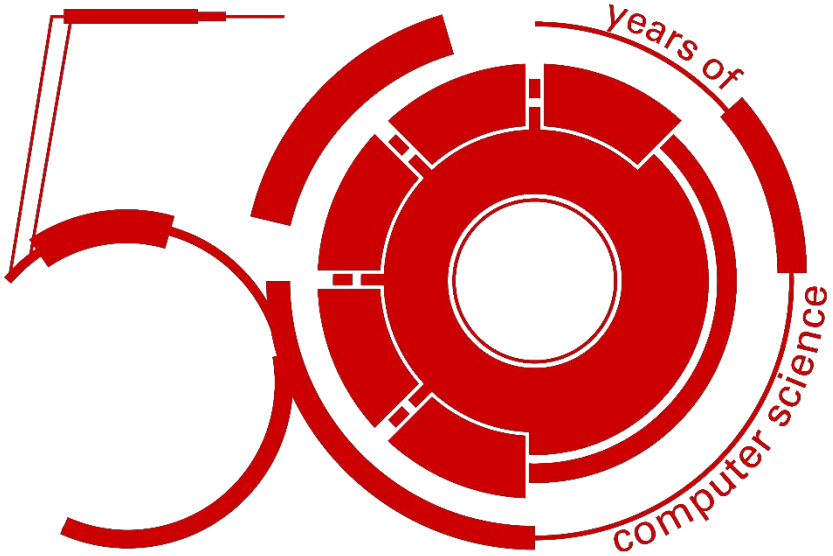


Conversations

A History of the N. C. State University

Department of Computer Science

2007-2017

Interviews by

Carol Lee and Carol Miller

Edited by

Zack Smith

August 1, 2017

Table of Contents

Preface	**2**
Acknowledgements	**4**
Dr. Dennis Bahler, Professor and Director of Undergraduate Programs	**5**
Dr. Lina Battestilli, Teaching Assistant Professor	**9**
Mark DeMaria, Undergraduate Student and Park Scholar	**13**
Dr. Christopher Healey, Professor, Department of Computer Science and Goodnight Distinguished Professor, Institute for Advanced Analytics	**18**
Dr. Sarah Heckman, Teaching Associate Professor and Assistant Director of Undergraduate Programs	**24**
Margaret Heil, Director, Senior Design Center	**31**
Dr. James Lester, Distinguished Professor and Director, Center for Education Informatics	**39**
Dr. Bradford Mott, Senior Research Scientist, Center for Education Informatics	**39**
Sean Mealin, Doctoral Student	**47**
Melissa Novitsky, Undergraduate Student	**54**
Dr. Douglas Reeves, Professor of Computer Science and Electrical and Computer Engineering and Associate Dean for Graduate Programs in the College of Engineering	**61**
Dr. George Rouskas, Professor and Director of Graduate Programs	**66**
Mr. John Streck, Research Faculty	**71**
Ken Tate, Director of Engagement & External Relations, Corporate & Alumni Relations	**77**
Dr. Mladen Vouk, Department Head (2004-2016), Distinguished Professor and Associate Vice Chancellor for Research and Development	**86**
Dr. Laurie Williams, Professor and Interim Department Head	**90**

Preface

It was November 7,2016, and we were looking for the Computer Science Corporate & Career Services Suite located in the CSC wing of Engineering Building 2 (EB2) on the Centennial Campus (CC).

"We" were Carol Miller, retired Lecturer who taught in the department from 1985 until her retirement in 2009, and Carol Lee, retired technical writer and digital artist. 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 were hired to update the history documentation for the 50th Anniversary celebration in the fall of 2017.

When 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. We also knew there were many research advances, reflected by changes in technology and the needs of society. However, we 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 with a digital recorder in hand, 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 that each could tell his or her story of their experience in the department during the decade.

After the first two days on this first visit, we recorded more than 16 hours of interviews. On February 2nd and 3rd, 2017 we returned and recorded four more hours of interviews. The second visit consisted of classroom tours, the Center for Education Informatics, the Senior Design Lab, and Hunt Library.

In the end we recorded more than 20 hours of interviews. We transcribed these interviews, and asked the interviewees to review them for accuracy. This collection provides an oral history of the department over the decade; a compilation of memories of people who participated in the decade's events.

These transcriptions are documented under the same title: "*Conversations: A History of the N. C. State University Department of Computer Science 2007-2017"*.

After transcribing the conversations, we perused them and identified themes. Then, we took the stories we heard along with numbers and important facts, and wove them into a history document.

Here, we saw noticed a remarkable consistency running through every conversation There was 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 stories.

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, *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 Education Informatics*

Sean Mealin, *Doctoral Student*

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

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

Doug 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 & External Relations, Corporate & Alumni Relations*

Mladen Vouk, *Department Head(2004-2016), Distinguished Professor and Associate Vice Chancellor for Research and Development*

Laurie Williams, *Professor and Interim Department Head*

Dr. Dennis Bahler

Professor and Director of Undergraduate Programs
Tuesday, November 8, 2016

Dennis Bahler meets with us today to talk about the undergraduate program. He has been Director of the Undergraduate Program for more than a decade.

Miller/Lee*: Dennis, we have been starting our interviews by talking a bit about the computing technology we currently use. Tell us what personal computing devices you use.*

Dr. Bahler: I have an iPhone (smartphone), an iPad (tablet), and two MacBooks (laptop). At home, I have a smart TV.

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!

Miller/Lee: *What is undergraduate enrollment?*

Dr. Bahler*:* We have more than 950 undergraduates today. We are as selective as politically possible in terms of growing the program. We are not at our all-time peak. We had numbers

around 1,100 at one point. Our enrollment has been cyclical, with peaks in late '80s, and again around 2000.

Today, we have 700-plus graduate students, including 200-plus PhD students.

Miller/Lee: *Is NC State required to have a certain percentage of students from North Carolina?*

Dr. Bahler: 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 percent, and we are nowhere close to that number. We are closer to 12 percent out-of-state students.

Today, there is no major need for students to go out of state for computer science. If you are from Georgia, you have Georgia Tech. If you are from Virginia, you have Virginia Tech. All states have major public universities. There is no particular reason – nor tradition – for students to come to NC State in large numbers from out of state.

Miller/Lee: *Does it make a difference which high school the North Carolina student attended?*

Dr. Bahler: No, that does not seem to matter. It's still not the case that very many high schools in North Carolina offer computer science courses, as distinct from math.

Our students are very employable by about the end of sophomore year. We have services online, resume matching, for students to find jobs. It's a miniature version of the placement office just for our students.

The last time I looked, we had more than 200 job descriptions waiting for students to apply. There is a huge demand for the students, with jobs available on campus and off. There is an even more elaborate placement service for mostly graduate students. We have hired a placement coordinator, and renovated part of the ground floor of our building.

Miller/Lee: *Is the community college system now more "pre-college?"*

Dr. Bahler: Yes. The College of Engineering has a written strategic plan to grow enrollment from now to 2020, mostly through transfers from the 58 community colleges. We have a long list of articulation agreements – this course at the community college matches with this course here, etc.

Miller/Lee**:** *What is our retention rate?*

Dr. Bahler: For computer science, many of our students have internships, so students graduate after five or six years instead of four. A lot of our students are not high-wealth, and need to work their way through the program.

There are 30,000 high-tech jobs in Research Triangle Park these days. The engineering career fair attracts hundreds of employers and thousands of students. Many of the students are from other campuses. The fair is two days at McKimmon Center, and attracts students in computer science and computer engineering from a large region as far away as southern Virginia.

And twice a year, computer science and ECE have their own career fairs.

Miller/Lee: *Who are the major employers for our Bachelors students?*

Dr. Bahler: This department is the number-one source nationwide of new university hires for IBM, Cisco, SAS, and sometimes for a couple 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.

Miller/Lee: *What changes have you seen in courses at the undergraduate level in the last 10 years?*

Dr. Bahler: We now have two regular undergraduate security courses – one in computer security, and one in network security. Both are 400-level electives.

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

New faculty creates one new course, presumably in his/her area of expertise. For example, we have a new security faculty who is a cryptologist.

We "piggy back" combined 400 and 500-level 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. And we now have an introduction to data science taught jointly with Statistics.

I am on a task force to explore creating an interdisciplinary undergraduate track or minor in data science.

Miller/Lee: *Do you see the students in last decade any differently from previous years?*

Dr. Bahler: It is basically the same – drawn from the same population. There are a few high schools with computer science AP credit courses, but very few.

Miller/Lee: *Do undergraduates take humanities courses?*

Dr. Bahler: Yes, they are referred to as General Education Requirements. In addition, all freshmen in engineering take a course in academic writing and research. CSC also requires a 300-level course in technical writing.

Our curriculum requires 21 semester hours of general education apart from major requirements. We offer a 200-level course that serves as a as a general education requirement. It is a non-technical course in gaming.

Miller/Lee: *Do students experience writing and speaking in undergraduate computer science courses?*

Dr. Bahler: Yes, the senior design course gives all students writing and speaking experience. Our senior design experience provides speaking experience, especially evaluative experience.

Miller/Lee: *What is the single biggest innovation in undergraduate education in the last decade?*

Dr. Bahler*:* The teaching faculty. We now have six teaching faculty and four lecturers. Of the six teaching faculty, four are women and of the four lecturers, three are women. The department has received national recognition for the proportion of women in the faculty. We are first 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 percent women.

The teaching faculty members each teach three courses a semester, and it works out very well. We do not expect research, though some do research.

All courses have a course coordinator. We have meetings periodically to align 116 (Introduction to Computing – Java) /216 (Computing Concepts) /226 (Discrete Math)/316 (Data Structures). We have a spiral design, so we deliberately expose students to the same topics over and over again in increasing depth.

Miller/Lee: *The faculty seems very collegial and very devoted to the students. And we have heard over and over how everyone is trying to make things better for the students.*

Dr. Bahler: This is true. Not all departments of computer science are like this.

Before we moved into EB II, we had offices in roughly ten buildings on two campuses. In addition to EB II now, we have outposts in Monteith, EB III, the Venture complex, and a couple other places, in addition to the lower-division undergraduate teaching that is still on Historic Campus in Daniels Hall.

We now have weekly luncheon meetings. Sometimes we have speakers – e.g. someone speaking on accessibility, disability services – and sometimes we don't have an 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.

Miller/Lee: *Any other recent innovations in the undergraduate program?*

Dr. Bahler*:* We now have undergraduate research projects. The students are paired with faculty. Some are Research Experiences for Undergraduates, sponsored as part of 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.

Miller/Lee*: Speed dating for research!*

Dr. Bahler: We want to give them the opportunity to be a part of research. We are encouraging them to attend seminars.

Miller/Lee*: We have heard students say, "Take the opportunity and see where it leads." It is great to hear about their opportunities from the students and to hear the enthusiasm of the faculty for providing these opportunities!*

Dr. Lina Battestilli

Teaching Assistant Professor
Tuesday, November 8, 2016

Lina Battestilli joins us to discuss the work of the professional teaching faculty in the department. The teaching faculty was created in 2009 and currently has six faculty members. Lina is an award-winning member of that faculty.

Miller/Lee: *Lina, tell us about the last ten years in the department. What do you teach?*

Dr. Battestilli: I teach a large-service course, Introduction to Computing MATLAB. My students are not computer science majors. The course number is CSC113, and it covers the same concepts as CSC116 (Introduction to Computing Java) but is not object-oriented. It is more (based in) engineering topics. Students learn problem solving through writing MATLAB programs.

I also teach CSC116 Java and CSC401 Networking elective course and am a technical advisor for Senior Design.

Miller/Lee: *How did you come to the department?*

Dr. Battestilli: I came here for grad school. I was attracted by the networking program. I did not have my undergraduate degree in computer science. Actually, my degree was electrical engineering. I was in Michigan, and decided I had more school in me. So, I did a search, and was attracted to the NC State Master's program, because it had a networking focus.

Around 2000, networking was a major research area, a big deal. NC State was innovative in having a Master's degree with a focus, a concentration in networking. And I was interested in studying that component of computer science.

I received a Teaching Assistantship, and I worked on my Master's, then I started working with Dr. Perros. The problem I worked on led me to stay on for my PhD with Dr. Perros.

Then I went on to industry. About this time my first child was born, and I did not want to do all that was required in doing a true faculty search, finding a faculty position, and doing the tenure track. And I did not want to move away. My husband encouraged me to "do something. Don't give up everything you have worked for."

So, I stayed in the area and began doing research work. I worked at MCNC, a technology non-profit in Research Triangle Park. I worked for NCREN (North Carolina Research and Education Network), a network system connecting public universities in a network that then goes out to the Internet. I worked in a research group.

Then I went to IBM research. I was able to work remotely, part-time while my children were little. While there, I ended up co-teaching Dr. Vouk's cloud-computing class. The class used VCL, Virtual Computing Lab, and an NC State University cloud system. Today we have Amazon Cloud, Google Cloud, Azure Cloud but VCL is a university – grown system.

NC State was very innovative with this system. Dr. Vouk was the main instructor for the cloud computing class, and John Streck and I were technical advisors to the student teams.

I had my IBM experience, but I really wanted to come back to the university. Then I heard from Dr. Perros about the new teaching faculty positions. There are six of us teaching faculty. I was the third teaching faculty hired. Sarah was the first, and I talked with her before deciding if I wanted the position. Sarah was carrying the flag. She was proud and excited to say, "I am a teaching professor."

I like teaching. I love my job. And 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.

I now know what technology is there to help me teach better. My priorities are all on teaching with focus on CS Education research, which is very different from faculty who are writing grants and doing research.

The core classes are mostly covered by teaching professors. Once you teach a class three or four times, that is when you get comfortable with the class. Here we have continuity. I have been teaching CSC116 several years, and I am getting better at that.

There is talk about having PhD students teach the course, and I have mixed feelings about that. Not everyone can teach effectively. I teach the same courses from year to year.

I think having the teaching faculty is a smart thing for the department to do. The faculty is a nice group of people. We talk about how to do things better. We share with each other – "Have you heard of this? Have you heard of that?" We share.

Miller/Lee*: Do you have other duties?*

Dr. Battestilli*:* Broadening participation by women is a flag I have been carrying since I came to the faculty. I am advisor for the Women in Computer Science (WiCS). We have a very active chapter.

I have been an advisor for three years. I believe there is still a lot that can be done on the problem of getting/maintaining more women in computing. The problem is big. We are communicating to figure out how to not lose any woman who has an interest in computer science.

We have broadening participation videos in CSC116. STEMBright is the company that created these five modules. The videos enhance success for under-represented college students in computer science. The modules are done outside class.

The modules are short (6-7 minutes) and we deliver them to the students on a timeline. For example, after Test 1, when they get their first B or C or they don't understand everything at once, they panic.

We ask, "Do you know what 'growth mindset' is? Just because you didn't do well on 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.

We hear positive messages. We are reaching exactly the students we have targeted.

We are still pretty low in women undergrads. Biomedical Engineering is at 50 percent. They have a way of marketing themselves a little bit better.

I wish I had more time to focus on this problem.

We are now looking at CSC216, Programming Concepts Java, so the transition from CSC116 is not such a steep learning experience.

(Students tell us) "We don't see many 'classes' in 116, then in 216 we are expected to use this complex framework that uses classes." So, we – teachers – are exploring ways to bring some of the tools into CSC116.

I have suggested adding a CSC 0 course on computer science principles. There are barriers with the number of courses, who is going to teach them, etc., but I think it is necessary. You come into CSC116, and you are overwhelmed by the syntax of Java.

It is a problem to focus on the problems. For example, sort a deck of cards. How do you do it? It is a puzzle…how do you do it? Forget the syntax.

Miller/Lee: *What personal computing devices do you have?*

Dr. Battestilli: I love (my) laptop. It is also a tablet. It has a touch screen, so when I am teaching I can write on the slides as they are projected. This is great for my teaching. I use Windows and Power Point.

I also have a smartphone. I was hesitant to switch from the flip phone. Back in 2009, I got my first smartphone. But after one week into that, I couldn't live without it.

Miller/Lee: *What is computer science today?*

Dr. Battestilli: 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. I joined the faculty involved in Senior Design last semester. The course is led by Margaret Heil. I am a technical advisor in one section.

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."

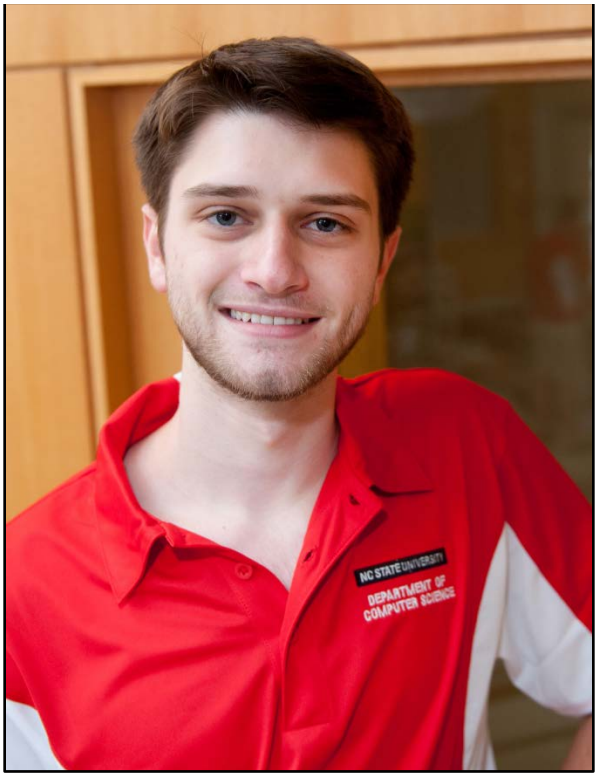
I am amazed at the students. They write code, but not from the ground up. The students must figure out how to integrate all these different frameworks. They are given multiple technologies, and have to make them work together. They are given a puzzle of technologies, and 15 weeks to learn the frameworks and make them work together to solve the problem and complete the project.

I think piecing together multiple technologies to solve problem is the most valuable skill for a computer scientist leaving school today.

I am super impressed with student performance. There is a strong emphasis on software engineering in this department that is sometimes painful for the students. But you can see they are not afraid of code. They can write good code!

We don't teach them any of the technologies they have to use. I look over their shoulders, monitor their progress, work with them to ask the right questions from their sponsors, and suggest technologies for them to research, but the students figure out the details. It is their project; they do it themselves.

For some of the students, jobs come from their projects. The industry throws these technologies at the students, and they figure them out. Computer science today is taking a puzzle of technologies and frameworks and solving problems.



Mark DeMaria
Undergraduate Student
Park Scholar
Monday, November 7, 2016

Miller/Lee: *Welcome, Mark. We are so happy to meet with you today, and learn more about the life of an undergraduate computer science major. Tell us a bit about yourself. What class are you in?*

DeMaria: I'm a senior.

Miller/Lee: *What's your Senior Design Project?*

DeMaria: I'm working on Infusion's Augmented Reality Prototype. 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, so they can decide if it's worth investing engineering resources in doing it on the HoloLens.

Miller/Lee: *What's on the Android? Is it visualization of the information coming from the sensor?*

DeMaria: The sensor is connected to a Raspberry Pi, which sends data to a database server, and we have a QR code for that sensor. And the Unity/Android application will look at the QR code, know what device it is, and ask the database to give it that data.

Miller/Lee: *What is an example of a real-world application? What kind of sensors?*

DeMaria: They imagined it being used in research labs and on factory floors where there's lot of machinery, so that's pretty wide-open.

Miller/Lee: *Who is on your team?*

DeMaria: There are four people including myself, all seniors. Two are graduating this semester and the other two in the spring – all very talented, all very hard-working.

Miller/Lee: *What do you like most about the course?*

DeMaria: Getting to do a project.

Miller/Lee: *What do you like least about the course?*

DeMaria: The paperwork – there's so much paperwork!

Miller/Lee: *What's your day like? Where do you live? We're curious about what it's like to be an undergrad right now.*

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

Miller/Lee: *Yes, please.*

DeMaria:

- Wake up;
- Usually skip breakfast – 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 the Main Campus doing design. I'm a design minor – art and design.

Miller/Lee: *In the School of Design?*

DeMaria: Yes – that keeps me sane! It's nice to keep in touch with the other side of my brain. I'm an independent filmmaker and photographer. My mom was a graphic designer, so she passed her genes on to me.

When I was deciding on what I wanted to do for college, I knew that I wanted to do something practical – something (with) engineering because I wanted to have financial stability, and I wanted to have a tool set or a skill set that was widely applicable to literally anything.

But I knew that I didn't want to lose the artistic side of myself, and I knew that sometimes when you go into engineering a lot of your other interests fall by the wayside if you're not intentional with your life decisions.

The minor is a good way to force me to do the work and broaden my horizons.

Next semester I'll be taking a textiles class, to learn how to shape and sculpt and things like that.

Miller/Lee: *Who are you working with in the School of Design?*

DeMaria: I'm not working with anybody, not doing any kind of independent research. My formal mentor is a Design Professor. The Park Scholarship requires you to have a mentor.

When you get here on Day One, you get a mentor and go to them for guidance. He was actually a computer science major, and then went to design as a graduate – it's Mark Russo.

Miller/Lee: *You shared that you had the goals of getting a very "practical" education while maintaining your artistic side. What led you to come to NCSU with these two fine schools, the School of Design and the Department of Computer Science? Is that what brought you here?*

DeMaria: There were a couple of factors. First, I wanted to get out of New Jersey, and so it came down to the University of Pittsburgh and NC State. Pittsburgh gave me full tuition, and NC State offered me the Park Scholarship. One thing about Pittsburgh is it's cold, and second, their computer science program is in the Department of Arts and Sciences, and that's kind of a red flag.

Miller/Lee: *And you wanted engineering…*

DeMaria: Yes! I wanted something practical and I felt I wanted to do something that was taken more seriously by the university. I'm very glad I came here!

Miller/Lee: *How did you research schools?*

DeMaria: With great help from my mom, but there was a list of colleges, grouped by discipline, so we predominately went through that list, and we also went online.

<u>Summer Enrichment in LA</u>

DeMaria: I spent my summer between freshman and sophomore year out in LA. The decision to go to LA was largely motivated by the fact that I did not get an internship between my freshman and sophomore years. So, I had a free summer, and I wanted to cater to that art side, so I thought, "Well, I'm going to have to work for the rest of my life so I might as well go do some film and photography stuff." So, I went.

Miller/Lee: *Did Park Scholars support this?*

DeMaria: Yes, they monetarily supported it with an enrichment grant, which you apply for.

I thought about the fact that I'd never been to California, and I certainly wanted to go to the film hub of the world. So, I looked at USC, UCLA, and a couple of schools in San Francisco, but

ultimately decided on UCLA, because they have a six-week summer course in film.

They advertised it as an advanced course, but it was really for beginners, so I really didn't get all that much out of it. But I think the enrichment of going to LA on my own and experiencing that city and that film culture was really useful. The formal tutoring (that) I got at the institution was not quite there. But that was a really fun experience, and I've wanted to get back to LA ever since I left!

Miller/Lee: *Are you taking gaming courses here? What are you taking with regard to film?*

DeMaria: That has been a challenge. There are certainly a small number of courses that cater to that, but they're not very directly related to Game Design. Which is all well and good, but I don't want to do the game design industry.

I've heard stories from other State graduates that it kind of limits them in what other jobs they can get – of course, that's on a case-by-case basis, so I can't say whether that's an ultimate truth or not.

One computer science course related to my art side that I've taken is Digital Signal Processing – that was a Special Topics Course taught by Dr. Reeves all about image manipulation and art manipulation – because that's right up my alley! I'm taking Graphics I with Dr. Watson, and next semester I'm taking Graphics II.

Miller/Lee: *Do you find you have received valuable instruction in how to function as a team member anywhere along the way?*

DeMaria: Answering that question for me is difficult, because through the Park Scholarship we have leadership training that we do starting First Semester, so on a leadership level I would say that I have received more instruction than my peers.

However, if I would look at what we have been taught, objectively, we have been taught processes, like Agile or Waterfall – how to develop software. So far as soft/people skills for leadership, probably not there as much.

We're process-focused, and we excel at that, but we're not good at teaching people skills. Senior Design addresses that, but you can't just tack-on soft skills at the end of a degree - it needs to be baked in.

Miller/Lee: *Were soft skills there in the Park training?*

DeMaria: Absolutely!

Dr. Christopher Healey
Professor, Department of Computer Science
Goodnight Distinguished Professor, Institute for Advanced Analytics
Tuesday, November 8, 2016

Miller/Lee: *It's election day, 2016. Are we going to see any of your visualization work on tonight's coverage of the election? I know in previous elections we have seen election visualizations created by you and your students.*

Dr. Healey: We will have some visualizations tomorrow morning. I have everything ready to go. I am hoping it will be fast, because I have automated as much as I can.

Fortunately, Politico hasn't changed the format of their web pages, so I can just scrape all the data off there and run it through scripts, and in theory we get the election visualizations. Our goal is a design that shows how groups of individuals voted for different elected offices.

Miller/Lee: *We want to hear more about that so we will return to it later in the interview but we want to start the interview with two questions we have asked everyone. The first one is what computing devices do you currently have for your personal use?*

Dr. Healey: I have an iPhone (smartphone) and a MacBook Air (laptop). At home, I have some gaming consoles, an Xbox and a PS3. No iPad, no tablet.

Miller/Lee: *Our second question is: What is computer science today? How would you define computer science in today's world?*

Dr. Healey: Computer science is an interdisciplinary area. It always has been, but more so now. Computer science is no longer a man or a boy, alone in a room, with no friends, programming a computer.

You can look at any area and computers are involved, and are probably integral.

Miller/Lee: *Your work has always been involved with different disciplines.*

Dr. Healey: My particular area, data visualization – now data analytics – is explicitly interdisciplinary. Data has to come from somewhere. It could come from a computing domain, but it often doesn't.

We use politics. We use biology. We use astrophysics. Right now, we are doing work in risk management, and in wildfire event coordination.

The data comes from all these different places then the results have to be disseminated back to the same people. If they are not computer scientists, we have to present it in a way that they can understand.

So, we spend a lot of time talking to people in the domain – "What are you doing? What do you want to do that you can't do now? How do you do things now? I need to know about your area to be able to help you."

Once we build things, we iterate. We try to figure out – Is this helping? How can we make this better?

The fun is, I get to learn about a lot of different areas. I now know all about how salmon migrate from the Pacific Ocean. I understand what happens when two gold molecules collide at the speed of light. I understand how cyber security analysts work …to the extent that I can, since I cannot talk directly to them.

We have got to learn the language of the domain. Sometimes it's easy. Sometimes it's not.

One thing to be mindful of is (that) you don't want to impose your solutions on their problems. That is not your job. Your job is to help them solve their problem, not to provide a tool and force the problem to fit the tool.

On the other hand, since you are the visualization/analytics person, you do not want to just give them what they ask for. You make suggestions, provide alternatives, and have them try them out.

Miller/Lee: *So how has this changed in the last ten years? What are significant changes in your area in last ten years?*

Dr. Healey: Big data. Data used to be hard to collect and hard to store. Now everybody has it. Now you can get a 4, 6, or 8-terabyte hard drive from Best Buy for a few hundred dollars.

Companies tend to collect lots of data, because it is easy to collect and easy to store. Then they wonder, "What do I do with this? Surely, there must be something magical in this data."

That's where data analytics and visualization, which is a part of that, comes in to play.

We have many, many people wanting to talk about data that has been collected. And we have a much larger volume of data. And although the computing infrastructure is growing, the ability to write code or perform sophisticated analytics has not grown as quickly. So that is a problem.

Miller/Lee: *So, you deliver results back to the client as a graphic image?*

Dr. Healey*:* It depends. It may be numeric result…it depends on the question. It can be a form of visualization, but not necessarily.

Miller/Lee: *Yesterday, we walked down to the James B. Hunt Library. Were you involved in any of the displays there?*

Dr. Healey*:* The one at the entry, the MicroTile 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.

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 10 times the content to design and develop the narrative.

Miller/Lee: *Does technology drive what you do? Research dollars? What determines the direction you take with your research?*

Dr. Healey*:* There are many, many requests for work to be done so we can pick and choose what we do. Some are driven by technology, such as the MicroTile wall in Hunt Library. But we have many more requests than time available to work on them.

Right now, we are looking at risk communication and risk mitigation for wildfire events through social media. People build residences in places vulnerable to wildfires. So, the first thing the wildfire prevention services want to do is communicate simple things people can do that will significantly improve the likelihood that their house can survive a wildfire event.

For example, don't use cedar shake roofs or do use specific landscaping plants that can actually serve as a fire break. During a wildfire event, there are two interesting focuses.

One 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, (such as) Twitter Visualizations 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.

Another focus is rumor mitigation during the event. Partial information comes out, then people fill in the missing parts with some conspiracy rumor. If the information is immediately released by an official source to squelch the rumor, people are distrustful. They think it is a lie.

So, you need to back track the rumor to the source, almost always, media. Then the PIOs explain to the source that people are inferring things that are not true. And they give the source the missing information. Then the source can come out with a second story, and that is more likely to be believed.

Miller/Lee: *Back to tomorrow morning – red states, blue states.*

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. The saturation level tells what the winning percentage was.

Miller/Lee: *So, you will take the results of today's election and tomorrow morning you will produce these maps. Who are the clients?*

Dr. Healey: The general public.

Miller/Lee: *And will you provide election visualizations like this for the entire country?*

Dr. Healey: Yes. They will be available on my university website.

Miller/Lee: *What is the major change in the department in the last ten years?*

Dr. Healey: The department has developed certain core research areas, and now has a very strong reputation in these areas: Security, Networking, Artificial Intelligence, Operating Systems, Software Engineering, Education in Computing, and Gaming.

Miller/Lee: *Chris, 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?*

Dr. Healey: 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.

Within the Institute, I teach visualization and something called Visualization Tools. I teach Text Analytics, Python, Color Theory, Geographic Information Systems, whatever it 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.

Students in the Institute always work in teams. One team is set for the whole year. Another team, a homework team, rotates every six weeks, so they get experience working with different people. 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 themselves. 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 US citizens.

Miller/Lee: *How was this institute created?*

Dr. Healey: Dr. James Goodnight, co-founder of SAS Institute, provided a gift to the university in 2006 to support curriculum development by an Institute faculty. That was the mandate for the Institute when he provided this seed money.

The Institute works closely with many employers like SAS across the country to enhance the curriculum, and insure it maintains a practical relevancy. Companies from around the country hire graduates from the Institute.

Examples include SAS, who has hired close to 100 graduates, Disney, the Jacksonville Jaguars

(along with) Walmart, Ernst & Young, the CIA, and Hanes Brand.

Currently, the majority of my teaching duties are housed in the Institute.

Miller/Lee: *What are your responsibilities in the Department of Computer Science?*

Dr. Healey: All of my research continues in the Computer Science Department. I currently supervise seven PhD students in the department, and I teach courses in the department.

I have a job and a half!

Dr. Sarah Heckman

Teaching Associate Professor and Assistant Director of Undergraduate Programs
Monday, November 7, 2016

We welcome Sarah Heckman, the first member of the professional teaching faculty in the department. Sarah became a Teaching Assistant Professor in 2009.

Miller/Lee*: Sarah, when did you come to NC State?*

Dr. Heckman: I came to North Carolina State University in 2000 as a Freshman. I took CSC116 with Carol (Miller) in the spring of 2001 *(Carol adds, "With 300 people…"*).

We were all together in Withers 218, with the flaking paint on the ceiling. It was the mainstay!

Miller/Lee: *What language were we teaching then?*

Dr. Heckman: Java. I remember the labs – it was really interesting.

You know, my uncle Andy was working on his degrees here at the time, and he's the one who convinced me to major in Computer Science. Over the summer, he was trying to teach me how to code with C++, and he bought the lab course pack, and he set it up on our machine at home, and I got to the Hurricane Tracker Lab, and I couldn't get past it!

There was something wrong with the configuration of the C++ compiler on our computer – so I was really proud when I got past the Hurricane Tracker Lab in Java!

I graduated with my bachelor's degree in 2004, and as I was going through, I took a class in software engineering with Laurie Williams, who is now the Interim Department Head. There was a great project near the end of it, and Laurie said, "I need someone to work on it next semester and see if it's something we can roll out." It was an anonymous feedback survey, so the teacher gets a feel of how the class is going.

I actually met my husband in Laurie's office that following spring semester, because we both ended up doing independent study to complete this particular project.

A couple of months into the project, Laurie approached me and said, "There's a CRA (Computer Research Association) that has a women's group. They have a Distributive Mentor Program and we should sign up and you can do research with me over the summer."

So I said, "That sounds great!" I was thinking about the accelerated Bachelor's/Master's Degree program, so I signed up to do research. And then I was hooked, and stayed here for my Master's and PhD.

Miller/Lee: *So, you stayed here the whole time?*

Dr. Heckman: I stayed here the whole time, which is a very rare thing in academia. I think it worked best because I stayed in the teaching track position. I was the first teaching faculty hired in our department with the professorial rank associated with the teaching modifier. It follows 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.

Miller/Lee: *This is so significant. This is the first time that the department – maybe – do you know if it was within the university?*

Dr. Heckman: Lisa Bullard over in Chemical Engineering, I believe, went to the teaching track several years before I was hired, but it's becoming a much bigger thing. There's teaching-track faculty in the College of Sciences, and there are several full teaching-track faculty throughout the university, so it's been around 12-15 years as a main track, and the numbers are growing.

Miller/Lee: *How many teaching track faculty does this department have?*

Dr. Heckman: We have six.

Miller/Lee: *So, you have gone from zero to six in this past 10 years?*

Dr. Heckman: I was hired in 2009. David Sturgill was hired in 2011, Lina (Battestilli) was hired in 2012, Suzanne (Balik) finished her PhD ,and she and Jessica Schmidt were hired in January of 2014, and Jason King was just hired in January of 2015.

Miller/Lee: *You have a very special view of all this, from undergraduate school until now.*

Dr. Heckman: Yes, at the 40th Anniversary, I was still in grad school, but I attended a good number of those talks.

Miller/Lee: *If you were answering the question today, "What is Computer Science today?" what would you say?*

Dr. Heckman: In some ways, I'm still kind of in coding, because most of the courses I teach in our curriculum are programming courses. But I also teach from a very serious soft engineering perspective.

So, I think probably what defines my lens of Computer Science is process and best practices, and how to fully engage our students into being good software engineers, because most of them do graduate and go into industry after completing their undergraduate degree.

In particular, I ask how can I best train them so that they are prepared to solve all sorts of problems in industry – not in a piecemeal way, but in a well-thought-out, well-rounded way using the appropriate tools and technologies to support their development, so they can be solving the more interesting problems, and not being stuck with programming the plain Java objects.

I want them to be thinking higher level design thinking, but process – and it really comes down to process. I think that's what has us fit into the College of Engineering – we are following an engineering process to develop the software.

I really try to focus a lot on maintenance in CSC216 (Programming Concepts). I've been doing some fairly transformative things in 216 – it's up to four credit hours.

Miller/Lee: *And it now has a lab?*

Dr. Heckman: Yes, There's actually a lab going on right now even as we speak (looks at watch) – it started seven minutes ago!

Miller/Lee: *Looks like a lot of labs.*

Dr. Heckman: Yes, we have nine labs. We moved 216 to a four-credit-hour course. We incorporated a 110-minute open lab, which means students are expected to continue work outside of the lab.

The jump between our intro class and our second semester class is a little rough for some of our students. I'm trying to make it less rough, so I've come up with guided projects to introduce the students to the technologies, because I've taken a lot of the technologies we used to save until junior year and I've moved them into 216.

Miller/Lee: *Can you give us some examples?*

Dr. Heckman: J-Unit, which is our unit testing frameworks. We do code coverage. I want them to have at least 80 percent statement coverage of XQ statements in their code and model classes.

We use three static analysis tools: PMD, FindBugs, and CheckStyle. Static analysis tools look at the source code for problems without execution. Students can use them to find potential problems in their code from the very first line. Additionally, this allows us to automate evaluation of comment structure and style issues.

Miller/Lee: *Are your labs connected in relevance with applications? Do they do apps?*

Dr. Heckman: They're building over the course of the semester a course registration system, so it folds into one big system. I also have them work with Eclipse, which is a big integrated development environment system, which is open source and incorporates all these tools in there.

Then I have them commit all their code to GitHub. GitHub (as a wrapper for Git) is a version control system that supports a history of code changes and collaboration between team members.

Undergraduate Research

About three years ago, our Strategic Planning Committee decided to put together a task force to start addressing some of the concerns that we had that we wanted to see done. The task force was really a great idea – I think it really energized the department – at least the faculty side of the department.

There was one on Undergraduate Research, there was one on Creating Undergraduate Tracks, which we're still working on. There was one on Modernizing the PhD Program and one on Making the Strategic Plan Actionable, identifying things faculty could really do in moving forward on the strategic plan and being recognized for it in our dossiers.

Ours was Undergraduate Research. At our first meeting, we were sitting around talking about how the faculty members are complaining that the students don't know what we do, and they don't come and find us – and we asked ourselves, "How do we fix that?"

My thought was, "Why don't we just have Lightning Talks, and have each faculty member give a five-minute presentation about their specific area of research or a project they want an undergraduate to work on?"

Miller/Lee: *So, this **was** like Research Speed Dating!*

Dr. Heckman: Exactly! We'd have cookies and drinks; we'd have the sessions on a Friday afternoon when most people could show up.

We were talking about this in the fall and I said, "Let's do this is January. We'll have it the first Friday of the semester and we'll get people signed up for CSC499's (Independent Study) the next week – let's just do it and see what happens!"

So, I organized it and I think 10 or 15 faculty came out to give talks, and we had standing room only in 3211 at that first Lightning Talk session!

Now, we typically have at least around 30 students attend every semester. We are also able to talk about other things as well. When I do my Lightning Talk, I give a little overview presentation of how I got into research and why research is great, and then I talk about organizations and opportunities for undergraduate research, and about funding for undergraduate research.

The university has an office of Undergraduate Research that will give stipends of $750.00 to students who sign up for it, but not many sign up to participate. This fall, we had 22 students registered for 499 (stipends), and that doesn't count the people who are paid to do undergraduate research, so I think we're at about 30.

Miller/Lee: *So, the secret of success with this program seems to have been the face-to-face contact.*

Dr. Heckman: Yes! A faculty member comes in and talks about their research – they're really super passionate about it! People want to work on it – it's really phenomenal!

There's still work to be done on it. For example, last spring we held a poster session toward the end of the semester for the students who were participating in research, and faculty turnout to that was not where I would have liked for it to be.

So, we need to maintain that face-to-face communication to reward the students who are participating in this type of research, and make sure the faculty and the other students are getting involved and attending.

Miller/Lee: *It reminds me of how pies ended up in Posters & Pies. In those projects, we have been mentioning – when students work with industry – at the end of the semester, the students give a little presentation and they have a poster – but we give them pizza pies and dessert pies, so now it's called Posters & Pies!*

Dr. Heckman: We usually have 300-plus at Posters & Pies. In the spring semesters, we're running 30 projects. We now have multiple sections of the Senior Design course. This fall we have, 27 projects.

Miller/Lee: *What has been your experience as a professional working woman?*

Dr. Heckman: Crazy – particularly this semester! This semester may not be the best semester to ask me, because work has consumed, and I don't know that I want it to consume to this level – mostly because I've spent all my weekend writing labs…but I'll be done in the spring.

Miller/Lee: *How has the department supported you?*

Dr. Heckman: Oh, they're phenomenal! Both my babies book-ended an academic year. I was trying for summer babies, but that didn't work. The department has been hugely, hugely supportive, including during my maternity leave.

Miller/Lee: *What about tenure track faculty. Are they given a reprieve (for maternity leave) on the tenure track clock?*

Dr. Heckman: It is my understanding they are.

Miller/Lee: *Because this has been a major thing in the last 10 years.*

As teaching-track faculty, I don't have a tenure clock, but I ended up being reviewed in my sixth year, just like any tenure-track faculty.

Miller/Lee: *It sounds as if faculty members have a sense of security here.*

Dr. Heckman: I think it helps here – and Ken (Tate's) work has done a lot of this – we're fairly sheltered in some ways from some of the legislative-type people that can affect funding. It's a very secure feeling to know that we have monetary backing to do things, and that we can fund things that we're interested in.

The department is just so phenomenal and collegial! We have differences of opinion, but it's handled in a very good way, and there's support for the different types of activities you want to do – and you have the independence to just try it out within reason, which is really great.

<u>Undergraduate Programs</u>

I am getting more involved with Undergraduate Programs, because I'm the Assistant Director now. I was the first promoted of the teaching-track faculty, which was exciting, so getting involved more at that level and trying to understand more about the curriculum and where we want to go as an undergraduate program, in particular, is really fascinating.

So, I see where some of the holes are and what we want to do. I want more for the next 10 years. I really want to start focusing on the tracks in our curriculum.

There's a task force on identifying the tracks. A track is not a formal designation, but we can say, "If you're interested in this type of job, we recommend that you take this particular type of track. We have a Games Concentration. If you're interested in going into a financial institution, you should be taking databases and you should be taking these types of things, and those would help you." Or what if we did a Security track or a deep sort of Software Engineering Dive or an AI Perspective for Data Science?

Miller/Lee: *Where does the decision about what courses will be offered to undergraduates take place? It is driven by outside demands and trends or from inside the department?*

Dr. Heckman: A little bit of both, and also what we can cover. If we don't have people to teach it, we're not going to offer a track in that space, but we're doing tracking of the graduate

programs – a Software Engineering Track, a Data Science Track, and a Networking Degree Program.

What I want to do is replicate a lot of these tracks at the undergraduate level by having cross-listed 400-500 level courses, but I want to widen the breadth of the 400-level courses that we offer at the elective level.

Capacity is an issue right now – it's a huge issue. We actually have Google funding that's a grant between Duke and UNC – so we collaborate academically, although we might compete athletically! We're trying to offer better TA training at the undergraduate level, and it's supporting my 216 TA's. We're calling them Peer Teaching Fellows (PTF's) and we're trying to see if we can't have better outcomes in 216.

Miller/Lee: *Are they Master's students?*

Dr. Heckman: No, I have six undergrads and four PhD students. I'd like to go eventually to all undergrads for 216, but training across all levels – undergrad, grad, Master's and PhD – is needed.

We're trying out a TA training course now at the undergraduate level, and then we'll replicate it at the PhD level, and then we'll start bringing in the hourly Master's students in the first semester that they are TA's. Right now, I only have the bandwidth to offer it once an academic year.

Margaret Heil

Director, Senior Design Center

February 3, 2017

We meet Margaret at the Senior Design Center and reviewed the purpose of our interview, explaining that we are compiling the history of the past ten years of the Computer Science Department.

Heil: For me to share a story, I can't just do the last 10 years. Because I really, really feel the Center's roots came from Alan (Tharp), and his being open to doing something completely different. That is what has made the Center.

Miller/Lee: *There are two questions we are asking each person we interview. First, what computing devices do you have?*

Heil: I have a smartphone, a laptop, and two desktops. I love my smartphone! I resisted and resisted, and now I can't live without it. I have a tablet, too, but I don't use it as much because of the phone.

Miller/Lee: *Our second question is, "What is computer science today?"*

Heil: One of the things that I have always felt strongly defines computer science is that it is incredibly dynamic and flexible. That requires our students to be adaptable, as well. Computer science is this free-flowing discipline that doesn't have the rigidity of other engineering disciplines.

My dad was an electrical engineer. When I was growing up, it seemed that engineering was in a box. When I came to NC State, I was amazed to find that computer science was in the College of Engineering.

One of the things that has always attracted me to computer science is that it's so fluid and so ever-expanding, and it flows into nearly every other discipline. I think it's incredibly exciting and always interesting, because it's always changing. It confuses me that computer science is considered engineering!

Miller/Lee: *We do refer to the disciplines as electrical engineering and mechanical engineering – but it's computer* ***science.*** *And it sounds as if you're talking about art!*

Heil: I come from that perspective. I have a double major in an art and a science. I could see the art in the science, and the science in the art. I think that's one of the reasons I fit with the program. You can see it from all different perspectives. I think that's what's going to keep it interesting forever. I really do!

I believe computer science is going to continually grow and to attract different kinds of people and to me that's just so exciting. The Center is exciting, because all the projects we bring in are very different every semester – and it just keeps evolving.

Miller/Lee: *Would you tell us about the program?*

Heil: I'd be happy to tell you about the program! It was established in 1994 to create partnerships with local industry, because it was so rich here in Research Triangle Park. Alan Tharp approached Bob (Fornaro) and said, "What can we do to somehow strengthen the partnership with these folks who are interested in our program?"

Bob knew lots of alums, and he started knocking on doors and saying, "Hey! Would you like to get involved with us? What do you think we could do?"

The industrial folks were incredibly excited about it and said, "Yes – let's do it! How 'bout if we come up with some problem statements for teams of students to work on, and see if they can solve them?"

And that's how it evolved. Corporate sponsors came in with problem statements, and Bob put a few teams together. The folks from industry served as mentors to the teams – they met with teams of 3-4 students on a weekly basis and helped the students to understand the problem more completely, so that the student team could come up with a viable solution.

Bob served as technical advisor to the students, listening to them and guiding them to make sure that they made sound design decisions. Senior Design was an elective course at the time, and Bob said, "Okay, here – work on these problems."

Right away, you have issues, because you're working with groups of students – teams of students – and you want them to follow methodology and come up with requirement specs and design specs, to test the program, and to communicate about it.

They had to talk with each other about it and to convey messages to Bob and to their mentors from industry. All of this quickly became overwhelming to Bob and he realized, "Wow! Maybe I need to bring someone in here who actually knows what she or he is doing with teams and communication."

Alan was very open to it, so they brought me on as an experiment to start teaching some of these other pieces – the teamwork pieces and the communication pieces – and that took off.

Incorporating those multiple perspectives – the art and science perspectives – really made the program more robust.

I started working with students on their technical presentations – not just by giving them feedback *after* their presentations, but working with them one-on-one *before* their presentations. Public speaking is very scary for many students. Luckily, I get a kick out of it, and I've always enjoyed sharing my love for speaking with students.

Over the years, I've worked with hundreds of students – guiding them as they prepare slides, helping them with the mechanics of speaking, and calming their nerves. This has always been amazingly gratifying for me! I can't help but smile ear-to-ear when I hear and see a student deliver a successful presentation for the first time in their lives because of their preparation, hard work and determination – absolutely the most wonderful thing for a teacher!

Bob and I also felt strongly about giving our students multiple rounds of feedback on iterations of their written documents as well. I continue to do this with our technical advisors and teaching assistant staff.

Writing is such a journey! And collaborative writing is especially challenging. We do our best, and our students are often overwhelmed with the amount of feedback they receive on written documentation. The feedback loop we create in Senior Design is extensive, and we strongly encourage our students to respond to our feedback, even if they disagree – we just want to hear a convincing argument!

Another 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 – (how) each of them is expected to be accountable to their team.

I have always been adamant about being clear about the expectations we have of our students – even though we now have multiple sections, I am a crusader for making sure our students understand what is expected of them!

One of the ways that we deliver a consistent message about our expectations is via a project management activity. I developed it by accident in the early years with a team lead by one of our top students, CJ Saretto.

He 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 time lines of related tasks/responsibilities. That team had the most effective process that semester – and the highest quality project!

So, I turned to Bob at the end of that semester and said, "I think I need to do that activity with every team every semester from now on." He said, "Go for it!" and I did and I have!

Since that time, I've coined the activity, "Task Planning," and facilitated a session with every team, every semester since that time, about 16 years. It's a pivotal time in the semester, and we really notice that teams have a different energy/focus after task planning.

Since becoming Director, some have said that I should delegate the facilitation of this activity to others. I'm a huge believer of delegation, but I insist on holding on tight to this activity and doing it myself!

I believe it has helped us to effectively scale up the Senior Design experience – by delivering a consistent message about how we expect our students to convey their progress, getting every student on the same page, holding each student accountable, facilitating design discussions within teams, assigning tasks, and pushing students to appropriately define project scope for success!

Plus, I get to see how each team is ticking. If I know how 29 teams are ticking, for example, then I can effectively gauge the health of the Center. That's what Directors do.

I feel as if the team-teaching paradigm really empowered the students, even in our early years as we were experimenting with different approaches. It gave students a more enriching experience and it was really, really fun to see the whole thing evolve. That was terrific – and it continues to happen. It's still an experiment, but a successful one!

We had a lot of success as a result of that team-teaching, and the program kept improving. Then, accreditation required communication and teamwork, so Senior Design became a required course. Alan was always saying to me, "Well, what are you going to do when you have to scale this up?" and I said, "We'll do it! We'll do it! Watch us!"

Miller/Lee: *I think it's important to note that there were other project courses and Senior Design was one of them, but it was the one the **students** were choosing so it was growing because they wanted to be part of it. They wanted the course to be **their** capstone!*

Heil: It also grew because of the industrial connection – now we have all these sponsors.

Miller/Lee: *How many do you have this year?*

Heil: We have 29 sponsors this spring semester. Last semester, we had 17, and we were just warming up for 29. Our record so far is 30 in one semester!

Now, we have multiple sections. In the early years, we kept it to one section. As a part of the scale-up and as part of using the space, we had multiple sections and multiple technical advisors who work with students across all three sections.

Miller/Lee: *Tell us about Posters & Pies.*

Heil: 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! This semester we'll have 29 projects, so the presentations will be a minute and a half (each).

The students spend 20 hours on average to prepare these 1 ½-2-minute presentations. That includes my time with them, their working on the slides, microphone time, and working in the auditorium. The projects are presented in the auditorium at the Hunt Library.

Then we go upstairs to the Duke Energy Hall and have Posters & Pies. The students produce really nice, professional posters, and each team has a table and does demos. After this we serve pies – pizza pies and dessert pies!

It's an exciting event, and we have everyone from student's families to potential sponsors to folks like Alan and Bob, who just enjoy being there. I always invite the next semester's 492

Senior Design students to come. I'd like to see more faculty members there. We usually have 300-400 people – and it's a blast!

Miller/Lee: *Who are some of the sponsors?*

Heil: 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!

We also have Triangle Strategy – the CEO partners with Alan Tharp, who recommended the Center to Patrick, the CEO.

Miller/Lee: *How has the Center changed in the past 10 years? You mentioned the funding – and you've got more space and more support.*

Heil: We do operate on donations. There are donations from sponsoring companies and the Engineering Foundation gives a donation for Excellence in Undergraduate Teaching. Each award is for $5,000, and that builds up pretty quickly. The funding is used for things the students might need – extra hardware or different kinds of software, or for extra money to support TA's.

In terms of how the Center has changed, the biggest thing that has happened since Bob was stepping down and I was coming up as Interim Director is that we were making changes to teach across multiple sections. That structure, combined with the larger number of students, really made a large difference in terms of how we've operated. We've had to make changes in order to accommodate for our growth.

Ignacio Domínguez, a long-time Teaching Assistant of the Center who then served as a Technical Advisor, was an integral member of our staff, and of making our Center paperless. He developed a submission system based on requirements that the staff and I developed.

One of the things we're proud of at the Center is the way we give our students feedback on everything that they do – written reports, presentations, everything! That was getting to be a problem…I was killing a lot of trees!

The submission system allows a student to upload a document, so that the technical advisor can download it, make comments, lock it, and upload it for the next reviewer. Next, the TA does the same procedure, and I do the final review. The student has all the feedback in one place.

It's spectacular! The submission system is one of the main reasons we've been able to scale up.

The other thing that has allowed us to scale up is that we have the teaching faculty, and that's a big deal. Now, we have people who are interested in Senior Design – people who want to teach and who have a gift for teaching.

Miller/Lee: *How have the numbers changed in the past decade?*

Heil: In the 2007 academic year, we had 74 Senior Design students and 23 projects. In the 2016-2017 academic year, we have had 175 Senior Design students and 46 projects.

Miller/Lee: *Are you getting some recognition from other computer science departments interested in doing the same sort thing?*

Heil: Yes! For example, I was invited to Clemson last year to hold a seminar about the Senior Design Center, because they really would like to create a similar Senior Design program. It was wonderful to share our story, and help them get excited about forming such an experience for their students.

I also co-authored a paper with Bob Fornaro, Mike Carter and Sarah Heckman – now one of our Center's Technical Advisors – called "Creating a Progression of Writing, Speaking, and Teaming Learning Outcomes in Undergraduate CS/SE Curricula" that I delivered at the 2012 World Engineering Education Forum held in Argentina.

Our model is quite unique, and it appeals to educators everywhere. We've spoken at many venues – in Canada, South America, Europe and in many places in the United States.

Miller/Lee: *Tell us about some of the awards the Center has won over the years.*

Heil: We had success at the IEEE Computer Science International Design Competition (CSIDC) starting with our trail blazing team in 2003 – they placed third in the world!

Then we broke records, and our teams placed first in the world in two successive years, 2005 and 2006. No other team from any other university in the world had ever done that!

Guess what the competition was based on? Teams were expected to write an interim, report and submit to judges. From that document, judges trimmed down 300 competing teams from across the world to 100 teams. Then, the teams were expected to submit a final written report. Based on *that* document, 10 top teams from across the world were picked to compete in Washington, D.C.!

The students also had to deliver a formal presentation, and then a poster session and demo – much like our Posters & Pies end-of-semester exposition!

In 2005, we had a team of students working on an early Internet of Things application called NEAT (Networks for Endangered Animal Tracking). One of the students on that team, Dakota, approached Bob and me about doing a live demo up in Washington for the competition. We

highly discouraged a live demo, but Dakota persisted. We finally told him, "Okay, only if you prepare and practice… it needs to work!"

So, a few days before the competition, Dakota biked around Washington – in 100-plus-degree heat – with a GPS antenna taped to his helmet with wires down to the SunSpot processor on his waist, to capture readings. He was stopped by the Secret Service, because it looked like he was riding a bomb around! Despite the drama, he persevered until the demo was perfect. On the day of the competition, Dakota calmly biked around the city and drove into the competition venue calm, and with a towel around his neck with all the collected data! So spectacular! The team easily placed first.

Our 2006 team winning team was just as phenomenal, and we broke competition records because our students could *work as a team, write, speak and convey their message*.

After 2006, the competition ended. In some ways, we were relieved – how can we keep this up? Then I was disappointed, because we had another team that following year that I knew would have taken the prize. And guess what? We've had teams every semester since that time that I'm confident would have walked away with the top prize. Our students are just that fantastic.

Dr. James Lester
Distinguished Professor
Director, Center for Education Informatics
Dr. Bradford Mott
Senior Research Scientist, Center for Education Informatics
Thursday, February 2, 2017

We gather with James Lester and Brad Mott at the Center for Education Informatics (CEI). The Center is housed in EB3 on Centennial Campus. After an informal discussion of the history project, we began the interview.

Miller/Lee: *What personal computing devices do you have?*

Brad: I have an iPhone and an iPad tablet. I have a laptop, a desktop, a personal Linux server in my basement, and lots of gaming devices. I have a serious "problem" with gaming devices.

I have an Xbox One, a PlayStation 4, a Nintendo Wii U, and all the previous generations before that. I have a collection of gaming devices, starting with the Atari 2600 and Intellivision. These were popular back in the late '70s and early '80s, and I have select collection of systems throughout the following decades. I enjoy collecting and restoring vintage video game systems.

James: I have a laptop, an iPhone, and a tablet that I don't use very often.

Miller/Lee: *We have asked each interview about how they view the field of computer science today How would you define/describe computer science in 2017? And how is it different from 1967, when the department was founded?*

James: We think about this a lot professionally, because we have lots of K-12 projects. We are looking at teaching computational thinking, which is much broader and more fundamental.

For the K-12 group, the projects are for middle school. We also do some projects for (the) college level, mostly non-majors.

We are very cognizant that computer science isn't just coding. It is very important for every kid to have the ability to think with algorithms, with data structures, even in the most simple versions. This is important for every kid from age 10 to 18 – for their whole life. I think it is very broad.

I think the closeness of computer science to math is very different now. In 1967, much of computer science was actually done in math departments. That is not true now. There is a lot of very sophisticated math in computer science, particularly in artificial intelligence, the area we work in, but it is not exclusively that.

Now we are talking about high end statistical reasoning, not just numerical analysis.

Miller/Lee: *Do you mean analytics?*

James: Yes, analytics. Big data. Machine learning. Sometimes people describe machine learning as higher dimensional statistics. But the probabilistic side of math is very, very important now as opposed to in the '80s. Numerical analysis was the be-all-and-end-all then.

I was six years old in 1967. I began computer science in 1983. From '83 to now, the big differences I see are the incredible diversity of concepts and disciplines. It's hard to imagine what computer science doesn't touch. So, to me, the difference is one of breadth and depth.

Brad: 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.

James: There is this famous quote by Donald Knuth, a very famous theoretical computer scientist. He said (that) in his view, one out of 50 people can learn to be a computer scientist. I often think about this. So, if we are trying to teach 50 middle schoolers how to be computer scientists, are 49 out of the 50 doomed? Are they going to fail? I don't think so!

Miller/Lee: *So, is the impact of your work over the last 10 years to get those middle schoolers learning computational thinking at a higher success rate than one in 50?*

James: I do think there are limitations. It is not universal. But I do think that computer science education can be structured in such a way that can help a lot of people.

We were talking about computer science education specifically, but we work in many different disciplines, many different subject matters. We develop personalized learning technologies for K-12, for college students, for defense training, for healthcare.

The technology is very different, depending on the discipline and the age group. We are interested in every aspect of technology-rich learning. We want to build personalized learning technologies that will help everybody…from training to formal science education, to museum settings, to defense applications, for medical training, to behavior change for healthcare.

There are many, many applications of these AI-based learning technologies to help people learn either for formal education or for training. So, the mission is to help everybody, not just middle schoolers.

Miller/Lee: *What drives what you work on – research dollars?*

Brad: We are interested in problems that we have expertise in, and problems for which we can find research dollars to fund us to work on the problem.

Miller/Lee: *Where are the research dollars?*

Brad: 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.

But there are grand challenges proposed by both groups and others, too – challenges to deliver personalized learning technologies. 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 job – to think effectively and to solve problems.

That is very different than it was 10 years ago. Today, there is much, much more demand from the outside.

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, EDUCAUSE – all these are very, very interested in how personalized learning and learning analytics and educational data mining can be used to solve these large-scale education problems.

Objectively, it 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 it. We still have to work hard, but there is external demand that is driving the research.

Miller/Lee: *Is there a downside that people believe they do not have to think any more? Do they tell themselves, "The computer will think for me?"*

Brad: We are going to use the computer to help them learn to think better. The case that AI is advancing so quickly that the whole job landscape is going to be fundamentally different, so the jobs that people need to fill will be very different.

I do think that the impact of AI and automation on the workforce is something to worry about. But there is also a guarantee that this is going to create many more kinds of jobs – currently, we don't even know what they are!

So, educating kids to be able to think computationally from a very young age, is unquestionably the best thing to help them prepare for what's coming in five or ten years. It's exciting.

Miller/Lee: *When did you become a Center?*

Brad: I think it was four or four and a half years ago.

James: I think it was chartered in 2012.

Miller/Lee: *What does it mean to be a Center?*

James: 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 percent research.

Brad: There are different models. Some Centers are more tightly integrated with an industry focus. They have industry partnerships.

Miller/Lee: *Are you wholly within the College of Engineering?*

James: 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 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 people like Eric Wiebe. He is not part of the Center in terms of where his office is located, but we have many, many joint projects with Eric and people like him.

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 inter-disciplinary. 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.

Miller/Lee: *Elaborate a bit about the Friday Institute and how it fits in.*

James: It is the William and Ida Friday Institute for Education Innovation. Its focus is looking at different ways to create and evaluate new forms of educational innovations.

The founding director was Hiller Spires, about 15 years ago. The Institute is part of NC State, and it is co-located with the Centennial Campus Middle School. It is terrific for doing studies of learning technologies. The Friday Institute is in some ways an analog to us. They have their own institute as well but they are within the College of Education.

Miller/Lee: *Brad, what do you see as the major changes in the last decade for your work?*

Brad: From the perspective of the kind of work we do, over the past decade a lot of the projects we had were investigating game-based learning environments. We took game technology plus AI technologies, and combined them to create rich immersive and adaptive learning environments, primarily in K-12 space.

Going back 10 years, there wasn't a lot of game-based learning. A lot of advancement has occurred. One big change we have seen is the platform where we deploy the systems. Traditionally, schools have had a computer room with desktop computers, and that is the environment we would deploy in.

Over the last decade, that has been evolving. Now, some schools have laptop carts where they bring in laptops to the classroom. Some schools have tablets. Some schools are moving towards having students use their own devices like their smartphones. Our software has to evolve to work in all these different environments. We must figure out what the best devices are for a particular project.

One of the things we have noticed when we deploy the software (is that) the device influences how the students interact with it. If you have four elementary students at a table, each with a laptop, it changes the interaction style of the students versus if they are sitting there with four tablets.

Different devices are changing how we think about the software, but also about how the student interact, how they collaborate using the software.

Miller/Lee: *Do you use more engines, more packages, today for creating the software, unlike in 1967, when every line of code was written for every project*?

Brad: That's been an evolving thing over the last decade. When I first started here and when I was doing my dissertation work, we were using the Source Engine. That was back in 2005-6. Back then, there started to be this notion that you could have a game engine, and the game engine would provide a certain set of functions like rendering, the physics simulation, and how to get 3D models into the virtual world. The game engine would also have ways of hooking in your own code to control how objects interact and behave.

Valve Software developed the Source Engine, which was used for a very popular game called *Half-Life 2*. You could "mod" this game. You could take the game, with all of its years of development, and then "mod" it to make it do some things it didn't originally do.

The Source Engine was designed around that idea. You had one game, with lots of assets for that game, and you could mod it to do other things. But one of the restrictions – and the reason we stopped using it – was that you had to own a copy of the game to use it. So, if you were deploying a game in a classroom, it doesn't really scale to the full classroom. It was okay for lab-based studies.

One of the first things we did after I started here as a research scientist in 2008 was to switch from the Source Engine to a relatively new game engine called the Unity Game Engine. It had some nice features; it was multi-platform, so versions of your game could run on Macs, but also on PCs. It also supported deploying games to web-browsers via a plug-in which allows for easier classroom implementations.

James: And the project mentioned earlier (Leonardo) had to be rolled out to nine or ten states so it wasn't possible that Brad could go down to a specific school and tweak it. We needed to be able to easily deploy our software on a large scale.

Brad: So, the game industry has evolved to more refined packages that provide certain functionality. It is much easier for non-expert coders to create their own games. We have leveraged that in our work.

For example, the Source Engine is very painful to work with. It is low-level (C++ code, memory management), but Unity Engine is based off higher level language (C#), and you can do a lot of things without even coding.

You have this visual integrated development environment where you can move objects around in the virtual world, and create animations without dropping down to the coding level.

Miller/Lee: *So, you guys are pulling from the gaming industry, from AI, from the educational domain – you are amazing!*

Brad: We draw on a lot of different expertise in the Center for our research. James has decades of AI research experience. I have AI research and game industry experience. We have digital artists, software engineers, and psychologists working with us.

Miller/Lee: *And has all of this just evolved?*

James: One of the great features of our department is that it really does invite interdisciplinary work. There are very few places like this Center in the country, because we reside in a College

of Engineering. Most work in educational technology resides in education departments, without the technology expertise.

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 were 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 their inviting this interdisciplinary work. There are many computer science departments that say they do interdisciplinary work, but this department has really done it.

Miller/Lee: *Are there other changes in the department over the last decade that you think should be remembered?*

James: I think that many of the people that are in the leadership positions now were hired by Alan Tharp. George Rouskas, Laurie Williams, Munindar Singh – highest scholarly impact faculty member! – Chris Healey, Rob St. Amant and others. These now-senior people in the department were hired by Alan. Then Mladen supported these people's work in many interdisciplinary areas.

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.

Miller/Lee: *What changes have there been outside the department – at NC State and broader – over the last 10 years?*

James: AI!

When I went to graduate school from 1986 to 1994, I thought AI was the most awesome thing ever. I had been a history major, and then I went back to graduate school in computer science.

Miller/Lee*: Wait! Tell us how you found your way to computer science. You were an undergraduate history major, right?*

James: 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 with nails from 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 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!

Brad: And this is also possible because today we have access to all this data.

Miller/Lee*: Chris Healey said the biggest thing in the last decade is everyone has big data. They may not know what to do with it, but people like you have figured out what to do with it.*

What are these million-dollar jobs going to do?

James: They will work for companies you have heard of like Google, Microsoft, and Facebook. Or they will go to work for companies you haven't heard of, like spinoffs from Siri or companies that do AI work for hedge funds. All aspects of our lives are very quickly getting AI-ified.

So, if you advise a 20-year-old kid what he/she should do, suggest they go do AI!

Sean Mealin
Doctoral Student
Monday, November 7, 2016

Sean Mealin with his Guide Dog, Simba, joins us now.

Sean is a PhD graduate student, and an NSF Graduate Research Fellow. His research focuses on using technology to enhance communication between dogs and their handlers. Right now, his focus is on working dogs, such as guide dogs for the blind and search and rescue dogs. Sean is completely blind.

Miller/Lee: *You are the only graduate student we are interviewing today. You work with Dr. Roberts, don't you?*

Mealin: Yes – my advisor is Dave Roberts. I work on the canine side of things. Our work has to do with how we can use technology to better work with and play with and live with dogs. I got into it for obvious reasons.

Miller/Lee: *What's computer science-y about that?*

Mealin: Computer science is interesting, I think, in terms of canine behavior and training, because computers are very good at what humans bad are at, and human are very good at what computers are bad at.

For example, a very large component of training dogs is the human/canine bond, and that's something you can never replace with a computer. Another very important aspect of training dogs is timing and being consistent, and studies have shown that in order to be as optimal a trainer as possible, your timing has to be within a fraction of a second in order for the dog to make the link quickly between "I just got food" and "I sat on command" – and you have to be very consistent. That is something computers are very good at that humans can be questionable at.

So, our hope is – at least for training – that bringing together the best parts of each makes it better for everyone.

Miller/Lee: *Are we looking at dogs for going through disaster sites?*

Mealin: Sure. We've worked with FEMA and their search and rescue teams, and over there is a lot of interesting work where you can actually 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.

Miller/Lee: *So, you would give them the signal to return?*

Mealin: Exactly! And you can also 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 it's 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 sort of remote control.

Miller/Lee: *Does the dog need to be trained from birth?*

Mealin: 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.

Miller/Lee: *Is a dog first trained to be a rescue dog and then trained to use the technology or is it all one piece?*

Mealin: 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.

Miller/Lee: *Do you usually tend to use dogs like Simba? Is he a Yellow Lab?*

Mealin: Yes. In a lot of our studies, we use Yellow Labs, because that's what we have access to. Simba is great, because he's always on campus with me, and we can pilot something with him before we actually start a formal study.

We have to be careful with Simba, (because) he is an actual working dog. We can't do any behavior modification, because his training is already so specialized! We have the Institutional Animal Care and Use Committee okay everything that we do with dogs, to make sure that they are safe and well-cared for at all times, since we are all dog lovers.

We also only use positive reinforcement in our studies. That means that we only use good things like food and toys to get the dogs to do what we want them to. When working with Simba, we try not to use food too much, because the biggest danger with guide dogs is that they become expectant that they can get food whenever they want.

If we go to a restaurant and Simba sees food on the ground, he ignores it. I don't want to let him get into the habit of thinking he can grab food that's on the ground!

Miller/Lee: *Were you an undergraduate here?*

Mealin: I was. I started in 2009, and did four years of undergrad, and four years ago I started graduate school.

Miller/Lee: *How did you get involved in the project that's going on now?*

Mealin: I wish there was a better story here. My senior year, I actually took classes with Dr. Roberts and the way he taught – the way he conducted exams – honestly, I'd go to this office just to chat with him, because I just found his style of passing along information to be very cool. At that point, I didn't actually have a guide dog.

I decided to get a guide dog when I was a senior. I was doing research with Dr. Murphy Hill in the department, and as an undergrad I actually had an opportunity to go to Innsbruck, Austria to present my work. When I was out there with only a cane, I realized, "If I'm going to be traveling, I really do need that guide dog, because they can do so much that canes can't."

There are trade-offs, right? A guide dog is obviously more responsibility, and requires more care than a cane, but I can tell Simba, "Find stairs…find seat… find elevators… find the doorway" so when I'm in a situation where I don't know anyone and I have vague directions like "Go four blocks left down that way, then go through the door." I can follow four blocks – that's fine – but if there's not a lot of foot traffic, it's very difficult to find the door sometimes, unless people are walking through it.

Miller/Lee: *Where did you get Simba?*

Mealin: I went to California to get Simba. There are a number of guide dog schools around the US and around the world, as well, but in my current project, we actually partner with a guide dog school up in New York, and we're assisting them with coming up with a better way to evaluate dogs in training.

Guide dogs are very expensive, considering the amount of training and health things they have to go through, and there's a very high rate of failure in guide dog training. Even though these schools have their own breeding programs – guide dogs are literally one in ten dogs, so the failure rate can actually be as much as 60 or 70 percent of the dogs within a program.

My current work is taking the heart rate and respiration rate and all these different things that we can measure on the dogs themselves, and lead to more objective evaluation criteria. We are trying to determine if a dog will fail later on – so they can focus resources on dogs that are more likely to make it.

Miller/Lee: *So this was a real transition for you going to a guide dog…you have to learn a lot, too.*

Mealin: Correct – yes! There are two things: When I received Simba I was between my undergrad and my graduate (degree), 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.

Miller/Lee: *But you were already in computer science…*

Mealin: Right – right. Dr. Roberts actually taught a game class – he's one of the gaming professors – and I just 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!

Computer science is almost unique in that it touches virtually every other area in the world today, so whatever your passion is or whatever you want to do, chances are you can do it from a computer science perspective.

Miller/Lee: *How did you find NC State?*

Mealin: *There is some discussion about factors that leading Sean to choose three universities to decide from – NC State, UNC, and UNC Greensboro. He explains why he chose NCSU:*

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 and toward my sophomore year, it was the 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 ended up having to adapt one of the final projects in 116 to be accessible, and 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, and I'll find hourly money for you, and you can give live feedback. That way, we have someone who would use the product involved in the product design."

After doing that project with her, and doing a study on blind software developers with Dr. Murphy Hill – because, once again, I was in his class – he asked, "How do you do this? No one's actually looked at how blind people think about software development differently from sighted people." That led to him and me doing interviews and eventually 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 Austria.

Miller/Lee: *What computing devices do you use?*

Mealin: I spend way too much time behind my laptop. I think that's common to pretty much everyone in computer science. I have a smartphone just to keep in contact with people, and I probably don't use it nearly as much as I should.

Miller/Lee: *Do you use a tablet?*

Mealin: Not too often.

Miller/Lee: *Everybody says that! Do you think we should tell Apple?*

Mealin: I see a lot of the faculty and staff using tablets, but most of the students I know don't actually use tablets now unless they have to.

Miller/Lee: *What is computer science today?*

Mealin: That's a hard question! On the surface you want to say, "How can computing be brought into our everyday lives?" or I guess in the more academic sense, "How can we study computing and use it to solve more problems and more types of problems?"

That's more the heart of computer science, because it's not just developing a product and saying, "There – you have a touch screen on the checkout line."

I think computer science focuses more on the class of problems we can solve, and how we can do it in a way that benefits humanity.

Miller/Lee: *What ideas do you have about how computer science is not yet being used for some problems that could be solved?*

Mealin: I think there are two lines of thought. There's the computer science in the way that can make people lazy, or get rid of the everyday problems that we don't want to deal with. But maybe it's good for us to deal with those problems, maybe it makes us think.

But we want to be lazy – I think that for 99 percent of people, that's just the human condition.

I think the other avenue is, "What are the spaces that we haven't even thought of, because (they're) so outside of our everyday lives, that computers can open up for us?" Look at how computers influence experiments on the sub-atomic level, or how computers can allow us how to create new types of drugs that were at best theories twenty years ago.

That's opened up entire new vistas of research and questions and everything, so I think that computers will continue to do that. And as we expand to space or expand to anywhere that humans in general just have not been able to get to before, (this) will give us the ability to think in that realm.

Miller/Lee: *Where in your everyday life would you like to see computers added to benefit your quality of life?*

Mealin: I think the obvious answer for myself is self-driving cars. Having a self-driving car would allow me to get to where I want to go without having to ask for a ride or schedule a cab or take public transportation.

There are trade-offs for all of those. Asking someone, you have to have the friends and the resources in place to be able to do that; cabs or Ubers cost money; public transportation can be free or cheap, but that costs time. Having my own way to get to school or wherever I want to pursue something would be the largest quality-of-life change.

There are cultural shifts, I think, that still need to happen, and people need to figure out where technology should be, and where technology shouldn't be.

The technologies you're dealing with are probably already invented – you're looking at adapting that technology to new uses – and I think that's where computer science is right now.

I think we understand a lot of the basic building blocks, but how can we build new buildings with those blocks – how can we build new structures and put them to new purposes?

Using canine technology for search and rescue and guide dog evaluation is great, but how nice would it be if it also allows people to understand dogs better? Canines and people fundamentally communicate differently – canines with very visual and body-language communication, and people with verbal.

What if we used technology to bridge that gap, especially for people who don't know how to interact with dogs or how to work with dogs or train dogs – having technology essentially train them and allow them to communicate more easily?

Melissa Novitsky

Undergraduate Student
University Scholar, STEM Scholar, President of WiCS, CSC Ambassador
Monday, November 7, 2016

Miller/Lee: *We welcome Melissa Novitsky to discuss the campus life of a woman undergraduate, who is also a leader in the student body. Melissa, what classes are you in?*

Novitsky: I'm a junior. It's my third year on campus, but because of credit hours from AP classes in high school, I'm just about at a senior status.

Miller/Lee: *I'm really interested in what today's undergraduate thinks computer science is. We'll keep that 'til later, though. What I want to know now is what it's like to be an undergraduate in 2016.*

Miller/Lee: *What's your day like?*

Novitsky: I 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 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.

Miller/Lee: *Are your classes mostly on the main campus with a few over here? What kind of mix do you get?*

Novitsky: 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.

Miller/Lee: *What are you taking?*

Novitsky: I just came from Interactive Game Design – that's an elective for us – and it's really fun! 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 system for my first project, and that's just so cool to me.

Miller/Lee: *Do you use gaming engines?*

Novitsky: We're using Game Maker. I was just working on it before this meeting. It's a really cool platform-maker. Basically – you can make objects and put them in your "room." It's pretty easy.

The class itself is also open to non-degree majors. I think it would be easier for a non-degree major to be able to come in and play that, and mess around with Game Maker. It's not a very heavy coding class.

Miller/Lee: *What are you specializing in?*

Novitsky: I would say my specialty is security. I've been working at CISCO, interning there in the Security & Trust Organization. I've been trying to take the security courses this year. I think they're trying to make it an official concentration in the department soon – I'm hoping they are! It will be past my time, I'm sure, but that would be really cool. It's crazy to me that we don't have a security concentration here yet.

Cyber security 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.

Miller/Lee: *Where do you eat?*

Novitsky: Most of the time, I eat at my apartment. I usually go home and have a big lunch, and then it's just kind of snacking when I remember that I'm hungry between working on projects. Students can just sit in the library or at home working for hours upon hours, and forget that they haven't eaten practically the entire day.

It's probably really bad, but we just get lost in our work and value grades – and hopefully learning – more than our health sometimes.

Miller/Lee: *Where do you work here (NCSU) on a project?*

Novitsky: It depends on the class and the type of project, but for Interactive Game Design we have group projects and we work in the Daniels Hall (building on Main Campus).

For other 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 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.

Miller/Lee: *In the Hunt Library?*

Novitsky: Yes, it's usually at Hunt Library. They have nicer rooms and bigger study areas, and we can connect our laptops to the 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.

Using Google Docs is great, because you can share one file on the Internet that everyone who has access to can edit and update. It's a fantastic tool, and has changed the way we study and collaborate.

Miller/Lee: *What else are you taking?*

Novitsky: I actually lowered my hours this semester because I'm president of WiCS, and in Ambassadors, and I'm involved in other stuff, so I dropped down to 12 hours, which is the lowest I've ever done. It's still full-time, and with everything I'm involved in it sometimes feels like it's the most classes I've ever taken at once.

That's partly because the content in the classes is much more intensive, and requires so much more effort and time. I'm in Network Security, Interactive Gaming, Operating Systems, and Communications for Engineers, which is the Technical Writing course we have here – it's an entirely online course, so I've never actually met the professor for that.

Miller/Lee: *Ken (Tate) told us about the Ambassadors Program.*

Novitsky: Yes, it's a fun thing to be part of. It's great to be able to sort of be the face of the department in some ways. I really enjoy helping the department with the various events it puts on, and being able to give back.

Some of my favorite moments from being an ambassador happen during Open Houses, where prospective NC State and/or CSC students get to come by campus, and we can talk to them about their interests, and how they can fit in at NC State. I love being able to tell younger people with an interest in Computer Science that they have a bright future ahead of them.

Miller/Lee: *Do you do any project work in Operating Systems?*

Novitsky: Yes, that class is about a project a week – there are homework assignments with some questions to answer, and a small program that you have to edit and make work. We usually have to use LINUX and VCL – the Virtual Computing Lab.

For that class, they have a specific reservation you have to use in order to emulate a specific operating system set up for the given assignment.

So, I have the networking class, which has its own programming projects, and I have the operating systems class with its own projects. They both use VCL, and, when it works, it's really great! At the end of a project period, when everyone is trying to work on their project and finish it, the VCL system just gets so slow!

Miller/Lee: *How do students know what's going on and what's available to them?*

Novitsky: They receive emails from Ken Tate, and, if they're part of WICS, they're going to get emails from me. I'll advertise about the events coming up, and any opportunities available in the area. Different companies or local groups will contact me, and ask me to advertise to the WiCS group about their events and opportunities, and I love being that gateway for that.

It's really gratifying when a WiCS member says, "Hey I got a job because of the mailing list," or "I had an awesome time at that event, I would have never known about it outside your emails."

In addition to emails, students get information through posters or flyers around campus, or the big TVs we have around buildings with slideshows of info on them, or through social media. We make sure to make an event on Facebook for just about everything. It's the fastest, easiest, and most reliable way to get an RSVP for an event and gauge your attendance numbers.

Miller/Lee: *What computing devices do you own and use?*

Novitsky: I have a laptop and my smartphone. I have an iPad at home – I don't use it all that often. I'm mostly on my laptop and my phone.

Miller/Lee: *Can you use the Virtual Computing Lab from your laptop?*

Novitsky: Yes, all my projects and homework assignments are done on my laptop. There's hardly ever a need to be on a desktop or a school computer.

Miller/Lee: *You mentioned that you were president of WiCS (Women in Computer Science). Is it for both undergraduate and graduate students?*

Novitsky: It's open to everyone, but it's mostly undergraduate participation. We've been trying really hard to get graduate students more involved, because we would really love more opportunities for the two groups to help each other out and give different perspectives on things, and especially for more mentoring participation.

As difficult as it is to get undergraduates to participate in events we host, it's nearly impossible to get graduate students to participate in our events. It feels like they're all in their little holes of the building, and they only come alive at night!

Miller/Lee: *What kinds of issues are women in computer science interested in? Are you a support group for one another?*

Novitsky: I view it as a community for people to come together and talk about any problems they're having, meet new people in their own community so we can see that we're not the only ones. In classes of 100, there are maybe 10 of us. It's officially at 13 percent, but on average, you're going to see about 10 girls in your classes.

Most of our (WiCS) events are social, so you get to know people and eat food. We spend a lot of money on food. It's good to bribe people to get them engaged. It's really hard to get students involved in things. We go through all this time to plan these great events, and then people don't really show up. You have to give them food and say, "Oh, we're going to give away free prizes!"

We do our best to create really awesome opportunities for our members, but everyone is just so busy with schoolwork. It's really hard for most people to make time for extracurriculars, and I totally get that, I just wish more people were able to branch out a bit more.

School, classes, and learning are very important, but I think it's also very important to do something with your time here in college. We're not going to be young and this (relatively) care-free for very much longer. Meet new people and make new friends while it's still pretty easy to do so.

Miller/Lee: *Now it's time to ask the question, "What is computer science to you?"*

Novitsky: It's solving problems creatively using logic and software.

Miller/Lee: *What are some of the problems being solved today with computer science?*

Novitsky: There are a lot of them in the world, but – that's a hard question – everything! Everything is being solved with technology. There's not a single product anywhere, I think, that doesn't involve technology in some way, with some sort of computer science logic behind it. Everywhere you go – it's just everywhere! Even my toothbrush has a computer in it, for goodness' sake!

That's something I'm becoming very interested in, actually, is the Internet of Things (IOT) and the security measures that – I'm hoping – will be incorporated in the development of these products.

Everything will soon be connected, and this opens up so many new windows with technology and society. It'll be the next industrial/technological revolution, and it'll definitely be a societal revolution.

Miller/Lee: *What drew you to computer science?*

Novitsky: 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.

It had the challenge that I liked from Calculus. It was challenging, and you had to solve problems and figure out how to do it, but it was really, really fun. It was a fun kind of challenging! 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. I think it was Ken Tate who 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! I've done so many things that I would not have gotten to do if I had chosen any other major here at NC State, or any other University.

My favorite example happened not that long ago. I was approached by the congressman's office from Raleigh 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.

Miller/Lee: *Why in the world was his office looking at doing a hackathon?*

Novitsky: 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. Most of the apps were 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 go vote at the recent elections, and he was on the ballot. First were the Presidential Candidates, then the Senatorial, then the Congressional. I thought, "I know that guy – third from the Presidency!"

Miller/Lee: *Anything else you'd like to share about your time here?*

Novitsky: Take the opportunities that are presented to you. My teacher just randomly asked me to be in computer science the following year, and I 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 and also – that technology is everywhere and that's probably not going to change any time soon!

Dr. Douglas Reeves

Professor of Computer Science and Electrical and Computer Engineering
Associate Dean for Graduate Programs in the College of Engineering
Tuesday, November 8, 2016

Miller/Lee: *Doug Reeves meets us in EB2. Doug, you have been with the department for a long time. Let's start by talking about computing devices. What computing devices do you use today? And what did you use when you arrived?*

Dr. Reeves: Thirty-plus years ago, my startup package was my own personal computer, a Sun workstation. Today I use a laptop, a Mac Pro. And I do a fair amount of web browsing on my smartphone. I had a tablet, but it got to be too many devices – too much to keep up with. But there are others who don't use laptops. They use tablets… they don't need to do keyboarding that much.

Most people are thinking, "I just want to get stuff done. I don't want to be obsessing with technologies, setting things up. I just want to get stuff done. I want to do some web browsing, read some email, and I don't need fancy capabilities for that."

Miller/Lee: *What is computer science today?*

Dr. Reeves: For me, the heart of computing is logical thinking…if I just had to boil it down. I could talk about applications. I could talk about systems. I could talk about technology, and about impact, but the heart is logical thinking. You can't get very far in computing if you don't think logically.

Computing is really powerful, and there are some strong organizing principles. Computer science is in same ballpark as mathematics, if you think of mathematics as the language that describes the natural world. Pretty darn fundamental. Computing is very close to that.

Joke – I wanted to carve on the outside of our building, chiseled in stone, "Computer Science ≠ Programming." I am a very happy programmer, and I have written much code, but computer science is not the same thing as programming.

Eventually, you have to put ideas into some programming language, but we can teach logical thinking without teaching it, using a programming language with intricate punctuation. Today, there are graphical languages for kids to emphasize logical thinking – "If I do this, then that happens" – seeing that connection.

Miller/Lee: *Are you teaching?*

Dr. Reeves: I am teaching a 700-level, PhD graduate course in Network Security. I generally teach one course per year, because of my other duties.

Halftime, I am Associate Dean of Graduate Programs at the College (of Engineering) level. I went one year without teaching, but felt disconnected from purpose of the institution, so I returned to teaching.

Miller/Lee: *We keep hearing the word "security…"*

Dr. Reeves: I didn't expect to be working in a field that I would see in the headlines of newspapers with great regularity…the standard, nontechnical, everyday audience newspaper. But that is the place security is today.

Miller/Lee: *Is there misunderstanding by the public with regard to what security is about?*

Dr. Reeves: I am sure most people don't get the technical basis, but I think there is widespread understanding today….understanding that we need to be concerned about privacy and protecting our data, and about who we share our data with.

The pervasiveness of security and privacy as an issue and the public understanding of it have certainly changed dramatically in the last 10 years – no question about that.

Miller/Lee: *What other changes have you seen in the last 10 years?*

Dr. Reeves: The most transformational technology is the smartphone. It has changed everything. I completely underestimated the iPhone the first time I saw it. I thought, "Hmm, that is kinda neat. You can flip pictures."

If we divide recent computing history into 10-year segments based on transformative technology, this 10-year segment would certainly be the smartphone. The 10 years before that, I would say it was personal computers. The next 10 years will probably be Artificial Intelligence and Big Data.

Miller/Lee: *Does the university try to anticipate what the needs will be? Is work at the university driven by public demand?*

Dr. Reeves: We are responsive to the public. We are a public institution. At a very basic level, we are responsive to the needs of the state. Certainly, our mission is to prepare our students for good, productive lives.

Miller/Lee: *Is there strategy to fields that will grow?*

Dr. Reeves: There is strategy. It is distributed/shared in a university, less like a company. It is not just one or two people creating the vision. To a certain extent, it is based on input and instincts of faculty – "We should really do this. There is a ton of research funding in this area" – and competitive aspects – "Georgia Tech is doing this."

Miller/Lee: *And some research is based on critical needs?*

Dr. Reeves: Certainly. They are placing their bets on what will be needed. Security is one of those areas. Security is still growing. The driver is (that) bad things are happening.

Miller/Lee: *Where did major research funding come from this decade?*

Dr. Reeves: It came from the Department of Defense originally, but now from the National Science Foundation.

Miller/Lee: *What about non-governmental funding sources?*

Dr. Reeves: We are better supported by industry than many departments. Industry funding tends to be short term and smaller scale. There are not many million-dollar grants or gifts from industry. There are some, but not many.

Miller/Lee: *Is our proximity to the Research Triangle Park important?*

Dr. Reeves: 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!

We've got another "leg" – tripod, chair, whatever – i.e. economic support. Fifteen years ago, I would not have thought finance. I talked with several people at those companies. They have some 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, finance, education, and government. The Triangle has a very diverse and very robust economy.

Miller/Lee: *What is your position in the dean's office?*

Dr. Reeves: I am the Associate Dean of Graduate Programs. I was the department's Director of Graduate Program before.

Miller/Lee: *What do you do?*

Dr. Reeves: I give money to departments for recruiting and for support in the departments, which comes down to fellowships, scholarships, and recruiting visits. Some of it is program support, not recruiting.

We have various events, programs for graduate students that are funded by the college. There is beginning to be more of this now, since we have a fee for graduate students in the College of Engineering. The fee specifically supports educational improvement or enhancement.

I am in the approval chain for all sorts of exception requests and various approvals of academic programs and student issues – e.g. appeals, dropping a course, getting into a program.

Miller/Lee: *What things do you see as significant in last 10 years?*

Dr. Reeves: Continued substantial growth in graduate program. We have 200 PhD students, 700-plus graduate students, and maybe 900-plus undergraduates.

Miller/Lee: *How much of growth comes from intentional recruiting?*

Dr. Reeves: We do not fully control the number of undergraduate students. The university and the college get in the act. At graduate level, the department controls it. The department makes its own decisions, and sets its own targets.

Computer science is in the enviable position of having way more applicants than can possibly be admitted, so they have complete control of where to put that knob… that is to dial it up and still have very good quality applicants, or dial it down and still have a strong, robust program.

Also, we now have premium tuition. I view this as an accomplishment. It means $2-2.5 million ongoing support directly to the department to support the graduate program. The students pay $2,400 per semester – the same for in-state and out-of-state – and those dollars go directly to the department.

The faculty has also grown tremendously in last 10 years. Now we probably have 45-plus in tenure track. The faculty is more diversified technically. We span more bases. The spectrum is wider, we have many different specialties.

Miller/Lee: *Tell us about the James Hunt Library on Centennial Campus.*

Dr. Reeves: 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.

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

Dr. Reeves: 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!

The reason I was on the library committee was that I have loved libraries from my youth – growing up in libraries, browsing books, taking books down off shelves.

There was one thing Susan Nutter (wanted) that she didn't get – a bar on (the) rooftop!

Miller/Lee: *Where did the notion of a library on Centennial Campus come from?*

Dr. Reeves: It was in the plans for Centennial Campus from the late '80s. The library has been built for four or five years. It is very supportive of computer science. It is very technology driven. This library is primarily for engineering and textiles.

Dr. George Rouskas

Professor and Director of Graduate Programs

Tuesday, November 8, 2016

Miller/Lee: *We meet with the Director of Graduate Programs, George Rouskas, in the new CSC Corporate & Career Services Suite in EB2. The new suite provides a communication center for graduate students and the department's industry partners.*

George, welcome! How long have you been the Director of Graduate Programs in the department?

Dr. Rouskas: For almost three years, I have been the Director of Graduate Programs. It has been interesting getting to know about the university, outside research and teaching.

Miller/Lee: *Tell us what the Director of Graduate Programs does.*

Dr. Rouskas: I lead the graduate program, so I do recruiting for both Master's and PhD programs. I, along with other faculty members, make admission decisions. I make sure the students do well.

We monitor their progress – for PhD students in particular. Four or five years ago, we began having a Black Friday, where faculty get together and review the progress of the PhD students.

Most Master's students know what they need to do. They take 10 courses. Most don't do a thesis. They progress in the program, as long as they maintain a 3.0 GPA. For PhDs, it is obviously a research program, so we need to make sure they meet research milestones in a timely manner.

There are certain time limits that the Graduate School imposes on meeting milestones. The university now focuses on graduating students in a reasonable amount of time, as opposed to taking a very long time.

The very first thing we do is to make sure they have a plan and an advisor, and (that) they meet their milestones. We do not typically have faculty and PhD students connected before they enter the program.

We have approximately 200 PhD students and 500 Master's. We have the 2nd largest graduate program in university, slightly behind Electrical and Computing Engineering. Our program is larger than several colleges at NC State.

We are the largest graduate program (PhD and Master's) in the country. This school year, we will probably graduate 30 PhD's and about 240–250 Master's students. I have to have two bottles of water to call all the names at graduation!

Miller/Lee: *Do you have a staff?*

Dr. Rouskas: We are very efficient. We do everything online. I have one admissions manager. We receive about 2400 applications each year, and he single-handedly manages those applications. I also have a graduate services coordinator who basically takes care of logistics once the students are here.

Miller/Lee: *How does graduate student recruiting differ from undergraduate recruiting?*

Dr. Rouskas: Graduate recruiting is very different from undergraduate. 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. Most Master's students are from India.

The PhD program has most students from China and the United States; a few are from Europe and from South America. The Master's program is probably 80 percent Indian.

Miller/Lee: *Are there different tracks /concentrations within the Masters program?*

Dr. Rouskas: In the past 10 years, we have (had) two new tracks, two concentrations – software engineering and data science. We are working on a third one in security. We also have a graduate certificate in data science that started this fall. It is a joint program with the statistics department, and we have about 12 students.

The process of establishing a Master's degree in data science has begun. It will be a joint program with Mathematics and Statistics. It is a long process, and we hope to have it ready by fall 2018. These are all new programs of the past three years.

We also have a Networking Master's degree. Networking has been around more than 10 years.

Analytics is a one-year program directed by Mike Rappa. It is not in a college; it is an institute. There they use techniques (such) as "black box." This institute is focused more on business. It is not in our department.

Our data science degree is more focused on fundamentals. We focus on algorithms, and how to build systems.

Miller/Lee: *Where do students go to work after they graduate? What companies?*

Dr. Rouskas: More than half go outside North Carolina, but most stay within the US. Most undergraduate students stay within North Carolina.

Our international students do not have roots in NC, so they take the best offers, wherever they are. A lot of our students go to Google, Facebook, Amazon, Apple, and a lot to Microsoft.

Now, we have a lot of financial companies like Bloomberg. Actually, they are software companies dealing with the financial industry. Deutsche (back office) hires graduates. Some like Fidelity and Bank of America hire mostly undergraduates. Many pharmaceutical companies hire our graduates. We have about 40-45 gaming companies in this area, as well.

Miller/Lee: *How do the social and political dynamics of this area affect international recruiting?*

Dr. Rouskas: I get requests from candidates coming from underrepresented groups. They want to know about diversity here, and if they will be able to socialize with peers. But I think in the graduate program, especially Master's, a lot has to do with networking and word of mouth. We have a large pipeline from India and China.

There are three things – academic status is very important. Economic considerations (are) the second factor…we are less expensive than our peers that are private. And the third one is community of their peers…this pipeline brings them here.

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

Miller/Lee: *What computing devices do you have?*

Dr. Rouskas: I can probably do 80 percent of my job with my smartphone. When I am waiting at the airport…I can read emails, reports. I use an iPad/ tablet when I need a larger screen. I use my laptop when I am working at my office or when I am giving presentations. I use the smartphone, laptop, and tablet in that order. I use the tablet the least.

Miller/Lee: *What is computer science?*

Dr. Rouskas: Computer science is just another tool for solving very difficult problems. Computer scientists are using algorithms and computational techniques. It is not just coding anymore – you can outsource that.

The way to think about computer science is it allows you to break down problems and use algorithmic components to solve difficult problems. It is abstract thinking. Obviously, you have

to understand technology and be able to break it down and use appropriate technology. But computer science is a tool for solving difficult problems.

Miller/Lee: *What is cluster hiring?*

Dr. Rouskas: 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 (in) collaboration with statistics and math, so we have faculty from these three departments. This is how we started the Master's and (the) certificate in data science. There is a cluster in digital forensics. It pulls some of our game faculty. There is a list of the current clusters.

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.

Miller/Lee: *Who is coordinating/overseeing/running these clusters?*

Dr. Rouskas: The provost. But each cluster will have a faculty member who takes the leadership role for that cluster. Each cluster works independently.

Miller/Lee*: Tell us about online education at the graduate level.*

Dr. Rouskas: About 10 percent of the Master's students (45-50) do the program exclusively online. The Graduate certificate program can be completed entirely online.

Online courses are exact equivalents of in-class courses. The only difference is the delivery method to the student. Projects, homework assignments, exams…are all exactly the same as the in-class course. We really want all students to have the same experience.

Our online classes are not like the classes offered by Coursera and other organizations. Their main focus is scalability — 1,000 or 10,000 students, then how do you grade it? Work must be graded by computers.

Our online course is the same as in class. Our Teaching Assistants grade the work. Students can call me or send me email. Delivery of lecture material may be different. Lecture material is often broken down into smaller segments. Online will not replace the university.

For online MOOCs (Coursera or similar), only a small percent make it successfully to the end. And even fewer pay for the certificate. To apply to graduate program, the student must have undergraduate prerequisites. If the student says, "I took this course at Coursera," that does not count. The program has rigorous requirements to achieve accreditation.

Miller/Lee: *Describe the graduate curricula for past 10 years.*

Dr. Rouskas: 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, gaming courses.

North Carolina School of Arts has a film study program. They want to create a joint Master's with us. Film studies majors there want to know how to develop the technical part with gaming.

Security has been very important over last 10 years, and so has Software Engineering. The code base has become so large that finding bugs and managing code is very important. We haven't collaborated with medical, but NC State has some collaboration in biomedical with the medical school at UNC. Education 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 smartphones. There are many areas of security; malware, privacy, and advanced crypto algorithms. The security of web browsers is important.

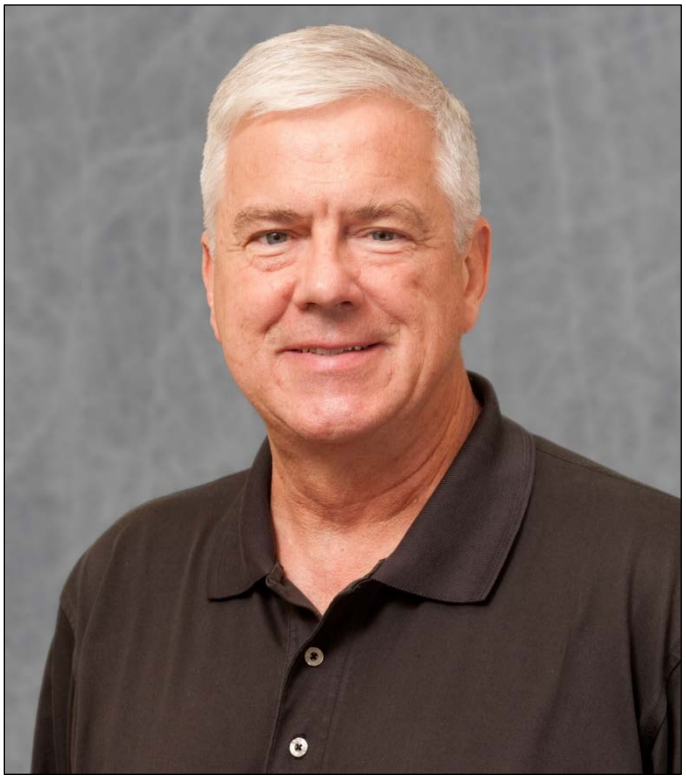
Miller/Lee: *What is the year like for the office of graduate programs?*

Dr. Rouskas: In the spring, we have recruiting, ranking candidates, calling them, organizing recruiting weekends, making offers. For the PhD students, the most important thing is having some research experience, some work on projects, and an interesting Master's thesis.

We are also looking for strong recommendation letters from faculty members who have worked with the students. We can see the grades, but we can't tell from the grades is how they will do in research.

In the summer, I do research and prepare for new students coming in the fall. There are a lot of questions from the students. I make sure they get registered. It takes two weeks to make TA assignments.

Financial support is distributed as a stipend from department. Top candidates may be offered fellowships. Money comes from the office of the provost or the dean. For the past three years, we have had premium tuition for the graduate program. Those dollars support the graduate program.



Mr. John Streck

Research Faculty

Monday, November 8, 2016

Miller/Lee: *John Streck talks with us next. John is a multi-talented and creative member of the faculty, who has collaborated with a number of other faculty at NCSU and has worked closely with Mladen Vouk for many years in various research endeavors.*

John, tell us about your work here at NC State.

Streck: I was at State for the first time from 1996 to 2005, working on networking courses, labs, and projects with Mladen. In 2005, I left to work at UNC-CH, managing their communications system until 2010.

When I came back to NC State in 2010, instead of coming into the central IT side – think OIT and Comtech – I came into the academic side. At that point, I was still had working in networking-related tasks, and had continued while at UNC to stay still in touch with Mladen.

But in re-entry to State, I was shifting out of the pure networking side and (into) more of a blend into the middle and upper layers of networking. (I was) working more on Cloud Computing, which I had worked (on) with Mladen and Aaron Peeler and those folks when they built the first platform during my first employment at State.

That was the time when I was in the Hillsborough building for Sam Averitt (the CIO at that time). Mladen had a big IBM grant, which was the hardware platform for Mladen's start of probably the first Cloud environment in academia. The team – which we didn't know we were, as this evolved – included Dr. Eric Sills, Michael Bugaev, Sam, and others. At that time, I wasn't actively involved with Mladen as far as doing the software, as I was a hardware tinker at heart.

Miller/Lee: *I was just thinking – Cloud Computing is a significant development of the last two decades.*

Streck: Eric, Aaron, and Mladen developed that, and it was built off an IBM software they had designed (and) put together, so they constructed it – and the Cloud that Mladen and Peeler those guys developed was really the management platform for doing Clouds.

I came back from Chapel Hill to work with Henry Schaeffer and Sam Averitt on a Homeland Security Project which involved using the Cloud, i.e. VCL, along with donated SAS software. So, that was my entry back into here.

Miller/Lee: *Did these projects come on a contract?*

Streck: It was a Federal contract, which included NC State, SAS, and UNC-CH. I was here three years.

Miller/Lee: *Did you all collaborate with each other or work independently?*

Streck: As much as you can collaborate – everybody has their own vested interests. As the project neared, the funded activities all went to SAS.

Miller/Lee: *SAS is now all Cloud Computing?*

Streck: At the time I came back to State, SAS had an internal development project with clouds that they didn't announce to the public, and I believe that was one of the underpinnings for SAS On Demand.

When I came back, my office was Mladen's old office on the Fourth Floor of HRC. I then re-engaged working with Mladen teaching, and it was a graduate class in Cloud Computing.

Miller/Lee: *So, we now have a graduate course in Cloud Computing. Is it a 500 level?*

Streck: Yes, and it's been there for six years. This year, the department established an undergrad course, and Patrick Dreher started. It's a little touchy, because of the subject matter – it's hard to get that into the undergraduate level, because of all the prerequisites you have to have.

You must have a good understanding of Operating Systems, LINUX platforms, and networking, because it's a combination of all those. Students who complete the Cloud course get jobs all over the place!

Miller/Lee: *You mentioned earlier that you were involved with both the technical and the business end of all that. That must be interesting from the university perspective.*

Streck: It was, and is still. What made it happen was having folks like Mladen and Dennis Kekas – Mladen with the deep understanding of the teaching and research side, and Dennis with the years of executive experience in industry production and R&D.

I was also on a dotted line to Dennis Kekas, because I worked with him before I left, and again when I came back to take over ITng. The acronym doesn't really fit the wording, because it stands for the Institute for Next Generation Systems. A very high-level man of the world named Wayne Clark came here from CISCO to help out, and also to help with the Hunt Library.

Wayne was the original director of ITng, but he didn't really want to run it. I've done a lot of start-ups and a lot of projects, so when Wayne wanted to leave Mladen, asked me if I would do that.

Miller/Lee: *Tell us about how projects occur – is it the impetus coming from the needs of a business or industry, or from the university's marketing to business and industry?*

Streck: It's both – and it usually centers around the question, "What's the technology de jour?"

First it was Clouds, and then there was IOT, and then there was something else – and I'm sure you all know from working in the field that most of these things aren't really new – they've been going on for the past 10-15 years or so, and industry needs a new movement to rally behind.

I have a colleague who says, "For Clouds, you should say 'someone else's computer' – that's all you should say," because that's what it is! You could also say it is the rebirth of the data center.

Definition of Computer Science

Miller/Lee: *What is computer science today*?

Streck: I would say first that computer science has become the *Franca Lingua* for Science…the language for all science and technology.

Take ECE. In my humble opinion, it's more computer science than it is anything else. Take materials, you're looking at how you do that and evaluate information and data. Take aeronautics, it's now all computerized for doing modeling or simulations. Almost everything you touch – even English now – NLP – that's all software.

The cross-cutting skill that has to be across all the verticals is computer science. Computer science, to my best understanding, grew out of mathematics – it used to be in the math department where I was schooled, and then it got enough inertia and became its own.

I think I'm a Renaissance Engineer, because I do everything. I do woodworking. I do all kinds of sports, etc. The computer scientist or any engineer/scientist should strive to make the product that gets developed, so it's an appliance to the end user. You don't have to think or read a detailed operations manual.

Some Anecdotes about Mladen Vouk and Don Bitzer

One thing that Mladen has done very well during the Vouk Years is that he will partner with anyone he sees as affording the best for the university.

I will tell you one thing that goes without saying – if you have Mladen, and go into any university or any large corporation, his reputation follows him…without a doubt.

If you can, get somebody to describe Mladen's office when it was on the bottom floor of Daniels – his and (Don) Bitzer's. What a group…very unassuming, but what a center for powerful ideas!

Miller/Lee: *Well, you tell us! What years are we talking about?*

Streck: Probably the mid-'90s through the early 2000s.

One thing about Mladen that is notable – and a lot of people would say this – he has more office space in the university… he's got more storage around here than you know of…and the case in point was in the bottom floor of Daniels.

Mladen had an office that was like a warehouse, and one thing that is notable to me is that Mladen is a *stasher*. He stashes everywhere and he can't throw things away. His wife Maja actually had to come in and help him clean up stuff. He just doesn't throw anything away!

Miller/Lee: *Is it stuff that's going to become obsolete?*

Streck: Oh, some of it already *is* obsolete, but it's there because he may have to recover something at some point in time. So, he's got that and – for the longest time - he made his own servers. I think he has stuff that's way beyond what anybody thought was going to work!

It was like Batman and Robin! You had Bitzer, and you had Mladen. You came in the door, and Bitzer's office was on the right. He had his couch in there and everything else. You would never know Don was this enlightened scientist, because it looked like he had this student hall down here – and Mladen had the other one on the other end!

But Mladen and Don 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 every 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! He works very closely with Dennis and everybody else here. 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.

<u>Personal Electronic Devices</u>

Miller/Lee: *What devices do you have?*

Streck: I probably have every device that would be the norm here, but which do I use the most? My number-one device would be my MacAir – my laptop – because I learned to type on a typewriter. I'm a touch-typer – so I can type as fast as any person can use a phone.

Miller/Lee: *Do you use a tablet for anything?*

Streck: I had a couple of tablets and gave them to my kids. I want to have a full-function system. The only reason I have a smartphone is – and I like the Apple because it's very intuitive – I've transitioned from voice to doing mainly text, because text is a good complement to not getting disturbed and not disturbing someone else.

But when I really want to get something done, I've found voice conversation is the best, because a person very rarely puts into words what they really mean. If I can talk to someone, I can usually direct the conversation very quickly versus going back and forth with e-mails, texts, etc.

Miller/Lee: *And you don't really get the nuances.*

Streck: Right! You don't get the nuances – you don't get the water cooler effect!

Miller/Lee: *What is something that person reading this 50 years from now would want to know about this past 10 years?*

Streck: In the past 10 years – the Vouk Years – the ubiquitous communication device is the smartphone – without a doubt; as a matter of fact, sometimes to a flaw!

Someone recently said they should allow cell phones in classes as a help along with what's going on, and I think maybe because of the inverted courses now, it may be the case. The classroom now is really for problem-solving, and all the lecture stuff now, you can do online.

Children and Computers

Miller/Lee: *How many years has it been that children grow up just knowing – from the time they start learning anything?*

Streck: You mean using electronic devices? I'd say around eight years or so.

Miller/Lee: *You used the word "intuitive" earlier…I would image people who work with children and computers have to use a lot of that.*

Streck: The area I'd like to focus on, is as long as it is used for knowledge augmentation. It's not the give-all of everything.

Miller/Lee: Now, being able to Google to find information makes your trip to the library nanoseconds, but when it replaces the ability to read to even think about stuff, I think that's a disservice because if this goes away, what are they going to do?

Streck: We always have connectivity to a degree, but there's got to be a certain amount of knowledge there so you can understand what you have to do, and there's a certain amount of creativity because this is not going to be creative for you.

A Final Comment about the Vouk Years

Anyone who has ever been with Mladen for 15 minutes or two hours will find that he is selfless – and that's probably one of the key things. Hopefully, he doesn't do himself in, because he spreads himself all over the place, but he doesn't sacrifice quality – he never sacrifices quality.

Ken Tate
Director of Engagement & External Relations
Corporate & Alumni Relations
Monday, November 7, 2016

Miller/Lee: *Our next interview is with Ken Tate, Director of Engagement & External Relations. Ken is the person who manages the communication and cooperation that facilitates the close working relationship between the department and our industrial partners.*

In recent years, Ken has extended his work to reshape the image of "what a computer scientist looks like." He has reworked the department's message via social media, and has created an Ambassadors program to link potential students with current computer science majors.

This recording starts while Ken is discussing the correlation between an interest in music and an interest in computer science.

Tate: This was just another connection that I've made over 15 years as I'm talking to alums. The volume of successful alumni who had a musical background – many like Kristopher Tyra – with these successful alums, that common thread was they either played an instrument, they played in the band here, or they were active in the arts in some way, shape, or form.

So, when we started applying those kinds of criteria, we saw our list of potential students go from 300 to 3,000, just in the state of North Carolina. That was Step One, getting Admissions to allow us to help them – and they did with open arms.

Step Two was to look at what we were doing, which was basically nothing. With my taking on and owning that Future Students Page, we blew it up and started from scratch and we said, "What is the image?"

You know, if you went out and looked at the feedback through research, the image of computer science is that it's very nerdy, it's geeky, it not a lot of fun – it's people working in a corner and drawing pay checks every two weeks – and they are happy. So, the definition of computer science was that it's just coding and it's just programming…certainly not doing anything fun or changing the world!

The other relevant information we got was that this generation in particular – we'll call them millennials – I know they don't always like to be called that – what they really want, rather than making a whole lot of money, is to do something relevant, something meaningful, something they feel is valuable. They want that work/life balance, but they want to do something that really makes a difference in the world – girls in particular, but I think guys almost as much.

So, we set out to find a group of young alums who were living into that, doing something really interesting, unique, different – maybe combined with a passion for something. So, we started collecting these stories. I had already talked to some, so I already knew it was kind of an easy task. Then we sent the professional photographers and we took some pictures, we sent videographers out and did some two-or three-minute little video vignettes – so now the Future Students Page is all about what you can do with this degree.

Miller/Lee: *How many of these have you done?*

Tate: We probably have close to 20 stories, but we've featured a dozen out here *(referring to posters hanging in the hallway).*

The other thing is that we had no interaction with anyone in the K-12 community, so we said, "Let's find out who the guidance counselors are, the math teachers – and if there are computer science teachers or technical teachers." We got a list of those, and it was about 10,000 names.

Miller/Lee: *How do you basically recruit?*

Tate: It's a multi-faceted thing. Every single year, we get that new list of students who are high in math test scores, interested in music, and who have expressed their interest through a

multitude of avenues in these disciplines that span all the elements of computer science, and that gives us between 3,000 and 4,000 names a year.

We do a multi-media kind of approach, so we hit them with e-mails, invitations to the open houses, and postcards. The other part of it is the teachers and the guidance counselors. We send out a big poster to them, we send smaller posters with the images that kind of track back to the stories that are on the website, so we're trying to drive them back to learn more.

Somebody on our Strategic Advisory Board had great feedback. You know a picture is worth a thousand words, right? A picture that elicits an emotional response is so powerful!

The posters we send to the middle and high school students have images like an infant obviously in a neo-natal Intensive Care Unit, because we have a story that maps back to how someone uses computer science in this field to help children. We have a picture of a tornado and we have a story about the WRAL weatherman, alum Nate Johnson. We have a picture of somebody handing someone a credit card, so we've got stories about cyber security and the security of our credit cards.

Every one of these pictures maps back to something everyone can immediately relate to and think, "That's what a Computer Scientist does? Oh, well, that's not so nerdy and geeky – that's kinda relevant!"

Miller/Lee: *What is the Ambassador Program?*

Tate: We had to get the agreement from Admissions to help. They said yes. We expanded into the net – the pool of candidates – so, another success.

We blew up the website and started afresh, and then we connected with the high school students. Then, this last piece you are referring to is the Student Ambassadors, about 25-27 undergraduate students that help us in any kind of event or activity where we need a student presence.

Every Friday, the College of Engineering has a "Visit the College" experience. They start them off in these big group meetings and tell them about the College of Engineering. Then, they turn them loose to go explore the University, the College, whatever. They give them some guidance, but in most cases, they're not guided tours.

So, now *we* say, "Look – for anybody who's interested in computer science, we will have a couple of Ambassadors here to lead that tour."

We will send Ambassadors out to middle schools and elementary schools and high schools to do little presentations. They've obviously worked every event that we've have in this last year. Since we've been doing this for the last five years, we track their service hours – they all work

as volunteers. We give them swag and shirts, and we offer developmental opportunities, so they're much better prepared and well-rounded when they leave us than when they came in.

Employers absolutely love this program! Employers kind of line up – I think I've got 12 sponsors now.

One of the things we're doing this year is the next iteration. One of the things I hear from our Strategic Advisory Committee is, "Hey, your students are so technically competent, but the thing that would really set them apart are the softer skills," and they say, "This is not just you; this is every computer science department."

So, we have evolved our curriculum over time to put more focus on teamwork, collaboration, and project work. It was always in 492, the Senior Design Class.

Miller/Lee: *The Senior Design course has become a required course within the past ten years, has it not?*

Tate: That course actually started before then, but now it is a required element – it's a capstone that every computer science undergraduate has to take. We were already doing that, but now we've started injecting some of those "soft skills" elements earlier and earlier.

Kristopher Tyra, one of our alums who is a Serial Entrepreneur – he's been successful at everything – has been telling me for the last 15 years, "I owe much of my success to my time in the theatre here at NC State, and we need to find a way to encourage more of the engineering students and computer science students to go see what's going on over there. Because that would really, really benefit them from a communication perspective."

He's been saying this, but he finally decided, "I'm gonna drag Ken over there," so he set up a meeting with the head of the theatre, John McIlwee, and had a great, great meeting, but what we're going to do – and we're going to pilot it this coming spring – they're going to help us create a series of four 90-minute workshops with very strategic communications-related outcomes associated with each one of the workshops.

They will be using theatre exercises, skits, games and improve to focus on skill development. It's going to be in the theatre itself, so it takes them out of their technical comfort zones here and puts them into something new and stimulating. But it's all about teaching them how failure and communicating, and making fun of yourself, and being able to make mistakes, and not fear speaking – all those things will be wrapped into it, and we're going to pilot that with those Ambassadors. They can't wait – they're so excited!

The other thing we do with the Ambassadors is that on the Future Students Page, there's actually a link that says, "Ask an Ambassador." So, when you click on it, it brings up all their pictures, all their profiles…and you can actually send them an e-mail.

The first year that we offered that, I honestly didn't think much about it until – at the end of the year – we were having this little celebration, and we were talking about service hours and the impact they had made on the department, and it occurred to me to ask, "Oh – how many of you have gotten an e-mail from a prospective student?" Every hand went up! I thought, "Really?"
So, I asked, "How many?" and most of them said, "One or two a week." I thought, "Wow!" We don't ask to see those – we've never asked to see the questions, we just trust our Ambassadors to give a very positive, yet really honest, response and answer."

Miller/Lee: *Was this evolution from the image of the geeky, walled-off, not very communicative computer scientist to what we are seeing now accomplished because people like you recognized what students were already going out and doing with their computer science education, and then began fostering it?*

Tate: We didn't change it; it was already there. We just needed to find examples and communicate them…but the Ambassadors have been an integral part of all that.

Now, students apply for early admission in October. They find out in December whether they get in or not, and we know that some of those students are the best of the best. They're not only being accepted by us, there's MIT and Carnegie Mellon and Purdue and Virginia Tech and Georgia Tech, so we have a whole campaign around congratulating them and telling them, "We recognize you have more options, but we'd really like you to give a serious look at NC State."

We divide those names up, too, and we give Ambassadors a list of names – to females, female names and to males, male names – and they send them hand-written notes. We don't tell them what to say – we just give them an outline and say, "Make sure you congratulate them and make sure that they know you are here to answer any questions that they have."

Ambassadors have business cards with their cell phone numbers and their e-mail addresses. That personal touch from a large university…we hear so often, "NC State being such a large university, we never expected to receive a personal note from somebody."

<u>Framework</u>

Obviously, we're talking about this period from 2007 to 2017, and I would call this the "Vouk Era," because I think that's consistent with the way it's been presented in the past.

Just as a frame of reference, we moved into EB2 in 2006, and we were the most consolidated that we've ever been, and now here we are in I don't know how many different buildings, but we're no longer consolidated.

Even though we're once again spread back over multiple buildings – both on Main and Centennial Campus – and part of that is just due to the way the state builds those buildings that are never quite big enough – as you know, as you grow, you gotta go somewhere.

But we have had these major labs and renovations and the library. I will give the library the credit for this, because it is just the most incredible workspace – a collaborative work space with hundreds of rooms that are like this (Suite 212).

I would dare say this vision for the suite wouldn't have flown, had it not been for the success of the library.

Miller/Lee: *How much larger, numbers-wise, is the population of the department since then?*

Tate: We are currently at almost 1,700 students now. I don't remember where we were in 2007, but undergrad population peaked in 2001. Undergraduate enrollments have gone up and down with technology innovation and market failures, but the graduate enrollments have been going up pretty steadily, although we're looking at capping that growth now.

Miller/Lee: *Is that both undergraduate and graduate? Is it about 50/50?*

Tate: Not quite. It's about 900-plus undergraduate and about 700-plus graduate, but because the Masters students churn so much faster, we actually produce more graduate talent annually.

Turning to the white-board:

Key things in here I think are going to be:

- Change of the Image of CSC
- Recruiting Students – Diversity

There's also something going on above – the way we look at the faculty that we hire as a university. Every Chancellor puts their own focus on what they going to do during their tenure, and when Chancellor Woodson came, his was on innovation, on making it easier to do business with the university – so we've seen this complete change of Intellectual Property regulations.

It used to be really hard to work with NC State, but I was in a meeting last Friday with Merck people. They have set up a hub here, and they said the reason was because all these universities they went to were so difficult, but not NC State. They told us that NC State is the easiest to work with from an IP perspective…so total change in the 15 years that I have been here.

Even though we are in a silo of the College of Engineering, and we are fairly unique in what we do – the problems that the world has don't fit within that silo. They span all these different disciplines, and now we hear the words "Cluster Hires." Most of the hire that we have made in the last 10 years have been Cluster Hires.

Miller/Lee: *Does that mean across disciplines?*

Tate: What it means is that the cluster might get defined as a problem like Information Security. Of course, Computer Science has a big part of that, but there would also be folks over in Humanities, as well as folks in Design and in Math and Sciences.

Miller/Lee: *Do those people actually collaborate in some way?*

Tate: Oh, yes – they work *in* this cluster. They're hired as part of that, and their research needs to be focused in this cluster problem that we're trying to solve, so somewhere here in your discussions, get some of these folks to talk about Cluster Hires.

Miller/Lee: *Does a corporation come to the university with an idea or a need and seek your input or collaboration or and/or also does the university market **to** corporations?*

Tate: I'm also going to put in here (*on the board*) Growth in Corporate support and the nature of that. We've got our ePartners ……. 1.4-1.5 million per year.

When I came here 15 years ago – 2001 – we had this program called ePartners, and it was just basically a way for companies that are looking to hire our students to have a partnership with us that had a portfolio of benefits that said, "If you give so much per year, we will recognize you as a partner, and then we'll give you special access to our students through exclusive events and activities and programs."

And, because of the demand for our talent, it was a real popular program.

What we have found is – and the answer to your question is BOTH! – we've had companies that have said, "You know what? We're changing our models and we really can no longer afford to do the research and development at the cost we were putting into it before. The margins are too thin, so we need to find other ways."

So, there are some coming from that perspective like, "How can we partner with you universities to do our work for us?" On the other hand, the NSF grants almost always have a requirement that I think is around 10 percent or 15 percent – that has to come from other sources….and corporations are great "other sources!"

Because of a lot of the faculty who are doing things here – and because NC State is a land-grant university and we've always had our feet right in the soil of real world activities – they want companies to come forward and say, "Yeah – we'll partner with you because we love the research that you're doing."

The way we've facilitated that over the last four or five years is that we've instituted these Research Overview Days. We do one per semester, typically at the end of the semester during exam period, on Reading Days.

We started out inviting in 30 to 40 corporate representatives, and we've been inviting all the faculty who might have an interest in getting some corporate support. We let faculty make 15-

minute overviews of their research, as it might apply to the folks in the room, and then later that day we would do a kind of Match.com, so the corporate folks and the faculty would go off and explore the opportunities.

We did that two or three times, and it was kind of successful – it led to some collaborative activity – but then the corporations said, "Well, what if you listen to us?" We said, "Oh!" So, we flipped the model completely, and one session was just them. That raised some issues, because some were not able to speak openly and freely in a mixed room, so now we're thinking about how we can handle that.

But that's how it's been evolving and so with corporations – either as panels or what-keeps-them-up-at-night, however they wanted to give their presentations - that stimulated the thoughts of our faculty.

Dr. Sarah Heckman has arrived for her interview.

Another big thing we added here – we talked about Cluster Hires – we also added Teaching Professors, which is something completely new, and she (Dr. Heckman) can talk about that. I give her a great amount of credit for this, because she heads this up, and for Undergraduate Research, because I dare say we had very few undergrads involved in research. Maybe just a handful went out of their way because they had an interest, but now we've got a whole program.

Friday ,they had all these students get up and talk about the research there were doing. How many, Sarah? Fourteen! These were great presentations! It's just unbelievable where this program is going, and hopefully this will fuel more US students going into the graduate program – which we have a problem with. We have all the international students in our program that we can handle, but we need more US grad students.

Miller/Lee: *What is computer science in 2016?*

Tate: Computer Science is a technology enabler that allows you to combine your passion to change the world in a socially-relevant way.

<u>Mladen Vouk and The Vouk Years</u>

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.

Females in the undergraduate pipeline have increased dramatically because of a real focus on our K-12 outreach, and we've assembled the largest group of female faculty members among departments in colleges of engineering. We became the first academic department to have our own set of student ambassadors! When we lost the ever-popular undergrad instructor, Carol

Miller, I thought we might be in trouble. No way! We go out and hire several teaching professors, which, in my humble opinion, have helped bolster our undergraduate experience.

Also on his watch, we have greatly expanded the number of undergrads involved in research, and we have moved up in almost all the rankings. 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!

Academic department heads have the unenviable task of leading a heard of high-spirited, extremely smart cats – I can imagine that it must be quite frustrating at times. Unlike corporate settings, academic department heads yield very little "position power." By contrast, the truly great academic leaders leverage the power of earned respect and influence to accomplish great things.

In my opinion, this is one of Mladen's greatest strengths – as he is so well respected across the university, and certainly within our department. He has great instinct, discernment and wisdom, and does an outstanding job of navigating the highly-charged political waters.

I personally have enjoyed working with him because he always supported me, and provided me the flexibility and resources required to influence real and meaningful change. If I brought a problem to his attention, with a potential solution, he always provided me the opportunity to tackle the challenge.

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 3-4 different titles and a corresponding number of duties.

Despite having so many plates spinning in the air at all times, they never came crashing down to earth. 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.

Dr. Mladen Vouk

Department Head (2004-2016)
Distinguished Professor and
Associate Vice Chancellor for Research and Development
Tuesday, November 8, 2016

Miller/Lee: *We welcome Mladen Vouk, the much beloved Head of the Department of Computer Science. He has served as Head for more than a decade. We share with him that we have already heard words of appreciation and respect for his leadership from others we have interviewed.*

Mladen, we are interested in hearing your view of computer science today. Let's start by talking about the computing devices you use every day.

Dr. Vouk: I have a laptop, a desktop, and a smartphone. I also have a tablet that I use infrequently. I use the desktop least.

Miller/Lee: *Tell us what you believe computer science was in 1967, and what it is in 2017.*

Dr. Vouk: 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 '60s and '70s, we had mainframes. In the late '70s and early '80s, 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.

Programming has been one of the components, but computer science has always been about data.

(Dr. Vouk is drawing on the whiteboard: A timeline from 1967 to present. It shows enrollment/interest in computer science over the 50 years going up and down in roughly 15-year cycles.)

Let's consider enrollment and interest in computer science. We began in1967. The interest went up and down several times over the 50 years. 1983-1984 and 2000 were peaks. Today it is high, but hopefully not at a peak. We see roughly 15-year cycles.

Mainframes, personal computers, Internet, web browsers, personal devices influenced the shape of the curve. For last six or seven years, interest has been climbing back up. Devices are becoming more personal. Devices and people are more interconnected. Social media, etc. connects a new bigger population seeking information.

We had economic recessions along the way, following the peaks. 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.

Miller/Lee: *Do you think there is a relationship between economy and the development of the technologies?*

Dr. Vouk: Yes. Enrollments went up with new technologies introducing new populations to information. By the way, the number of women was 50-50 in the earlier period (1980s), then it went down and never recovered. The group of people using computing has become broader and broader. Now we have the Internet of Things, everything generating information.

Today, we have many more users than developers. Early on, we had more developers than users; then, with the Internet and the web, we shifted to more users. Today, we have fewer developers relative to number of users. Computer science is all about developing information and distributing/using it. The science part of computer science is, "*How* to do it."

Miller/Lee: *We have been hearing a lot about security. How is it related?*

Dr. Vouk: The easier the access, the more people get involved. And security gets to be more an issue as more people who get involved know less. The crime has always been there, but there are different types. We have robberies…take data and run. We have espionage…more insidious, hidden activity, glean things over time. We have cyber war…it lasts 15 seconds, and then is totally done!

We are seeing more problems, because larger and larger parts of the economy depend on computers. That generates social change. Computer science is about the transfer of information.

Miller/Lee: *What is the major change in computer science over last 10 years?*

Dr. Vouk: For the last 10 years, personal devices have become very accessible. These devices provide access to information by a much larger population.

Miller/Lee: *What about changes in the department over last 10-15 years?*

Dr. Vouk: For 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 700-plus graduate students, including 200 PhD students. We have been consciously growing the research side. The research budget has been growing at seven to ten percent over the last 10-15 years or so.

Miller/Lee: *Is there is a focus on certain areas of research in the department?*

Dr. Vouk: Software engineering, systems, AI (part of education informatics, games), and security. For the past 10 years, the big "winners" in research are games and security. More recently, we have data science, 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, education informatics, security, and networking, Networking is coming back…the research focus depends on devices.

Miller/Lee: *What would you like to be remembered for?*

Dr. Vouk: We did no evil. We had no scandals. We have a collegial department with strong faculty and strong student body.

Miller/Lee: *The treatment of women here is very respectful…*

Dr. Vouk: When it comes to women, recent statistics show we are number one in total number of tenure-track female faculty among all departments of computer science within colleges of engineering.

Overall, we have about 30 percent women in the student body, graduate students plus undergraduate. Undergraduate enrollment is about 15 percent women. We have been climbing up. Of our undergraduates, 96 percent are U.S. citizens. In-state is about 80 percent. Retention rate is pretty good.

I have done research looking at girls' interest in computer science in elementary and high school. At grades 5 and 6, interest in computer science is about equal for boys and girls. In high school, we lose about half of the girls, and half again at entry to college. Once they get here, retention is pretty good.

Miller/Lee: *Tell us about Cluster Hiring at NC State.*

Dr. Vouk: 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. Education informatics is another cluster. A cluster might have someone from Psychology, someone from English, and other disciplines.

The way it works is a group of faculty members get together to research "X." 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!

Miller/Lee: *What are some other changes in last 10 years?*

Dr. Vouk: We also have research in some areas that have wide impact on society – rescue dogs, girls in computing, and the science/psychology of security.

We have excellent faculty and excellent student body, and a collegial attitude.

Career update: Dr. Vouk was named Associate Vice Chancellor for Research Development in January, 2017, and stepped down as department head December 31, 2016.

Dr. Laurie Williams
Professor and Interim Department Head
Friday, February 3. 2017

We meet Laurie Williams, recently named Interim Department Head, in her office on the third floor of EB2. Laurie's office is very welcoming, with bright colors and couches for her guests.

Miller/Lee: *We have two common questions for those we have interviewed. The first question is: What are the personal computing devices that you have?*

Williams: I have a laptop. I do not have a desktop – but I have a very powerful laptop. I have an iPad. My iPad is essential. I don't see how anyone can *not* have an iPad – and a smart phone.

Miller/Lee: *You are the only interviewee who has talked about using the iPad (tablet).*
illiams: My iPad is like paper. I have a big one. It is like reading a piece of paper. Everything is on there. If I get to the airport, I don't have to think, "I wish I had brought this paper or that book. It is there – and there's no extra weight."

I still read personal books on paper. I don't have any personal books on the iPad, but I do have work books. Any work book is in the Kindle version. The flexibility of always having work books and papers with me is great. If I am in an airport or waiting for a meeting to start, I can read.

Miller/Lee: *Our second common question is: What is Computer Science in 2017?*

Williams: I see Computer Science as the underlying technology that enables everything. It is almost like electricity now. Systems are in cars, refrigerators, video cameras…everything. So we are enablers. Computer scientists are enablers.

Students in Computer Science can pursue not just their love of Computer Science, but also a domain that they are interested in as well.

Miller/Lee: *You mentioned Computer Science in a domain. Is your research connected with the health care industry?*

Williams: Yes. The bigger picture is security. I am co-director of the large NSA Center.

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 ten 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.

The NSA was here this week. I was at the NSF a few weeks ago. 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.

Back in 2007, we had security faculty, but we have many more faculty members now, and more classes. We are trying to get security into the classroom, because students need to know how to develop secure code from the beginning, rather than waiting to take it as an elective course.

Miller/Lee: *Has the demand escalated for students with knowledge of developing secure systems?*

Williams: Yes. Companies are advertising for many more professionals who are knowledgeable in security.

Students can develop systems insecurely or securely. If they develop a system insecurely, then they have to make it secure. But they can learn to develop it securely from the beginning. Techniques are not that much harder, just different.

For example, there can be two forms of a data base command, in which one line can be secure and one not. You teach the secure form.

From a requirements standpoint, you have the students realize from the beginning what the code is supposed to do. You have them think about who might want to break it, and how they might get in. It's a mindset.

Miller/Lee: *We have discussed security. What other changes do you see in last ten years here in the department? What are some of the things worth remembering – things that weren't here ten years earlier?*

Williams: Two come to mind. One is many more women faculty. 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.

The three biggest efforts include the security center, an NSA-sponsored center. It has been here five years. It is $2.5 million a year. That is a lot of money.

We have hired new faculty, and have some faculty that were not in security ten years ago.

Miller/Lee: *Mention some faculty that are currently involved in security.*

Williams: I am the co-director of the lab, and Munindar Singh joined me as partner three years ago. Other faculty are Doug Reeves, Will Enck, Alessandra Scarfura, Alex Kapravelos, and Jessica Staddon.

We have Jason King on the Teaching Faculty. He is the undergraduate program security person. There are lots of opportunities, due to the shortage. There are lots of programs that Jason can help us apply for. We are moving towards an undergraduate concentration in security.

Miller/Lee: *Now you have an undergraduate concentration in gaming, correct?*

Williams: Yes, it is the only concentration we currently have. We are using it as the model.

So, security is one of the big areas of research. Gaming is another one. Gaming is applied to serious contexts, as well as to recreation. James Lester's Education Informatics is the third.

Those are the big three areas. The Education Informatics is a university Center. Gaming is moving in that direction.

Miller/Lee: *Explain what a Center is.*

Williams: A Center is an official university designation. Their finances flow differently, and they are required to be self-sustaining.

Miller/Lee: *One of the most important changes in the last ten years is the Teaching Faculty.*

Williams: That happened in 2009, with Sarah being 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, and the feeling there of the teaching faculty being lesser. For example, questions of, "Do the Teaching Faculty attend faculty meetings?" and so forth.

There is none of that here. They are not second-class citizens. Everyone so values their attitude and how they prepare the students, how they innovate the curriculum. They are flexible – "Can you teach this class? Yes!"

Mladen made the Teaching Faculty happen.

Miller/Lee: *Are there other things that should be remembered?*

Williams: More females in the faculty, major research centers, teaching faculty – this is all part of Mladen's legacy. And he 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.

Miller/Lee: *Another theme we have heard is the multidisciplinary nature of research and education within the university, and within the department. We've heard about cluster hiring, centers, and institutes.*

Williams: That was a great thing that the university decided to focus on. It is still a struggle, I'll admit. It is a challenge to manage these multidisciplinary groups; for example, who do you report to? But it is working, and it is progressing.

The best example for us is the Gaming Cluster. They have all the disciplines in the same space. And because they have a space with offices next to one another, they have submitted more joint proposals than clusters in which members are in different buildings.

Miller/Lee: *What are the clusters that include Computer Science faculty?*

Williams: There is an analytics one, and a geospatial analytics cluster. There is a Games Cluster – possibly two of them. Doug is working on creating one called forensics or possibly digital forensics.

Miller/Lee: *Another theme we have heard is the maturity of the graduate program over this decade, the dramatic increase in dollars and enrollment.*

Williams: Absolutely – including attracting students to the PhD program – and better delineation. The Master's students are Master's students, and PhD students are in the research programs.

We are having increased involvement of undergraduate students in research. If they are involved, they are more likely to pursue a graduate degree. For example, Sarah was in my undergraduate software engineering class, and she never imagined she would have a PhD someday. But making that observation that we see something in them… that can make the difference. Reaching out to our undergraduate students is a good source of PhD students.

Miller/Lee: *An important theme we have heard in our interviews (with students, faculty, and staff) is that there is a collegial atmosphere within the department.*

Williams: I have been here 17.5 years, and the collegiality the entire time has been amazing – every single day! We are in the midst of coming up with a new department 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.

Another 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 and 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.