; most are from the Triangle. More than 100 corporations are represented in those 590 projects.

"A 15-week job interview"

Dennis Bahler, Associate Professor and Director of Undergraduate Programs

This department is the number one source nationwide of new university hires for IBM, Cisco, SAS, and a couple of others. Cisco hires more Masters and Bachelors from NC State than any other single source in the United States. IBM is in the same category.

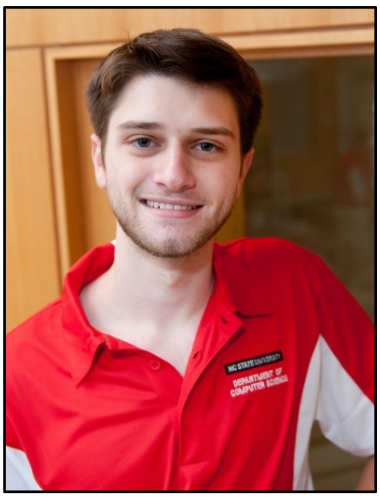
Our senior design experience provides projects funded by industry. The industry will deputize an employee to work with this group of students and this is often essentially a 15-week job interview. They slide right into fulltime employment after graduation.

Build A Bear and More!

Margaret Heil, Director, Senior Design Center

Who are some of the sponsors of Posters and Pies?

> Well, it's all over the board. We have IBM and Allied Telesis (which is here on Centennial), Dell EMC, Bronto, and Bandwidth – they're also here on Centennial. Cisco is in and out. We have Fidelity Investments and a small company called Infusion. Infusion did all the Build-a-Bear stuff. They're a fun sponsor!



Mark DeMaria, Senior and Park Scholar, Does Senior Design Project for Infusion

I'm working on Infusion's Augmented Reality Prototype. (Infusion is the company located in Raleigh who collaborated with Build-a-Bear). Imagine that you can take your phone and point it at any kind of sensor – it could be a pressure valve or temperature sensor – and if you used the camera application, you could put a little data point to tell you what's coming out of that sensor. They wanted us to do it on the HoloLens, Microsoft's new headset, but they only have one so we're doing the prototype on an Android.

"We're talking about Rock Star dogs!"

Many students get opportunities to work with organizations in other locations. Sean tells us about working with the Federal Emergency Management Agency (FEMA) in Virginia.

Sean Mealin, PhD Student, and his guide dog Simba work with FEMA

We've worked with FEMA and their search and rescue teams. There is a lot of interesting work where you outfit the dog with a miniature computer – that's how small computers are nowadays – and sensors. We can monitor the temperature and heart rate and respiration rate of a dog and make sure that the dog is healthy while working, because a lot of those dogs will literally work until they drop.

So you would give them the signal to return?

Exactly! You outfit them for the environment with gas sensors and radiation detectors. Having that available to the handler allows the handler to pull the dog back from dangerous situations when the dog might not be aware of the threat. Then there's the long distance. Since wireless communication is everywhere nowadays and so cheap to implement, you are able to actually have a camera on the dog so the handler can see what the dog is seeing in real time using a phone or a tablet. Sending commands is another aspect of that. We can put small vibrating motors around the dog's harness, very much like the ones you find in a cell phone. The dogs are trained so when one group goes off it goes left and when another group goes off it goes right and when another group goes off, it comes back to the handler – so it's a sort of remote control.

Does the dog need to be trained from birth?

I think any dog in a search and rescue role will be above a minimum level and it would not take them long to learn. That's something we have not studied, how late we can actually train them. But at that point we're talking about **Rock Star dogs** and it wouldn't be hard for them to pick up that very simple training. You use the dog's instincts.

We worked with pre-existing search and rescue dogs on this project. We were invited to one of the FEMA training grounds up in Virginia, which is basically a junkyard, almost where it replicates a disaster area. There are things the dogs can climb in and over and under – and people can hide in the rubble and the dogs will find them.

ePartners

The Computer Science Department describes ePartners as "a program that provides the framework for the global business community and the NC State Department of Computer Science to develop and nurture strong collaborative relationships, as they work toward goals of mutual interest. In recognition of their generous support, ePartners have access to a comprehensive portfolio of benefits, which can be designed and tailored to meet their specific needs."

Ken Tate

In 2001, Dr. Alan Tharp's vision for the ePartners Program was in its infancy. Through strong personal relationships with a handful of alumni, he identified a small number of RTP-based companies interested and willing to partner with the department via small, unrestricted gifts. While the original donations were small, their unrestricted nature provided a much needed and highly flexible funding source, essential to the department maintaining the highest possible educational experience for its students in the face of possible legislative budget cuts in the future. Sensing that the ePartners Program had great long-term potential, he hired me to provide the strategic guidance and grow the program to its full potential.

I was very fortunate to leverage my background as a corporate executive with more than two decades of client and partner relationship management experience at Nortel Networks, to quickly add structure and value-add engagement opportunities to attract new sponsors. Every departmental program, student group, event, activity, and strategic initiative has become a potential sponsorship opportunity. The list of more than 40 unique sponsorship opportunities includes hackathons and competitions like DiamondHacks and HackPack, student groups like the CSC Student Ambassadors and Women in Computer Science, critical events like our Posters & Pies and Year-end Pig Pickin', and strategic initiatives like our Women in Technology 'Lean In' Circles and our Outreach and Broadening Participation efforts.

Since I arrived in 2001, the ePartners Program has experienced exponential growth, now featuring more than 110 affiliates across three distinct recognition levels (Super ePartners, ePartners and Corporate Friends). Partnerships have evolved from small, unrestricted gifts to much larger faculty awards and research support. The cumulative support from the 50+ ePartner and Super ePartner companies now regularly exceeds $1.25M annually, with more than $350,000 annually in completely unrestricted support. And because of the tremendous exposure and active engagement with faculty and students, ePartners have a real advantage when recruiting computer science talent from NC State, with as many as 70% regularly accepting roles with ePartner companies.

The ePartners Program is now widely recognized as the model corporate relations program frequently shared by corporations as the premier "how to" and copied by other departments and universities across the nation.

Following are several examples of how ePartners funding supports the departmental goals. (from the *ePartners in Action* webpage)

New Programs & Initiatives

- Women in Computer Science is a student organization working to help increase the retention rate of women in the computer science discipline.
- WiCS Circles, which are based on the Lean in Circles.
- ePartner funds have allowed us to expand and enhance our outreach efforts, forging bonds with K-12 science and math teachers through active participation with the NC Science Teachers Association.

A new Leadership in Technology Executive Speakers Series was launched in 2007 because of the generous ePartner support from Fidelity Investments.

Keith Collins, NC State Grad, asks "How do you Respond to a Data Tsunami?"

Recruiting Top Faculty

Recruitment support and start-up packages put the department in a position to effectively recruit high quality faculty to strengthen our foundation, provide expertise in new areas, and help assure a quality faculty-student ratio.

Professional Development

Travel funds make it possible for students and faculty to attend conferences and other professional development programs. They also make it possible for award recipients to attend their award ceremonies.

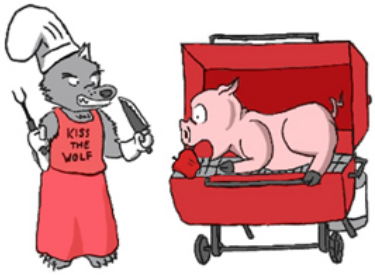
WiCS members enjoy a special moment with IBM's Fran Allen at the Grace Hopper Conference

Dennis Bahler tells about other support from ePartners:

We (the faculty) now have weekly luncheon meetings. Sometimes we have speakers (e.g. someone speaking on accessibility, disability services) and sometimes we don't have agenda but we get together and talk. This has been going on for past four or five years. This is sponsored by industry. We have a lot of support from ePartners.

We recently had to extend the wall space where we recognize them!

ePartners Collaborate with CSC to Host Annual End-of-Year Pig Pickin'



What began in the mid-90s as a departmental end-of-year picnic has become an annual tradition referred to as the Pig Pickin'. This event is planned by students and includes their awards to faculty and staff. The party, in which 400 to 500 people are treated to a picnic, no longer includes only barbeque and fried chicken from Clyde Cooper's, but also features Middle Eastern and vegetarian cuisine from Neomonde. To top it off…NC States Howling Cow Ice Cream.

HOWLING COW™
ICE CREAM FROM NC STATE UNIVERSITY

BTW

For over half a century, generations of North Carolinians have savored NC State's premium ice cream on the campus or at the North Carolina State Fair. Howling Cow is made on campus at the Department of Food, Bioprocessing and Nutrition Science's Feldmeier Dairy Processing Lab in Schaub Hall.

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Dana Lasher was one of three faculty who received a pie in the face from some loving undergraduate students at CSC's annual Pig Pickin'.

Inventing the Future

We are in the midst of coming up with a new vision for the department. The strategic planning committee is working on it. One key word that someone mentioned and everyone jumped on was to make this a *joyful* place for work and for study.

Laurie Williams

In the spring of 2017 Dr. Elizabeth Mynatt (BS CSC 1988) was the keynote speaker for the CSC diploma ceremony. Dr. Mynatt is the Executive Director of Georgia Tech's Institute for People and Technology (IPat), a Distinguished Professor in the College of Computing, and the Director of the Everyday Computing Lab.

Dr. Mynatt expressed her concern that the field of computer science does not have a professional oath as do professions like medicine. She shared an oath based on the tenets of the medical profession's Hippocratic oath and invited the graduates to join her in making this pledge "as a formal recognition of the importance of our field to the wellbeing of society, and our collective responsibility to fulfill our obligations:"

> *Today, I join the ranks of computer scientists worldwide.*
>
> *I will remember that I remain a member of society, with special obligations to all my fellow human beings.*
>
> *I will design and build computing systems that enhance the quality of daily life for individuals and for society.*
>
> *I will protect the dignity of users and others affected by computing systems, respecting the diversity of all cultures, and safeguarding against threats to health and safety.*

I will respect the privacy and rights of all people and recognize the special role I have in judiciously collecting, storing and using their information, and creating systems that aim to shape their behavior.

I will work for fair wages; honorably guarding my reputation and my colleagues in our work practices, while respecting the intellectual contributions of others.

I will improve the public understanding of computing and its consequences.

May I always act so, as to preserve the finest traditions of my field, and may I long experience the joy of inventing the future through my endeavors.

Dr. Mynatt left the graduates with the words of Alan Kay, another pioneer in computer science, who said, "the best way to predict the future is to invent it." She notes, **"It is now on your shoulders to own that amazing opportunity and responsibility. And you have been in the right place to prepare you."**