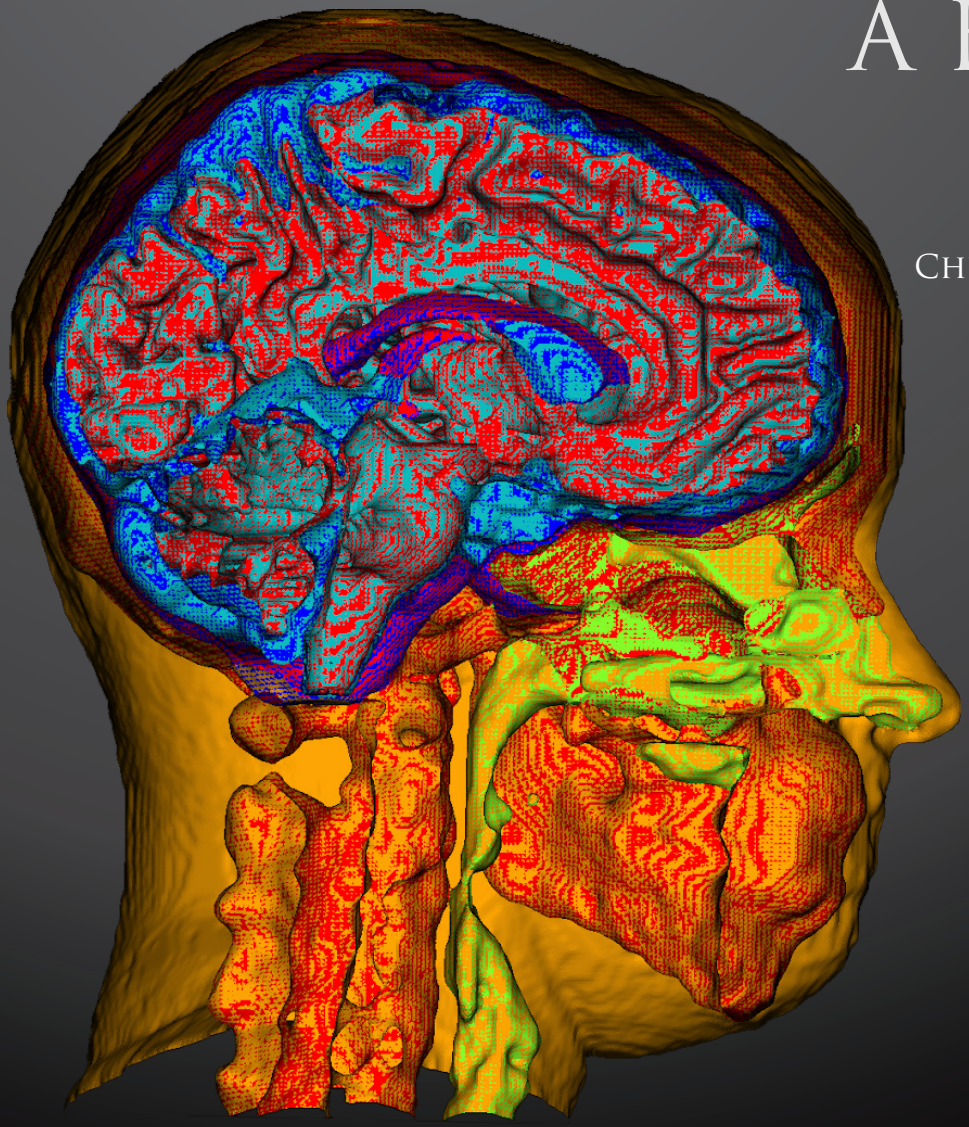
THE UNIVERSITY OF UTAH

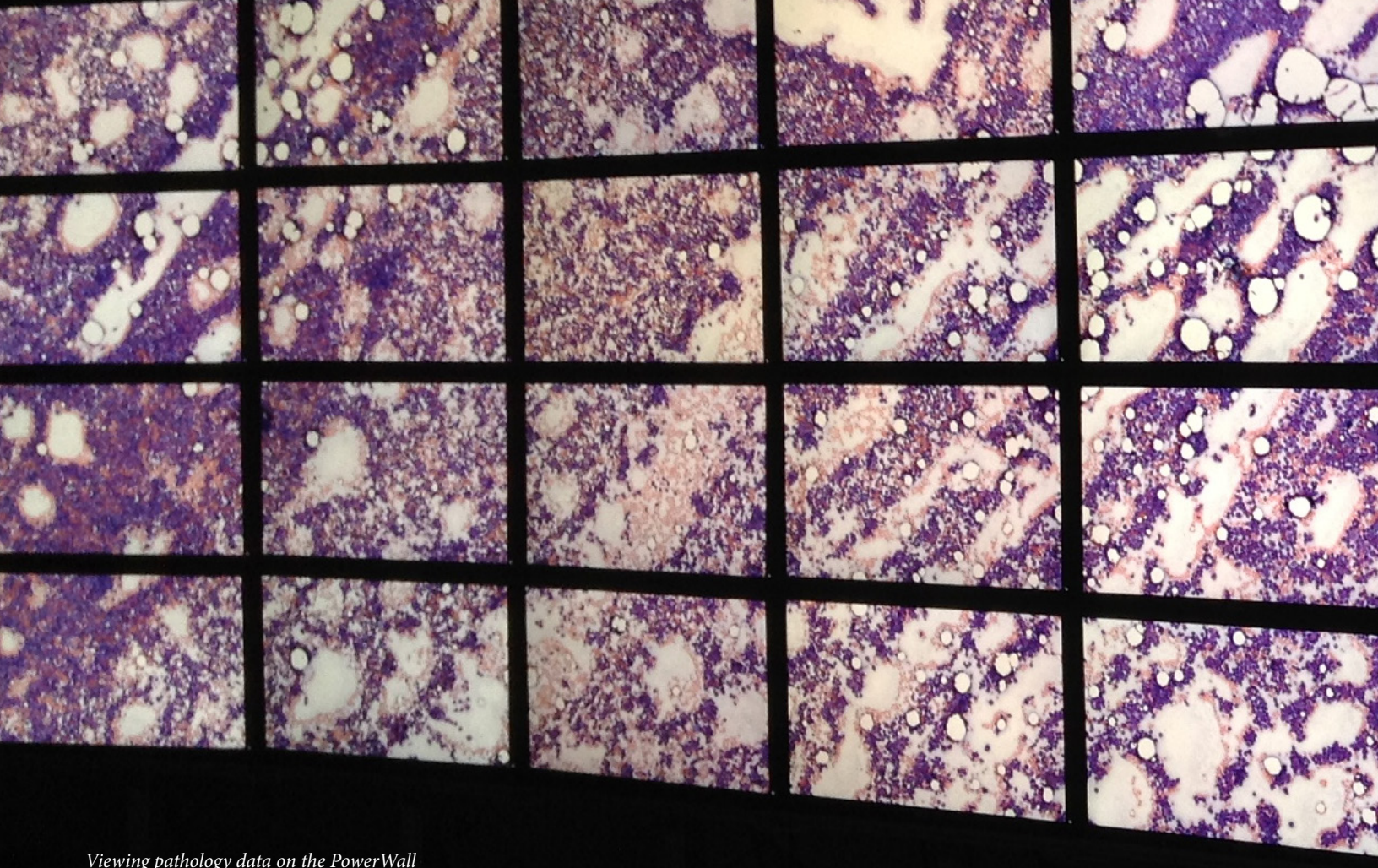
SCIENTIFIC COMPUTING AND IMAGING INSTITUTE: A HISTORY



Interviews With:

David W. Pershing
Christopher R. Johnson
Robert S. MacLeod
Charles Hansen
Gregory M. Jones
Katharine A. Coles

EVERETT L. COOLEY COLLECTION
University of Utah Scientific Computing and Imaging (SCI) Institute Oral History Project
American West Center and J. Willard Marriott Library Special Collections Department
University of Utah



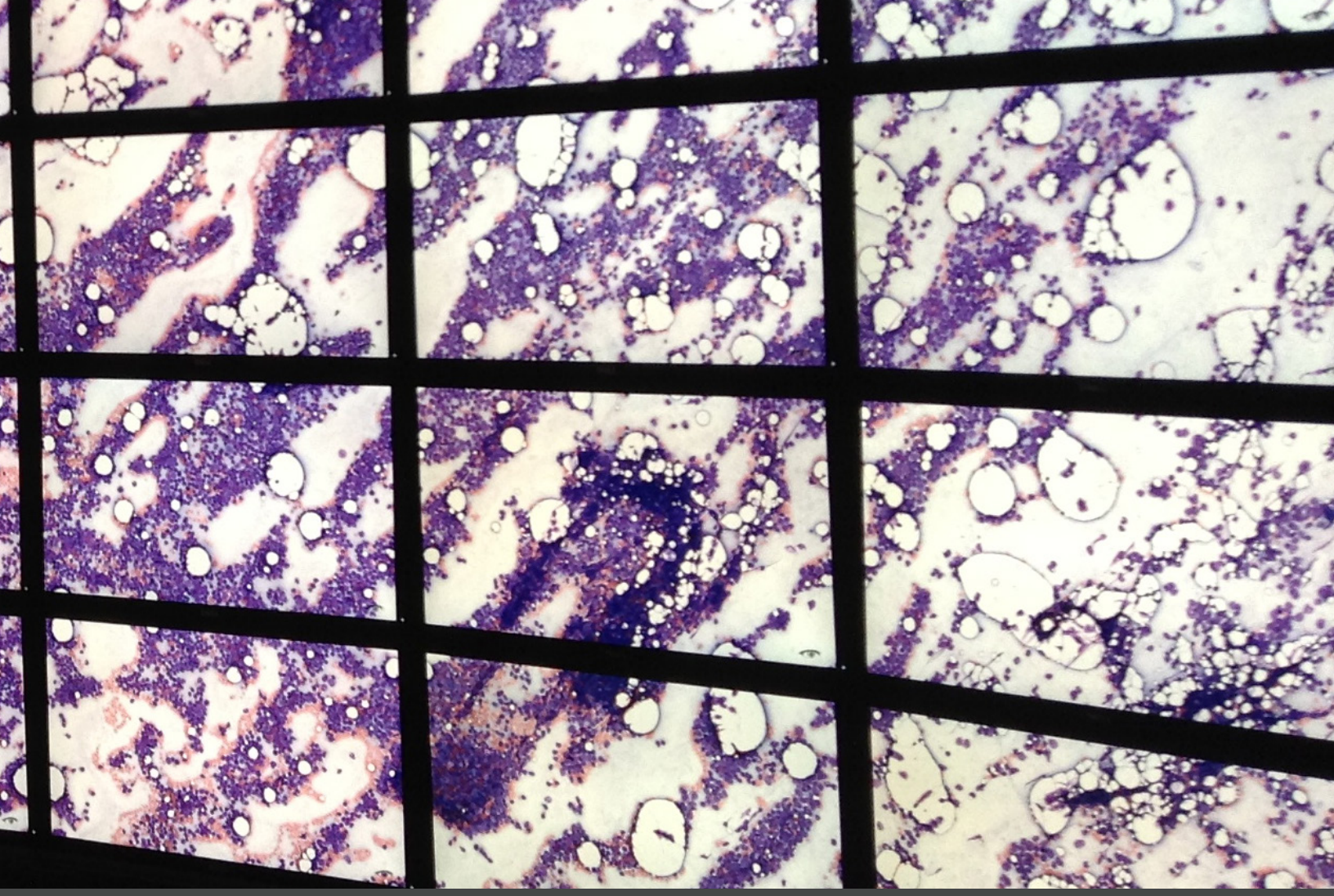
Viewing pathology data on the PowerWall

The Scientific Computing and Imaging Institute

Drs. Chris Johnson and Rob MacLeod, along with their first graduate students, founded the Scientific Computing and Imaging (SCI) research group in 1994. Early growth in 1997 and 1998 and awards of a National Institutes of Health National Centers for Research Resources (NCRR) and a Department of Energy Advanced Visualization Technology Center resulted in the SCI research group graduating to the status of a University of Utah (UofU) research center. In 2000, the Center for SCI joined seven other UofU permanent research institutes as the Scientific Computing and Imaging Institute. The SCI Institute is now home to approximately 200 faculty, students, and staff. The SCI Institute's 20 tenure-track faculty members are drawn primarily from the School of Computing and the Departments of Bioengineering, Mathematics, and Electrical and Computer Engineering, and most faculty members have adjunct appointments in other departments.

The history of the SCI Institute is underpinned by a culture of multidisciplinary, collaborative research. SCI Institute faculty members are recruited with both academic achievements and collaborative histories as the driving characteristics. The SCI Institute culture and its research reputation have enabled the director to recruit recent faculty members such as Dr. Christopher Butson in 2014 as the director of neuromodulation research and an associate professor in the Departments of Biomedical Engineering and Neurology & Neurosurgery; Dr. Alexander Lex in 2015 as part of the leadership of the Visualization Design Laboratory (VDL); Dr. Akil Narayan in 2015 as part of SCI's scientific computing group in mathematics; and, most recently, assistant professor of computing Dr. Bei Wang. In 2017, Dr. Wang joined the SCI Institute visualization group, ranked by CSRankings (http://csrankings.org) as the top visualization research group internationally.

Over more than two decades, the SCI Institute has established itself as an internationally recognized leader in visualization, scientific computing, and image analysis research applied to a broad range of domains. The SCI Institute's mission is



to solve important problems for humankind by performing cutting-edge collaborative image analysis, scientific computing, and visualization research. Alongside our research goal is our mission to use our research to educate students and staff. The SCI Institute is proud to have graduated, with an education at the cutting-edge of research, over 400 graduate students and postdoctoral fellows (the Institute has also interned nearly 100 undergraduates). SCI Institute graduates move into faculty positions with universities internationally and also become innovators with companies such as Exxon Mobil, nVIDIA, Google, Intel, and Medtronic.

While one of the primary application foci of the Institute continues to be biomedicine, SCI Institute researchers also address challenging computational problems in a variety of application domains, including astronomy, environment, materials, and energy. SCI Institute research interests generally fall into the technical areas of scientific visualization, scientific computing, image processing and analysis, and scientific software environments. SCI Institute researchers also apply many of the above computational techniques within their own particular scientific and engineering subspecialties, such as fluid dynamics, biomechanics, electrophysiology, bioelectric fields, parallel computing, inverse problems, and neuroimaging.

A particular hallmark of SCI Institute research is the development of innovative and robust software packages, including the SCIRun scientific problem-solving environment, Seg3D, ImageVis3D, VisTrails, ViSUS, Cleaver, map3d, and Pfeifer. All these packages are broadly available to the scientific community under open-source licensing and are supported by web pages, documentation, and user groups.

On the cover. A three-dimensional, full-head, female surface mesh generated in Cleaver and visualized using SCIRun. Ally Warner.

David W. Pershing

An Interview by Christine Pickett
19 August 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3385
SCI Interview 1

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS AUGUST 19TH, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE PARK BUILDING, OFFICE OF THE PRESIDENT. CHRISTINE PICKETT IS INTERVIEWING UNIVERSITY OF UTAH PRESIDENT DAVID W. PERSHING FOR THE EVERETT L. COOLEY COLLECTION.

CP: This Everett Cooley oral history project interview focuses on the unique culture of the University of Utah's Scientific Computing and Imaging Institute, or SCI. We will be talking today about President David Pershing's pivotal role in the success of SCI.

After three decades at the University of Utah, David Pershing became the fifteenth president in 2012. He joined the U in 1977 as an assistant professor in chemical engineering and was named a Presidential Young Investigator by the National Science Foundation in 1984. He was the associate dean of the Graduate School from 1983 to 1987, the dean of the College of Engineering from 1987 to 1998, and the senior vice president for Academic Affairs from 1998 to 2012.

President Pershing received the Distinguished Teaching Award in 1982 and the Distinguished Research Award in 1990. He was made a Distinguished Professor in chemical engineering in 1995, and was a recipient of the Governor's Medal for Science and Technology in 1995 and the Rosenblatt Prize for Excellence in 1997. In 2002, he was recognized as the Engineering Educator of the Year by the Utah Engineering Council.

David Pershing is the author of more than 80 peer-reviewed publications, has been awarded 20 research grants, and has been granted five patents. He was the director of the U's Center for Simulation of Accidental Fires and Explosions, which was supported by a grant from the US Department of Energy.

Your association with the Scientific Computing and Imaging Institute goes back many years. How did this come about?

DP: [laughs] It surely does. I think I first met Chris when I was the dean of the College of Engineering. It was clear to me from the beginning that Chris was a rising star, and that Chris was one of those unique people who was going to require special support. I felt that if we took the time and invested the effort to support him, great things would happen. And certainly history has proven that to be true.

CP: Absolutely.

DP: If you look around the university and look at our pinnacles of excellence, they are almost always associated with one or two key people who have a vision for what they want to do and who have ultimately made a great big difference, whether they are associated, sometimes like Chris, with an institute, or sometimes with a department. Such people always have special needs. And they need somebody in the administration to try to help them succeed with whatever their vision is. Chris is definitely one of those people.

CP: Going back to that time period. The head of a center at the U reports to the dean of the college, which you were. And that is what Chris Johnson did in your early years as dean of the College of Engineering. How did it happen that he continued to report to you when you became senior vice president and then president? Which is a twist.

DP: [laughs] It is a twist. It's a twist and it's a bit unusual. Basically, what happened is SCI and Chris just moved up with me. And I kept them with me. By the time I became the senior vice president for Academic Affairs, SCI had become highly interdisciplinary. It was clear to me that it would be better – and this is what Chris wanted, let's be honest, too – if they reported to the senior vice president, that it would help facilitate the interdisciplinary connections. And so that's why we decided to do that.

When I became president, it was a little less clear, because that's very unusual. But at the time, the vice president for Research, which is the sort of more logical place for an interdisciplinary institute to report, was Tom Parks. Great guy but with very much a bioscience kind of orientation. He was the chair of neurobiology and anatomy before becoming VPR. Tom and I sat down and talked about this and decided that we would divide up these big, multidisciplinary centers in terms of responsibility. And so I kept three as president. SCI is the biggest and most powerful for sure, but all along it's been so that I could help provide the resources he needed to grow. And that's been the key reason. Even now, as president, that's what I'm trying to do.

CP: So how long is this association now, about 25 years, something like that?

DP: Yes. The association must be. Well, I have been at the university now about 38 years. So it's at least 25, yes.

CP: Pretty impressive.

DP: A long time.

CP: Chris claims that this particular, this unique, reporting structure has contributed to the success of SCI. To what do you attribute the success of SCI beyond your crucial support? What other factors do you think have played into it?

DP: I think that he may be right, that I've been able to help in some ways. But certainly the real thing is that he is amazing and he has hired amazing faculty and staff. And they are valued by the highest levels of the university.

CP: And he manages to retain them.

DP: He manages to retain them. I was going to talk about that. Chris has an uncommon characteristic for these charismatic leaders. And that is the ability to identify, attract, and retain outstanding people. This has no doubt been the key to SCI's growth and success. It's amazing. He will come over here and say he has identified some—well, most recently, some amazing young woman he believes we can attract. And it turns out to be true.

So one of the things Chris does so very well, in fact, probably the best of anybody I know, is he works hard to promote his own people, in terms of awards, making sure they're taken care of financially, making sure that we are thinking about the things that are important to them individually, whether it's childcare, whatever it is. And that really works well. There's no doubt about it.

CP: According to Chris, SCI Institute was "one of Dave's experiments in interdisciplinary research." And Rob MacLeod thinks you may have regarded SCI as a template. They both asked me to ask you how you viewed the early SCI.

DP: I think that's right. I don't know that I was smart enough to have intentionally done what Rob said about the template but that is in fact what we have done with SCI. It is a template. And Chris is correct: SCI was a big experiment in the beginning.

One of the things we learned was that it's very hard to do interdisciplinary research. And the people who are trying to do that need special support. The three institutes that I work with are SCI, the Institute for Clean and Secure Energy, ICSE, and Energy and Geosciences, EGI. I still have all three of them reporting to me as president. And they all have the same characteristic, that they're trying to work across very diverse fields. I think they need special kinds of support to do that.

CP: Was that type of center unique at the time?

DP: It was. Chris's was. Well, let's see. We had two. We had the Center for Engineering Design under Steve Jacobsen and then SCI began to grow and come up. Not all parts of the campus have these. Engineering thinks this is sort of the normal way of things. And it's been really good for them as a college. Some parts of the campus don't have these big institutes like this. I think there's a real advantage when we can get them to grow and foster the growth.

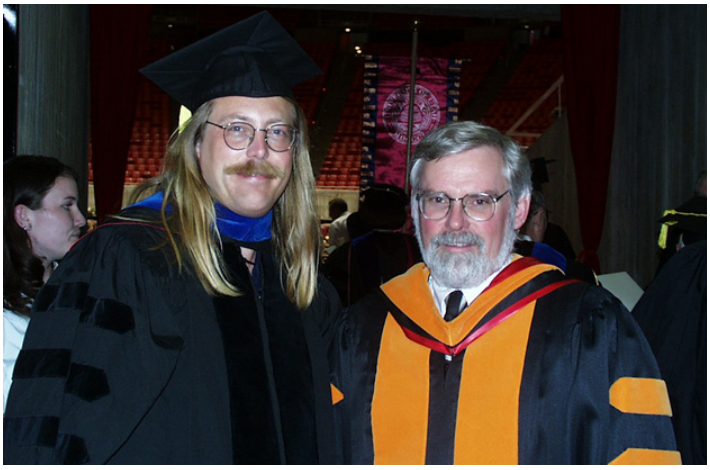
CP: I know that Chris reports annually to you. He's mentioned that.

DP: Right.

CP: How does he quantify to you the success of SCI in his annual reports?

DP: This is funny. He does report annually to me—there's absolutely no question about that—but not in the conventional sense. He does not provide me with a big, thick book that sits on a shelf

President David Pershing, 2017



Chris Johnson (left) and then dean of the College of Engineering David Pershing in the mid-1990s.

and nobody ever looks at. What he does is he comes each year during the budget sessions and provides, without a doubt, the most dynamic budget presentation that Cathy Anderson and I see. Both of us – and I know I speak for Cathy as well – look forward to the session with Chris Johnson and the SCI team.

CP: What's the presentation like?

DP: Well, of course it's highly visual.

CP: Of course.

DP: In fact, we now, in the president's conference room, have a beautiful high-definition screen so that he can use it. We use it for other things, too. But obviously, one of the great things we use it for is for him to come over and show not just beautiful images but now, of course, it's videos of all kinds of things. And I use his videos in my presentations as well. So the way he reports to me is in a highly visual sense, not in a sort of dull paper report.

CP: That makes perfect sense. Will you describe the importance of SCI for the University of Utah?

DP: I will. SCI is one of the crown jewels of the university. I think of it as like the Huntsman Cancer Institute, the Moran Eye Center, the Hinckley Institute of Politics, and several others that we have at the university that are very special places. We think of them as being very important to research. And they surely are. But they're also very much a core part of the training of our young people, of our undergraduates, our graduate students, in some cases postdocs. That's what the university is really all about, as well as research. There is no question that SCI is valuable across the campus. They help us attract faculty and staff, not only for themselves but sometimes they help with spousal hires.

CP: For other departments.

DP: For other departments. They hire somebody and we get this amazing spouse for another department. I've actually heard Senior Vice President Vivian Lee talk about the importance of things going on in SCI, in presentations that she was making about health sciences. And I always find that a little bit funny.

But SCI has also helped us at both the national and the international level, in terms of the whole STEM world.

CP: Because of their collaborations.

DP: Exactly. And we are always using their results—I'm as guilty as anybody of using their stuff when I'm recruiting students. I show images that were created by people in SCI. I run videos that were created by people in SCI. They help the university in a very, very broad sense. And that's why I do think they are part of the crown jewels.

CP: That's wonderful. How do you envision SCI's future, let's say, going out maybe five years or so, maybe more?

DP: I think the future for SCI is very bright because the world is becoming more and more visually oriented. Young people today, that's the way they think. They're all on the screens. They're with the games.

CP: No choice with big data but to visualize it.

DP: That's right. That's exactly right. As I said before, Chris has hired just some amazing young people, who are the future, not only of SCI but also of the College of Engineering and the School of Computing. And so they are the path forward. Clearly, one of the open questions is what happens when Chris gets ready to retire, and Rob.

CP: Well, they just can't, right?
[both laugh]

DP: They just can't. Well, that's a solution—

CP: That's what he said about you, though.

DP: Right. That solution works in my world [laughs] but it's not going to work forever. Chris and I are talking about this. We have actually started talking about that because it would be stupid not to plan for something that's this important to the institution as a whole. And that is one of the great things about his ability to hire amazing people: there are people who can grow and I believe will be able to help take SCI forward.

CP: Yeah, he has some wonderful new hires.

DP: And that's the key. Yeah. That is a real skill. He has that ability. Randy Olson has that ability, in Moran, to hire amazing people. And that's very important.

CP: But they'll need a president, too, who supports them the same way.

DP: They will need a president who supports them. It doesn't have to be the president. But it has to be either the senior vice president for Academic Affairs or the vice president for Research. One of the top people running the university has to believe in this idea.

CP: So it sounds like you and Chris have a lot of planning to do.

DP: Well, we do. We have planning to do. But it also is important that I make sure I help mentor people who are going to take these senior roles to understand the importance of these amazing institutes.

CP: Thank you so much. This is a great contribution to our story of SCI.

END OF INTERVIEW

Sunset over the University of Utah

Christopher R. Johnson

An Interview by Christine Pickett
27 July 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3383
SCI Interview 2, Interview 1 with Christopher R. Johnson

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS JULY 27TH, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING DISTINGUISHED PROFESSOR CHRISTOPHER R. JOHNSON, FOUNDER AND DIRECTOR OF THE SCI INSTITUTE, FOR THE EVERETT L. COOLEY COLLECTION.

CP: This Everett Cooley oral history project interview focuses on the unique culture of the University of Utah's Scientific Computing and Imaging Institute, or SCI. SCI is the subject of our interview. The founder, Chris Johnson, is the spokesperson.

First, just a slice of your impressive biography, by way of an introduction. In addition to being the founding director of the Scientific Computing and Imaging Institute, Chris Johnson is also the codirector of the Center for Integrative Biomedical Computing, a Distinguished Professor of computer science, a research professor of bioengineering, an adjunct professor of physics, a faculty member in the Computational Engineering and Science Program and in the Brain Institute, a cofounder of Visual Influence, Inc. (which provides visualization and image-processing algorithms and offers consulting services), the coeditor of *The Visualization Handbook*, and a member of the board of directors of the Computing Research Association. He has authored more than 150 peer-reviewed articles and book chapters, edited two books, given hundreds of keynote and distinguished lectures, been the principal investigator for dozens of grants, been the advisor or served on the committee for hundreds of master's and doctoral students, and dedicated nearly 30 years of service to the University of Utah in various capacities.

Chris's distinguished career has been recognized with the following awards: the National Institutes of Health Young Investigators Award in 1992; the National Science Foundation, or NSF, National Young Investigator Award in 1994; the NSF Presidential Faculty Fellow Award from President Bill Clinton in 1995; the Department of Energy Computational Science Award in 1996; the Par Excellence Award from the University of Utah Alumni Association in 1997; the State of Utah Governor's Medal for Science and Technology from Governor Mike Leavitt in 1999; the William R. and Erlyn J. Gould Distinguished Lecture on Technology and Quality of Life Ninth Annual Address, titled "Computer Simulation and Visualization in Medicine," at the J. Willard Marriott Library, University of Utah in 2000 (his address was reported to have been so well attended, standing room only, that the fire marshal expressed concern, as a side note); the Distinguished Professor Award from the University of Utah in 2003. He was also elected Fellow for the following: the American Institute for Medical and Biomedical Engineering in 2004, the American Association for the Advancement of Science in 2005, and the Society for Industrial and Applied Mathematics in 2009. He received the Utah Cyber Pioneer Award in 2009, the Rosenblatt Prize for Excellence from the University of Utah in 2010, the Institute of Electrical and Electronic Engineers, or IEEE, Visualization Career Award in 2010, the IEEE CS Charles Babbage Award in 2012, and the IEEE Sidney Fernbach Award in 2013, and he was elected an IEEE Fellow in 2014.

His current areas of research include scientific visualization, scientific computing, image analysis, and scientific software environments.

So, if you will, Chris, give me a sketch of what led to the founding of SCI, specifically, which of your academic and research experiences contributed to your setting up what became the Scientific Computing and Imaging Institute. And also, please discuss the forerunners to SCI.

CJ: All right. So in the beginning there was no SCI.

CP: [laughs]

CJ: In the beginning there was just a young assistant professor of computer science, and there was a young research assistant professor of bioengineering, Rob MacLeod. And I had a single PhD student. That was the very, very beginning. As a young assistant professor, my main concern back then was to get tenure, was to succeed at being a young academic. That meant doing research and writing papers and writing grant proposals, hopefully successful, being funded, advising graduate students, and doing all of the things that one does in order to have a favorable tenure review six or so years down the road. And so there was not even a possible mention or insight into what would become the Scientific Computing and Imaging Institute back in the early 1990s.

The research areas that I was and still am interested in are visualization in scientific and biomedical computing and image analysis. At that particular time I was interested in applying those in the study of problems in biomedicine, specifically back then it was looking at computational models of cardiology function. We still do work in those areas, along with Rob.

Rob and I had met I guess a year or two before and started what would become a collaboration since maybe 1989, 1990. We

have worked together all those many years.

In the beginning we wrote grant proposals. I would say I was extremely lucky that I think all of my initial grant proposals, maybe the first four or five in a row, were funded.

CP: That's a great start.

CJ: Which is an amazing start and one that is perhaps even unthinkable in today's funding climate, how difficult it is to get funding. So I was very lucky to be where I was when I started my career. I also was very lucky in that I had a built-in editor at home, my wife, Katharine Coles, who's a big part of this story.

Katharine (Kate) is a professor of English here at the University of Utah and the former poet laureate of the State of Utah. She's a Guggenheim Fellow, and just published her seventh book of poetry, called *Flight*.

CP: Which is wonderful.

CJ: Early on, I had her read all of my publications and grant proposals. I was not a particularly strong writer at that time, so there were lots of red marks coming back and lots of long discussions about how my writing could be improved and needed to be improved. I think I was, unfortunately, what many scientific writers are, a lazy writer, in the sense of having a passive voice and using weak phrases, "As one can see in equation five," etc. Kate explained to me that she, as a poet, should be able to get the gist of what I was writing without knowing any of the technical mathematics if it was really well written. And that started me on a long process of learning how to become a better writer.

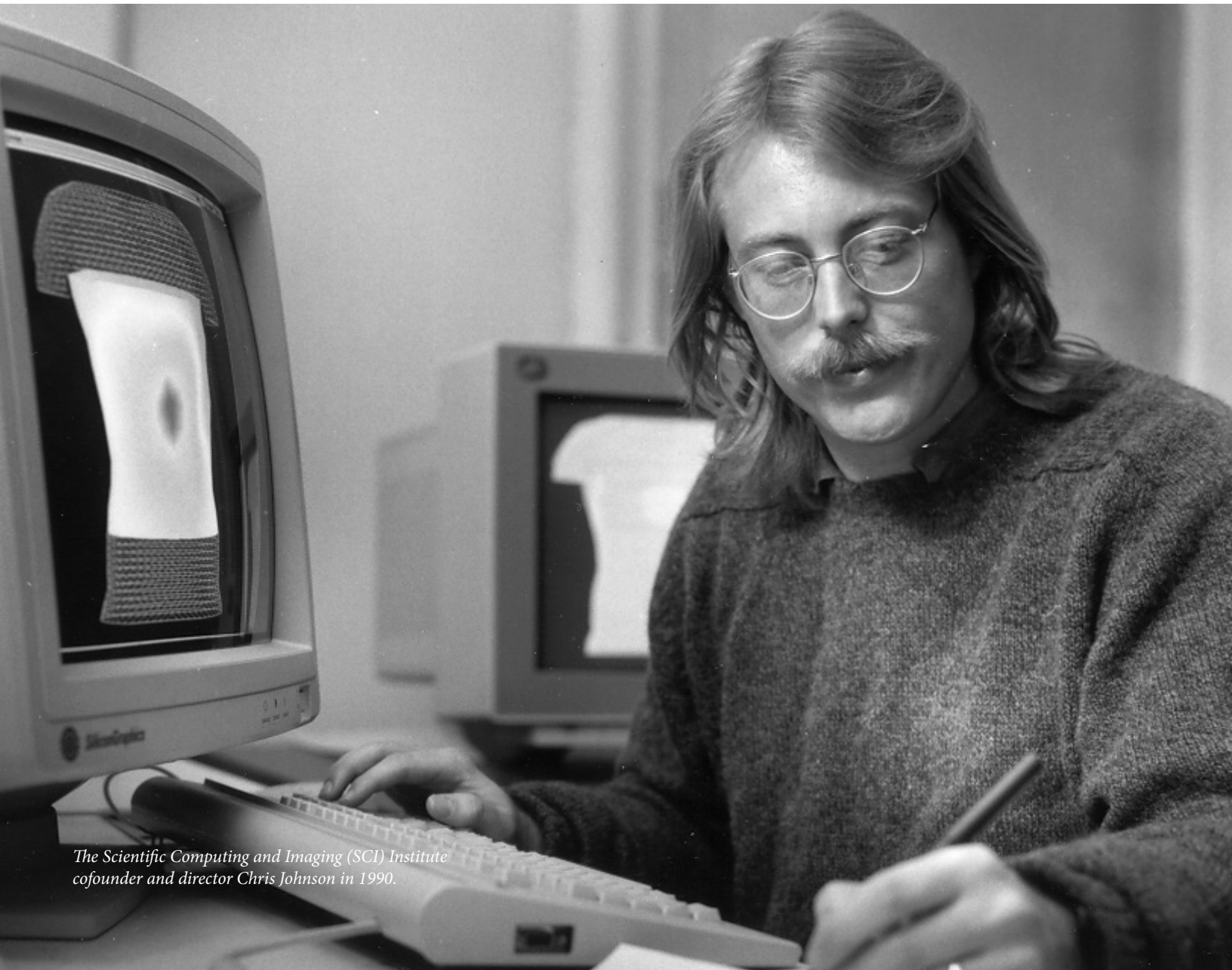
CP: What a wonderful partnership, though, for you.

CJ: It is wonderful! I do the IT at home and she helps with the editing.

CP: [laughs]

CJ: It's a good combination. It really is. That, I think, really helped me win those early grants and continue to win the grants to this day. I frequently get feedback from reviewers on paper submissions that the paper is very well written, which is something that I take pride in. But being an effective communicator, either verbally or in written word, has been enormously key to my success. I think that's something that many scientists and engineers overlook the importance of: they don't spend enough time becoming excellent communicators.

We were able to get several of these initial grants. And that



The Scientific Computing and Imaging (SCI) Institute cofounder and director Chris Johnson in 1990.

means that we had money to go hire additional graduate students. Also, I had my first postdoc, John Schmidt, who I had met on a visit to Duke University. I was very impressed with him so I convinced him to come out and be a postdoc at Utah. He is still here at the University of Utah.

CP: Really?

CJ: He's a research professor over in mechanical engineering. He decided, as many of us, that while he was just going to come for a year or two and then—

CP: Stayed forever.

CJ: And then stayed for those 25 years since that time, so that was really great. I was also very fortunate to have had a set of really great students. Some of those graduate students joined my group because senior professors Rich Riesenfeld and Elaine Cohen were on sabbatical one year when I was a young assistant professor. I was asked to teach their graduate class in computer-aided geometric design. I had never taken computer-aided geometric design, let alone teach it. So I had to work really hard to learn the subject. I was five minutes ahead or behind the students at all times. But there were a number of really great graduate students in that class. I was able to recruit some of them to be early students in what then became the SCI research group.

A couple extraordinary students to note include Steve Parker—Steve is a brilliant researcher. He was very shy, barely got into graduate school, and then would become this amazing researcher. He would become an assistant professor of computer science here at the University of Utah. He would then cofound a startup company called RayScale that nVIDIA then bought primarily to get Steve. Now he's the vice president for high-performance computing at nVIDIA. He's one of my amazing former graduate students.

Han-Wei Shen was another of the students in that class. Han-Wei, another brilliant researcher, he's a now senior full professor of computer science at the Ohio State University. I think he has just graduated his 18th PhD student. So he alone has produced 18 academic grandchildren for me.

CP: [laughs]

Cycling has been a central component of the SCI Institute from the beginning. Rob MacLeod and Chris Johnson regularly cycled up City Creek Canyon for many years, discussing research on the way. They often invited other faculty, staff, and students to join them.

CJ: Which is startling. Soon after, Dave Weinstein came to join us from Berkeley. He had a very strong math and computer science background. Dave would become the chief technology officer and then the CEO of our first startup company, Visual Influence. Just this year, he has joined Steve Parker at nVIDIA, so it's been very interesting to see how the SCI Institute students have gone on to have great careers and some still stay in touch with each other.

Rob MacLeod was there from the very beginning. He was then a research assistant professor of bioengineering and also at the Cardiovascular Research and Training Institute, the CVRTI. He is still at the CVRTI and now he's a full professor of bioengineering.

I think it was probably 1994 when we had enough people in the group that we decided to have a name. So before that we were just Chris/Rob's research group, but then we decided, well, we have enough people, we should have a formal name. Finding the right name took a long time. We got suggestions from the graduate students, postdocs, myself, and Rob, and went back and forth and back and forth, trying to come up with a three-letter acronym that was pronounceable that we thought would be the right name for our research group. It was graduate student Dave Weinstein who came up with Scientific Computing and Imaging that we pronounce "ski."

CP: It's a great acronym.

CJ: It works really well in Utah.

CP: Yes, it does.

CJ: [laughs] And our first logo, which Dave Weinstein designed – I'll have to get you a copy of it – had skis that crossed, in addition to the SCI that was there. And that has really worked well with us through the entire time since we were the SCI research group.

In 1996, when we got our first national research center awarded, we became the Center for Scientific Computing and Imaging. And then we got another center. First, we had an NIH center, then we got a DoE center. By 2000, we had grown enough to request to become a formal university research institute. From 2000 until today we've been the SCI Institute, a formal, permanent research institute at the University of Utah.

CP: With the centers continuing to grow under SCI.

CJ: Yes, we currently have five research centers that we direct and three other research centers that we are part of within the SCI Institute. We've grown to over 200 total faculty, staff, and students, on three floors of the John and Marva Warnock Engineering Building. I find myself walking into our space and thinking, 'How in the world did this happen?' Because it wasn't the plan in the early days. It was only after we had multiple research centers and we had grown enough. At this point, I was the bottleneck for everything. Everything had to come across my desk. It was a flat management plan because we had little or no administrative support in the beginning (and I had little or no administrative training). Finally we were able to hire a half-time secretary, Raelynn Potts, whose background was in theater. Thankfully, Raelynn became full-time. Then, because of all the grants we had, she started to learn how to do some of the financial parts as well. Through lots of on-the-job training, Raelynn became our first accountant. We hired another person to be the administrative assistant and secretary. So we started to have, finally, some support for administration and that helped

greatly.

As a side note about Raelynn, we supported her to get her MBA. So she started from a theater major, then became a secretary, then became an accountant, then got her MBA, while at SCI. A few years later she became the head financial person for the School of Business.

CP: That's an interesting career arc.

CJ: Yes indeed. So she was an amazing part of the early days of the SCI group and then center and then institute.

CP: Quick question. You mentioned the institute is now housed in this amazing building but where were you located prior to—

CJ: Ah, yes. So our first offices were over in the Merrill Engineering Building, on the third floor. We had taken over what was formerly a chemical engineering lab that was remodeled for us. We had a little corner that was down the hall directly from where the current School of Computing is. And we kept growing and growing. People would not like to see me walking down the hall and looking at their offices [laughs] because I might be eyeing their offices for future SCI Center offices, etc. We grew significantly over in the Merrill Engineering Building until we came to the Warnock Engineering Building, which was in the summer of 2007.

CP: Oh, so you were actually the institute for several years before.

CJ: Yes, we spent the first six and a half years as an institute in the Merrill Engineering Building.

CP: I didn't know that.

CJ: That's right. So we were an institute and had a significant footprint over in the Merrill Engineering Building before we came over here. Initially we were supposed to have only two floors of the Warnock Engineering Building, but during the time that WEB was being built we had grown so much that we had two and a half floors by the time we hit the building. Now we've expanded more and have three floors of the building.

CP: You've mentioned that administrative support, particularly the support of your interdisciplinary efforts, allowed you to start SCI. And you've credited now U of U president David Pershing for that support. When did you and Dave first meet?

CJ: Dave was the dean of the College of Engineering when I was hired as an assistant professor of computer science, so we met very early on. It was the then chair of the Department of Computer Science, Tom Henderson, who hired me as an assistant professor. Tom was incredibly supportive of the work that we did and he worked with Dave in order to get us additional support as we were growing from just a small research group to a medium to a large research group and then to a center. When we became a center, I started to report to Dave Pershing directly as dean of engineering.

CP: How did that come about?

CJ: It was the structure within the College of Engineering, that the large interdisciplinary centers would report to deans of colleges and institutes usually report to a vice president, whether that is the provost or the VP for Research or up in the medical campus they report to the senior vice president for Health Sciences. I reported to Dave Pershing as dean of engineering and then, he became

Photograph of, left to right, Rob MacLeod, Chris Johnson, and Mike Matheson (IBM) taken for a piece in Discover *magazine called "The Body Electric" written by Carl Zimmerman in 1993, pages 72-77.*

the provost of the university and when we became an institute, I reported to him as provost. That was in 2000. When Dave Pershing became president, because the new provost hadn't been hired yet and we weren't sure if that new person would be the right fit, Dave took us with him, so I continue to report to him as the president.

I've reported directly to Dave for 20 years, which is pretty amazing. He has had a significant positive impact and played a pivotal role in the success of my career, especially with the interdisciplinary endeavor of first the Scientific Computing and Imaging research group, the Center for SCI, and then, probably more importantly, as provost and president supporting the SCI Institute. And I think – but you'll have to ask him – that—

CP: I will.

CJ: [laughs] That the SCI Institute was one of Dave's experiments in interdisciplinary research because, especially at that time, in the late '90s, early 2000s, this whole idea of doing interdisciplinary and multidisciplinary research and education was deemed very important. The universities all across the world were now trying to become more interdisciplinary. A lot of them would say how important it was but none of them really had the structures to be able to implement something that was truly interdisciplinary.

Dave and I worked together for many, many years, trying different ways of implementing an interdisciplinary research center or institute in a university that is primarily organized by vertical silos of departments and colleges. Having something that cut across those departments and colleges was a huge challenge. It took us several years before we came up with the kind of power-sharing method that we have today, in which I, as institute director, get the budgets for the faculty FTEs, but the departments have the faculty positions and/or tenure. It's a combination of neither of us get it all. We have to share and we have to work together in order for us to hire great faculty.

CP: Talking a little bit more about David and his experiment, how do you quantify your success in your reports to him?

CJ: Ever since I reported to him, I have an annual report that I have to present to him, which includes a budget report. My annual report is a combination of showing him, convincing him, of his return on his investment and then highlighting some of the faculty and students' research successes. I got the idea of structuring my

annual report in this way because at one point, when he was provost – and I think he was just kind of learning the ropes of being provost – he said he felt like he was an investment banker because he had this set amount of money and it was not nearly enough to do all the things that he wanted to do. So he had to come up with a portfolio of people and projects that he was going to invest in and support. Of course, he wanted to have the most impact that he possibly could have from that investment. After I heard him talk about how he thought about part of his new job, I took that seriously, and in all my budget meetings I put together a slide presentation in which I talk about the impact that the SCI Institute has had in every way, shape, and form, from the number of best paper awards that we've received, the number of grant proposals, the amount of research funding per faculty member, the student fellowships, the professional service that we perform, awards that we are given, university service. You can talk about impact in many, many different ways and I try to cover them all [laughs].

CP: So he's assured of value for money spent.

CJ: That's right. I can say, "Dave, if you give us another faculty position, then I can assure you a good return in this way that this faculty member will perform very well."

CP: That sounds like a very workable relationship.

CJ: Fortunately, because of the quality of the faculty we are able to recruit and retain, it builds upon itself. The better the faculty, the more good faculty that we get, it's easier to recruit even better faculty. It builds upon the culture that we have and it makes my job easier every year because the faculty are just so great and reporting their amazing accomplishments to Dave is enjoyable.

CP: Excellent. Let's turn for a minute to your success as an administrator, which is huge. But did you have any background when you founded SCI, administrative background?

CJ: Absolutely none [laughs]. And that was a problem. I was a scientist. Most of my formal training was in physics. And then I became, I guess you would say a computational physicist or a computational scientist with links to computer science but still maintained my links with physics and other subjects as well. In all my PhD studies in physics and math and computer science and bioengineering, none of them trained me to be a good administrator, or had any administration content whatsoever. It's really something in academics that makes little sense in that the academicians always choose their administrators from their faculty, so chairs of departments and deans of colleges and vice presidents, etc. None of them have been trained to do these administrative positions and it shows [laughs].

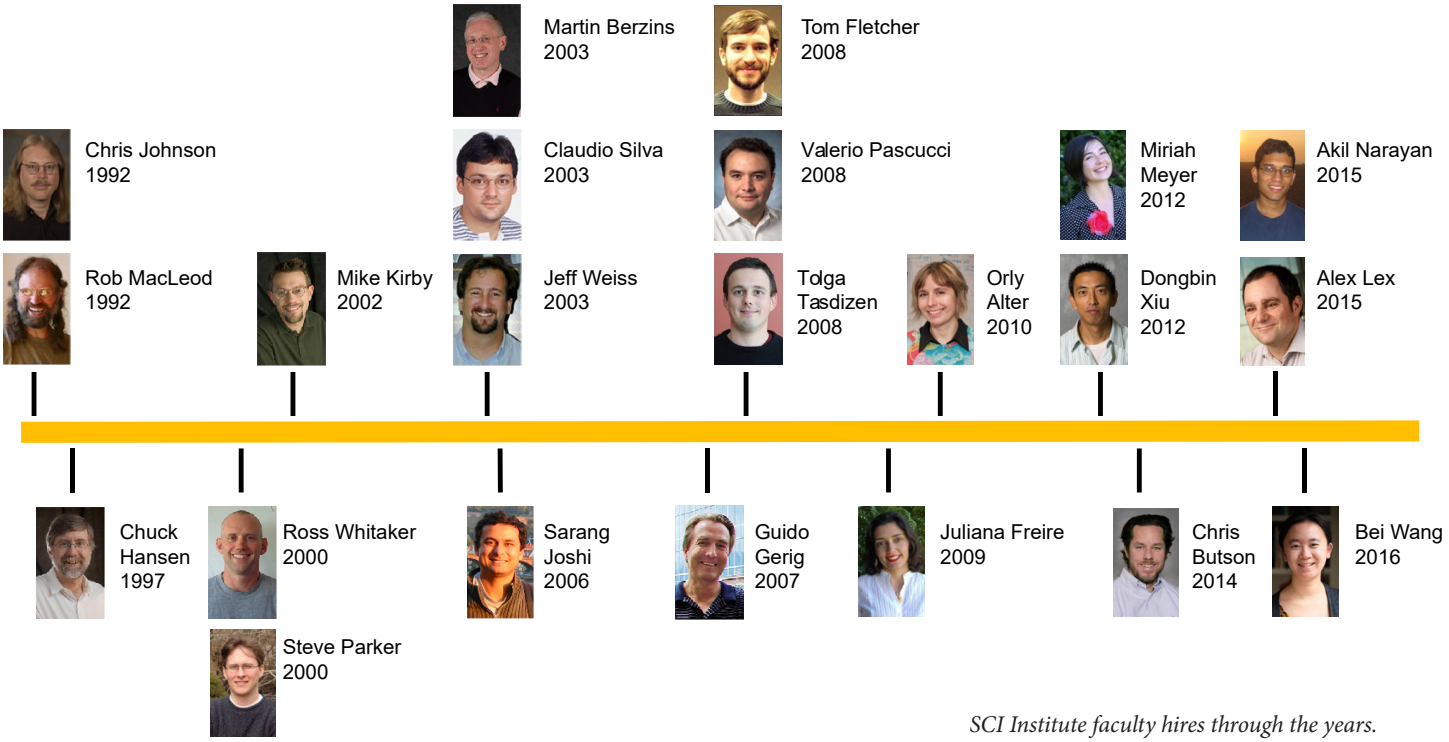
CP: Yes it does, frequently [laughs].

CJ: It's only those people who decide to go and learn how to be good administrators who end up being good administrators because nobody is—I mean, maybe people have natural organization and people skills or something that they've accrued over their time, but it doesn't mean that they're going to be excellent administrators.

CP: But you're a great administrator, so how did you learn?

CJ: I learned from many different ways. I read many books on administration and leadership. I talked to a number of international leaders I highly respected and asked them how did they get there. They started out as professors and now they were leading large national or international research centers and institutes. How did that happen? I would often talk with them, ask them questions about, "What did you do in this particular situation?" I've continued to do that throughout my career and found the right people, I guess, who knew a lot about a particular area, or at least I thought they did, and I was able to emulate, practice some of that, of what they were able to do.

Examples are Larry Smarr, who was when I first met him, the director of the National Center for Supercomputing Applica-



SCI Institute faculty hires through the years.

The original SCI research group. Top row left to right: ***Chris Johnson, PhD.*** *Associate professor in the Department of Computer Science in 1996. Currently the director of the SCI Institute and Distinguished Professor of Computer Science.* ***Rob MacLeod, PhD.*** *Research associate professor in the Department of Bioengineering in 1996. Currently a professor in the Department of Bioengineering and School of Medicine, associate director of the SCI Institute, and associate director of the Nora Eccles Harrison Cardiovascular Research and Training Institute.* ***Han-Wei Shen****, PhD in Computer Science in 1998. Currently a professor in the Department of Computer Science and Engineering at the Ohio State University.* ***Steve Parker****, PhD in Computer Science in 1999. Currently vice president, professional graphics at nVIDIA.* ***Yarden Livnat****, PhD in Computer Science in 1999. Research scientist at the SCI Institute.* ***David McAllister****, BS in Computer Science in 1996. PhD in Computer Science from the University of North Carolina in 2002. Currently a graphics processor expert at Samsung Semiconductor.* ***David Beazley****, PhD in Computer Science in 1998. Software developer, teacher, and author.*

Bottom row left to right: ***Ruth Klepfer****, PhD in Bioengineering in 2000. Senior principal scientist in the Cardiac Rhythm and Heart Failure group of Medtronic.* ***David Weinstein****, PhD in Computer Science in 2003. Currently director of Enterprise Virtual Reality at nVIDIA.* ***John Schmidt****, PhD. Postdoctoral fellow from 1993-1995. Currently an adjunct assistant professor in the Department of Mechanical Engineering, University of Utah, and a research scientist at the SCI Institute.* ***Peter-Pike Sloan****, BS in Computer Science. Currently a technical fellow at Activision.* ***Prasad Gharpure****, PhD in Bioengineering in 1996. Senior architecture manager at nVIDIA.* ***Carole Gitlin MacDonald****, MS in Computer Science, 1995. Currently a software engineer at Bentley Systems.*

tions, NCSA, at the University of Illinois, which was one of the four large NSF-funded supercomputing centers. I used their facilities at NCSA and got to know Larry. Larry was absolutely one of the best leaders I had seen at a national level. He then went to the University of California in San Diego, UCSD, and founded what's called Cal IT2, which is another big national, international center. He's been on numbers of advisory boards, the President's Information Technology Advisory Committee, to advise the different presidents along the way and he's written a number of really high-impact reports. I've become a good friend of Larry's. He definitely was an early mentor to me.

Andy van Dam, who was the founding chair of the Department of Computer Science at Brown University, who then became the vice president for research at Brown University. Andy is still a great friend and was one of my early mentors in learning about how in the world do you become a leader.

CP: So you were just picking their brains about how they accomplished what they did within administration?

CJ: Absolutely. All the books that I've read, most of them—I didn't really find that many books that were about academic administration—they were mostly business leadership and administration, so there wasn't always the right parallel there. But I was able to define an idea or two out of those books and then keep reading and grab another idea or two and add it to my portfolio. A lot of it was trial and error. It was try, fail, fail better, faster.

CP: [laughs]

CJ: And then get off the ground or get back on the horse, whatever analogy you want, to do it better. My leadership skills have had to change enormously through the time of when it was just me and Rob and a few graduate students. Then, we would sit around the same table and I knew everything about everything. At that time my leadership style was much more of a top-down and I'll say micromanaged style. I knew everything about everything that was going on.

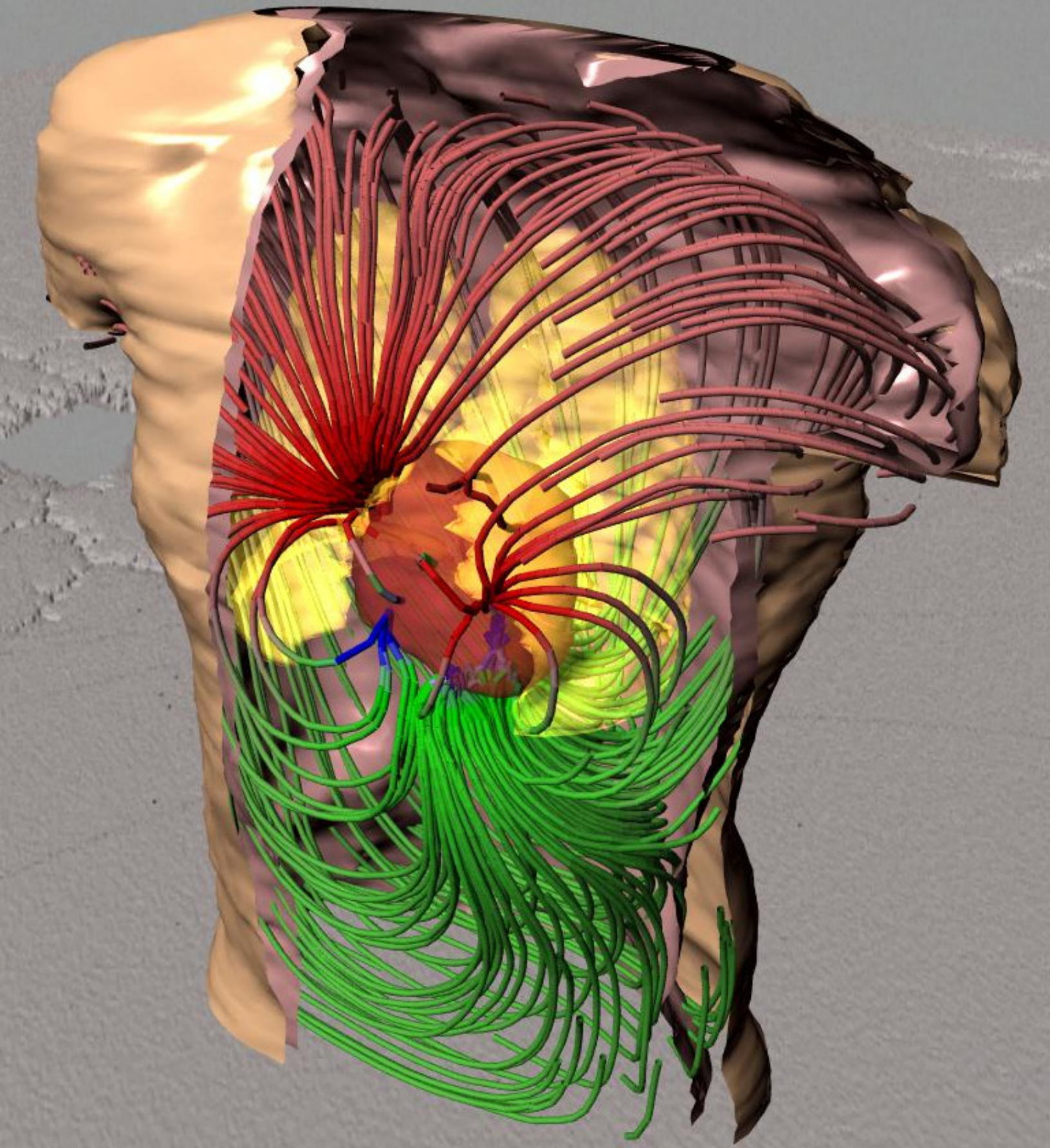
Then, of course, as time went by and we grew to having 30 or 50 or more people, I had to learn the important but hard-to-do art of delegation. As Greg will tell you, Greg Jones, my associate director for 16 years, I was not especially a natural at delegation. I think a lot of people who are successful, it's because they're particular and they pay attention to the details. They work hard. They want something done a specific way that they think is a very high-quality way, and they have difficulties letting go of that micromanagement.

CP: It's kind of a fine balance, isn't it?

CJ: It's very difficult. Greg will tell you that I would stand over him and watch him and say, "No no no no, you're going to make a mistake," and grab it back. It took several tries before I was able to let go and know that they're going to make mistakes. They're not going to do it exactly how I would do it. The key, though, is really hiring the right people.

CP: So you can trust them.

CJ: I entirely trust them to do things the way that they want



The first project on which Chris Johnson and Rob MacLeod worked together: a computer simulation of the electricity in the body due to the heart's electrical activity. At the time, it was the most sophisticated computer model of the heart's electrical activity within a human torso. Discover *magazine in 1993 published an article on the work and featured this image in the article. It is now called the Utah Torso Model and has been used by many researchers to do bioelectric field simulation.*

to do, and on occasion it may not be what I would've wanted to do, but then I can just talk with them about it and make sure we're on track with each other. By and large, they just do fantastic. I'm so lucky that I am surrounded by these amazing administrators, staff people, who do things every day without my knowledge!
[both laugh]

CJ: That are fantastic.

CP: And do it well, too.

CJ: Really well. And they support the mission of the SCI Institute and it continued as we got larger and larger, and grew with more and more faculty. I had to learn different kinds of communication, different kinds of administration along the way, and I'm continuing to learn as I continue to get older at this job.

My wife Katie, we were talking about this interview, talking about that you should interview her as well.

CP: She's on my list.

CJ: Because she's been there from the beginning. She reminded me that at the early SCI parties, which we would host at our house in Sugar House, she would cook, because there were just a few people in the group in the early days. Then we got big enough where it was too much work for her to cook so we would order pizza and it would be delivered. As SCI grew, we moved to our current house, which is up in the Avenues and we got so big that we'd have the SCI parties catered.

CP: That's evolution for you.

CJ: We were one of Rico's first customers and got to know Jorge, the owner of Rico's. I was interviewed by the *Salt Lake Tribune* when they did an article about him because we had had Rico's cater SCI Institute events so many times.

Then we got too big to hold SCI parties at my house. So now we have the annual party at Memory Grove, which is a really wonderful place. But it just mirrors my administrative [laughs] side, in terms of the change as we grew from a small group of people that could sit around a conference table, to a center that had multiple faculty PIs and many, many graduate students and some staff, to an institute with—we're now I think 20 regular faculty members. There are more than 40 PhDs at the SCI Institute, postdocs, research scientists, faculty, 80 to 90 PhD students from eight departments at any one time, and a number of staff from administrative to financial to computer systems to graphic design.

CP: To media [laughs].

CJ: To media. Overseeing, managing those people, administrating, leading those people has been a challenge. It's been interesting. One that never stays the same.

CP: Now, you mentioned in another conversation that you learned indirectly about some important kind of goals, shall we say, from Evans and Sutherland, about hiring the best people and so forth. Tell me about that.

CJ: Yes. I was really, really lucky as a young assistant professor because some of our amazing alumni in computer graphics were brought back for a special celebration of the time of David Evans and Ivan Sutherland. It was a very special time back in the late '60s and early '70s when David Evans was brought to the University of Utah to create a program in computer science. He was at Berkeley

SCI Institute faculty in 2003. Top row left to right: Chris Johnson, Greg Jones, Rob MacLeod, Chuck Hansen, Steve Parker. Bottom row left to right: Ross Whitaker, Martin Berzins, Yarden Livnat, Oleg Portniaguine, Mike Kirby.

in electrical engineering at the time. James Fletcher was president at that time, who would then go on to be the head of NASA. I was so impressed with that time that I've studied that history quite a bit and learned—

CP: And you've called it a golden age.

CJ: Yes, it was a golden age, yes, absolutely. James Fletcher played, I think, a much larger role in the success of that age than people know about because he was behind the scenes. But he was also very instrumental in helping Evans and Sutherland get the original funding from ARPA when they started. Dave came to Utah and the first person he hired was Ivan Sutherland, who was then at MIT. Ivan had created the first interactive graphics program, called Sketchpad. The third faculty member was Tom Stockholm, who was a signal-processing person. He created the technology for the CD-ROM and many other technologies. Those three, with a number of other faculty, were able to get significant funding from ARPA, the Advanced Research Projects Agency, which is now DARPA, with Defense, the D in front of it. Before, it was just ARPA and it was funded for the future research that might support our country.

They were able to get a grant for about five million dollars a year back in the early '70s. I think in today's money that would be 25 million dollars a year equivalent research money. I don't know anybody who has a 25-million-dollar-a-year research grant. They basically created computer graphics, to a large degree. I mean, there were other researchers out there, but Utah was really put on the map by those three early faculty.

The students who came here to study with David and Ivan and Tom would change the world and continue that legacy. Ed Catmull, who got his PhD here and then cofounded Pixar. He's still the president of Pixar and now also the president of Disney Animation. Alan Kay got his PhD here. He invented object-oriented languages and also coinvented the laptop computer. He won the Turing Award a few years ago for his contributions. John Warnock got his PhD here. John cocreated Postscript and then cofounded Adobe and was the longtime president of Adobe, Incorporated. Jim Clark got his PhD here. He was then a professor at Stanford for a little while and then cofounded Silicon Graphics, Incorporated, SGI. And then later he founded Netscape, which was one of the first Internet companies. He's since founded WebMD/Healtheon and My

SCI Institute imaging research on display at the Salt Lake City Main Library, 2008.

CFO and many, many other companies.

Anyway, they were brought back for a special devotion, in a sense, a celebration I should say, of David and Ivan, and I got to meet them. I pummeled them with questions about how things happen. How did this small place in the mountains of Utah that's not on either one of the coasts, that doesn't necessarily have a reputation for computer science, let alone computer graphics or other things of that ilk, how did it become one of the most powerful places in the world in that area and would impact the world so much? You think about Adobe and Pixar and SGI and Netscape, you're thinking about billions of dollars of companies that have come out of the University of Utah computer science.

I've talked with Alan and John and Ed and others multiple times and I got to know them well. I've had those friendship relationships with them since the early 1990s. Asking them how such a successful culture was established by Dave and Ivan, they all basically said the same things and it was, "People, people, people, is the most important thing you have to worry about." You want to always find the best quality people. Never sacrifice the quality of the people, even if it becomes difficult and you can't find the right person when you need to. We've definitely had that situation, where it's taken multiple years to find the right faculty member. They would then go beyond that, though, to say, "You want to find people who can work well together." They thought that one of their strengths was, instead of having individuals who just went and sat in cubicles or offices by themselves, they worked really well as teams, and that they had the best resources—

CP: In the hands of the best people.

CJ: And the best people. Dave and Ivan and Tom and some of the other faculty were able to create an environment where you had these best resources in the hands of the best people, working together and they did amazing things.

CP: So by "supportive" you also mean retention, keeping those best people, by supporting them.

CJ: Yes, absolutely. I tried to emulate the environment and culture that Dave and Ivan created. It sounds easy. You just go hire a bunch of really smart people. You get some good resources. You put them in a supportive environment.

CP: And mix slowly [laughs].

CJ: That's right. And fabulous things will come out. I found it was a lot more difficult than one would think, I guess maybe especially in an academic environment. Given SCI's interdisciplinary nature, it was a challenge. What was also key was making sure that everybody who came in here was really, really top in their field research-wise, and that they could get together and get along very well. We have instituted what we call the "no asshole" rule, where we know lots of really smart, smart people but they just don't necessarily play well together and when they walk into a room other people leave. That is not conducive to a good collaborative environment.

CP: So how do you deal with that?

CJ: It's really all about the hiring up front. With almost all of our hires, we have known the people we're hiring, so we've gotten to see them in action. In some cases we've collaborated with them for multiple years. We've done a lot of targeted hiring, where I go to the faculty in an area and say, "Who is the best young image analysis person in the world you want to work with?" And they say, "Sarang Joshi, who's now at UNC." I get on the phone and I invite—I haven't met Sarang Joshi, but I trust my faculty in this area that they are going to go find the right person. So I get on the phone and I invite Sarang Joshi to come out and get an interview. Then, if the visit goes really well, then I tell them that they have to stay.

CP: [laughs]

CJ: And that has actually worked—

CP: Well, we were going to talk about retention but you've answered that question [laughs]. They have no choice.

CJ: That's right. They have to stay. But it's getting those right people to come to Utah. I spend an inordinate, an enormous, amount of my time in faculty recruitment. I think that's one of my most important jobs I do is in hiring the right people—the faculty, the staff, and the graduate students. Getting the right faculty here has been just so important to the success of the SCI Institute.

CP: You know, I was just thinking that, in terms of the "no asshole" rule, the atmosphere here is such that there's an expectation of individuals, which is good. And people live up to expectations. That must play a role, too, that people see how everybody else is behaving and do the same.

CJ: Yeah, I think that's right. And so I've always gone with the leadership by example rule, instead of the leadership – I tell you to go do something—

CP: By beating you over the head [laughs].

CJ: That's right. And we're very much more about carrots than the stick here. And it is about, I think, leadership by example by all of the faculty and then incorporating the new faculty into that way of working together.

Things that are different about the SCI Institute, in terms of its support, are the amazing staff. Unlike most departments that share a few secretaries or accountants or other staff, we take some of our funding and we hire more, better, higher paid staff who can help the faculty do a lot more of the work that PhD, faculty, high-end people shouldn't be doing, they wouldn't be doing if they were in a business. But for some reason at a university you find these top PhD researchers, faculty out making copies and doing their travel forms and all of the stuff that is just taking time away from the time they should be doing their research.

CP: So with the good staff you increase the productivity of the—

CJ: That's right. In the early days I would actually quantitate the effect of higher levels of support. When a faculty member would come from a different university, and I had their record at the other university, in terms of their publications and their funding for example, and that after a few years at the SCI Institute their publications would increase in number and their funding would increase as well. While I'd like to think it was just they got smarter by walking in the doors, it was, I think, primarily that we provided much more staff support for them. As such, they had more time to do the great research that they were wanting to do and did in a smaller quantity elsewhere.

CP: And were supposed to be doing.

CJ: And were supposed to be doing. And they just were able to do it here. And so that's certainly one of the keys to our success is the ability to have a really great staff for all of the SCI Institute, for all of the faculty and all of the students. And that is part of the supportive environment that we have here is that they know that they're going to end up not having to do a lot of the other stuff that "normal" faculty would have to do. They can spend more time on their research.

CP: You mentioned the success of this model. What are some of the great success stories of your hires, faculty or staff? I know there are so many.

CJ: Yes. It's great. And I like to brag about them all. Individual faculty – so the first faculty member who I hired was Chuck Hansen. Rob was already here and so that was great. Having Rob MacLeod already at Utah working with me turned out to be one of those rare happenstances that has worked out over the last 30 years or so. Our first faculty hire was Chuck Hansen. Chuck is a visualization expert. He was then the head of the visualization team in the Advanced Computing Lab at Los Alamos National Laboratories. I had started a collaboration with Chuck because he was one of the best in the world. I had had some of my students, Steve Parker and Han-Wei Shen and Yarden Livnat, who was another one of my early graduate students, who is still here as a research scientist, at Los Alamos with Chuck during summer internships and had done some great work and we had started to publish together, etc.

When I had a faculty opening I talked to Chuck and I said, "Hey, I've got a faculty opening. Who do you think I should hire?" And he said, "Me."
[both laugh]

CJ: "Oh. I didn't know that was possible." It turned out that that year was this amazing set of people who were on the job market in visualization. And all of them applied here. And all of them got faculty positions at good places. And they all became highly

Professor Valerio Pascucci (right) giving a demonstration to Alan Kay, during SCIx 2012

impactful visualization researchers. But after all that, when I reviewed all of those people, I thought Chuck was the strongest. And I hired Chuck, which turned out, I think, to be the right move. That was the right decision. Chuck became an IEEE Fellow before any of the other candidates and he would win the IEEE Visualization Technical Achievement Award. Chuck would go on to have an incredibly successful and high-impact career research-wise and professional-leadership-wise as well. He really helped set the tone of the future faculty I would hire.

The second person I hired was Ross Whitaker. The great story about Ross's hire was that when I interviewed for a faculty position at UNC, when I was on the job market, before I decided to stay at Utah, Ross was the graduate student who was in charge of taking me to lunch. He was a PhD student in computer science at UNC. We got to talking. He was doing image analysis. He was doing this very interesting research – I still remember – it was anisotropic-based partial differential equation solvers for image segmentation.

CP: What a memory.

CJ: I was really impressed with Ross's dissertation research. Image analysis was one of my interests. I corresponded with Ross after my visit to UNC and got some of his code and tried it out. Then I lost track of him for a little while. The reason was he became a postdoc over at a research institute in Germany for a while and that ended in the middle of a year because of their funding model. Ross then went out for his job interviews, but there were not very many openings at that time, so he ended up at the University of Tennessee in electrical engineering. I only knew that because I was giving an invited talk, by Jack Dongarra's request, who was in computer science, at the University of Tennessee and Ross came up to me afterwards. I was like, "Wow. I didn't know you were here."

So when we had our first opening for a young person in image analysis, Ross was the guy I wanted to get. Ross is now an IEEE Fellow. He's now the director of the School of Computing here at the University of Utah. He is a member of the Computing Research Association's CCC, which is their council of people who are thinking about the future of computer science. He has a very high H index for his work in image analysis and is one of the world leaders in research and image analysis.

I could go on and on and on. One more is Miriah Meyer, who is linked in the story because she was Ross's graduate student. She came to SCI as a PhD student after having an undergraduate degree in physics. She was working at a company in Pennsylvania and had decided to go back to school. At first, she thought she wanted to do computer graphics. She initially worked with me for a while. I was trying to get her interested in doing some visualization but she just wasn't interested at that time. She then entirely switched gears and she started working with Ross on geometric modeling. She finished a PhD here in geometric modeling and did a little bit of visualization. Then she went to do a postdoc at Harvard, with Hanspeter Pfister, who's one of the international leaders in visualization and computer graphics. Miriah got interested in doing not only scientific visualization but information visualization. She got really interested in new ways of representing high-dimensional data, and biological data-genomics and molecular biology. Miriah spent months in biology labs talking to biologists and learning what they did and what their goals were, reading their papers, seeing what their current state of the tools for visualization analysis was, asking them what worked well, what didn't work. She then went off and prototyped and designed systems that she thought would work better, put them in their hands, got feedback, and did another prototype. She ended up creating these systems that enabled the biologists to make discoveries that they couldn't have made using their current visualization and analysis tools.

When Miriah was a postdoc at Harvard, she ended up getting a really highly competitive NSF CCC fellowship. Once she finished her fellowship at Harvard, Miriah went on the job market looking for faculty positions. It turned out that we were looking for a new information visualization faculty member at the SCI Institute. She had – ask her – but I'm going to say at least nine offers, maybe more, so we had a huge challenge of recruiting her.

CP: So you just called her and told her she had no choice, right? [laughs]

CJ: No, we worked really hard. I think that the reason we were able to—Because she had offers from the University of Chicago, from Duke University, from the University of Edinburgh. Many good places. I think the way that we out-competed those other places is that we were able to solve her two-body problem. Her

First photo: The SCI Institute had multiple teams at the 2002 intramural ski race. Second photo, left to right: Kerry Kelly (now professor in the Department of Chemical Engineering in 2017), Oleg Portniaguine (president of Computational Geophysics, LLC, in 2017), and Professor Ross Whitaker (now director of the School of Computing in 2017).

husband is a lawyer. Initially I thought that would be easy, but it turned out that it was challenging. Dave Pershing came to the rescue, again, because her husband, Brian, is now a member of the general counsel at the University of Utah. Dave helped make it possible to successfully recruit Miriah.

Dave has helped us solve a number of faculty retention issues because a good number of our faculty are two-body professionals, myself included. My wife is a professor. Rob MacLeod's wife, Annette, who is—she just recently retired. But she was an anesthesiologist at the Huntsman Cancer Institute. Sarang Joshi's wife is a professor of languages and literature. The list goes on. Dave "got it" earlier than most other people, figured out that if you could make both spouses happy, the chances of them staying were much higher and happy people are more productive people. You know that if one of the people in a relationship is unhappy that the chances are—

CP: They're both unhappy [laughs].

CJ: That they're going to be unhappy. And they're not going to be as productive. And you may likely lose them in the future. Dave figured that out and helped enable us to both recruit fantastic people and retain them.

Mentioning Sarang Joshi as a specific example. Sarang was a professor at the University of North Carolina at Chapel Hill. When we were recruiting him to Utah, Johns Hopkins University was also recruiting him. Johns Hopkins University is a very highly acclaimed university. However, when he approached them about a possible position for his wife, who was a professor at NC State in languages and literature, they basically just thought, 'Well, that's your problem,' and offered little or no assistance. But I was able to approach Dave, then provost, about this. He was able to help with a position in languages and literature. And that was how we were able to recruit them and retain them here at Utah. So there's another example of Dave's support but also I think his enlightened view of how this works [laughs] in the big picture. And he's been able to recruit and retain a lot of people who were stronger than the University of Utah may have normally been able to recruit against other top places.

CP: By making that type of accommodation.

CJ: Exactly. This has been, I think, a really important way in which I've been able to recruit some of my top people and retain them.

CP: Well, before we move away from this question, how about discussing one of the staff members, maybe, like Nathan Galli?

CJ: Sure. So we have these amazing, amazing staff. And we have since the very beginning with Raelynn. And we continue to have. And they really are the backbone, if you will, of the day-to-day operations and the support that make things work so smoothly and so well here at the University of Utah.

Nathan Galli is one of our star longtime staff members. Nathan started out working part-time. I don't even know when. A long time ago. I hate to ask him how many years ago. But it was a long time ago. I remember that Richard Coffey, who was then our head of computing facilities, was friends with Nathan. And we were starting to try and set up our web pages and then also do more graphic design and posters and brochures. We quickly figured out that as computer scientists, as visualization people, we can make nice visualizations, but we are not professional graphic

Deb Zemek, the administrative manager of the SCI Institute.

design artists and we do not have those skills, and that if we could have somebody with graphic design skills, that would really help. Nathan started part-time. We liked what he did so much that we found a way to be able to hire him full-time. Nathan really has established the look and feel of the institute from the very beginning.

After Dave Weinstein did the initial logo with the skis on it, which was kind of kitsch and cute, Nathan redesigned it and it is the logo that we still use today. People throughout the world know us because of Nathan's ability to communicate effectively through graphic design. And he's a great artist in his own right.

Nathan is one of the people—I have a set of people here I consider my go-to people, that they will make things happen no matter what and have over and over and over again. They will make it happen.

Deb Zemek is another example. Deb started out as being my secretary, administrative assistant, but quickly became the key [laughs] to operating the institute on a daily basis. She's the administrative manager for the institute. When we hired her she was one of the secretaries over at Evans and Sutherland (E&S) Inc. And there was a pool of seven administrative assistants who saw to the needs of their vice presidents. Then Evans and Sutherland started to go away and they started laying off people and cutting jobs. Deb was still employed there as one of two administrative assistants for all the VPs. When I talked to one of the VPs it was clear that—she had decided, well, the writing was on the wall and the job was going to probably end at some point. So she started looking around. But when I talked to one of the VPs at E&S, he told me that Deb would be the last one that they would ever fire. And they'd probably fire VPs before they'd fire her. I thought, 'That speaks really highly of somebody who can deal with a bunch of high-end VPs.' So I made a very good decision. One of my best decisions ever was to hire Deb. I can't imagine the SCI Institute operating without her.

Nick Rathke is the head of our computing facilities. He's

Steve Parker, PhD in Computer Science in 1999. Currently vice president, professional graphics at nVIDIA.

another go-to person, who makes this place hum, in terms of its facilities. Greg Jones is my associate director. Greg has been with me since 2000, with a short break because Governor Jon Huntsman stole him for a little while to become his science advisor. Fortunately, Barack Obama picked Jon Huntsman to become an ambassador for China.

CP: Then you got Greg back [laughs].

CJ: And then I got Greg back. And Greg has been essential. For every hour he works I get an hour back. And it's even more than that now. He's just done so much on his own. He has a PhD in physics but he, too, went back and got an MBA. He's really been the head of our industrial liaisons program. He's been the key person who has been responsible for starting a number of our start-up companies and being the interim CEO to get things going and launching them. And his humor has mitigated lots of tense situations over the years. He is just a fantastic person.

But I remember when—So Greg was over in radiology. He did work on medical physics. He had also worked out in a storage company for a while. He used to do a lot of travel. When I was looking for an associate director, and we decided to hire Greg, we really didn't know what he was supposed to do because I'd never had an associate director before. So Greg kind of invented his position along the way and has continued to invent that position every day for 14 of the 16 years, minus the two with Jon Huntsman and the state. And I'm pretty sure he invented those, too. And he is another huge reason why we're so successful.

There's just person after person after person I can point to that I've been able to find and recruit and then retain who have contributed enormously to the success of the SCI Institute.

CP: We'll get back to retention in a bit. But for now, in terms of attracting the best, have you tailored your admissions criteria to attract the best graduate students? How does that work?

CJ: I'll say that getting the best graduate students is one of the most challenging things that we do.

CP: I bet.

CJ: It is easier for me to attract top faculty and postdocs than it is graduate students. The reason for that is the areas we specialize in, visualization, image analysis, and scientific computing, are not subjects that most undergraduates take as a part of the regular coursework. So if they're not involved with some undergraduate research that might be in one of those areas, then they might not know that this is the area that they might want to be in as graduate students. So we have challenges in getting some of the top graduate students. Often, some of those top graduate students are thinking they want to do something else, like Miriah with computer graphics. Steve Parker also thought he wanted to do computer graphics. Then we moved them over into visualization or image analysis or scientific computing after they started their graduate program.

We have spent a lot of time thinking about, 'How can we do a better job at recruiting our top graduate students?' The best graduate students we get often come from two different ways. One is from collaborators we have nationally and internationally that they have as undergraduate researchers and they tell them to come here because we're known as one of the very best places in those areas. The other way is luck. They apply for whatever reason and some of them turn out to be the best people we have ever seen.

CP: You seem to have an amazing group of graduate students.

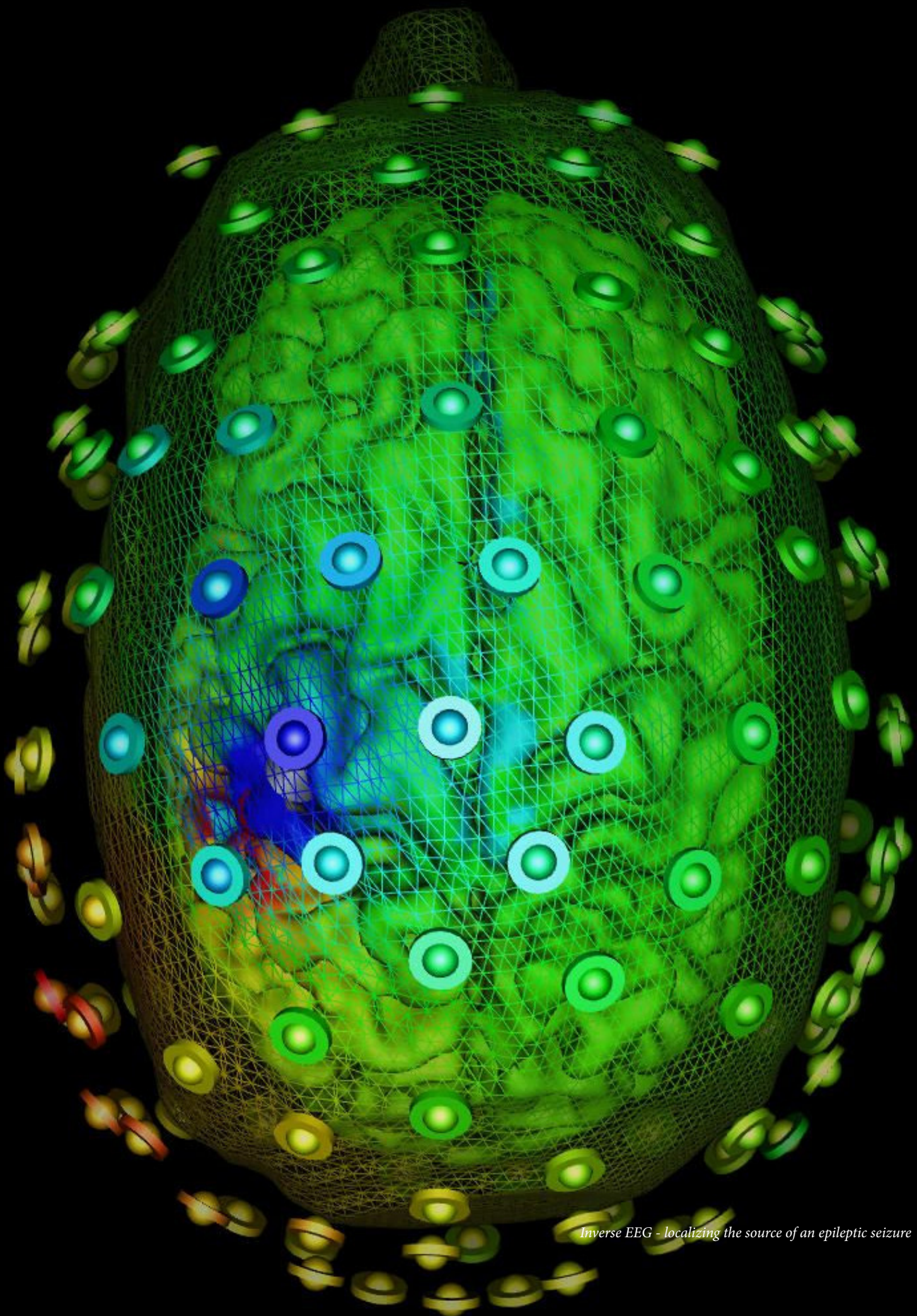
CJ: We do. And part of that, too, is the environment that we have here, where you get these top, top people and they help set the tone of what is expected. One of my former students, Gordon Kindlmann, who is now a professor at the University of Chicago, he worked so hard that he would sleep under his desk.

CP: [laughs] Poor guy.

CJ: Which is not necessarily a great thing. But he had this environment around his desk. It was kind of a—I think he called it a "geekosphere," or something like this. But it had such a reputation that either *Nature* or *Science* actually featured it in one of their articles about academic student environments. So he had this little world there. But we would encourage him to go home every once in a while and take showers.

CP: Did he have a home?

CJ: He did have an apartment. But he didn't drive. He would only ride his unicycle back and forth between here and there and other places. He has since learned how to drive. He has two children and a lovely wife. But as a graduate student he was putting in the 100-hour-plus weeks and was so inquisitive and creative, he was the person in the lab where all the other students went to ask questions. "How do you do this? How do you do that?" And he would help them.



Inverse EEG - localizing the source of an epileptic seizure

CP: Well, that's got to rub off on other students, yeah.

CJ: Yeah, absolutely. And we see it all the time here. Another part that I think is unusual for an academic environment is that we have shared space in the SCI Institute. So unlike most other university departments – there's Professor X's lab that's next to Professor Y's lab that's next to Professor Z's lab, and all of their students and postdocs and staff are in that space – we don't have that model. We have a model that all the space is open and shared by the SCI Institute. There are multiple graduate student laboratories that may have 15 or so students in them but they're not dedicated to a particular professor. It's just somebody has graduated and then that seat is open and then the next graduate student, it doesn't matter if they're bioengineering or computer science or mathematics or whatever, they go into that space.

So we have these spaces where there are mixtures of different PhD students from different advisors, and getting to know each other. And they're much more willing to get up and go talk to the people they're working with than they would have just to get up and go talk to some person they didn't know. So by having this shared interdisciplinary space we basically force them to get to know people in different areas. And they all have different skill sets. They all learn from each other about what those skill sets are. And there have been numerous collaborations between the students and then advisors who have different backgrounds—

CP: That evolve because of proximity.

CJ: Because of proximity and this mixing that we do. And we don't isolate them by Professor X's lab and Professor Y's lab, etc.

CP: I think this is a perfect lead-in to another question. You were talking about putting the best resources in the hands of the best people. We've got the first element: the best people. So let's talk about those resources, the incredible facilities, the equipment. And as a lead-in to this, I recently read the dissertation acknowledgments of one of your students. And this student says, "I thank the Scientific Computing and Imaging Institute for creating a great research environment and providing wonderful amenities." And, really, this is echoed in pretty much all the dissertations of your students. So let's talk about that a bit.

CJ: Yeah. That's really nice. And it's very nice for me to hear those and see those written in the dissertations and get that kind of feedback. And it is, I think, in part, in terms of the resources and the environment, which are linked a lot—so we spend a lot of our time going out and getting the best computing facilities, the best networking, the best storage. Anything that is going to help us do our research better, we are going to go out and get. We sometimes spend a million dollars a year on new computing equipment in order to get the best resources.

And again, these resources are shared throughout the entire institute, so it's not just Professor X's computer or Professor Y's. We have teams of faculty that will go out and get together and say, "Well, we need to get this kind of computing facility." And then we make it available. So, for example, Chuck Hansen and I are the PIs on our nVIDIA GPU Center, which we've had now for eight years. And that was over a million dollars' worth of equipment that is shared by all SCI Institute researchers. We had the second nVIDIA center in the country. We got a 128 GPU cluster and we actively made that available to everybody within the SCI Institute. So there was a not only unique but unusually high-powered resource that not too many other universities had, especially at that time, only one. The University of Illinois had one and we had one. Then Harvard was the third. This new resource enabled our students and staff and faculty to do things that most other people could not do. We go out and get great resources and we share them. And then we have people like Nick who help keep them working.

But it's also, I think, the environment that we've been able to create. Part of that is afforded now by the beautiful building we're in, thanks to John and Marva Warnock, who, when we were designing this building, basically gave us free hand to design it and said to create an environment that's conducive to what you want. I had free hand to be able to design our space. With lots of help from Nathan Galli and other faculty and staff we were able to design our environment with lots of light, with open spaces.

CP: That's what's striking is the light, yeah.

CJ: And the open spaces and places for collaborations, whiteboards everywhere, the wall talkers, which we put on that are like the whiteboards, the café.

CP: The coffee machines.

CJ: The coffee machines have quickly become one of the things we're noted for. I have that in the acknowledgments of our slides when I give talks.

CP: There're so impressive.

CJ: Our productivity machines. We have five espresso machines in case four break down.

CP: [laughs]

CJ: And we are known throughout the world as having some of the best coffee in a research institute.

CP: Amen.

CJ: And they help with productivity. And we gladly pay for that. It's just another example of the kinds of things that we do that a lot of other university departments, research centers, etc., don't do. I can't tell you the number of times I've been to other places where there's some old Mr. Coffee or whatever bad, stale coffee pot that's there in some lab. And they're not willing to pay for a nice coffee machine or espresso machine. It's like, wow, this is the biggest return on a small investment that you can do [laughs] is have some nice coffee, sodas, milk, refrigerator, microwave, all of those sorts of things. Ping-Pong table, foosball table.

CP: The Ping-Pong tables, yes.

CJ: That's right. Just simple things like that. I mean, certainly, I got some of those ideas, I will admit, by visiting Pixar when I went to visit Ed Catmull one time, with then Governor Mike Leavitt. You walked into the main place at Pixar and there was a badminton game going on [laughs] right in the reception area.

CP: It relieves stress.

CJ: And they also had a nice restaurant and exercise facilities. We have some exercise machines. We don't have a nice restaurant yet. But it's just those kinds of things that make the environment of coming to work every day just nicer. And you want to stay. You have a better time. You're happier. It's just more conducive to doing good work.

CP: Why don't other institutes and departments – you've mentioned that before – why don't they pick up on that as a key to productivity?

CJ: I don't know. Budgets are always tight and so you have to decide what to spend the money on. But things like the coffee and the Ping-Pong table, they're just small amounts of money. Grants don't pay for those I note [laughs], so people do. And the faculty, I will say that our gift money, the vast majority of it, has come from faculty contributions. Many of us give thousands of dollars a year back to the SCI Institute to our gift account. And that money is then used to buy things like the coffee and a Ping-Pong table and other things like that. For whatever reason, some people don't think those are good investments. But I think they're great investments when creating a positive, nice environment. All of those things work together so that people want to be here.

CP: That kind of fits in with what you mentioned previously as one of the key points, how you avoid sacrificing quality. It is a balancing act, right?

CJ: Yeah. Everything is a balancing act [laughs].

CP: Of course.

CJ: But having the amazing building, being able to design it in a way that it turns out that people like a lot—And we've had multiple people come from around the world who have visited us to see the building and like the way that we've designed the light and the spaces and the open spaces and the collaborative spaces. So other people have ended up liking it, too. We feel very lucky that we get to be in this building.

And then the other things that make it really positive, when you have to be in proximity to 200 other people, working together, and how can you best make that space work? We put the graduate student spaces in between where the postdocs and the faculty are, and their doors are there so that you could go through the graduate student spaces to get to the other offices so there'd be mixing between the students and the faculty and the postdocs as much as possible.

CP: How many of those spaces do you have, the graduate students?

CJ: I think we now have six. I think we now have two on each floor. We've made it so they all have some natural light. In the Merrill Engineering Building, while it's a very functional building, is not necessarily the best one, in terms of its natural light. It has glass, great offices all the way around. It's basically a big square. If you're fortunate enough to be a faculty member and have an office on the outside, then you get a nice view. But then 80 percent of the building has no windows and no light. So all of the other offices and all the student labs, none of them had any light. I remember when we moved in our first year in the Warnock Engineering Building and the first snow happened, one of the students sent out mail saying, "It's the first snow." And another student said, "Isn't it amazing we know it's snowing?" Because usually, over in the other building, you'd be working all day and you'd come out to your car and there'd be a foot of snow on it. You'd have no idea that it had been snowing for the last several hours because you were in a dark, windowless office.

CP: Yeah, they're pretty grim places for some students.

CJ: And here they have some natural light, which I think is a very positive thing.

CP: Yes. Well, this seems a logical place to end this session. And next time we'll pick up on talking a bit more about the supportive environment.

CJ: All right, sounds good.

END OF INTERVIEW 1 WITH CHRISTOPHER R. JOHNSON

Left to right: Alan Kay, Chris Johnson, and Professor Tolga Tasdizen at SCIx 2012.

Christopher R. Johnson

An Interview by Christine Pickett
24 August 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3384
SCI Interview 3, Interview 2 with Christopher R. Johnson

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS AUGUST 24TH, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING DISTINGUISHED PROFESSOR CHRISTOPHER R. JOHNSON, FOUNDER AND DIRECTOR OF THE SCI INSTITUTE, FOR THE EVERETT L. COOLEY COLLECTION.

CP: This Everett Cooley oral history project interview focuses on the unique culture of the Scientific Computing and Imaging Institute. This is the second interview with SCI director Chris Johnson.

So let's see if we can pick up where we left off. We were discussing several aspects of the supportive environment at SCI. Is there anything you want to add to that, such as other elements that have gone into creating this environment?

CJ: Now I'm trying to remember what I said last time. I think just to emphasize the supportive environment: there's a set of principles of collaboration, of the golden rule, of supporting each other, and that it takes everybody working with those principles to really make it happen. I think what happens in a lot of academic situations is that, for all of us, time is the quantity of which we have the least amount, and we're all trying to work so hard, and especially younger people trying to work on their careers and get tenure and promotions, etc. And yet, what we find is that if we take some of that precious time and give it to our colleagues, to help them succeed, it really comes back multiple times over in the future when they will help us. I think this type of culture is not often seen in a more regular departmental type of structure.

CP: It's very generous.

CJ: It's the generosity of the individuals willing to take some of their precious time to give to the other faculty to make them successful that really helps build the overall success, and that's one of the features of our supportive environment.

It's not just the faculty. It's the staff. We hire staff members who are there to really help and support the faculty and each other. That same viewpoint, that same philosophy, is really spread throughout the whole institute.

CP: Going back for a minute to hiring the best people, which we have discussed before, also, what faculty or postdocs have you recently recruited?

CJ: We have multiple faculty we've recently recruited, all young faculty, which has been great. The three most recent faculty who we've recruited in the last year are Alex Lex—Alex is a visualization faculty member. He does information visualization. He got his PhD at the University of Graz, in Austria, and then did a postdoc with Hanspeter Pfister at Harvard University. Alex was definitely the top visualization candidate who was out on the market, so to speak, when he was ready to look for a faculty position. He had a number of faculty position offers, both from universities in the US and also in Europe, so we had to really compete because there were considerations about him and his wife being from Europe and wanting to be closer to their families. He had offers from European universities, he had offers from multiple US universities, and he had offers from high-tech companies as well. So we were very fortunate to be able to get him to come to the SCI Institute instead of one of those other places. It's a great example as it has happened multiple times before.

The next person we hired, who has just moved here, physically, this summer, is Akil Narayan. Akil comes to us from U Mass. So this was somebody who was already an assistant professor elsewhere and had been making a name for himself in terms of research. When we had a position open in that area, I asked our scientific computing faculty, who was the best young person in the world they wanted to work with the most, and it was Akil. And so I called up Akil and invited him to come out and give a talk and then told him that he has to stay. And that worked out.

CP: [laughs] The usual approach.

CJ: Yes. The third faculty member we just hired recently was already here. It was Bei Wang. Bei's husband, Jeff Phillips, has been an assistant professor in the School of Computing for the last few years. Bei has been first a postdoc and then a research scientist here at the SCI Institute. She was doing that while raising young children, and once their children got older, she could really go full force with her career. At that point, Bei and Jeff went on the job market trying to solve the so-called two-body problem, and because both of them are great, they immediately got multiple offers elsewhere. Fortunately, we were able to also make them an offer and convince them to stay here in Utah.

So those were our three most recent, great faculty hires, all within the last year, and all from, in a sense, different circumstances. But we were successful. They were our top choices each

time. We feel really great that we were able to get them.

CP: Yes. Once you've attracted the best people, such as these three examples, how do you retain them? How do you keep them here?

CJ: This is a continuing and I think will be a significant challenge for the future. Let me explain the challenge first. Because they're so good, and they were becoming more and more well known in these areas, and because of the boom in computer science, and the number of open positions elsewhere, we are being looked at as a place to try and go steal faculty members.

CP: Marauders.

CJ: Yes. And we have lost a few faculty recently for that very reason. Other universities came in and offered endowed chairs and much higher salaries. And I do not want to have us be seen as the place where people come—

CP: [laughs] The go-to place.

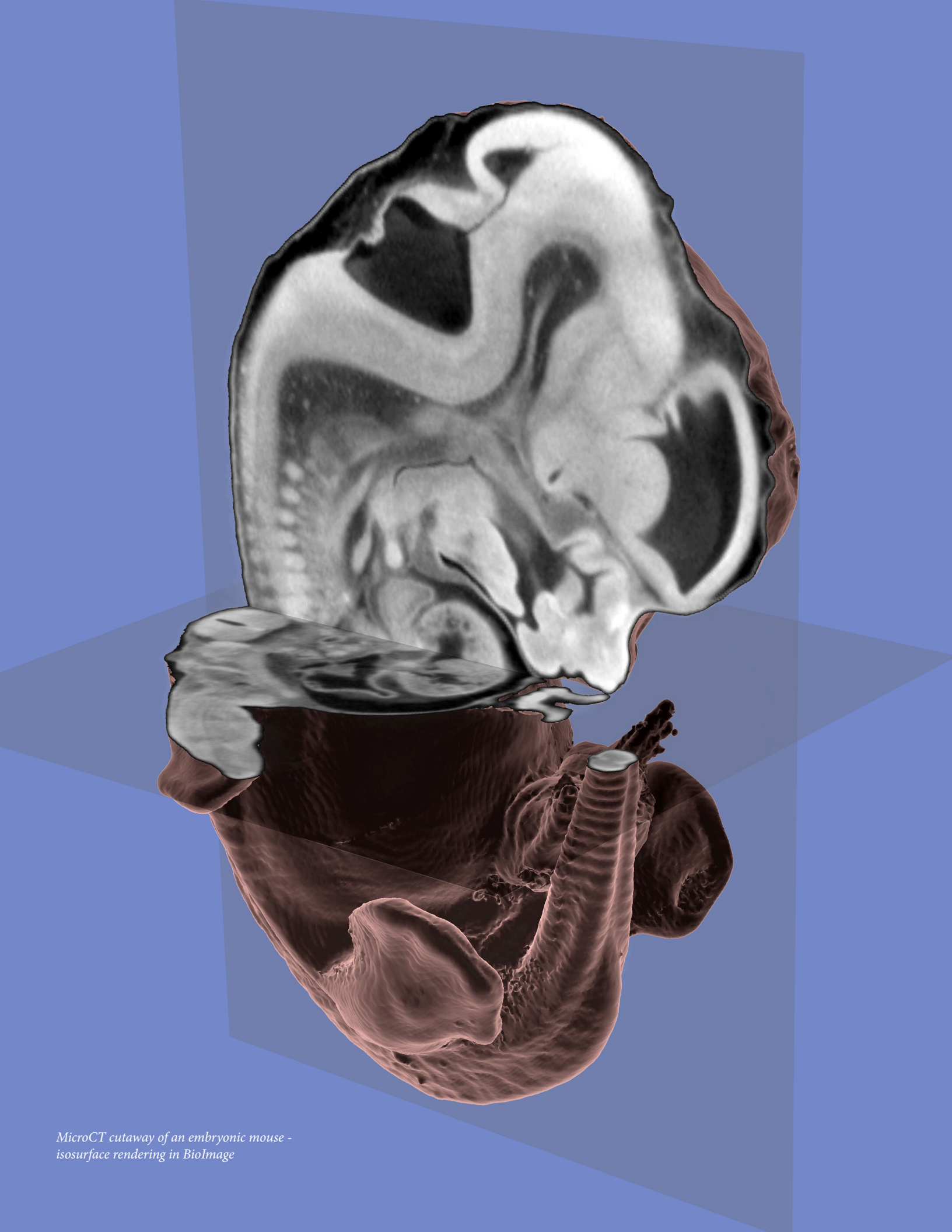
CJ: Come and get great faculty. And so it is becoming even more important than providing the great environment and being able to live in such a beautiful place and have this nice building and things, that we have to go above and beyond that with our faculty in terms of pay and in terms of things like endowed chairs, to help secure them, and to help make it so that they'll be able to resist these huge offers that come from the outside.

I'm working with President Pershing on that. At the University of Utah, I think it's one of the shortcomings that we see, is that for a university of our stature and for our institute and the departments in engineering, that we have very, very few endowed chairs compared to our peers. So our peers elsewhere, the majority of their faculty have endowed chairs. And I'm the only one out of all the faculty here who has an endowed chair. So it's quite a big difference. It's something that I think the University of Utah really needs to spend some time and effort and work on. But it's just one of the ways that we can keep our faculty here.

My view on faculty retention has come from Dave Pershing's view. I think there are two big-picture views on retention. One is—there are definitely some people who think this way—that, "I'm not going to pay attention to you unless you go out and get an offer from some other university. And then I'll think about matching it." And then the other is, "I want to keep the people as happy as possible so that they don't even entertain looking at these other offers and then, when they do come in, that they don't think about going elsewhere." And that's the way that I've really learned from Dave: to try and keep people as happy as possible because I feel that once somebody goes out and gets another offer, then they've already got a foot out the door. And the chances of you losing them are much, much higher. And I also don't think that that shows your appreciation for the person as well as appreciating their work.

I try to do as good of a job as possible of, in addition to creating that environment, providing them good raises and other

Chris Johnson, 2008.



MicroCT cutaway of an embryonic mouse - isosurface rendering in BioImage

things that they may want in terms of flexibility or something that I can help with in any way, equipment, or something, that I can find a way to help and provide support, so that they are happy campers. That's what you want.

CP: Well, we'll return to retention in just a minute, but what do you do if you hire someone who turns out to be not among the best? How do you just kind of gently—

CJ: Well, so far, it hasn't happened.

CP: Oh, good [laughs].

CJ: So far, we have never had to ask anybody to leave the SCI Institute, although we have procedures and processes in place in case that happens. I think there are two ways in which that might happen. One is a faculty member would come through and their quality wouldn't be high enough so that they wouldn't get tenure or be promoted. So far we have a 100 percent success rate over the entire history of all our faculty; all have been easily tenured and promoted.

The other case may be if a faculty member changed areas, so that maybe they'd like to become a philosopher or similar, in an area that might not necessarily be within the core research areas of the SCI Institute. And we'd have to figure out a way to work with that and make a transition.

So far neither of those situations have come up. We have been fortunate, so far, to really be able to both choose really good people and then mentor them and work with them and collaborate with them to help them to become stronger and stronger researchers and team players.

CP: So that's part of it. So if someone comes in and they don't have the same collaborative spirit, say, as other individuals, do you just work with that person to build that?

CJ: Yes, exactly. Because that's not really something that's taught through the graduate training process. And so, if they had already been strong collaborators—and we do look for that as part of the hiring criteria—no matter what, it often takes time, because you're in a new environment, just to find out what other people are doing. And then part of my job and Greg's job is to find these collaborative opportunities and to put together teams that can respond to certain calls for research proposals.

We often work on collaborative research proposals. Always we work on collaborative proposals with the young faculty as they're trying to build their careers and they're not expert grant writers yet. We'll bring young faculty in on a proposal to be a co-PI or a senior investigator on a larger team grant proposal so that they can learn the ropes along the way, and see how we collaborate and how we work together. This process teaches them to be stronger at writing individual grants but, also, then they know how to be part of a team where they may be a co-PI or a senior investigator on a few of these grants, but then they will go on to lead and become a principal investigator on a larger collaborative grant in the future. This mentoring system has worked really well.

CP: You had told me before about your annual faculty retreat. And it seems like a perfect example of what you do to retain individuals. So if you don't mind, will you walk me through the retreat? What is on the agenda annually?

CJ: Sure. We take a few days before the beginning of the spring semester, in January. We get everybody together. We put this on the calendar a year in advance.
[both laugh]

CJ: And I remind the faculty on a regular basis when this is going to happen so that we get everybody there because it is the case that people are so busy that a third of the faculty are traveling at any one time, so unless you plan about a year in advance you have several faculty miss the meeting. We take a half a day, usually at the Hotel Monaco; we reserve a room and start off with lunch together.

Then we begin, usually, with some sort of an icebreaker. I think of it as sharing something with each other that potentially people didn't know about you before. Every year that changes a bit. This past year it was, "Tell us something that's outside of your work that you are passionate about."

CP: What were some of the most fascinating?

CJ: Well, Valerio Pascucci talked about a new group he has formed to do food reviews and a restaurant review club. They have created a website where they go and review restaurants around the city together, on Thursday nights. Ross was talking about these amazing fishing and nature trips that he takes to Belize with his wife, Kerry, every year, where they just kind of go out and they're outside of the Internet and email, just out in the middle of nowhere, and they go out and do all these interesting adventures in Belize. Akil talked about salsa dancing; he is apparently quite good at salsa dancing. Part of the discussion, since he was new, was are there salsa dancing groups within Salt Lake City? And I didn't know about this but there are and other people knew about these. And I talked about my orchids. And so it was just a—

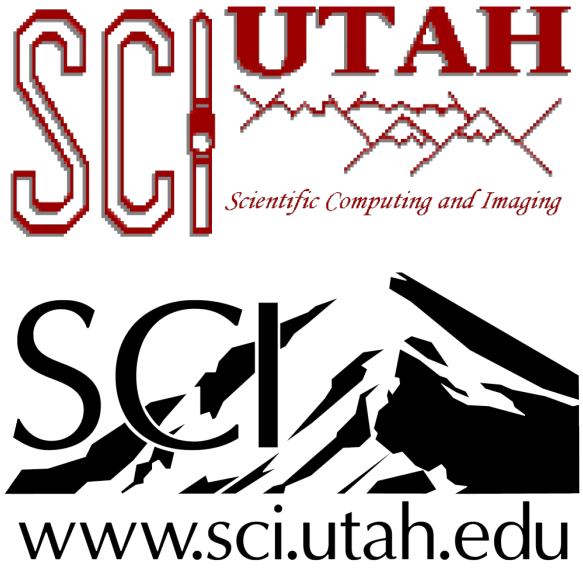
CP: That's a great icebreaker [laughs].

CJ: So it's a great icebreaker. So we go around.

CP: A new perspective on people, too.

CJ: That's right. And we do something new like that every time, and we find out new things about each other that we didn't know, and so that's fun. Then we will start the more formal part of the meeting. I will give an overview of the state of the SCI Institute in terms of highlights from the last year and personnel highlights, best paper awards, other research highlights. We'll talk about other leadership opportunities or things that people have done, and the grants that we've gotten, other awards. Then I'll go into the annual budget, which Erica prepares for me every year. This year it was really great because she did the Star Wars theme before the budget,

NIH Center grant deadline before electronic submissions.



Top: The original SCI Institute logo designed by graduate student David Weinstein in 1994. Bottom: The current SCI Institute logo designed by graphic designer and manager of the media group Nathan Galli in 2000 when we became an institute.

and came up with some really interesting budget numbers, trying to make the report a little less dry. So she found the relationship between pounds of coffee for the amount of research grants to see if there was a correlation between the amount of coffee we drank and the size of the grants.

CP: That's great [laughs].

CJ: We continue to have a very high hit rate in terms of our percentage, much higher than the national averages, which are, maybe 10 or 15 percent at the National Science Foundation or NIH. We have routinely been in the mid 30th percentile in terms of hit rate and last year we had a success rate of over 40 percent on our grant proposals.

I think that really speaks to our attention to detail. It's a combination of how much time and effort we pay in terms of the effort that goes into the grant writing, but also the great support we have, including yourself, with editing. We also have Erica and Kim helping with the pre-grant work and budgets. So the faculty can really spend the time focusing on the research statements. And they do that very well. I think that has really helped us in our ability to obtain research funding over the years.

Then, we move on to public relations in terms of what we've done, how many people have covered us, and our experiences at various conferences with research booths and things like that. We also talk about the status of our graduate student graduation rates. We look at them by department and by master's versus PhD and over multiple years and look at trends to see how we're doing on the educational front.

Then we usually take some breaks. In the past I've asked the faculty to go around and tell their favorite joke. Much of the meeting is really talking about our vision and our strategic plans for the future, and that often revolves around faculty recruiting and where our biggest needs are. What are our plans for the future? How many faculty should we try to convince President Pershing to give us this next year? And given those faculty new slots, what areas should they be in? What are the most important areas that are coming up that we see for the future? And we have a lot of interesting discussions about the faculty areas.

CP: How far out do you project?

CJ: We try to look out five years. And I think that that is reasonable. It's hard, but I think beyond that is probably just a little too far to do real strategic planning for practical purposes. So we try to do a five-year strategic plan and talk about that.

We then have a section, which changes every year, that gets more faculty involvement on the research side. This past year was to tell us a short – they're only supposed to have one slide but most of them cheated and had two or three slides – but tell us the new research that you're most excited about. So everybody goes around the room and talks about their newest research.

Last year it was, "Tell us about collaborations with other SCI Institute faculty that you would like to have." And most of them didn't talk beforehand so it was the first time they'd put up and say, "Oh, I'd like to work with you and you."

CP: Oh, that's nice.

CJ: And we did have some new collaborations that came out of that. I'm thinking this next year, although I haven't finalized it yet, of asking the faculty to present other faculty's research. So they have to go and learn a little more about—And I think I'll do it with the furthest away faculty and see—

CP: That's almost mean [laughs].

CJ: I think it could be fun.

CP: [laughs] I'm kidding.

CJ: We'll see. But we discuss recent and future research ideas and that's always really great in terms of just getting more discussion going and people finding out what everybody's doing.

Finally, we end up discussing, going around the table, faculty member by faculty member, asking, "How can we improve the SCI Institute?" What are the things that we could do better? And we make a list, and during the following meeting I will follow up on that and say, "Here are the things that we came up with. And we were able to do this and this and this. We're still working on this other one." And try to make progress on getting better every year.

Then we have a little reception with some beer and wine and snacks, and then people go home.

CP: Very nice. Maybe we should mention, at this point, SCI's mission statement as a kind of summing up of the four points we have been discussing, which are hire the best people, never sacrifice quality, put the best resources in the hands of the best people, and create a supportive environment. What is that statement?

CJ: [laughs]

CP: Do you have it memorized?

CJ: I don't know if I have it memorized word for word. To solve important problems by performing cutting-edge collaborative image analysis, scientific computing, and visualization research for the benefit of humankind. And then we have these markers of what it takes to be able to do that in terms of working on real-world problems, working as collaborative teams, and having a supportive environment. And it works all together.

CP: That is a good summing up for it, I think.

Images from SCIx 2016 featuring keynote speaker Dr. James Clark

CJ: It's not been formally written down for much of the time within the SCI Institute. Then at a faculty retreat, we hammered it out, put it on a slide, and went around the table, and edited it until everybody thought, 'Yeah, that sounds good.'

CP: I think it's excellent. Well, there are some core values – you touched on this a bit – some mottos, maybe, running through your conversations, for example, and in other interviews, and also evidenced in other individuals' opinions of you: a focus on a true collaborative spirit and personal responsibility. The mottos: going above and beyond and living up to expectations, problem solving and critical thinking, and, one I think is very important, the golden rule, which is even mentioned in SCI's student handbook. Have these values always been important to you? And how do they contribute to the unique culture of SCI?

CJ: Yes, I think they've always been important to me. And I've always tried to lead by example because I think it's hard to lead any other way [laughs]. I don't think it works out when people just tell you to go do something but don't do it themselves. So providing that kind of culture and having other faculty provide that same kind of leadership has really helped with the new faculty who have come in and with the postdocs and with the graduate students, where they're seeing all of these faculty, by example, take personal responsibility, follow the golden rule, and support each other. And it rubs off. They emulate what they see and these people who they hopefully respect and are working closely with, and that then rubs off on the graduate students and other people within the SCI Institute. You continue to get a more and more supportive environment, where people are working really hard and doing some really great research. And we have lots of stories of late nights, working through the night to meet deadlines for grant proposals and research papers, conferences, etc. I'm sure other research groups also share that as well. But I think it helps create a culture by which people are really trying to do the best that they possibly can, and really going above and beyond when necessary. The SCI Institute faculty and staff certainly do that.

We have these amazing staff members, which are—I call them my go-to staff, that no matter what is going on, they will step in and help and get it done. That can be, for example, driving very quickly to the airport with a grant proposal that has to go out on the last FedEx shipment plane at 7:00pm or whenever it goes out, to doing anything, ordering pizza, or whatever, just to help. And that whole group feeling really helps in getting everybody to go along with it.

CP: And you've created that feeling, I think.

CJ: I certainly have tried to. And I've had lots of help, definitely.

CP: I mean, just any institution that incorporates the golden rule, I think that says quite a bit. Well, I have a couple more kind of personal questions. Hope you don't mind. A real morale builder at SCI, and something that adds to the feelings of camaraderie and cohesiveness here, is the regular posting of faculty, postdoc, and student achievements on the institute website, as well as the global emails from the director—you—announcing any and all achievements, from a successful defense, to a five-year staff award, to the most prestigious award at an international conference. Each successful doctoral defense is also followed by an email invitation

from the committee chair to join him or her in congratulating the successful candidate. This inclusiveness is lovely. So please comment on that.

CJ: Yeah. I love to be able to announce our contributions in every way, shape, and form, and our successes. And I also like to tell people about interesting things, and sometimes amusing things [laughs]. I think it just helps build a positive environment and a positive attitude. I've always been one who is much more about carrots than about sticks. I think that congratulating people is a great way to support them and to make them feel good about the success that they have and to want to continue to be successful, and we've done that since the very beginning.

We actually used to do it in a more formal way, where I would collect things every month from the faculty, and then once a month send out this kind of long list of all our contributions. And it got a little much after a while, as we grew. Now it's a little more selective. But we put some of it on the website, and we save some of them for the general emails. You don't see the ones that I send to the faculty on a regular basis. And then, after each defense, I always follow up with a student who has successfully defended their PhD, and welcome them to be a SCI Institute alumnus. That often leads to some nice interchanges in terms of a little reflection from the student about what it's been like to be a student here. So far, all of those have been very positive, so it's been nice for me, especially when they're not—most of these are not my students, personally, and I haven't been on their committee. But just to hear more about their experiences of being a student here at SCI and what they found was very positive and supportive. So that's a really nice time for me.

CP: Yeah, I can imagine. Another – you touched on this – the funny things, but you also send global emails that include very good jokes, beautiful photos, interesting facts and figures, and soccer game updates. So my question is, how do you find the time?

CJ: Well, I spend probably way too much time sitting in front of a computer.
[both laugh]

CJ: Those are some pieces of my little mini breaks for myself when I'm working on a grant proposal or a research paper or a review or a report or something like that. And then I find something interesting that I think might be of interest to everybody and then send that out. It's one of the prerogatives of the director, where I get a little more leeway in terms of being able to send out amusing things or interesting things I think [laughs].

Burning the midnight oil for a demonstration at SIGGRAPH 2001

CP: Or soccer facts. I'm learning quite a bit about soccer now.
[both laugh]

CJ: Yes. And you may not even know that we have a number of specialized email lists within the SCI Institute. So there's a "Ski Not SCI" email list. There's a "Biking at SCI." There's also a "Beer at SCI." And other interests of subsets of the groups that we feel might not be appropriate to always spam the entire SCI email list with but that people in those areas would be interested in updates or new things about skiing or biking. So those are also lively email lists, too.

CP: That's nice. SCI hosts numerous events and activities in which the faculty, postdocs, graduate students, and staff are involved on obviously real team-building exercises. Will you describe some of the workshops and seminars, as well as meetings and get-togethers, that you host?

CJ: Sure. They're wide ranging and numerous. They go from being very formal things, like the NIH Center for Integrated Biomedical Computing. We annually host an external advisory board meeting in which we have experts from around the world come and review our progress from what we've said we were going to do for the previous year and what we did. And the certain faculty—well, faculty, postdocs, students, and staff—who are a part of that particular center, are involved with a very formal process of presentations and posters and demos.

There are more, I'll say teaching-oriented things, that we do in terms of workshops, like the IBBM workshop that we've just held this summer and the previous two summers, in Park City, which is on image-based biomedical modeling. And that's led by Rob MacLeod and Ross Whitaker and Jeff Weiss. They went out and got a five-year NIH research training grant to be able to put on this two-week training every summer. It's an all day, every day, for those couple of weeks, training on image-based biomedical modeling. They each give presentations. Our software developers are there and graduate students are there to work with the students in learning the new software and the new techniques. They work with real data and hopefully learn a lot about the techniques, the tools, software, algorithms, to be able to help in their own research. We've got a growing number of students now coming from outside the US, as well as inside the US, and also more senior people, even some professors coming and attending that workshop.

Then, of course, we have a number of more informal things that go on all the time. Coming up next month is the annual SCI Institute, whole institute, party that we'll put on. It's a big celebration that we used to have, in the very beginning—my wife, Kate, used to cook in our small house in Sugar House, for the few people who were part of the SCI research group. Then it became larger, such that I think we started ordering pizzas. And then we moved into our new house that's now – well, we've lived there for 20 years now, up in the Avenues. Then we had the SCI parties catered. And then we got large enough so that we couldn't fit everybody in the house. Now we go to Memory Grove, to Memorial House, each year. That's been, also, a very interesting evolution of just our socialization as we've grown over time.

I guess one of the premier events that we do, that we're going to do this year, is SCIx. And SCIx is a time in which we have

an open house for the entire Scientific Computing and Imaging Institute. And we open it up for not only our university colleagues but also to the public, in particular to the state government and to local industry. We have always had a significant, famous—often, well, currently, always with Utah ties—keynote speaker come in. John Warnock was our first keynote speaker. Alan Kay was our second keynote speaker. We then invite other speakers to come in and put on panels. But basically it's an entire day of posters and demonstrations and discussions and then celebration, really, of the research that we do at the Scientific Computing and Imaging Institute.

CP: Who's the speaker for this year?

CJ: Jim Clark, who founded Silicon Graphics Inc. (SGI) and Netscape and Healtheon/WebMD and many other companies. SCIx will be November 16th. We're doing it at the same time to coincide with the Supercomputing 2016 Conference, which is in town, down at the Salt Palace. There will be thousands of people here. We will, in addition to the local community, rent buses and have people picked up down at the Salt Palace and bring them here for both looking at presentations during the day, for the open house, and then also for the keynote that's in the evening, and followed by a reception. In the past, we've had many hundreds of people come.

CP: That's what I was going to ask, how many attendees you have.

CJ: And what's really great about it, it really serves many purposes. The night before we do SCIx, we have an internal review. Well, it's kind of the late afternoon or afternoon. And we go floor by floor so that everybody can see everybody else's work. When you become so large, it's often the case that the students don't know what some of the other students are doing. And this is a time where all the students, all of the postdocs, all the researchers and faculty can find out what the latest, greatest research is going on at the SCI Institute, which is really great. And then we have a nice dinner together after that. It serves a really great purpose internally, just to find out what we're all doing, which often sparks new collaborations internally.

Then during SCIx itself, we have a large number of faculty who come from throughout the rest of the University of Utah campus and then see what we're doing. And that has spawned a number of new collaborations. We have people from local business coming in. That has spawned new collaborations. Having some of the people come in from the state government, that's been a way for us so they can see what the money that they're giving to the university is being used for. And I think that's been really positive in public relations.

CP: And do they respond? They come?

CJ: They do, yes. We've had President Pershing and other senior administrators come, deans, and vice presidents, etc., come. It's both a way for us to show each other the great research that we're doing, and also, really, show a much, much larger contingent of the university and the state what we've been doing. It is the case that oftentimes we're better known elsewhere, in terms of what we're doing because the researchers in our field are outside of the State of Utah. This gives us a way to show the people in Utah what we've been up to and the research that we're doing.

CP: How about the general public?

CJ: We haven't done an opening or I guess an invitation to the general public, just because of space considerations and parking. We had 500 or 600 people come last time, so we had to reserve ahead of time to get parking, which is hard, as you can imagine. And then just how many people we were allowed, by the fire marshal, to have in the building at any one time. We had to work it that

Students during our summer workshop on image-based biomedical modeling (IBBM)

Governor Mike Leavitt signing legislation at the SCI Institute

way and kind of prioritize.

CP: One thing I'd like to mention that I am aware of just from looking at it, doing some editing recently, was the high school summer internship, sponsored by the R. Harold Burton Foundation.

CJ: Yes. This was started by Greg Jones a few years ago. It was in response to having people interested in working with us. Specifically, we're a graduate research training institution, where we have faculty and postdocs and graduate students. And then we had a number of undergraduates who wanted to work with us in some way, shape, or form, and do an undergraduate research assistantship or internship with us. Greg's undergraduate program has been very successful. We've had a number of really great undergraduates work with us, who have gone on to become graduate students here or elsewhere.

We also had interest with high school students. This was really reaching out beyond our usual place of comfort, I think. Greg decided that one way to engage the high school students is to take the software that we've created from our research and put it in their hands, and then give them some interesting datasets, and give them the task of trying to learn something about these datasets with our research software. And that has proved to be a successful idea. We've had a number of these summer interns come through and have interesting datasets, and learn something about the research mission and research motivation of the problems and why we created the software, and then get inside and use the software, which is often not just push a button, easy to use, because it's continually changing research software. The students have to learn the software and learn about the datasets and underlying science. We have some of our software developers and graduate students and others help them along the way. At the end, the students give a presentation of what they've learned over the internship. They get to practice their presentation skills as well.

CP: And then they present, also, at their schools, when they return. Is that right?

CJ: They do. That's right. We've gotten some really positive feedback from the high school teachers being kind of amazed at what they've been able to do during their summer, and wishing that all of their students could have that kind of experience. And then the students talking amongst themselves, giving the feedback about, "Well, I thought I wanted to do such-and-such, but now this has really opened my eyes that I want to become a bioengineer or a computer scientist or work in the intersection between computing and medicine," or something like that. It's been a really rewarding program. We received some funding from the R. Harold Burton Foundation to be able to support part of the program, which is also very nice.

CP: Just prior to our meeting, Greg was taking around a high school student, all the floors, introducing him to everyone, and showing him all the ropes, because the student had expressed interest when they ran into one another someplace.

CJ: Yes. And we're always happy to share our research expertise and interest and tell people about what we're doing, because we're so excited about what we're doing, so it's fun to be able to tell our stories.

I used to keep track of the number of groups and the kinds of groups that we've had coming through here, but the list has gotten so long. We've had legislators visit, president's alumni advisors, other advisors, many, many different alumni, both as groups and individuals. We've had Girl Scout troops and Boy Scout troops visit. For a while, we were noting that we had had many more Girl Scout troops come than Boy Scouts. I don't know why.

CP: How do they hear about SCI?

CJ: It's almost all word of mouth. Certainly within the university, there's the—our presidents and vice presidents know about us, so they get people to come here. But otherwise, it's just word of mouth. Likewise, I go out, locally, and talk to—I've given multiple talks to the Rotary Club and other local social and industry and other places throughout SLC. So there's a number of local industry and other kinds of organizations that invite me to come and give talks and I go and give talks. I think one of those plaques up on my office wall is from the Rotary Club.

CP: You need to aim for the Girl Scouts up there.

CJ: And the Kiwanis Club.

CP: That's outreach for you.

CJ: That's right. And I can't remember what it was, but I've given talks in many places throughout the state, at high schools, even elementary schools.

CP: That must be really exciting.

CJ: I gave a talk, several years ago, to an elementary school class, which was challenging [laughs] because I—

CP: Well, yeah, what do you tell elementary-age children?

CJ: We talked about trying to talk about how we use computers to say something about our bodies and the modeling of our bodies and function. I tried to tell them, in a very high-level way, what we do. I showed them a video that we had put together about making a model of the human thorax to show the electrical activity of the heart. And in one of the sections of the video it showed how we go for magnetic resonance images, and then we outline the different tissues, and then we make them into a bunch of tetrahedral little elements, and then do simulations, etc. The teacher, as a class project, had the students make tetrahedra and then write something on them for me. They sent me a box of tetrahedra out of different colored construction paper [laughs] with what they had learned about my talk. I thought that was great!

In 1998, researchers from Stanford University were given permission to create a digital version of Michelangelo's David (Digital Michelangelo Project). The resulting digital model was so high resolution that SCI Institute researchers needed to use new parallel visualization techniques to render the model.

Architecture	Moran Eye Center
Bioengineering	Nephrology
Biology	Neurology
Biomedical Informatics	Neurosurgery
Brain Institute	Nuclear Engineering
Cardiology	Obstetrics
Chemical Engineering	Orthopedics
Chemistry	Pathology
CHPC	Pathology/ARUP
CTSA	PCMC Cardiology
CVRTI	Pediatrics
EGI	Pharmaceutical Chemistry
English	Physics
Epidemiology	Physiology
Genetics	Psychiatry
Geography	Psychology
Geology	Radiation Oncology
Huntsman Cancer Institute	Radiology
ICSE	School of Computing
Materials Science	TCO
Mathematics	UCAIR
Mechanical Engineering	UPDB

A growing list of departments, centers, and institutes at the University of Utah the SCI Institute has worked with on collaborative research projects

CP: That's a treasure.

CJ: And all of the faculty are usually out talking about their research to other researchers. But I think Greg and myself, in particular, we talk a lot about our research to non-computer science researchers, to US senators, and many others. We think that's very important. I think it's something that scientists don't do very well. They don't communicate effectively to the general public. I think it's to the disadvantage of both the scientists and the general public. We try to do a better job at communicating our research to the general public.

I have been, for example, part of the Computing Research Association, of which I'm a member of the board of directors. They set up a time for a number of top research computer scientists to give briefings to members of Congress and staff at the Library of Congress a few years ago. I thought that was really interesting, being able to talk to the politicians. Most of them are lawyers or professional politicians, and almost none of them are scientists. Trying to tell them why what we're doing is important, and convey that in a way that they can understand it. It's a challenge.

CP: Definitely. Hearts and minds need to be won on several fronts.

CJ: They do. I think we have an advantage because of the visual nature of the research that we do.

CP: Yes.

CJ: And we do a lot of work in coupling visualization with biomedicine and so people feel more of a connection to our work. I've given presentations to our state legislature. And, so far, it's all been received very positively. I think it's a good thing for us to do.

CP: Absolutely. Well, kind of a shift from grade school outreach. I'm curious about the SCI Institute Distinguished Lecture Series.

CJ: Yes. This is something that I do with part of my endowed chair. I get a certain amount of money that I get to use toward research from my endowed chair, and I use a certain piece of that ever year to bring in some of the best and brightest researchers throughout the world to the SCI Institute so we can learn about what they do and they can learn about what we do. We've been doing this for a number of years now. It has really been successful in terms of exposing our faculty and staff and students to some of the best researchers in the world that they would, likely, especially the students, never get to meet in person, but now they do. I think a highlight for both the students and postdocs, and for the distinguished lecturer, is that we have the students and postdocs take them to lunch. It's very competitive about who gets to take the distinguished lecturer to lunch.

CP: How's that decided?

CJ: I usually just decide.

CP: I'm kidding.
[both laugh]

CJ: Every distinguished lecturer has commented positively on how great it was to just have lunch with these very enthusiastic students, asking questions and hearing more about their research. I send out emails every year to get suggestions from the faculty of whom we should get for the next year's distinguished lecturers. I primarily target our youngest faculty and ask them, "Who would you like to meet?" That's been really useful for our young faculty, to meet senior distinguished people and have a chance to sit one-on-one with them in their office and show them their research, that they wouldn't necessarily have that opportunity before. And that's been a really great way for our young faculty just to build their network of people they know and who know them. I think that's been very successful, and a great use of part of my endowed chair money. And we have 8, 10, or sometimes even more, distinguished lecturers every year. I just sent out the draft of the first lists, partial list, a while ago, and we have yet another really great group of people coming this year.

I'll also say that as part of the Distinguished Lecture Series, throughout the year, I host—I call them SCI Institute faculty and friends get-togethers at my home. And they're often tied with a Friday, late afternoon, early evening of the distinguished lecturer visit. We usually have our distinguished lectures on Fridays. They give the lecture at two o'clock and then meet faculty and students. And then, at 5:00, people come over to my house for a reception and honor the distinguished lecturer. Whatever faculty are in town come over. We invite other people, other faculty from other departments, administrators. All of the senior administration has come multiple times. That's another way that especially our young faculty get to know other faculty and some of the senior administrators. The SCI faculty get to meet the president, or they get to meet the vice president for research, or other people who they just normally would not meet in their day-to-day work. And that has really been a very positive thing. I host these SCI faculty and friends get-togethers at least once a month, every year.

It's also a time when the faculty can just get together and talk outside of the normal research environment. And they're more

relaxed. New research comes out of those discussions, and new collaborations. I also ask especially the young faculty, "Are there other faculty on campus that you'd like to get to know?" I invite them to come over, and that starts a discussion.

CP: Wonderful. Well, this is kind of a broad question, but SCI has a wide network of campus, state, national, and international collaborators, which contributes, of course, to SCI's success. Tell me about some of these collaborations, starting at whatever level you wish.

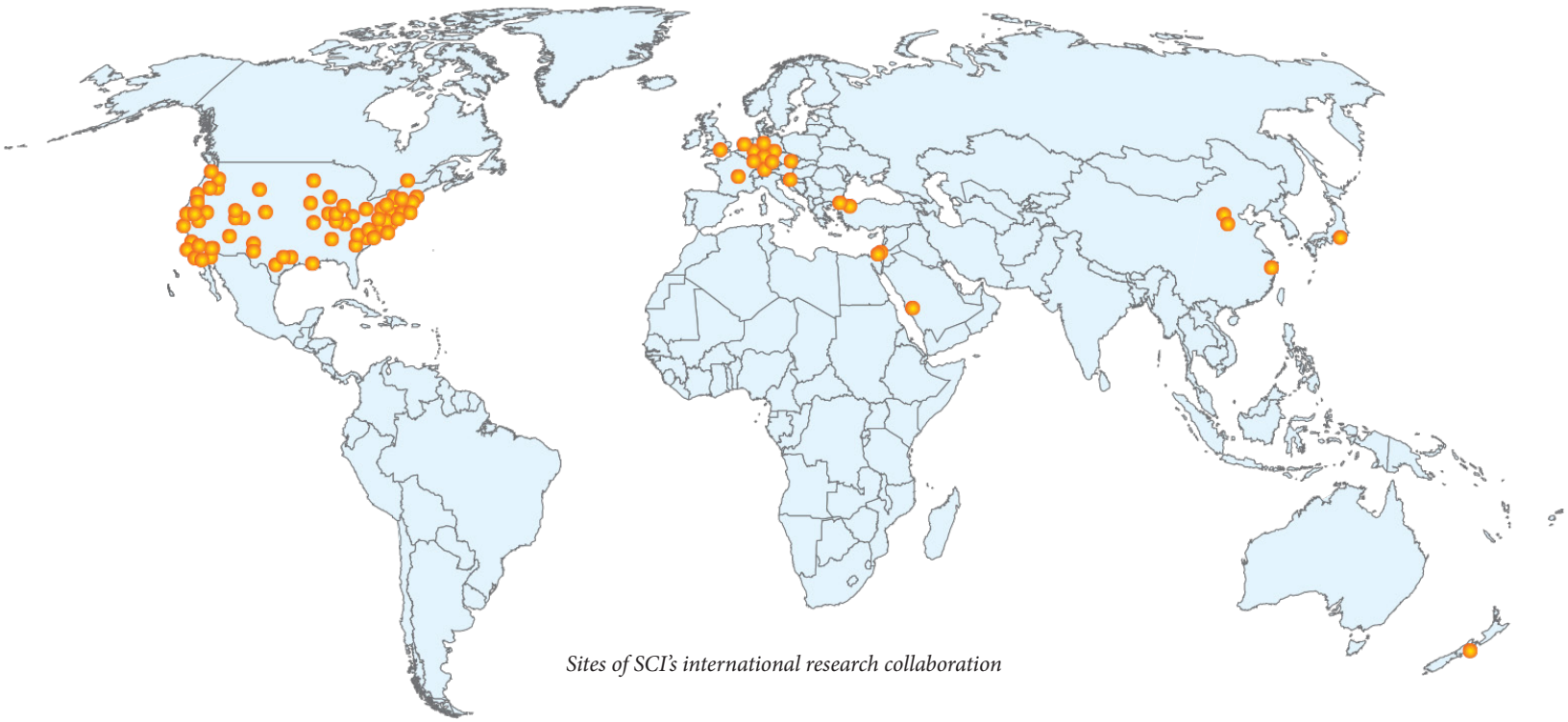
CJ: I'll start just with some general statements about collaboration. We really think effective collaboration is important, but it's also very hard. And this is something that Rob and I learned from the very beginning, just learning how to collaborate with each other, and then bringing in other people who were outside of our own areas of expertise to be able to collaborate with. It really has been a lifetime learning experience of how to create successful collaborative teams, because everyone is busy. And especially if you don't have a funded grant that supports that collaboration, as with almost all new collaborations, they're just starting to get together, sometimes the prioritization isn't there, and there just aren't enough hours in the day that people were willing to put together to make the collaboration successful, because it takes a lot of time and energy. Over time, we've figured out some hallmarks of what is likely to lead to a successful collaboration, and that helps us narrow down from the space of all possible collaborators or projects ones we think have a higher possibility of success.

CP: And what are some of those hallmarks?

CJ: The hallmarks are the contribution of time. We need to have regular meetings amongst all the collaborators who are able to give updates on what has been done, what are the roadblocks, what are our next steps. And I'll tell you the standard way that these collaborations arise—they're multiple but they're mostly varied within: someone hears about something that we have done in visualization or image analysis or scientific computing, and they think that we might be able to help them with solving a research problem that they have. Our first step is usually an exchange of information, often in the form of making short presentations to each other. We invite that researcher who is outside of our field to come in and give a presentation to our faculty, and sometimes postdocs and graduate students. Then we return and give a presentation to them about, "Well, these are the kinds of things that we have done that are similar-ish to what you have done." Not exactly the same but there might be a foundation of, "We could apply or extend or something like that to your particular problem."

Every once in a while, there's somebody who will come in and they'll have a problem that's just outside of our area of expertise. Then we try to point them to someone or another group that might have a better fit with that. And then it's trying to figure out if there's enough interest in terms of the faculty who are in that area, if there's enough time. Do they have the time to commit to this one? For example, Miriah Meyer has people sitting outside her door wanting to collaborate with her and she just does not have enough cycles to do all this, so she has to be very particular and prioritize.

And because that became such an issue that we became quickly overstretched and overcommitted because so many people wanted to work with us, we tried to develop kind of an internal prioritization scheme. Rob came up with the term "cone of influence." The idea of the cone is that you have a person at the point. And if we are able to help solve that particular problem in a person's research, in a positive way, that they are a person in the field who will go out and give presentations showing the work we did with them and then that will expand interest to others and our impact will become greater and greater. Our cone will be wide, and we'll have a significant amount of impact. That sticks in our mind as not the only motivator because we've certainly done research projects that are really, really interesting, and they might not have that big of a cone of influence, but just from an intellectual point of view, the projects are very interesting to us. But we do try to keep the possible impact of our collaborations in mind in terms of how much return on our investment of effort and time can we have in terms of impact, in terms of, will this lead to a successful research grant that



Sites of SCI's international research collaboration

can then support new postdocs and students, and we'll be able to have a longer term commitment with people, three or five or more years. All of those things go together in trying to figure out how to choose good new collaborative research projects.

Then, when you get it right, it's really transformative. The best ones, I think, are when we're able to work with other researchers who are outside of our field and solve a problem that neither of us could have solved by ourselves. We're creating new visualization research or image analysis research or scientific computing research that enables a biologist or a physicist or mechanical engineer to be able to create new research in their area. We couldn't have done it without them and they couldn't have done it without us. And they publish research papers in their areas. And we publish research papers in our areas. For some new collaborations, we will be able to use initial results to go out and get new research grants and do even more great work together. That's kind of the way I look at successful collaborations.

CP: What are some examples of your collaborators?

CJ: We have many internal collaborators at the U. I have a slide, I think I've shown it to you, and I have to continually update it, of the number of faculty in different departments we've collaborated with at the U. It spans many of the medical areas, for example, radiology and cardiology and genetics and the Huntsman Cancer Institute, and many science and engineering departments. It's a continually expanding list of collaborators. I want to double check on this but I think it might be 20 to 30 percent of our research funding is with faculty outside of the SCI Institute but at our own university campus. Then another third or more is with faculty within the SCI Institute but outside of the University of Utah campus. We have collaborators with many of the Department of Energy national laboratories, with universities all over the country, from Harvard and UNC and MIT and Stanford and the University of Washington. There's a very long list of current and past collaborations with researchers at other universities.

In addition we're finding more and more international collaborations throughout the world. I think it mostly started in places in Europe but it's now grown to many different countries throughout the world. As the world becomes more and more of a global place and the Internet has connected us with easier ways to communicate, international research collaboration has definitely taken off for us.

CP: What about your continued financial support of SCI? You have the support of the central administration, very strong support. What about grants and corporate partners? We've talked about grants a little bit.

CJ: Yes. The way the budget model works is that the State of Utah, via the University of Utah, gives us the nine-month salaries of our tenure-track faculty. Currently, we have 18 tenure-track faculty and we have a couple of openings right now. Then, the central administration, through Dave Pershing's office, gives us a particular amount of money for administrative support, which is great. It's never enough, but it's great to have. Then the rest of all the funding for other staff and all the postdocs and all the 80 or 90 PhD students we have at any one time comes from research grants or collaborations with industry.

Being able to compete effectively for research grants is hugely important. All our graduate students are on research assistantships that are funded through research grants and/or fellowships, or with industry. I think, at any one time, we have about 50 or so funded projects from the federal agencies, National Science Foundation, National Institutes of Health, Department of Defense, Department of Energy. And we also have funding from a number of different companies, for example Exxon Mobil, General Electric, Intel, nVIDIA, and others.

The SCI faculty are all very busy writing research proposals. All the faculty have multiple funded grants to support their graduate students and research scientists and postdocs. They also have to come up with research funds to pay three months of their salary if they want to get paid all year 'round. It's a significant enterprise. Many of those grants are collaborative in nature. This is where our great accounting team comes in to help us with managing all of the research money. I think last time I looked we had

ImageVis3D and ImageVis3D mobile were developed at the SCI Institute and now have over 95,000 downloads.

research expenditures around the 20-million-dollars-a-year level. It's a significant amount—that's almost all personnel with a certain amount for high-end computing equipment. It's a significant amount of money to raise every year. It keeps me up at night sometimes.

CP: I bet it does.
[both laugh]

CJ: …when we lose grants or something doesn't work out as well as I want it to. But now that we have more faculty involved and we have a larger number of grants, it's a little bit easier. We have an executive committee, within the SCI Institute, that meets every week, and that includes our head financial person, Erica. Erica and Greg and I also meet, in addition to that, on a regular basis, to look at our research funding. We look at the status now, and then what's our near term and we try to do forecasting and figure out how are we going to do in the future and what we need to do in order to continue to be successful and to support everybody. This is an area, certainly, that I had absolutely no training in whatsoever.
[both laugh]

CJ: I have had to learn a huge amount. I never knew how much time I would spend looking at spreadsheets of budget information in order to be successful at managing and leading a research institute.

CP: So corporate partnerships, and, as you mentioned before, the endowed positions, that help fill in any gaps.

CJ: That's right. One thing I will say that we haven't been good at, that I continue to try and do better at, is the foundational support, the giving from foundations and donors. For example, we have a small amount from the R. Harold Burton Foundation. We have a few other examples like that, but we do not have an endowment, unlike the Huntsman Cancer Institute has in the 50-million-dollar endowment range. At HCI if something goes wrong with their funding, they have money that can run the entire institute for a year or two.

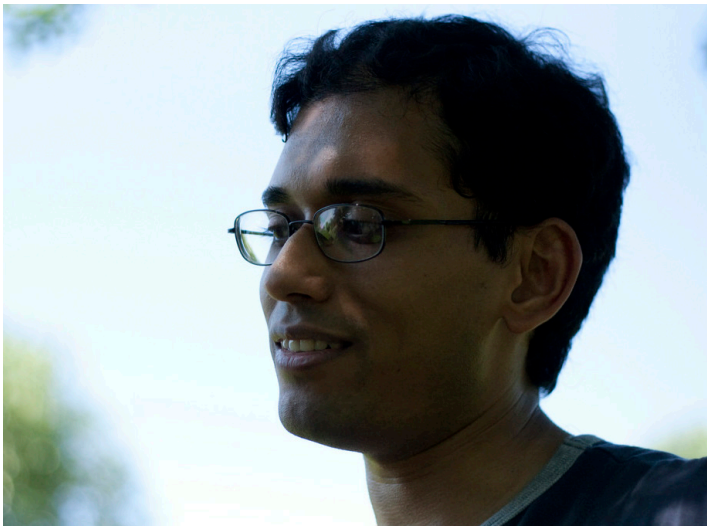
CP: The slush fund [laughs].

CJ: Yeah. And we do not have a slush fund [laughs]. We're riding on the edge, if things don't work out, all the time, we don't have a backup. Having backup funding is something that I would really like to see happen.

CP: How are those cultivated, those foundations?

CJ: It's very difficult. And it seemingly happens more easily up in the School of Medicine. People, I think, because of saving a loved one or experiences they've had themselves with particular treatments, or if people have died of particular diseases, they would like to be able to overcome that. It's a little bit harder, in computer science and engineering, to find those kinds of monies. But it's possible because there are peer groups elsewhere that have funding from these kinds of foundations. Sometimes it's through an individual, a wealthy individual who wants to support the center or institute. Sometimes there are other foundations, like the Keck Foundation, that specifically support science. We try to compete, and we just haven't been successful at that level yet, to get major endowments to the SCI Institute.

It's something I think is important, not only for the security of the institute, but it would allow us to do more risky research



Dr. Akil Narayan joined the Institute in 2015.

in the form of small seed grants. For the traditional granting foundations, you have to have done a certain amount of that research before they will think you're capable enough to do it. So it's very rare that they're going to take something that is just really, truly blue sky and out there and fund it. However the ability to fund such blue sky research is very important. To be able to give small seed grants to our faculty for these kinds of really-out-there, high-risk, high-reward types of research, I think it would be wonderful if I were able to do that. And to support graduate students and have more graduate student fellowships, I think that would also help us attract higher quality graduate students. I think it would be really, really great if we were able to find that kind of foundational support. I keep trying.
[both laugh]

CP: Well, this seems like a good point to talk about the friends of SCI. Who are the friends of SCI?

CJ: These are people who have given us some support in the past. It's primarily a number of individuals but also some corporations who have given us some support, usually in the form of one-time gifts. At this point, I guess in the big scheme of things, they are small, but they help a lot. We keep wanting to add more friends of SCI and to find some bigger participants, especially from industry, but personal support as well. We are trying to create an environment in which other universities have done a better job, like Stanford and Princeton and Harvard, in cultivating their alumni, for example. And we're now getting old enough to where we can maybe start cultivating some of our alumni who have graduated from the SCI Institute, so we'll start to work with our alumni. But we really need to have people outside who maybe don't know as much about us but would like to see our research and think we're doing good stuff and who would like to support the SCI Institute mission.

CP: And like to be involved.

CJ: And like to be involved, yeah.

CP: Well, this sounds like a good point to stop for today. We'll talk about SCI's future next time.

END OF INTERVIEW 2 WITH CHRISTOPHER R. JOHNSON

Christopher R. Johnson

An Interview by Christine Pickett
21 October 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3439
SCI Interview 4, Interview 3 with Christopher R. Johnson

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS OCTOBER 21ST, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING DISTINGUISHED PROFESSOR CHRISTOPHER R. JOHNSON, FOUNDER AND DIRECTOR OF THE SCI INSTITUTE, FOR THE EVERETT L. COOLEY COLLECTION.

CP: We've been discussing the culture, or, as Rob MacLeod says, the ethos of SCI, but we haven't really drilled down on a major factor: the personality of the leadership, specifically, your personality. I'd like to try and approach this from a couple of different angles. First, your broad view is certainly an important personal characteristic. Tell me about your early education. I gather your educational route was quite circuitous, from special education to premed, chemistry, botany, finally physics. And, also, you recently mentioned one of your favorite quotes, which seems to fit here in our discussion, from Douglas Adams, "I may not have gone where I intended to go but I think I have ended up where I intended to be."

CJ: It is a great quote and I think it aptly describes my path and where I have ended up. So, yes, I had a very circuitous route to getting here. And it did start out, from high school, in the summers, I volunteered my time at a summer camp for children with autism and other special needs, intellectually disabled and Down Syndrome. And I got such a tremendous amount of fulfillment in helping those kids on a daily basis that I thought, 'That would be a great career if I could do that every day.' And so, when I thought about what I wanted to do, going into college, special education was what I thought I wanted to do.

CP: Do you miss that choice now?

CJ: No, because I think once I started thinking about that path, I found out that what I really wanted to do was help them more than the kind of day-to-day thing but more on a could we find a cure for autism, or could we find better treatments or diagnosis. That's the transition that took me from special education to premed. I went down the road for premed, which means you take lots of chemistry and biology courses. I hit organic chemistry, which I found, to my surprise, was all about memorization at that time. It was all about, "Here's the Grignard Reaction, and it works, except for these X number of cases that you have to remember that it doesn't work for." Now it's taught differently but back then, many years ago, it was a lot about memorization. And I was not very good at that.

About the same time, I took my first physics course. And I figured out that I could do the whole first semester of physics by just knowing one equation, F=ma, and then some mathematics to derive everything else. And it was like, "Wow, this is good." I had talked to one of the physics professors there, Harvey Hansen, who had taught the undergraduate calculus base physics class for years and years and was quite the showman. He would do things like have all the students say, "I believe in the conservation of energy," and shout it out in the classroom and things like that. One of the things that he did when I came to him and said, "Well, I was thinking about changing my major from premed to physics," he took out his yellow pad of paper, and he wrote on it, he put "God" at the top, he put "physicist" second, and at the very bottom of the paper he put "rest of mankind." And he said—

CP: That's an incentive.

CJ: And then he said, "And there's still discussion about the ordering of those top two." As with many physicists, he had quite the ego. But as a young, impressionable undergraduate, I thought, 'Oh, well, that's what I want to do.' Such conversations helped lead me down the path to physics.

I was really lucky to get involved in a laboratory as an undergraduate. I was in an experimental, solid-state physics laboratory. I got to do all kinds of things that usually only graduate students would do. I published a paper as an undergraduate and went to an American Physical Society Conference and presented a research paper as an undergraduate. This experience really sparked my interest in continuing with that education. And so, when I thought about graduate schools, it was physics.

I also was interested in mathematics. I also was interested in philosophy and many other things. But they were all related to physics in some way. When I came to Utah for my PhD I was part of an NSF-funded center or project for general relativity that was headed by professors Richard Price and Karel Kuchar. General relativity is not a huge area of theoretical physics, so there was money, I think, for a visiting professor and some postdocs and some graduate students. I met a number of brilliant people coming in as postdocs who had PhDs from Princeton and Oxford and MIT, etc. And they were on their second or third or fourth postdoc and they could not find faculty positions, because back then, theoreti-

cal physics, and especially general relativity, there might be one or two faculty positions open each year.

CP: When was this?

CJ: It was in the mid '80s. And so, I thought, 'Wow. All of these guys are smarter than I am, and this is not going well.' It also was the time where I figured out that I had a very naïve view about how becoming a professor was supposed to work, in which you just got your undergraduate degree, then you went and got a PhD, and then you became a professor. I didn't know there was such significant competition involved. There were hundreds of people vying for a single position and you had to be better than everybody else. It was like, "Oh my goodness." That was a time when I decided, "Well, maybe I better go learn about this computer science stuff." And I started down that road. As part of the transition I met a professor in the mathematics department, Frank Hoppensteadt, who was interested in applying mathematics to biology. Because of the physics background, I always took lots of mathematics. Sometimes one learns the math first in the physics classes, sometimes you learn it in applied math classes. As a theoretical physics student, I had taken, I think, almost as many math classes as I had taken physics classes.

I started to learn about mathematical modeling of neurons and I thought that was really interesting. That took me down the road of applying math and physics to biology and medicine. That was my transition from theoretical physics to biophysics or medical physics. Then, because biology and medicine, physiology take place in such complicated geometries of our bodies, organs, unlike physics, where you can write down equations in closed form and solve them using pencil and paper, one needs to use computational techniques to solve the physics equations for biomedical applications. Certainly today, physicists are using computers and we work with physicists and astronomers on really interesting large-scale computational problems, but back then, that wasn't the case. It is amazing how this has changed in the course of my career! Computers were often thought of as dirty physics. And if you were a really great theoretical physicist, you had the pencil and paper and your brain and that was it. But if you really wanted to model biology or biological systems or physiological systems accurately, you had to do it with an approximation that can only be done computationally. That was when I started really learning more and more about applying computers to problems in biology and medicine.

This is the time when I met Rob MacLeod, who had come as a postdoc at the Cardiovascular Research and Training Institute (CVRTI), who had a PhD in biophysics and was interested in similar types of applications. We started working together on applying and creating models and doing simulations and visualizations of cardiac simulations. At that time, I think I was more interested in the computational and physics side of the work, and Rob was more

Chris Johnson, 2004.

interested in the physiological medicine side of the work. That was a great combination. This took me more on a path along the computer and computational science side and took Rob more on the bioengineering side, which was a great collaboration, and has continued to be a great collaboration from that time in the late 1980s and continues today, almost 30 years.

My main core research interests were (and still are) in image processing, computer simulation, and visualization. Over time, it turned out that those research areas would have many applications in other areas outside of what Rob and I were working on. These areas—imaging, simulation, and visualization—became the foundations of what would become the SCI Institute. Way back then, we were just interested in image analysis and visualization and scientific computing. And over time, we found that we could apply techniques from imaging, visualization, and computing to different application areas. We still are very, very strong in the biomedical and biology applications, but we have branched out into other applications of visualization or scientific computing or image analysis over the history of the SCI Institute.

CP: So your initial broad base allowed you to continue to be broad in your focus throughout your research interests.

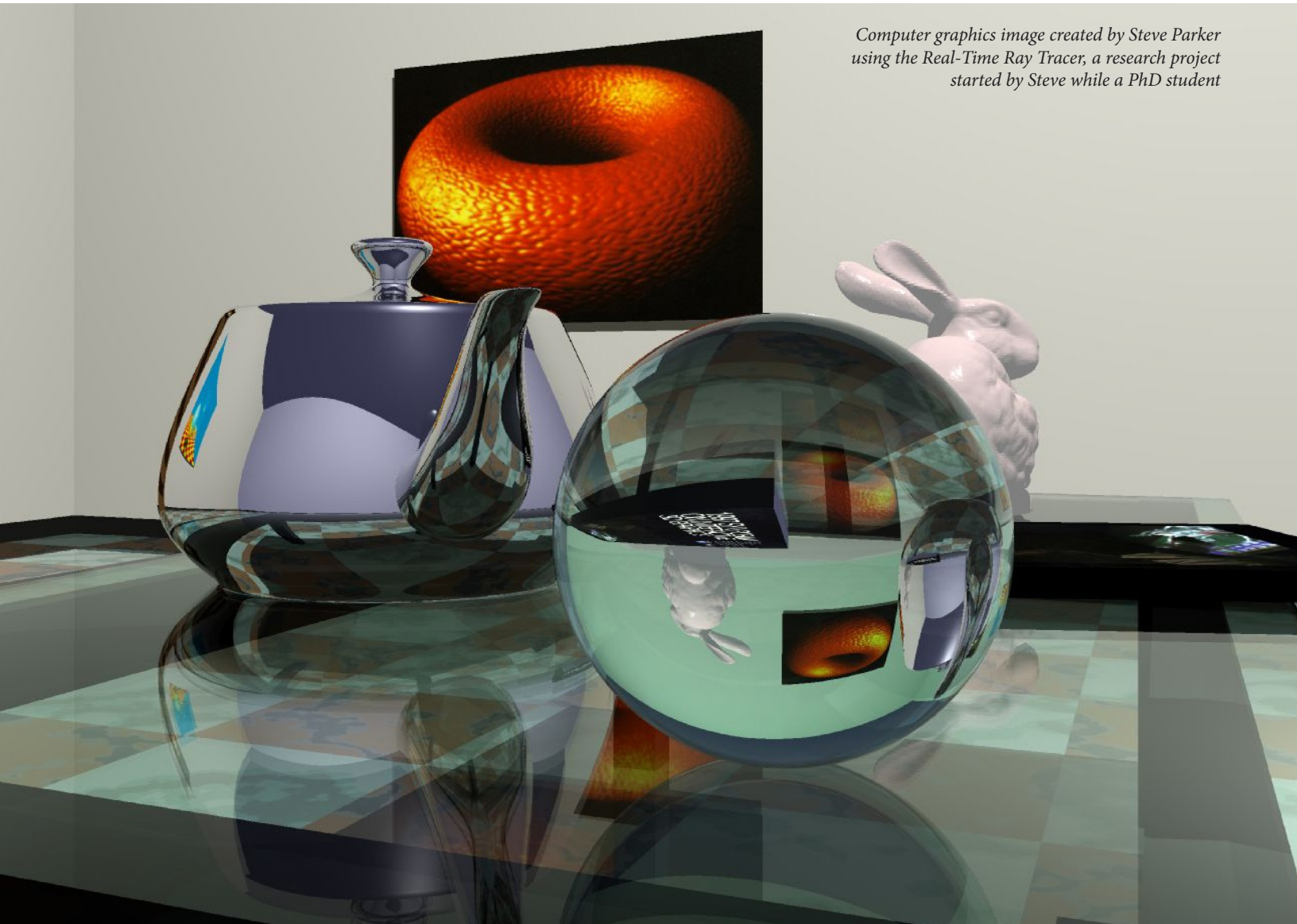
CJ: It really was great in the sense that I was able to carve out a unique niche for myself—and it wasn't always easy because of the way that the universities are so discipline oriented, where fitting into a particular department where you could get tenure was a challenge in the beginning. When I interviewed for my first faculty position, I interviewed in computer science, bioengineering, math, and physics departments.

CP: Covering all your bases.

CJ: And I got offers in most of those areas. I ended up choosing to come here in computer science. The Department of Computer Science at the U was interested in starting a computational engineering and science program at the time and my background was perfect for that. I was the person who was hired to do that, and created, with many others, the computational engineering and science program at the University of Utah back in the early '90s. But the decision to become a professor at Utah was really a decision with my wife, Katharine. She was interviewing and would get offers at small liberal arts colleges, but my offers were at larger science- and engineering-oriented universities. We looked around, and the best offer overall that we had when we were on the job market was here.

I started here as an assistant professor in computer science and Kate was an assistant professor at Westminster College. Over time, Kate moved up to the University of Utah and so we're both here.

CP: We'll come back to your nontraditional background in a



Computer graphics image created by Steve Parker using the Real-Time Ray Tracer, a research project started by Steve while a PhD student

minute. But why don't we continue this thought a bit. I was thinking that another contributing factor to the culture of SCI would seem to be having a dedicated director who has been here for the long haul. And you've noted before how much you and your wife enjoy life in Salt Lake. Do you think this has played a part in your devotion to the job?

CJ: Absolutely. At some point, both my wife and I had gotten good enough at what we do to attract attention at other universities. We started to get inquiries about, would we be willing to move to other universities. Actually, today we have a distinguished lecturer who went through the same discussions with the same place, at a point in his career. After much discussion, we both decided to stay at Utah, but for different reasons I think. Our initial discussion was considering a very high-end, top university in the world, which took us a long time to make a decision, "Do we want to go for the prestige and this really top place? Or do we want to stay in Utah where we really like the quality of life?" We decided to stay and build our careers at Utah, so we could have both a great quality of life and the quality of work was great, too.

Kate and I spent months talking back and forth, going back and forth, and exploring various scenarios. Being the quantitative person that I am, I made graphs.

CP: [laughs]

CJ: Which, I guess, is probably a reasonable thing to do, just to look at everything, but in the end, it's how you feel about it.

CP: Gut reaction.

CJ: The gut reaction came in, and I actually got feedback from one of my mentors, Andy Van Dam, a longtime friend, who was the founding chair of computer science at Brown University and then was the vice president for research there and continues to do amazing work. But he had gone through something similar where a large university tried to hire him away to become a dean. He thought his wife wouldn't want to move, but she liked the other place. He told me the way he finally made a decision was he got up one day and pretended like he had made the decision to leave and go to this place and lived the entire day with this decision, and how he felt, and then got up the next day and did the same thing but seeing how it felt if he would stay at Brown University. Basically, he wanted to know how his gut reacted at the end of those days, and that was how he made the decision. I did the same thing, and decided to stay at Utah. I think that was the right decision, overall, for both myself and for my wife.

CP: What are the main attractions here for you both?

CJ: I think, for us, both the quality of work—so the creative writing program is one of the top in the country, and so for her this is one of the top places she could be for her work. I think they have more Guggenheim Fellows than any other place in the country in creative writing, and she's one of them.

And then, for me, because of the support I'd had from Dave Pershing and others, I had been able to create this really great place, where I was able to go and gather some of the best people in the world and in the fields of visualization and image analysis and scientific computing to come and work here with me and have this great environment. The supportive environment of the university, where we could both excel and be leaders in our areas, at the University of Utah, and be supported, was a huge factor for us.

Top: The Warnock Engineering Building nearing completion in early 2007. Bottom: SCI Institute faculty and staff building their desks, bookcases, and file cabinets soon after moving into our new home in the Warnock Engineering Building in 2007.

CP: That'd be so hard to walk away from.

CJ: It really is. And then, the quality of life in Utah is so nice because we travel all the time. I travel too much. I looked the other day and I have 1.9 million frequent flyer miles.
[both laugh]

CJ: Basically, I don't want to use them if I don't have to. I would rather stay home because I have to travel so much. I use my frequent flyer miles to upgrade and to take Kate on trips. In the summers, if we can travel together to Europe or somewhere, I can use them then. Since we travel everywhere, we see how it is to live in other places.

Salt Lake City is such an easy place to live compared to a lot of these other bigger cities, where more prestigious universities might exist. I think of Princeton, for example, which is a great university, and it's a beautiful place, but it's more than an hour drive to any airport. With my travel schedule, that would be horrendous. Thankfully, we have a Delta hub that's 20 minutes from our house that has direct flights to anywhere in the US and now several international flights as well. We live 10 minutes away from work and 10 minutes from downtown. We have a light rail system. There's little

The Silicon Graphics (SGI) Visualization Supercomputing Center 2001. Left to right: Chris Johnson, Gordon Kindlmann, Richard Coffey, and Chris Moulding.

or no traffic. Just the ease of day-to-day life—you can spend a lot more time enjoying both your work and your life without the hour commute and the hour to the airport or all the traffic.

Recently, I was in the Bay Area visiting IBM Research in Almaden, and I had arrived around five o'clock, and just the short trip from the airport to the hotel, there were six lanes of stop-and-go traffic. I had rented a car and it was just so stressful. I can't believe people were doing that every day of their lives, and I am very happy that I don't have to. I ride my bike to work and back on many days, and when I don't, it's a 10-minute drive from my office to my home. I think the easiness of life in Salt Lake City has a lot to do with why we have stayed at the U.

Of course, it's a beautiful place to live—the mountains and accessibility to the outdoors. We have a house in the upper Avenues that looks over City Creek Canyon, which—there's no way we could afford that if we had lived on one of the coasts—the cost of living is much less here. There are just so many positive attributes about living in Salt Lake City that we have not found—you might find pieces of or some things that are better elsewhere, but overall, we haven't found any place that's better.

CP: I agree with everything you've said. Those are my reasons, too. I know I wouldn't enjoy the same lifestyle anyplace else.

Well, let's go back a bit, then, to your nontraditional background. You were exposed to different ways of problem solving as you went through this circuitous route. In other words, you have a larger toolbox. Please explain that to me.

CJ: Yes, I think that that has been very beneficial and very important to my development and success as a scientist. When you're in a particular discipline, you learn the tools of the trade in that particular discipline, those ways of thinking. When you're a physicist, you think about physical thinking. When you're a mathematician, you have mathematical thinking; computer science is computational thinking; biology, biological thinking. These are all somewhat different ways to approach the world and approach problem solving, and they're all successful in their given, particular areas. But I think one of the things that I was able to garner in going from discipline to discipline was learning these different ways of thinking about problems and different ways of problem solving. As you said, I was able to make my toolbox larger so that when I approach problems, I could look at them from different points of view. I think that's been very important for me, individually, as a scientist, but also, in putting together collaborative teams, and approaching problems of who are the right team members and what are the right kinds of expertise that we need to solve a particular problem or to go after a particular problem. I think that having the larger problem-solving toolbox also helped when we began doing the more and more interdisciplinary research that we do now, because I could understand and speak some of the language of the physicists or the mathematicians or the biologists or the chemists or the people in medicine we collaborate with. I had at least a jump, a leg up on the conversation and understanding a little bit about the background and the ways that they were approaching the problem, and could compare it to the ways that the other people in the room were approaching those kinds of problems.

CP: So what skill sets and personalities fit together.

CJ: That's right. And I can also, every once in a while, act as translator between a physicist and a computer scientist, and be able to help bridge that initial gap in the conversation because they don't speak the same technical language. I do think that's been really helpful for me, overall, in terms of the science and the collaboration, and from a leadership perspective, and for getting research grants funded.

I do think that that circuitous route that I took and that broad path that I walked down, or usually ran down—really turned out to be very useful. As the Douglas Adams quote portrays, I absolutely could not have figured out how to do that from knowing what I know now and then going forward and saying, "Start. Okay, well, you need to do this, this, this, and this, and this, in order to get where I am now." So it was luck and just following your interests and then being in different situations at different times, like being in physics and figuring out that maybe I wasn't smart enough to be the world's best theoretical physicist in this area and I need to go and learn some other skills, and finding what skills I was good at, and being able to excel in those areas.

CP: Which turned out to be perfect for what SCI needed.

CJ: That's right.

CP: Now we'll get into maybe a little deeper discussion of personality traits. From conversations with your codirectors, and specifically Greg Jones, I've come up with a list of three personality traits that I believe are key to understanding the culture of SCI. First—and this was something that you'd said early on, a realization for you—but first is generosity. You told me in our early discussions that when you became a senior professor and researcher, the biggest turning point for you was realizing it is all about other people, how you can help other faculty and students. I want you to tell me about this realization, but also, Greg Jones has mentioned how, at conferences, you never present yourself or your work, you present the SCI Institute. He says you actually celebrate SCI at conferences. So, your thoughts.

CJ: In the beginning, I certainly, I think like most faculty, when you're an assistant professor, it's all about you. It's all about your research and your success and trying to get tenure. Early on, certainly, it was a lot about me, me, me, but being willing and able to collaborate with people effectively, like with Rob and with others. Then, at some point, you get a level of success from that hard work and focusing on your own career, to a point where you can

start looking outward instead of inward. I think that happened to me many years ago, once I became a distinguished professor, maybe even before that, that I had achieved more goals than I had gone after. If you look at my wall over there, you'll see a number of awards, and I'd never, in my wildest dreams, thought I would have a wall that looked like that.

I had gotten to a point where I had really achieved more than I had set out to do. And so, thinking about my future in terms of, well, what is it that I want to do for the next X number of years of my career? I really started thinking about what would be the best thing for the SCI Institute and that's about using my talents, time, drive, expertise to help the other faculty and postdocs and staff and students to be successful in their careers. I get a lot of fulfillment when I can help a faculty member receive a new award or help a graduate student get a position or a postdoc get a new position, a new faculty position or a new position in industry. That's tremendously fulfilling for me and I really enjoy that. It has become one of the best parts of my job, helping the other people in the SCI Institute succeed.

What was the other part?

CP: Your behavior at conferences, where you present SCI rather than yourself or your own research. You say, "SCI's research," rather than, "My research," for example.

CJ: This is a transition, I think, that successful leaders need to be able to make, and is a trait that helps define successful leaders. I've known some people who have been able to do that but I've known others who have not been able to make the transition and still always talk about their own research, no matter what. It is the case that every once in a while I do talk about my own research at certain technical conferences, but because of the success of the SCI Institute and the great research that we do here, I'm often asked to give keynote talks or plenary talks or distinguished lectures at these conferences. I just gave one last week, as a matter of fact. I think I've given three in the last month.

CP: And what were those?

CJ: Last week was the Chinese association for science and technology. The week before was a distinguished lecture at IBM Research. The third one was at Oregon State University at a workshop on visualization, on big data visualization. All of those were somewhat different presentations. The one last week was on biomedicine, and the one at IBM was on large data visualization, etc. In all of those presentations, I presented mostly the work of the faculty of the SCI Institute and I love doing that. I want to promote the great research that everybody is doing here. For me, it's a win for everybody within the institute. It's like building upon all the strengths of all the people who are here, and not just my research, and not just any individual's research. Because we do research in so many different applications and technical areas in image analysis and visualization and scientific computing, depending on the conference, I can focus and highlight those different areas for that particular presentation.

After almost every single presentation I have ever given, I have had people come up and want to find out more about some area that I talked about, and then I get them in touch with the faculty member who did that research. That has spawned a huge number of collaborations over the years. Just last week, one of the people in the audience was very interested in the work that Chuck Hansen is doing with FluoRender, a visualization system for confocal microscopy, and she had downloaded the software and got in touch with me. I just exchanged emails with her yesterday. She's at Harvard and Brigham and Women's Hospital, as a genetics researcher, and is very interested in using FluoRender for her research.

When I was at IBM Research, multiple people were in-

Left to right: Mark Anderson (conference chair), Chris Johnson, Bei Wang, and Alex Lex present at Future in Review 2017.

terested in different aspects of the research I talked about, and I've gotten them in touch with them. One example was with Valerio Pascucci. I know they just had a conference call with some of the researchers at IBM Research and Valerio's team. This happens all the time, and it's one reason I think it's important that I'm out there giving these talks, even though I don't like to travel anymore. It was really great in the beginning when you hadn't traveled at all and you were young and never had been to most of these places.

CP: But now, same old [laughs].

CJ: Now, they know me at the Frankfurt airport.

CP: That's not necessarily good [laughs].

CJ: And at the Sheraton Hotel in the Paris airport. I always enjoy being in—especially new places—meeting new people and seeing old friends, and the science in the area, but it's the getting there and back that is tiring.

CP: Need to come up with an easier way to do that.

CJ: Yes, I would like to do that. Fortunately, with the better quality of the video conferencing I have been able to cut down on some travel. But we need faster transportation and easier transportation.

CP: And less painful.

CJ: Yes.

CP: The second personality trait—and Greg Jones also highlighted this one—I think it's very important, in my opinion—but your absolute loyalty to the SCI family, the faculty, the staff, the students, and the collaborators. I think this is evident and so important.

CJ: Yes, I do feel a tremendous loyalty to everybody at the SCI Institute. And it is like a family, to me at least. I definitely feel protective of the faculty, and I feel like one of the ways that I can help my faculty be successful is to shield them from some of the things that I have to do with the administration or with funding or politics or other things that would take up their time, cause anxiety, cause them to not be able to spend as much time and energy on their research. I think that's one of the things I can help with, as director of the SCI Institute, and help my faculty succeed.

But beyond that, there is definitely a loyalty to—I want to protect them just from harm in the world.

CP: And Greg's also mentioned your firm belief in second, third, fourth, and fifth chances.

CJ: That's right. And it's not always easy. I have not always been good at that, but I have gotten better at that over time, and just understanding that people are going through different times in their lives and they have different stresses, and some of those are professional and some of those are personal. And I don't know about most of them, probably. And so being able to just be more understanding and allowing people to go through whatever they're going through and try to help support them in that process is something I've tried to learn how to do better as time has gone on. I think, in the end, it has just made everybody closer and more supportive of each other when you're able to reach out and help a little bit maybe along the way.

CP: People don't feel threatened. They feel secure.

CJ: I've always wanted to create a supportive, secure environment in which people can pursue their research in the ways that they think are best and support them. At the same time, I want them to be part of the whole. I don't want the person who just sits in their office by themselves and only does their own thing without consideration to contributing to the bigger whole. And there is absolutely a tendency for some people to do that because it's easier. It takes more energy to interact with your colleagues and takes more time away from your own research to be able to give some time to your colleagues. But I found that doing so, it will give you back way more than you have put in, in the future.

CP: How specifically do you encourage people to do that if you notice that people aren't engaging?

CJ: Very directly, yes. Very directly. I've had multiple conversations with multiple faculty over time. It usually starts off as just trying to get them involved in new projects and asking them to collaborate, and hopefully that will start to spark. And then after a few of those projects take off, then they'll just do it naturally, on their own. Sometimes it takes a little bit more prodding, a little bit more direct interaction from me. Sometimes it takes me going to them and wanting to work on a project with them to provide a spark, so that they can see the benefits of collaboration. It happens most often when people are coming here who've already had careers elsewhere, so they already have a way of working and they've had their own lab and they do things their own way and they found that to be

Professor Tom Fletcher meets with high school summer interns, 2014.

successful. And now, here I am saying, "Well, no, you don't get your own lab. Your students are in a shared space and we share all the facilities and the administration. And we want you to work with other people." There's definitely a transition period where it takes a while, to go from the—

CP: So just a bit of patience.

CJ: Yes. But it happens. And it's happened over and over again, and it's been great to watch people develop and start moving out of their comfort zones into working with other people and developing larger comfort zones and being more successful overall.

CP: What are some examples with staff or with students?

CJ: I think that it's on an individual basis with everybody because everybody's different, faculty, staff, and students. I think with the staff and the students, we're able to be a little more direct upfront, because they often haven't already had a career doing something. Some of the staff have but most of the students haven't. With the students, I can be more direct on, "I would like for you to be part of this collaboration." And sometimes it just depends on the student. Sometimes they're ready to go, and it's all I can do to keep them from having too many collaborations, which I've had before. I have to reel them back in because they start going all over the place. With other people, you just have to keep pushing a little bit, then a little bit more, to get them in that first collaboration because they don't want to do it or they don't know how to do it.

CP: So part of your background is psychology.

CJ: I think I've learned a lot of applied, on-the-job psychology over the years. With the staff, if a staff member had worked at other places and already had a way of learning, then that's kind of like the faculty member, of teaching them and encouraging them.

CP: Helping them fit the job, really.

CJ: That's right. The way that we do things here. I think once they make that transition, it is very smooth in how they all interact, and they support each other. When someone is sick or they're going to a conference or they're having a child or whatever it is, then other people can come in and help support them during those times. And that's worked out really well.

CP: Well, our next trait, the final one—and this, also, Greg discussed—it's the respect that has grown over the years among the faculty, and, of course, by extension, to everyone else. He said it wasn't always there. It was something that had to be cultivated. From your part, what has gone in to growing this respect?

CJ: I think it's a combination of both myself respecting all of the faculty, and I do, I wouldn't have hired them unless I respected them, but I think much of it comes from the senior leadership, the senior faculty, many who have grown up at SCI, from being junior faculty, who are now senior faculty. Rob MacLeod and Chuck Hansen and Ross Whitaker, who've all been here for a number of years and have worked together on many, many different projects successfully. Through that process of working together, they gain the respect for each other. I think it's then bringing in younger faculty or other faculty who have moved here from other universities and have them be part of these collaborative processes with some of the senior people who've been here a longer time. They then start to gain respect, more respect for these other faculty and staff. I think it, in a sense, is contagious after that, where we have—

Professor Chris Butson, left, using a virtual reality system to explore neurons in the brain with graduate student Will Usher in 2016.

[break in interview]

CP: So, we're continuing with respect.

CJ: I think I was saying that after a number of these interactions, especially with the senior faculty who have worked together for so many years and done it so well, that then the new faculty, young faculty, and the faculty who moved here from other universities, start to gain that same respect, and it's almost contagious in that way. And then they continue that tradition.

CP: Self-perpetuating.

CJ: Yeah, self-perpetuating. There's an expectation that we're only going to hire really smart, great people. We all agree and we trust each other to make those decisions so that each area is really in charge of identifying and recruiting and hiring into that area. The rest of the faculty defers to the specialist in that field. They'll certainly give feedback, input, etc., but they trust the faculty in that field to know best about who is the best person to hire in that area and who would work, not only well with them but work with other people within the SCI Institute. And so there's that trust. And that trust has been exhibited over and over again. And it's never betrayed, so that you continue to have it being a positive thing where you don't have to worry about so-and-so faculty going out there and hiring somebody who's not going to fit or who isn't good enough, etc. Everybody trusts that each other will do the right thing and hire the right people. And then they see it in action. It reinforces their decision to trust. I think just having that happen over and over again with the new faculty we hire and the projects that we work on together has just perpetuated that trust over time.

CP: We'll talk about that a bit more in our next session when we talk about the future of SCI, but Greg mentioned that that respect has really been a cornerstone, and then that will be perpetuated in the future.

CJ: Yeah, I think so, too. I think because it does build upon each other and it has over a number of years. When you have people who have been here for 15, 20, 30 years, and then they continue to educate and work with new people who come in, then it just continues to perpetuate, which is really great.

END OF INTERVIEW 3 WITH CHRISTOPHER R. JOHNSON

Christopher R. Johnson

An Interview by Christine Pickett
8 November 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3440
SCI Interview 5, Interview 4 with Christopher R. Johnson

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS NOVEMBER 8TH, 2016, ELECTION DAY. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING DISTINGUISHED PROFESSOR CHRISTOPHER R. JOHNSON, FOUNDER AND DIRECTOR OF THE SCI INSTITUTE, FOR THE EVERETT L. COOLEY COLLECTION.

CP: Just a couple questions today and you can take them individually or tie it all together. Where does SCI go from here? In other words, how do you envision the future of SCI. And your final thoughts.

CJ: Where does SCI go from here? I'll start with that one. This has been a wonderful exercise in thinking about where we've been over the last 25-plus years of starting with myself and Rob MacLeod and a small group of graduate students, and then growing into a larger laboratory, adding a new faculty member when Chuck Hansen joined us and we became the Center for Scientific Computing and Imaging. Then, making the transition to deciding, well, is this something we really want to do, or should we just stay the same size and be a center or a large research group.

Around 2000, the new century, we decided to take the bold step and try to do something that had more permanence, that would have more impact, have a longer lifespan, with many more people. That's when we proposed to the university to become a formal institute. And we have grown substantially, significantly since that time to over 200 total faculty, staff, and students.

Reflecting on those changes over these last few months has been very interesting. I guess some of the things that I've thought about during this time are the different paths I could have taken as an academic. I could have chosen, like many academicians do, to focus only on my own research and have a small group of a few graduate students and a postdoc, and just one grant or two and be very happy at doing a particular set of research that I could make an impact in by myself and with my small group of students. But when I look at the number of publications that have come out of the SCI Institute over the years—it's in the thousands—of journal articles and conference proceeding articles and reports and dissertations and theses—and just to think about how I've been able to magnify my ability and my impact to a much, much larger extent.

CP: So you're happy with your choice [laughs].

CJ: I'm happy with my choice. I think I could have been happy following the other path, too, but I certainly would not have had nearly the impact in the world if I had not created the SCI Institute and interacted with all these amazing people, and provided that supportive environment in which these really smart, hardworking people could do amazing research and collaborate with each other. It's been a really interesting exercise to go through this interview and think about the different paths and where we've gone and how far we've come.

CP: And what's been created.

CJ: Yes. It's really quite something. I think over the years we've become an integral part of the University of Utah, such that, in my discussions with President Pershing, if I were to get hit by a bus or if and when I retire in the future, that the university thinks that we are of high enough worth that they would like to see us continue, and I agree. We've started to talk about succession plans for the directorship of the institute, and also its future on the campus, and how we would continue to grow, and in what ways we would continue to grow in the future.

When I think about the future of the institute, I usually think about it in a five-year window. I have thoughts every once in a while that go out beyond five years, but it's so hard even to think five years ahead because things change so rapidly, and one is always on the lookout for new opportunities, and it will take you in directions that you have not planned, which happens all the time.

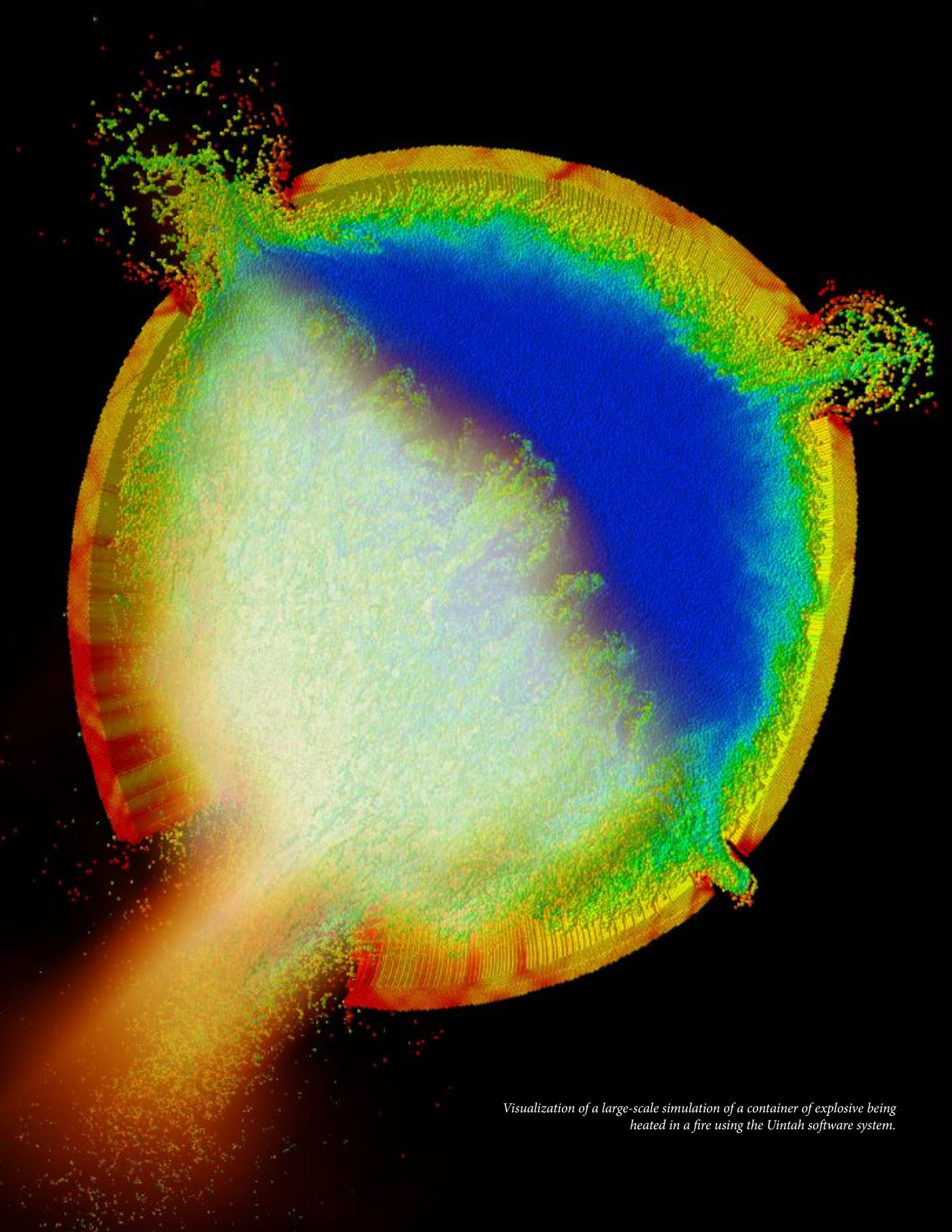
In terms of the overall planning, I see us growing, continuing to grow at a level of one or two faculty a year. I think that when we've grown faster than that, when we've had, three or more new faculty at the same time, it's been much more difficult to acculturate those faculty into the way that we work together in such a tight, collaborative interaction. I think that that is really important to the environment. And the way that we do things here is to bring people in and really, especially with all the faculty, young and old, and bring them into the culture of how we work together so well and so effectively and collaboratively. And that we want to do that in a very thoughtful way as we move forward.

CP: So they have time to assimilate.

CJ: Yeah, exactly.

CP: And you to them, of course.

CJ: Yeah, absolutely. I think adding one or two faculty at a time



Visualization of a large-scale simulation of a container of explosive being heated in a fire using the Uintah software system.

is a good growth model for us. Also, we can estimate the number of postdocs and graduate students a new person is likely to bring in, depending on whether they're a young or more senior faculty member. I think that in the next five years we want to concentrate on getting more young faculty. In thinking about how long we've been here, then looking at the slide that has the distribution of the faculty, as far as rank, we have many more full professors than we have associate professors, than we have assistant professors. Seeing how that's changed over the years has been quite amazing. We have an amazing set of senior faculty now. For the future, we definitely need to be bringing in some more young faculty. Miriah Meyer is up for tenure this year, and once she gets tenure, which I'm sure she will, that will leave us with only three assistant professors. And all the rest, the other 17, will be tenured faculty.
[both laugh]

CP: That's an interesting ratio.

CJ: It's an interesting ratio. I continually think about the diversity of our faculty. Within computer science especially, it's so challenging to recruit women and minorities, because we have been, as a field, ineffective in broadening the diversity of our field. The latest studies show that we had the most diversity in our field back in 1984, and it's gone down.

CP: So that's nationwide.

CJ: That's nationwide. We are similar to those standard numbers, in terms of the number of women and minorities on our own faculty. There have been millions and millions of dollars and studies, from the National Science Foundation and others, that have put together these programs. Every once in a while, one is successful in a local environment, but nobody's been able to figure out, overall, how to make those changes so that we see much more diversity within computer science. Apparently, it's a very hard nut to crack, and nobody has been able to crack it, yet. But I certainly continue to think about diversity, especially from my days at the ACCESS program, which was all about bringing in young women in science and engineering. I directed that program for a number of years and was on the faculty every summer and taught. But not many of those students went into computer science. They almost all went into other fields of biology and math and chemistry.

Professor Guido Gerig, left, with a student in 2010.

CP: So those other related fields are not affected the same way?

CJ: I would say physics is and some of the other engineering is affected in the same way. But more of the life sciences—biology, bioengineering—they're almost 50/50, in terms of students. And then you look at physics and there are maybe one or two women faculty out of 30 or 40. And computer science is pretty similar. It's amazing.

CP: And no explanation.

CJ: And nothing—I mean, there're lots of theories out there, but no one can—and people have implemented new—based upon those theories and speculations—people have tried out new things and they've been somewhat successful here and there, but nobody's been able to find something that really works in a big way.

CP: Is that true only in the United States?

CJ: It's true in most places in the world. There are, I think, examples of where, for whatever reason, it's not true. For example, in Italy, I think in mathematics there is a much larger percentage of women than in most other European countries or in the US, for whatever reason. Nobody's been able to figure this out, but it's something that I think about. It's always on my mind when we're doing faculty hiring and we want as diverse of a place to work as possible. We do better with the students and the staff, but are still working hard on faculty diversity.

And I think of areas for the research—we've primarily been in these core areas of visualization and image analysis and scientific computing. And I think that the visualization side is the side we have the most people in and we're probably the most well known internationally, in terms of our research. We have more visualization faculty at the SCI Institute than anywhere else in the world. That's not the case in scientific computing or biomedical computing or image analysis. So we definitely have some places to grow. I think especially in biomedical computing and scientific computing, we just don't quite have critical mass in those areas to really compete at the national and international level. I think that those areas will grow, and especially with the advent of big data and data science and linking in with the computational science and scientific computing that we have already. I think that leveraging that for the future makes a great deal of sense. This year we're going to be looking for a new person in scientific computing, somebody who has skills in data science. We're also looking for a new faculty member in image analysis and continuing to build in those strengths as well.

My short-term, five-year lookout says that we're just at the tip of the iceberg of starting to use visualization and imaging and computing to tackle really complicated real-world problems. I think we chose, albeit luckily and not on purpose, but we chose well, in terms of the areas that are the pillars of the SCI Institute, that these continue to be important to many, if not most, of the important interdisciplinary problems that we see in the future. The research pillars of visualization, imaging, and computing span the space of medicine and science and engineering, and more and more into the social sciences and business and the humanities and even art. We're seeing that our impact is broadening, if anything, for the future.

CP: What are some of the examples of the real-world problems in those areas?

CJ: Certainly many applications in medicine. They cross all the fields in medicine: cardiology, neurology, cancer, genetics, radiology, you name it.

CP: Infectious diseases probably?

CJ: Yes. Pathology, development, aging. I can't think of any part of medicine where the combination of some of the things that we do is not important and applicable, and the same with most of the sciences and engineering, too. There's just problem after problem after problem. And what we're seeing is that some of these techniques are also important in other fields as well. In business and finance, because of the increasing need for large data analysis and the need for information visualization, but also for computer modeling and simulation, as well. For digital humanities, there are many different applications of visualization and in the image analysis as well, from old texts and automatic text reading, and then trying to understand the different texts and how things change over time, of texts and poems, etc. Miriah Meyer and Nina McCurdy and Kate, we already have published papers—

CP: Poemage.

CJ: Poemage. That's right. An interesting application, a useful application of our visualization in the humanities. And in the social sciences and geography and geology and geophysics, you name it, I think it is just taking off. Having more people who span some of those other spaces, who are outside of our traditional work in science and engineering and medicine, I think will be really interesting for the future of SCI. I think we'll see a broadening over the next several years, instead of—I'm sure we'll still go deep on many applications, but instead of only adding people who are more like ourselves, we'll start to broaden out in these areas, still in the core areas, but that they'll be broader application areas for this technology, and some new technologies as well in these areas.

It will be fun and interesting. And it will change a lot every year, from now until whenever I decide to retire, and we find somebody to sit in this chair and continue moving us forward in different ways. I am sure it will be really exciting to see what happens.

CP: And you've started a little bit of that already, too, for example geophysical studies. And I know Amy Gooch did the agricultural study, which is very applied science in a way.

CJ: That's right. And Miriah just recently got a new grant with Kerry Kelly, Ross's wife, who's in chemical engineering, on pollution analysis and visualization, looking at some of the climate and weather and effects. We recently had a visit by the president and several faculty of the Carnegie Institution for Science, and they brought a whole breadth of new problems in astronomy and astrophysics to us, as well as many other problems and challenges. We saw many possibilities for new collaborations. Actually, they were so interested that they're coming back in December with a smaller group to talk about more collaborations with us in the future. I will say that I've recently had multiple discussions with different people in physics and astronomy, talking about new telescopes that they're building internationally, and the large amounts of data that they're recording on a daily basis, and they need analysis and visualization tools to help them understand these enormous amounts of data. We have an initial grant from the National Science Foundation to work with some folks on the ALMA Astronomy Project, and we're in the process of writing another proposal with them and

Professor Miriah Meyer presenting at TedX Waterloo, 2011

with some other of the physicists here for new visualization and data analysis. The importance of visualization and image analysis and scientific computing just keeps broadening. The more we look, the more applications we see, and I see a really bright future for us. We're not going to run out of things to do.

CP: Never going to be bored.

CJ: For a long time in the future I can't see a time when we are going to be bored. It's really been about managing our success. It's trying to choose the best possible collaborators who have the most interesting problems that we can work on, and then using those as ways to gauge and to extend our impact. If we work with the best people on the most interesting problems and those people have success based upon our collaboration, then that brings other really interesting people with more interesting problems to our table we can meet and collaborate with.

When I think about just the sheer number of opportunities that we have, it vastly exceeds our amount of time that we have to be able to work with these people. I actually spend a fair bit of time just trying to get people in touch with other people outside of SCI I think might be able to help them, because we're overloaded with projects and collaborations right now and we just don't have the cycles to be able to do everything that comes our way. And that's a good problem to have.

CP: It's an excellent problem to have.

CJ: It shows we're relevant and that people are interested, but there's just too much out there for us to do, which is great.

CP: Greg had mentioned the growth of—shall we maybe call them semiautonomous centers in SCI? How would that fit in? Would that take off some of the burden?

CJ: It's a way we're thinking about organizing some of the different areas and different enterprises. I think the model will provide us with additional structure that groups of faculty will be able to

Professors Claudio Silva and Juliana Freire in their data analysis lab at NYU-Poly

have dedicated centers for different areas of emphasis, and that will bring in and organize a new set of collaborators who will be under the umbrella of a center. I would love to see—and we are starting to have—more and more centers that are driven by different faculty who would like to move along a leadership line themselves. It's a way for them to do it within the context of SCI, so they don't have to leave SCI to be able to exercise their interest in becoming a center director or leader.

CP: Some other city.

CJ: Yes, that's right. It's, hopefully, a way that we can keep our star faculty and also work with them and help support them in their goals to take on more leadership capabilities and goals for themselves with these new centers.

CP: And whatever different directions you go, you will always be trying to maintain this very respectful environment, what we've discussed is the culture of SCI, I assume.

CJ: Yes. That's the nice thing about having these structures internally is that we are setting it up so that we'll have shared infrastructure and shared personnel so that the new centers will have staff who are partially funded by the SCI Institute and work with everybody, and then partially funded by the center to do center-oriented work. They'll always have a foot back into the SCI Institute and always be part of the culture, the environment, everything that we do within the SCI Institute, within the center. It's a way not to get separated. It's very easy to just cut yourself off and not interact and go off in your own corner and be independent, which is fine in many, many ways, but it's not the kind of culture that we have at the SCI Institute. I think that trying to keep that culture is very worthwhile; otherwise, there would be no reason to keep them within the institute. They would just go off and do their own thing. And faculty are—certainly they can do that if they want to do that. I think that most of the faculty, thus far, see the benefits of staying within SCI's overall umbrella, in terms of the infrastructure and the staff and the help that we can provide them. So they can, in a sense, have their cake and eat it, too. They can have their level of independence and the goals of directing their own centers, research centers, but at the same time, still have a little bit of the nurturing, the safety net, the support that comes along with having it within the SCI Institute.

CP: Yeah. What we've talked about—it's not just amazing research that's come out of here but this very unique culture, that defines SCI, really.

CJ: It does. And the more I travel—I was just at the University of Illinois, at the National Center for Supercomputing Applications last week, and that is another center that has lasted over the years. I think they just celebrated their 30th anniversary. NCSA was started by Larry Smarr and has a very large footprint on the University of Illinois campus. They have had multiple successful directors over the years and they have continued to grow and continue to be important to the University of Illinois campus. When I was talking to their leadership about NCSA and SCI, there just aren't that many places around the world where these interdisciplinary centers and institutes have been able to be created and then thrive for multiple decades. We see ourselves as very fortunate to be among those handful of national and even international centers and institutes that have had the longevity such that they're still relevant after 25 years or even 30 years, like NCSA.

CP: Very impressive.

CJ: So I'm happy. I'm proud that we've been able to do that and I think we'll be able to continue to be successful and celebrate our 30th anniversary in the not too distant future.

CP: And then after that the 50th.

CJ: [laughs] That's right.

CP: Well, do you want to throw in a few of your quotes and give us some final thoughts, too?

CJ: I do. People who are reading this and don't know me personally will not know that I pretty much wear shorts and polo shirts every day. Although it is the case that I do wear long pants after it snows, and in the winter, although there are people who know me that will tell you that I never wear long pants—
[both laugh]

CJ: There's a wonderful quote by Henry David Thoreau that says, "Distrust any enterprise that requires new clothes." I definitely agree with that one.

CP: Trust Thoreau [laughs].

CJ: It's been fun to be able to have a position that I don't have to require new clothes.

CP: Or long pants.

CJ: Or long pants for the most part of the year, which has been great.

I was on a panel at the Visualization Conference a few years ago where it was about creating successful centers and institutes. The question that was put to all the panelists was, "What do you think are the reasons for your success?" I have a slide that was just a tongue-in-cheek slide, which was, "Be tall, blond, left-handed, vegetarian, and wear shorts. If you have all five of those things, you cannot help but be successful."

CP: [laughs] That's the definition here of SCI.
[both laugh]

CJ: Of course, those may be elements of my personality, but it has much more to do with the hard work and the collaboration and the people and the things we've talked about over the last several interviews.

Let's see. Maybe a couple more quotes just to—I want to make sure we have the Douglas Adams, "I may not have gone where I intended to go, but I think I ended up where I intended to be." I think we had that one before. Which is really true.

And there's one by Herm Albright, "A positive attitude may not solve all your problems, but it will annoy enough people to make it worth the effort." One of the things I really learned is that always having a positive attitude has really been helpful. I see so many times throughout my career where we've had people who will say, "It can't be done." It's so easy to shoot down fragile ideas, and it's so hard to provide an environment in which fragile ideas can take off and become less fragile, and become successful. I think that that's something that I do and that we do here really successfully.

CP: Yes.

CJ: We really take care of those fragile ideas and the people who have those fragile ideas, and try to support them, and ward off the naysayers.

CP: I think SCI kind of exudes a very positive attitude.

CJ: I do, too. I think that it has been one of the cornerstones of everybody who's here is that ability to be positive. It's not to say that we're not honest about things that are not correct, but that those scientific discussions are different from the kind of new ideas that people have in the ways and the areas and the new pieces of technology, the new ways of doing things that are fragile and that we protect.

I also want to do Eddie Cantor's, "It takes 20 years to make an overnight success." There have been many people who have just discovered us or found out about us and think that we're an overnight success. Well, yes, once you count those first 20 years—

CP: The rest of it's overnight.

CJ: Then we're the overnight success. Definitely.

CP: How about the Kurt Vonnegut? Just for a funny note.

CJ: Let me just find that real quick. Kurt Vonnegut: "Those who believe in telekinetics raise my hand."
[both laugh]

CP: I love that one.

CJ: That's a good one.

CP: You've got a great list there.

CJ: I do. It is a great list, and I enjoy going through them from time to time to look at them and rethink about them. Hopefully, I'll be able to keep this list of quotes online growing, and continue for future generations to be able to look at my quotes and enjoy them.

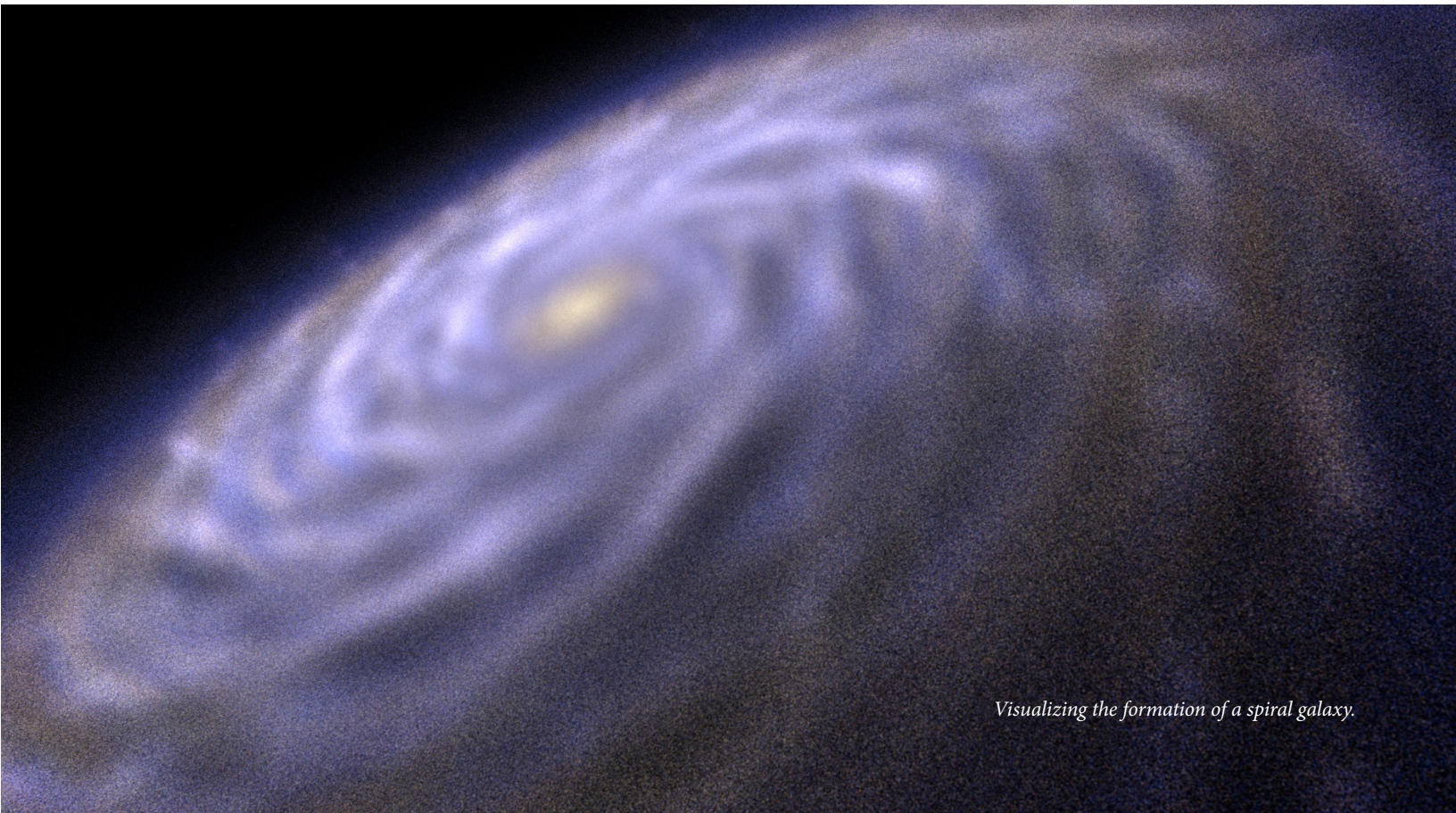
CP: Part of SCI's legacy.

CJ: Yes [laughs].

CP: Thank you so much. This has been an amazing experience.

CJ: It's been fun. And thank you. Thank you very much.

END OF INTERVIEW 4 WITH CHRISTOPHER R. JOHNSON



Visualizing the formation of a spiral galaxy.

Robert S. MacLeod

An Interview by Christine Pickett
3 August 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3382
SCI Interview 6, Interview 1 with Robert S. MacLeod

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS AUGUST 3RD, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING PROFESSOR ROBERT S. MacLEOD, ASSOCIATE DIRECTOR OF THE SCI INSTITUTE, FOR THE EVERETT L. COOLEY COLLECTION.

CP: This Everett Cooley oral history project interview focuses on the unique culture of the University of Utah's Scientific Computing and Imaging Institute, or SCI. Several individuals are contributing to the discussion of SCI. As an introduction to each, we are including a brief bio.

Robert S. MacLeod, the cofounder and associate director of SCI, is a University of Utah professor and vice chair in the Department of Bioengineering, and an adjunct professor of internal medicine, cardiology. He was also the cofounder of Comprehensive Arrhythmia Research and Management, or CARMA, at the U.

Rob holds the following positions: associate director of the Nora Eccles Harrison Cardiovascular Research and Training Institute, the CVRTI; associate chair and director of the undergraduate program in biomedical engineering; codirector of the National Institutes of Health/National Institute of General Medicine Sciences Center for Integrative Biomedical Computing; codirector of the summer course on image-based biomedical modeling; member of the board of directors of the Computing in Cardiology Society; member of the International Council of the International Society of Electrocardiology. Rob has published 120 peer-reviewed articles, played a role in the organization of nearly 50 conferences, been the recipient of numerous grants, including several from the National Institutes of Health and the National Science Foundation, and served as an editor or reviewer for dozens of granting agencies and journals. He has served as the advisor or as a committee member for nearly 200 doctoral and master's students and has supervised 11 postdoctoral students. Rob's research interests include cardiac electrophysiology, computational electrophysiology, computational electrocardiography (forward and inverse problems), cardiac arrhythmias, electrocardiographic mapping, scientific visualization, bioelectric signal and image processing, biomedical image analysis, atrial fibrillation, experimental investigation and clinical detection of cardiac ischemia, and defibrillation.

First, thank you very much, Rob, for contributing to this discussion of SCI. The institute, according to Chris Johnson, owes much of its success to you. And he has also credited you with contributing to his own early success. He has described your long collaborative relationship as well as friendship. And he notes that the two of you complement one another. Tell me about how and when the two of you met and how your early collaborations led to the founding of the predecessors of SCI and ultimately to SCI.

RM: Chris and I first met during a visit I paid in 1989 to the CVRTI. At that time, I was finishing my PhD and looking for a postdoctoral position and came to the CVRTI to interview and to explore that option. So Chris and I met during one of those interviews. He had just assumed a position at CVRTI and we immediately connected, realized we had a lot of common interests and wanted to solve some of the same types of problems in our fields, and especially to make more extended use of computing. We knew that computing was a wave that was going to grow and going to become a bigger and bigger factor. And we recognized that potential and thought that's the tool set we wanted to grasp and develop.

At the same time, we knew we had a lot to learn in the classic techniques of experimentation and clinical data gathering and in these areas of, for me, electrocardiography, electrophysiology of the heart. And so the CVRTI was a natural home for me. It's why I came here in the first place. The experimental capabilities were outstanding. The people were among the world's best. And I knew I could learn a lot about that aspect of the field and that by understanding both the data acquisition side, experimental side, even some of the clinical aspects, and then bringing computational tools to bear, that there was a lot of progress that we could make.

Chris was more of a physicist and a mathematician. And so we, right away, complemented each other in our skill set. My training was in physics initially and then physiology. So I knew a lot more about the functioning of the heart and the organs and the rest of the body than Chris would've had in his training. And he knew a lot more about relativity and numerical methods and elaborate mathematics that I had never had a chance to learn. So right away there was a natural complementary relationship there. So even though we focused on the same problems, we came at it with a different even starting point, skill set, and interest perspective.

And that was when we first met. Then I went back to Canada, completed my PhD, and then returned in 1990. In fact, two days ago was my 26th anniversary here at the University of Utah.

CP: Happy anniversary.

RM: Thanks! Before I came back in 1990, we'd been in email and we knew we wanted to hit the ground running and start working together on some projects. And we thought the smartest way to get to know each other was to ride bikes together. And so we started a longtime habit, highly addictive habit, of riding our bikes up City Creek and using that time, especially riding uphill, to ride next to each other and talk about our dream, our vision, the ideas we had, how we might go about this, what we needed, who we needed to talk to, all those things that formed a framework and a grounding of what has become the SCI Institute. And that went on for I can't even remember how many years and was, yeah, just a wonderful foundation.

And, of course, during all these conversations, once again, the complementary nature of our personalities started to emerge. And in a nutshell, Chris is the less patient one. I'm the slightly more patient one.

CP: He says the same [laughs].

RM: I think he's the one with a better sense of the big vision and the ability to focus on the larger scale. And I'm probably a little better at—not worrying. I'm not a worrier. I think we're both very optimistic people. But just thinking about the details and trying to anticipate what we needed to check on, gather, implement, organize, how to make all that work.

So between those sort of two, I wouldn't say poles, but those two complementary aspects, we were able to cover a lot of different aspects of what we needed to do. Chris had been here longer. He had the connections. I was a newcomer. Within a couple of years of our first meeting, Chris started to make stronger ties toward computer science, which later became the School of Computing, whereas I developed my ties more with bioengineering and the biomedical engineering program and cardiology and the medical connections and developed this physiology, very biomedical-centric skill set that I think continues to form this complementary nature of our relationship. He's much more the computer scientist and the visualization expert. And I enjoy the application of these things, specifically to biomedical problems. And so I think, while he continues to be involved in brain research, for example, and loves to have a hand in biomedical applications of computational tools, and I certainly love to learn new computational tools and develop them and I guide developers and help software come together, we certainly continue to have our core strengths in slightly different areas that are just remarkably complementary.

And so we've just gone on in so many regards, both finding commonality of vision and purpose and being able to divide up the tasks in a way that works for us both. So whenever there's a new problem, a new task, a new grant to write, a new center to create, it doesn't take long for us to figure out who's going to do what. There's a certain pattern to that. We know each other's skills. We can very quickly allocate the job at hand and get on with it.

And I think, of course, at the base of it all is a friendship and also a great deal of respect for each other. And it's hard not to respect all that Chris has accomplished. And I do at all levels. And I feel that same respect from him. So I have complete faith and trust that the parts that he'll take on, the decisions he'll make, will be for the good of the group. We've both individually done very well and are certainly as successful as we want to be individually but we also, I think, are very good at recognizing that that success is incidental to the success of the collective.

CP: The good of the group.

RM: Yeah. And we both get an enormous kick and enormous

SCI cofounder and associate director Rob MacLeod (2011); heart model in background.

gratification out of seeing our students do well and make their way in the world, to see our colleagues come and prosper. We love to recruit good people, but we don't just give them the keys to their office and let them make their way in the world. And that's because we know it's important to provide mentorship and support. But we also get a lot of personal joy out of seeing those successes. And that eventually feeds the success of the whole enterprise and ultimately the whole university.

I think that's another thing we share: we're incredibly happy with the way the University of Utah has been able to support us over the years and see this new vision, which was pretty radical at the time. And it wasn't an obvious thing 25 years ago to say that computers were going to be ubiquitous, and computational and visualization tools were going to be something that every scientist has to have access to. That was a novel idea at the time.

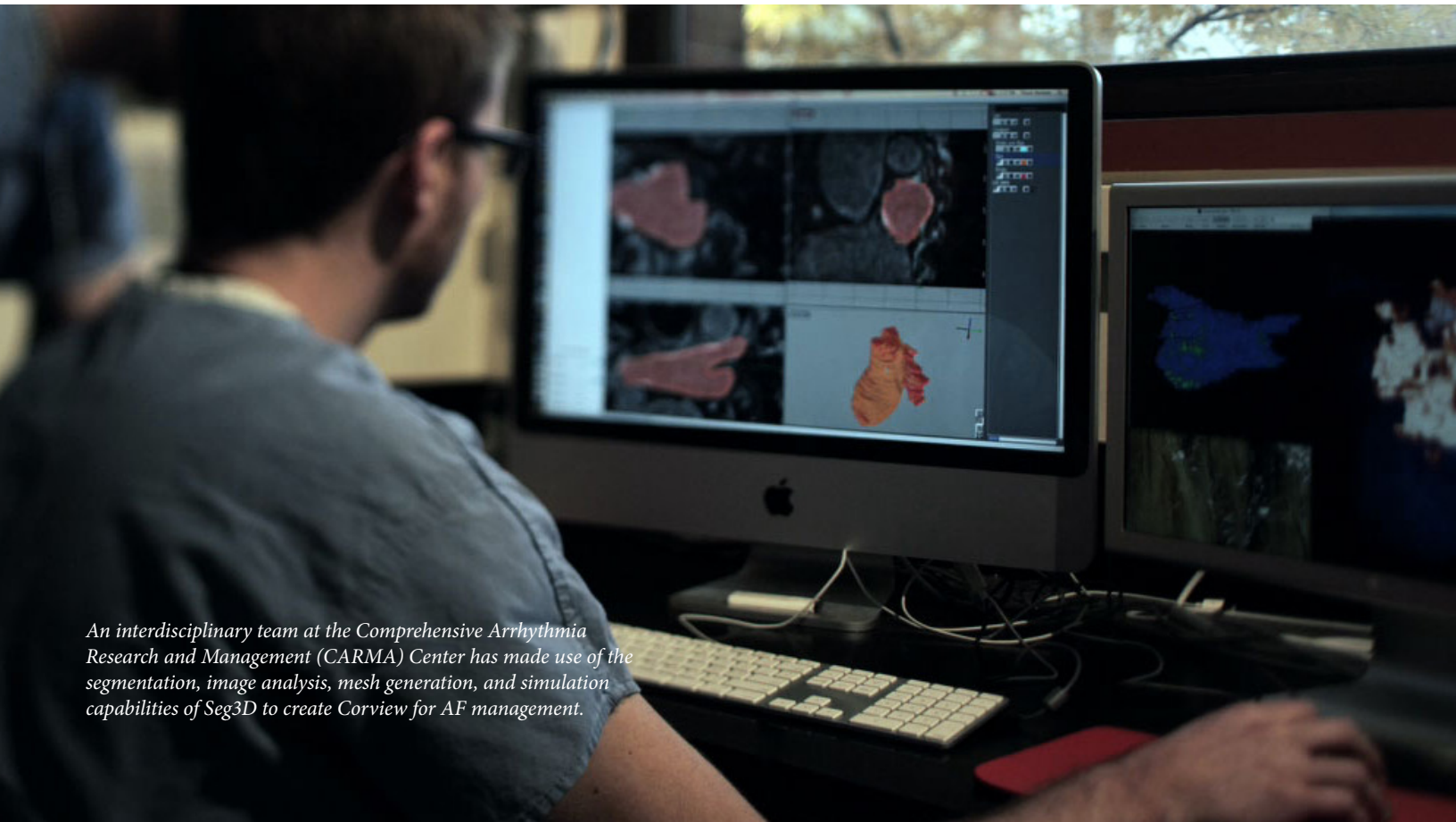
CP: What were those—specifically you mentioned on your bike rides that you had dreams and visions. What were some of the dreams and visions? Because you went through a couple other centers before you arrived at SCI.

RM: Yeah. SCI was kind of always there. SCI was the core. SCI is the centerpiece of my career. And whenever I do get engaged in other groups and other centers I always see that as a—I don't even want to say spinoff. Instead, I see it as a related activity. It's an opportunity where I hope my experience having created SCI can be of some use. And obviously my involvement comes out of some expertise in that domain. I wouldn't go off and start a center in biomaterials or other field unrelated to my core expertise. But I'm quite confident doing it in any area of cardiology. So I think SCI was and is always the core, always the place we focused the most attention. And it certainly has our first allegiance. And we just saw it as a great opportunity for people to come together and both develop and utilize technology.

I think what frustrated us in our early interactions with computer science—because, again, neither of us came out of computer science. We don't have degrees in computer science. And we started to interact with computer scientists because we knew they had great capabilities and that this was going to be our well, on the technical side, to draw from. And we knew we had to get to know them. And so we did. But one of the things that frustrated us from the very beginning was seeing the number of amazing discoveries and novel breakthroughs, great ideas, and clever algorithms that resulted in a paper at a conference, let's say, and never really went any further, never made it into the hands of scientists. And when you work in that crossover domain you realize how important it is to have access to those tools. That a tool developed in a vacuum, published in a vacuum, and that never makes it into anyone's hands, is just a wasted effort at the end of the day. We always saw this from a very pragmatic perspective.

Of course we understand the elegance of computer science and the beauty of math and appreciate that there's intrinsic beauty in that we don't want to push that responsibility for translation to the inventors of some of those ideas. But we always thought there has to be somebody in this whole game who can understand these ideas, extract the most valuable ones and put them into application, bring them to the scientists, based on an ongoing discussion about what the scientist needs. Then we need to explore how to expand and modify and gather the tools together that the scientist really needs to accomplish the ultimate goal of what we're all interested in. In my case it's biomedical sciences. SCI obviously has a broader scope than that.

But at the end of the day, I think all of us, even the computer scientists, are here because we want to see what we do applied to something and computer scientists also want it to feel like they're making a difference in some area of application. And that's a great motivator. When you spell that out, when you hold that in



An interdisciplinary team at the Comprehensive Arrhythmia Research and Management (CARMA) Center has made use of the segmentation, image analysis, mesh generation, and simulation capabilities of Seg3D to create Corview for AF management.

front of somebody as an opportunity, that motivates a huge percentage of scientists and especially engineers.

CP: That's the whole basis for what you're doing here.

RM: Yeah, it really is. It really is. It's turning these little gems into something that becomes the whole ring or the whole piece of jewelry.

CP: It's a huge interdisciplinary enterprise, isn't it?

RM: Of course. I mean, therein lie both the challenge and the fascination. And some people (like us) love that challenge. For some people, it's the worst thing in the world they could ever do. Some people want to be in a very well-confined, well-constrained area of their discipline. And thank goodness because they become the true experts and they make amazing progress. But some of us don't feel comfortable in that box.

CP: You want to tie bigger things together.

RM: Yeah.

CP: You're, as we mentioned, one of the associate directors of SCI. What is your particular role in your position as the associate director?

RM: We have a core group of us who are the standing associate directors. Greg Jones is one of them and he, since he came to SCI, has handled the administrative responsibilities and managed that whole side of things, as well as lots of personnel, and even a good deal of science. So I would say he's been more of a full-time associate director in practice. And then Chuck Hansen, who was the third person to join the institute, or the group, before it even became an institute; he and I are the standing associate directors. And my primary interest, I would say, is certainly the biomedical applications. So I'm very curious and very happy to help and facilitate and just track and do whatever I can when one of the SCI groups gets involved in biomedicine. And that can be as diverse as pointing out granting opportunities, helping them formulate their specific aims, making connections for them. They may have a great idea that I can see the potential of but they don't know who would actually be interested in that idea. They don't have a biological or biomedical partner. And I love to find those relationships and nurture those relationships and see them take off.

So I see myself fundamentally playing that role. As an executive, we obviously share lots of discussions and decision-making on practical aspects of the institute, everything from space to infrastructure. We all have those discussions. But we tend to involve as broad a group as we can in a lot of these decisions that affect everybody. There's a very strong sense, in the institute, that while the director position is the decision maker, it's not sort of a Swiss-style democracy, if you will, but that everybody has a voice. Everybody can come to the table. Everybody can express their opinions. I think Chris does a remarkable job of listening well and taking all the input when he makes decisions. And that percolates, obviously, down to us as an executive. We really want to make sure that the decisions that affect everybody should involve everybody. And so when we're looking at new large-scale computers or space decisions or anything like that, that affects the whole place, then the first thing we do is make sure we get input, and, as often as possible, try and create consensus. We do a lot of rule by consensus here. I think the number of difficult decisions that Chris has to make at the end of the day is probably pretty small. And whenever

Graduate student Harsh Bhatia presents during a recruiting event, 2012.

he does have such a decision, he's had a lot of input. And I think everybody feels that, even if the decision maybe doesn't go quite the ideal way from their perspective, they know they've had their say. And I think there's a strong loyalty within the group and a great deal of respect for that style of leadership.

CP: Now, I know that you have a strong interest in institutional memory, you've mentioned before. I mean, that was part of the impetus for talking about the culture of SCI. And Chris has mentioned a strategy for success that he learned indirectly from David Evans and Ivan Sutherland. Four points: hire the best people, never sacrifice quality, put the best resources in the hands of the best people, and create a supportive environment. So I think what I'd like is your opinions on each of these.

The first one – and you've touched on this a bit already – but how have you gone about attracting the best people? What is your recruitment strategy?

RM: Yeah, it's really interesting. The thing we learned pretty early on is that it's rare that by casting a broad, open net that you'll, with any efficiency at all, end up with the sort of people you want, that the best approach is to seek out, learn about, and identify those people, then approach them and actively recruit them. Passive recruiting is an incredibly time-consuming process. And I don't know of good ways to do it, quite honestly. I don't think we create the filters that well to sort it out quickly based on submissions of paperwork or things like this. So we do an awful lot of, I would say, ongoing opportunist recruiting, in the sense that we're always looking for good people when we go to conferences. We travel a lot and, we meet people all over the world. And I think all of us keep a little list in our heads of the kind of people who might fit at SCI. And, of course, we aim most often at the younger end of the spectrum. We want to bring new people into SCI all the time and young people especially. So we love to interact with even grad students but certainly postdocs and junior faculty as we see them in all these interactions we have.

This is one of the reasons, I think one of the motivations, for as much travel as we do. It also allows us to promote. And that's another aspect of this. But I think it allows us to actively look and meet people. And that network of people is useful for many, many things. It's useful for collaborative relationships; it's useful for obtaining support, interactions, people to test things, people to pro-

vide data. It can be all sorts of different things. So we're very big on building these personal relationships.

But one aspect of that is always the recruiting one. And I think we're always looking for those good people. So that's step one. And then step two is to bring people here and make sure they see what it is we have going on. And my experience is it doesn't take long, when you have somebody here, even if they come for a couple of days to give a talk, meet with faculty, meet with students, it doesn't take long to size them up and see if there's a certain resonance that occurs.

CP: So you've gotten good at that then, obviously.

RM: I like to think we're okay at it at least. And it's one of these sorts of things that we look at, I think quite objectively, and don't view it as a value judgment. It's just there's a quality of interaction that we're looking for. And when you just put somebody in the middle of it and watch them work, watch them interact, watch them engage, watch them resonate with the place, then I think you can identify those that you would say, "That's the kind of person I think we could benefit from, that would fit." And so fit is everything. Fit is so critical.

CP: Chris mentioned before the "no asshole" rule. How does that apply? The culture here is so amazing. How does that work?

RM: Yeah. We certainly have lots of people who come and are sometimes quite forceful, saying how much they would love to come back and how great a place it would be to work. It has a lot of visual appeal to start with. And so people get wrapped up in that. But I think when you watch people interact, when you watch how well they listen, when you watch how well they're able to seek out commonality versus seek out opportunities to improve their stature, to make themselves look more whatever, more powerful, smarter—So I think it's really key to have people who are good at listening and good at wanting to know what is going on in this place. And then being able to take the next important step, which is to say, "I could interact with that. I could see how what I'm doing would fit with what you're doing. And here's how we might go forward on this if we were to somehow work together." And I think that ability is essential. The people who do well here I think are the people who do interact regularly and are good at listening, good at seeking out other people to talk to.

And conversely, the people who struggle a little more are the people who tend to be a little more isolated. They sit in their offices and don't really reach out too much, don't go to the seminars, don't ask questions.

Students attending a graphics processing unit (GPU) course presented by nVIDIA, 2016.

CP: Do they survive long-term, those people?

RM: You know, most don't. Everybody who has left SCI has gone on to bigger and better things. And that's the most important thing. The last thing we would want to do is to keep somebody who was discovering it wasn't working for them. What I've learned over time, and this is one of the hardest things in leadership, is actually firing people or encouraging people to go. What I've learned over time is that there are many, many different environments. And most people will find the right one if they just search long enough. And by helping them with that search I'm ultimately doing them a big favor. And overwhelmingly that has been my experience, that in a month or a year somebody will come back who has left and thank me or thank us for helping them make that break, and helping them make that move, because now they're in a much better place and really enjoying things.

So I think fit on all sides is important. And it has this plus side that we're looking to recruit and keep people who fit well here. But I think just as positively we're looking to identify those people who would fit better somewhere else. I'm not going to tell them where their best fit is. They have to discover that. But if I can help somebody come here and recognize this is not the right place for them, then I think I've done them a favor. I think I've done us a favor.

And I have wonderful relationships with some of these people. Some of my closest collaborators are people who wouldn't actually fit here and who didn't fit here. Some of them even came to visit and we thought we might want to recruit them until we got to a point where we realized this really wasn't the right fit. As fantastic as this person was, this wasn't the right place for them. And so they've gone on to other things. And like I say, some of them are my closest collaborators.

So it can work on all sorts of levels. But you need people who just fit in that groove, who get the big picture, who get the importance of the whole over the individuals, and have the ability to perform the interaction, the listening, the stepping up and guiding and helping, even if it's not in any sort of job description, those sorts of attitudes are what we look for.

I think in ways we work like I picture a small business, where there are no boundaries as to who does what. You set up some kind of structure but when there are cables to be laid out and power strips to be plugged in—

CP: Everybody pitches in.

RM: Everybody does it. You just do it. There are no questions here about the appropriateness of a task according to pay grade or place in the hierarchy.

CP: And this applies, too, obviously, to the staff you hire.

RM: Yeah, absolutely. Absolutely. They have to have that attitude, too. They have to have that flexibility. They have to see the fun of it. I think we offer them lots of opportunity to be fulfilled in their careers. We're always thinking about how can this person move up to the next level? And if the next level's not here, then for their own good they're probably better off moving to a different organization. We only have a hierarchy that goes so far. And if somebody wants to move up, then moving on is the best thing for them.

For example, we set a policy in place where we didn't want individual faculty, even very prominent and successful ones, to

Graduate student Joe Kniss uses stereo glasses to immerse himself in a 3D volume magnetic resonance angiogram (MRA) of an aneurysm, 2000.

Professor Bei Wang during a panel discussion at Future in Review 2017.

have single, dedicated administrative support. We wanted them to have all the support they needed but we wanted to have that distributed over several people. Similarly, we didn't want single people to only be attached to one lab or one person. We want everybody to be part of the collective administrative team.

And I think that's worked out extraordinarily well. I think the individual faculty feel well supported. They feel like, even when their main assistant is not available for all kinds of good reasons, they know there's a backup. They know there are other support people who know what they do and know what they need and can step in and help out.

CP: That's key.

RM: It is key. And so the compartmentalization is very soft and very flexible. And we also encourage people to continue to grow and develop—and I've seen this, too: people get hired in one position and they get it figured out pretty quickly. And then the first thing we'll want them to discover, through conversation or trying different tasks, is, for example, that there are some other things that they could do that would broaden their skill set. This would give them more to do in their day and make them feel more fulfilled and ultimately make them more qualified, should they ever move on to other positions.

CP: You wonder why other departments and institutes don't—

RM: I really do.

CP: It seems simple in a way.

RM: Yeah.

CP: I think that answers a question, too, about how you've created such a supportive environment. But it does seem such a basic approach that works so well.

RM: Yeah, we have discovered these things, in part through our own experiences. We also spend time in different organizations, too, and try and observe how they function and try not to make all their mistakes.

CP: And the successful ones probably do exactly this.

RM: Exactly. It's what we've learned. And Chris has really made a study of this. He's spent more time than anyone, not just discussing but reading about how organizations function well. And this is, I know, one of his pet topics and hobbies: to understand how organizations work. And so I think we've used all that knowledge that he has gathered.

We've had administrators who were doing their MBAs. And we encouraged them every week or every month to come in with whatever new idea they've learned in one of their classes to see, okay, how would that work for us? Is that something that we could do here? And so we're always anxious to try new things out and see what does work, again, for the good of the collective.

And so, yeah, I think that attitude works. It just allows us to take on things that nobody thinks we could take on. And we have a history of doing that. I mean, the very first, this big NIH grant, that we still have, when we first approached the NIH about even applying for one of these grants, they, very nicely, looked at us and said, "Oh, you're a little young. Maybe you haven't got quite the experience that we look for in these positions yet. We have other grants in our program that are smaller grants; maybe you could start with one of those." We just kept looking around at what they were looking for and discussing what it is we had in mind. And we thought, 'No. We have a scope that's big enough. We think we can take this on. We think we can learn what we need to play at this level.' And so we didn't get the grant the first try and went back for a second try and have been funded successfully ever since on this single grant on this one project.

So I think that taught us a lot. The first failure taught us that you just have to try and take stock, that you will overreach occasionally, but that just means you have to rethink it and go forward again. And so by no means every application since then has worked for us. But I think we're good at judging what we're actually capable of. And we were not intimidated and certainly not anymore. But I think even back then we were not prone to intimidation, to think that we're too small or Utah is too insignificant or we're too young. We realized that it is, and it should be, about what we can actually bring to the table, bring to the discussion, what we can actually contribute.

CP: And I think you've also given that to your graduate students because if they have failures of papers, they just keep on going.

RM: Oh, yeah. They get—

CP: Undaunted [laughs].

RM: Exactly. And they learn pretty quickly they have to be. On the academic side of it, it's really fabulous to watch students progress. And they naturally come to us and they want to know, "What should I do? What kind of career should I pursue?" And I've had students, quite explicitly, ask me, "What are the key characteristics to be successful at this whatever?" And some of them even during interviews. It started as I'm interviewing them to see if they would be good grad students and all of a sudden they're interviewing me about what I think it takes to be a successful grad student.
[both laugh]

RM: And so we're always trying to evaluate. What are the characteristics? What are the features? What are the things that make people successful—or at least improve their chances of success? We can't make anyone successful. They have to make themselves successful. But we can, with the right kind of support, make sure they have exposure to the opportunities, to learn the skill sets, and to

match those to the career path they want to pursue.

CP: That kind of leads into another question. Do you have some examples of your successful recruitment strategy, maybe even recent examples, postdoc or faculty?

RM: Yeah. We never set this out to be an explicit strategy but I guess it's a reflection of the process that we believe in. We've had two recent hires, both of whom were grad students in the department. And I think that's something that some organizations shy away from. They say that there's nepotism involved in hiring their own and have to be careful of this. We look at it the other way. We watched people develop as grad students. We have a good sense of where they were. We've watched how they progressed out in the rest of the world. And so we know a lot about where they came from. And we've been able to track their trajectory, I think, in a very healthy way. And when they come to visit we quickly see if the lessons about SCI and the interactions they had with us stuck with them. Or did they leave and then just breathe a sigh of relief and go off in another way of working? And that's all fine. Like I say, these are not value judgments.

But in both the cases I am thinking of, they were people who kept in touch with us and people who we saw get on amazing trajectories, people we felt confident have just gone on a trajectory that kept them harmonized with what goes on here, where we really had the strong sense that they understood the value of the education they got here and the training they got here. And they were ready to come back and give to the organization, to really do their part to support the other students and the whole organization.

And so both those have been remarkably successful hires. This is Miriah Meyer and Chris Butson. And so they've both done extraordinarily well, in terms of getting funding and good teaching reports and making progress through their promotions in their respective departments. So I think they're great examples of the kind of hires that were pretty easy to make.

And I think in both cases, again, we were following them. Of course, you always try and follow your students and see what they're up to. But these were two we kept an eye on.

CP: You had it in mind.

RM: We just saw they were on the right path. And if there were an opportunity that fit their ambitions, that they would be people we would actively go after. And I think in both cases they've been just outstanding success stories so far. They're three or five years into their time here. One can never tell for sure, but all the indications are phenomenally positive.

And I think, again, the key thing that I still see in them is this willingness just to contribute, to see this not as a stepping stone, not as a way to make oneself more important, not as a vehicle to greater glory, but as a place to really contribute and make progress and leverage what's here, add to the sum total of what's available and allow other people to leverage even a greater sum of capabilities. And I think that ethos is a really important one. And they got it as students, so they still have it.

CP: How about graduate students? Do you design special admission criteria or is there any recruitment there? Or is that a little more difficult?

RM: Yeah, it's an interesting process because, as with many similar situations, there's a role that an institute can play and there's a role that the department has to play. And I think that's one of the aspects, on many fronts, that we've learned to negotiate effectively. We engage well with other departments, to find ways to create win-win situations, so that our recruiting somebody becomes their recruiting. Our success becomes their success and vice versa. And this is clearly true with the students.

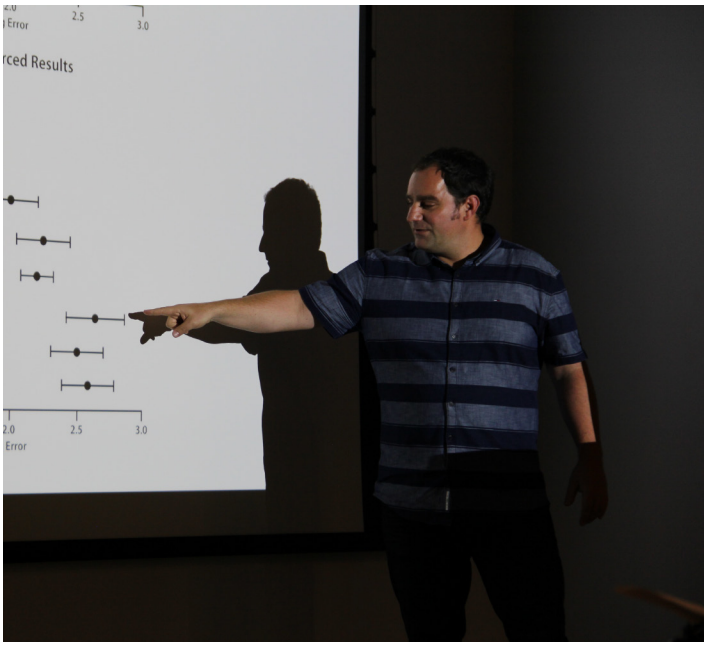
In October we plan – this is the third or fourth time – to cosponsor a booth at the major biomedical engineering conference in the country. And this will be a cosponsorship, literally, between the Department of Bioengineering and the SCI Institute. And we'll send people at our expense, as well, to help run that booth. And then we'll recruit students attending the conference and others (including me) to help out with running the booth. And so I think we make strong commitments to the departments and work really well with them, like I say, on many, many fronts.

Specifically, on the grad student recruiting, I think we have the same goals, to recruit outstanding graduate students. And so, again, it's a bit of a balancing act. There are certainly cases where I would say we take more of an aggressive stance on certain students who we may have heard about through whatever connections. We then try to facilitate their interactions with departments to make sure they get into the right program.

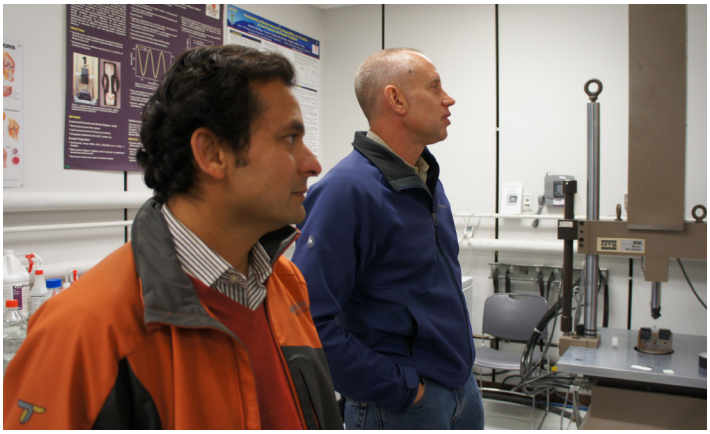
CP: So they are kind of targeted, then?

RM: Yeah. Some definitely we identify. Our colleagues from other programs contact us and say, "I have a tremendous student who I think would fit really well." And we'll work with that student and say, "Okay, what do you seek to achieve academically and what kind of program would work?" One of the big decisions when they come to work at a place like SCI is literally which department to belong to. I mean, we have five different departments represented here. So those are conversations we like to have early and give the students a sense of what's what.

It's worked out really easily and smoothly because a lot of us in SCI have very strong relationships and strong responsibilities in our individual departments. So that's another aspect of, I think, why departments generally work well with SCI. We have had chairs, vice chairs, and directors of programs in the academic departments who are SCI faculty. And that's ongoing today. The past



ProfessorAlex Lex discusses data visualization methods, 2017.



Professors Sarang Joshi and Ross Whitaker tour the Musculoskeletal Research Laboratory (MRL), 2011. MRL is directed by the Institute's Jeff Weiss.

two chairs of the School of Computing have been SCI faculty. And I've been vice chair in bioengineering for 10 years now and will continue in that role. And another SCI member was the director of the graduate program in bioengineering for several years. The current and past directors of the graduate program in the School of Computing are also SCI faculty. So we really commit to those relationships and I think that helps us a lot.

We work really closely with the departments on other fronts. When the department initiates or develops its recruiting program we try to be helpful partners. For example, if they want to do a tour of students through the SCI Institute or have somebody from the SCI Institute explain what we do here and how we might help their research or how we could possibly provide a home for them, if they want it to be based in SCI, we're very quick to respond to all of those requests.

In some cases, we initiate our own relationships with prospective students, postdocs, or faculty and then work with departments to get them into the appropriate department. In other cases we are very responsive to whatever the departments ask us to do for them, recognizing that good students, faculty, or staff benefit everybody. They benefit the college. They benefit the university. Even if they're not SCI personnel, for example, if I have a collaborator in bioengineering and that professor gets a great student and we work together, that benefits me and my students and our group. The whole goal, I think, and the whole recognition here, is there are almost always only benefits to collaboration and synergy and talking together, to just putting individual egos somewhere else and realizing that we all will benefit if we all contribute. And that's the ethos of SCI. And I don't think we push our system on the departments but we try to encourage other departments with our own actions. We try and convince them that we really want to put our money where our mouths are and support, in whatever way, their initiatives that have that same flavor as ours.

And we're fortunate, I think—and it's great to hear that you're talking to Dave Pershing, because I think he's been an amazing supporter of SCI. He has picked up on that sense of—you call it interdisciplinary and that's part of it, but there are so many other aspects to it, that creation of community, of open community. There is a notion of open science, which is a buzzword that has lots of meanings but I think we have created sort of open communities here on the campus that make it possible for a poet to work with a computer scientist or a physician to spend time in a computer science institute like ours.

And when we first started, all this had to happen – I don't want to exaggerate – but I had to pursue these collaborations a little secretly. I couldn't be too open about these things back then because it was seen as somehow betraying somebody if you worked across department or college boundaries.

CP: But now SCI's renowned for it, globally.

RM: Exactly. It's worked. And I think that tide has turned in many, many places. And Chris and I came from a place that had a strong ethos of collaboration and cooperation within the walls of that institute but not as much a sense of the responsibility to other groups on campus as a whole. They saw themselves as a very strong, tight group, with international relationships and an international reputation. And they did. It was a world-class place. It still is.

What has changed there, and again, this has been one of my roles in that organization, the CVRTI, was to look outwards a little more, to cooperate better with the natural departmental partners that are on this campus and to be accommodating. During the time I was acting codirector of that institute, when a cardiothoracic surgeon needed a lab to do a procedure and test some ideas, we were willing to be open to that, provide access to lab and technical assistance. And I think we've moved a lot in that direction. And I think that's been to our benefit now. So now the CVRTI is not only known internationally, it's also known on campus to a much bigger extent than it was. And that's been my goal all along.

I spent five years as an acting codirector there and eventually one of us became the full-time director. I think during that period we recognized very quickly that the prevailing isolation approach just wasn't sensible. It doesn't work at the world level. Why should it work at a campus level? Isolationism just never works in my mind. So that's one very specific example where we've changed the climate of an existing institution and I think opened it up to its own benefit.

CP: A little bit of a switch here to one of the points in success from Evans and Sutherland, indirectly from them: to never sacrifice quality. It seems like that must be a bit of a balancing act.

RM: Yeah, it absolutely is.

CP: What does that mean here?

RM: Yeah, exactly, what does it mean here? So I think it means things like when a faculty member is not having success, by any metric—And we try very hard to use a broad set of metrics, and not just focus on the money; that's a very narrow perspective on success. So when a faculty member's not getting the grants, getting the papers out, maybe not achieving aspects of their own success, we try to get active. We try to make them aware that they are not alone, that there are experienced people within the institute who've been down this path before, and really offer to step up and preserve that sense of quality. At the same time, and Chris is spectacular at this, we try very hard to recognize accomplishments when they occur. And so when somebody gets a grant, when somebody gets a paper published, when somebody has a major talk somewhere or wins some kind of award—

CP: Or even their five-year awards I've noticed on—

RM: Exactly. Even the five-year staff awards. The news of those successes gets circulated. And I think it's really important, because it does support that notion that quality is recognized. We try to

turn that success into salaries. We pay good salaries to staff, better than many other departments are willing to. And we try to do it in a way that directly ties to their contribution and the quality they bring to their task.

CP: And I think it encourages, even beyond collaboration, a feeling of camaraderie here.

RM: Yes. That for sure exists. Another approach we use is interacting and discussing our research, presenting our research and ideas to people. We believe that by gathering input and by being open to input, the quality of what we do will improve. There are also different ways that we both track quality and then try and improve quality. It's no good just sending somebody a piece of paper at the end of the year and saying, "You're ranked four," or, "You're quality number seven," or something like that. That's really a small part of the story. And I think we all would rather use, as metrics, just the sense that people have of themselves. People know when they're happy with their own levels of achievement and quality. And so if you can engage with them on that basis and literally say, "Are you happy with how things are going? Are you happy with how your papers are getting published or your teaching's going?" And if they're not, then there has to be a willingness to step in and say, "Okay, let's get people together to help. Let's identify resources. Let's improve whatever or make available whatever it is that you think, or we might suggest, would help improve quality." Because there's a huge amount of wasted ability that we see. I mean, we see lots of faculty in other places – and I certainly won't name names or places – where you just think, 'This is such a shame. This is a person who is capable of so much and yet they just don't get the support necessary.'

CP: There seems to be almost, like, in sociology, for example, the expectations one has of another person. But that seems to contribute a lot, too, that excellence is expected here.

RM: Yeah, absolutely. Absolutely.

CP: Not gold stars on everybody's forehead.

RM: Sure. There are some outstanding examples who motivate everyone. It's great to have some really outstanding colleagues around, at every level, about whom you can say, "Oh, that's what I could become." And we don't push any kind of weird metric or we don't try and come up with an impact factor that we impose and we are not constantly engaged in ranking each other or rating each other. I think we try much more just to instill the self-satisfaction of achieving goals that, I think, we all have. We've all come to this academic career mainly because we have ideas we want to pursue. We love the flexibility. We love the atmosphere. We love dealing with students. We love the excitement of research. So that's not about getting rich or being personally important. It's not about power here.

CP: No, it seems to be a personal feeling of going above and beyond.

RM: Yeah. And I think we believe and say things like that. We make it clear that quality is important. We try to use those words when people come to work with us. When we hire people, we let them know that there is that expectation.

CP: And it becomes the atmosphere.

RM: Right. Exactly. And I think that really helps a lot. It's interesting, we've had some students who are not terrific. And you kind of wonder how did the drive for quality not rub off on them at some point [laughs].

CP: Well, some people [laughs] it just never does.

RM: It's quite astounding. But the good news is that most students and most people, when they come in this environment, they do respond to it. They do step up. They do achieve a lot more of their potential.

CP: In your student handbook there are a few things I noticed: the sense of personal responsibility, which needs to be highly valued, as I mentioned, living up to expectations. And one, which to me is amazing in a student handbook, the golden rule is mentioned.

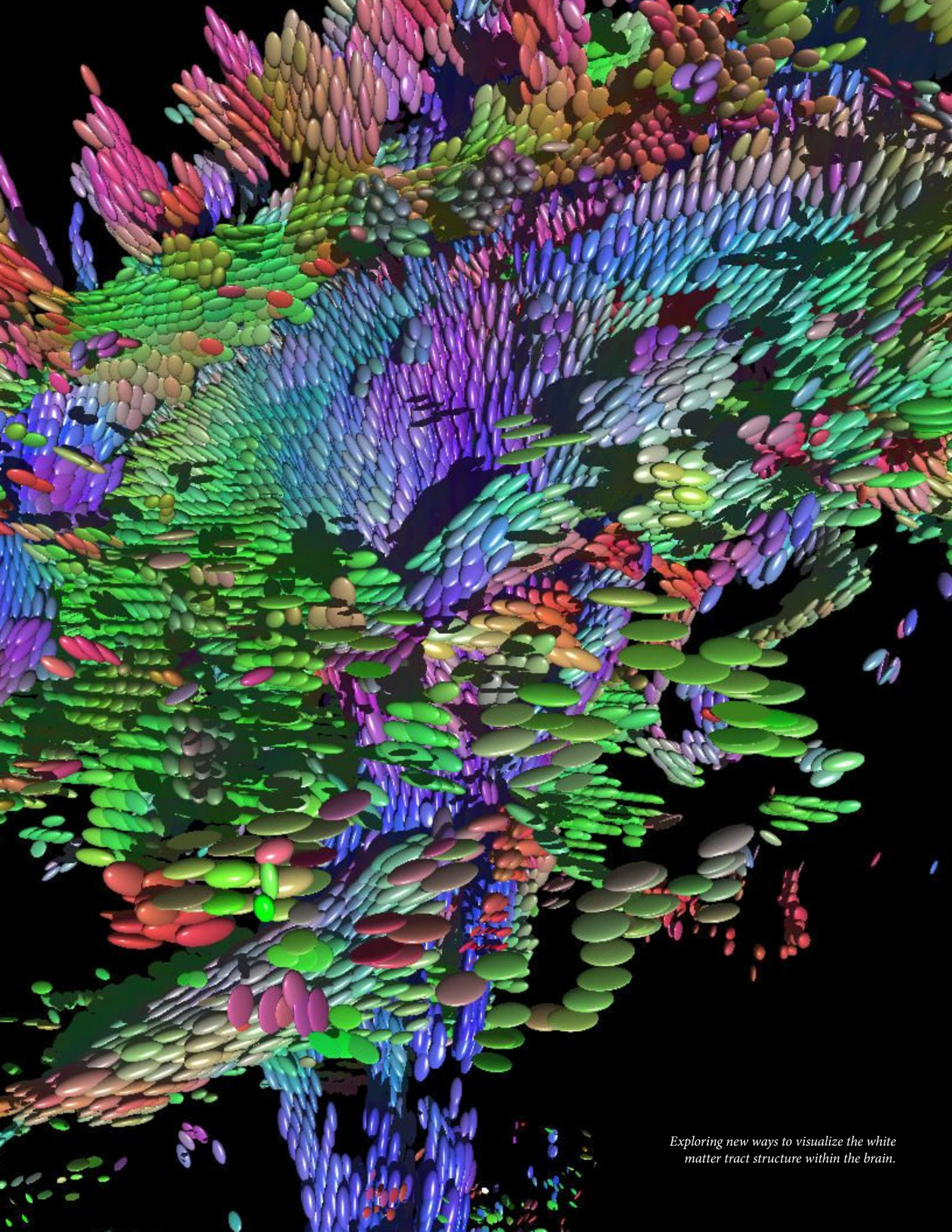
RM: Yeah. We see respect of individuals and their differences becoming a theme that we see at all scales. And it became very clear right from the start that had to be fundamental to how we operate.

CP: So you discussed that early on. The two of you had a notion?

RM: Yeah, it's interesting. I can't remember ever sitting down and talking about it explicitly. I just think it emerged from our personalities. I think we just brought that ethos to the table. And neither of us went to fancy, highbrow schools or had these incredible credentials that would make somebody immediately say, "Oh, that's the pedigree we want." And so I don't think we had an inferiority complex. I just think we took it to the other level and said, "Well let's just stop all these arbitrary criteria and these little games of evaluating the value of people. And let's just respect each other, give each other a chance, and then see what happens."

And so I'm a passionate believer in a lot of the aspects of our academic system. And we were just, literally, yesterday talking about this. I lived in Europe, I went to school in Europe. I love a lot of the culture there, I still enjoy being there. I have collaborations there. And education is one of those topics that I love to discuss. So we have a Dutch and a German student, a Dutch student just visiting. We have German postdocs. We have a lot of international students. We were having this conversation about the German system versus the American system. And I think one of the things I love about the way we teach people is – and this plays out at all scales – is that we put people in this situation in which their performance is relevant to what it is they want to become. So we don't say, as other systems do, "Your performance in high school will determine your ability to become a doctor," for example. We say, "Come to the university. Grow up. Interact with doctors. Spend time in a hospital. Learn what that life is like. Take challenging courses that cover the kind of material you'll have to know should you decide to become a doctor. And then make your decision. And then apply and see if you meet the criteria." And I think that way of doing things works at all scales.

So I think when I bring a grad student in, I don't care what university they came from, I want to see and I want to read and I want to get a sense when I talk to them that they're committed. That they have motivation and they really want to try hard. And if I have those qualities to work with, I think we can do amazing things. And I think we've always looked for those sorts of people who just brought that energy, that commitment, that enthusiasm, the motivation. And we didn't worry too much about what their grades were or what university they were fortunate or unfortunate



Exploring new ways to visualize the white matter tract structure within the brain.

enough to go to, but much more what can they perform here in this setting, in this environment? And if they can live up to the quality and find a place here, then they are in the right place.

CP: And it probably causes them to even be more dedicated, having that opportunity.

RM: I think so. I think that's so. I think lots of people who, again, don't have the official sanctioned pedigree really appreciate the opportunity, really appreciate being respected and given a chance. And I'm a huge believer in just giving people opportunities and not having preconceived ideas about whatever their prospects are. And I think that's something that Chris and I have always shared. And tolerance has always been a key part of our personalities.

And so I think it just was a natural extension to how we could create a supportive environment. On the one hand we can say, "You're probably not going to be happy here unless you get to a certain quality. But we're going to try and get you that point of achieving quality. We're going to do the best we can to get you there. And if it doesn't quite work out and it's not the right place for you, that's fine. There are other places that will work out fine. And you're not a failure because you didn't end up staying here or this wasn't the best step in your career path." And so I think as long as you combine all those things, then you minimize the drama and you minimize the emotional negativism that can really block progress, block openness, block the ability to listen to others.

And this is something that everybody gets here early on, gets used to the fact that when they present an idea, when they discuss something, that there's going to be other, sometimes critical, comments about those ideas. And it's not going to be behind their backs and it's not going to be over the coffee machine. It's going to be in an open setting where everybody respectfully says, "Yeah, this might work but have you thought of this?" Or, "I actually think there's a problem with that idea. And here's why."

And I think creating that sort of openness is something we've recently had reinforced again and again, in all kinds of other settings. We have ties through the University of Utah with graphics to the movie world. And so we get this same message from people like Ed Catmull and from another Disney Animation studio person who gave a talk here just a few months ago. They tell us that the only way they find they can really get everybody on board is to have these open discussions in which all ideas are welcome, all ideas are valued, and evaluated. And they're all discussed. And if they're rejected it's not a function of who had the idea, or any of the baggage that might come with, but as honest and open and realistic an appraisal of the idea as possible.

So the bottom line is everybody gets used to critique, if you want to call it that. I think critique is an incredibly positive thing. It's an incredibly helpful thing. It helps people formulate their ideas and refine their ideas. And it's not a negative atmosphere that has to surround that whole setting. So we really, I think, work hard and are effective at creating the sort of setting where people go into a discussion thinking, 'Okay. I've got to have it down. I've got to know it all because there's going to be people actually listening to me. They're going to actually try and ask me hard questions. And I've got to be ready for that.' And I think that creates just the right atmosphere. And at the same time, they don't go in thinking, 'Oh, I'm going to get beat up on this. And no matter what I say they're going to be all over me.'

CP: No, not at all.

RM: It just doesn't work that way here. And that would not be tolerated. And so I think, in the end, people are very good at working together, interacting together, sharing, and helping each other, through critical thinking and not just cheerleading. We do cheerleading but I like to think we're better than that. We bring a deeper understanding and a deeper level of support.

CP: You definitely do. How about the resources? We know about the people, the best people. So you have also put the best resources in their hands—this beautiful wraparound view. Several different levels I guess: the facility itself, the building itself, what's inside the building, the funding, of course, and how it all kind of ties together.

RM: Yeah. It does tie together. I'm trying to think of a way to unravel it and start at a beginning but it's so circular that's really hard to do. If there is a start, I guess it's that right from the beginning we showed a commitment to contribute to the institution, to strive very hard for success, and to make that success, to some extent at least tangible and accountable. We were successful with funding right from the start. And we showed a commitment to that. And we showed a commitment to academic scholarship. And I think that created a confidence at the university level, at various levels of the system, that we were the real deal. We were not just here to convince somebody to build a nice building for us that we could retire in, but very committed to achieving success and achieving excellence and being a home of excellence.

And I think the university, for their part, has been remarkably good at recognizing, identifying, seeking out excellence, and trying hard to support it. And that means hard choices. That means that certain programs don't get that same level of support and that the money isn't equally divided across the entities. And I think that's a smart way to build excellence. I think, ultimately, pinnacles of excellence draw everybody up with them. I think a good department can draw up a college and a good institute can be a landmark for other good institutes. Good scientists in the lab, if it's done right, can be an encouragement to other scientists. And so I think that's kind of how it all got started and how we established the credibility we needed to be taken seriously.

And then it comes down to obviously pushing. When we first started seeing designs for this building, we weren't that excited about them quite honestly. And we were told that this is some

Ideas flow out of offices and labs and continue over coffee.

kind of state standard, that there are certain room sizes that are allowed and window sizes that are allowed. And we kept pushing and saying, "Well why?" Why is that good when we know from lots of business experience that buildings are being crafted in very different ways today, that there are very effective ways to create space, and that we have to think about what it is we're trying to do here and then decide, what is the best way to create that space?

We were working in a very dark building, where the light only made it to the outer perimeter. And huge, huge parts of the building were dark and literally people had no idea what time of day it was even. We didn't really think we wanted to create Las Vegas culture in an academic setting.

CP: [laughs]

RM: And so we just said, "We need light. We need light." Light is such a part of—

CP: Natural light.

RM: Natural light. Light is such a part of this place, too. It's just so much of what the West has, the sun and light and big views. And so what are we doing hiding all those and creating barriers for those? And so we had to push very hard for just simple little things like a lot of glass, glass walls, and lighting that wasn't indirect fluorescents because nobody actually prefers that type of lighting.

CP: The labs, too, have natural light.

RM: Exactly. The labs get natural light. We thought it was actually really important that students don't feel like they're going into a dungeon every day. And so we just saw all those things as not a way of pampering anybody but of creating a productive environment and an environment where people would like to be. It's no good when the student or the professor sets up a great office at home and spends the majority of time there and only comes in when it's absolutely necessary to teach or go to a meeting or something. We wanted this to be a place where people want to come and interact. So I think we achieved that.

But it absolutely required pushing and insisting and asking hard questions, essentially using the scientific approach of saying, "What data do you have to suggest that this is the right way or the best way to do a building? It's not even clear that it's the cheapest way. So why can't we open this up and see things from a different perspective?"

Natural light was a must when designing the Warnock Engineering Building.

So when the building started to go up, one of the first things we did is we bought a whole bunch of construction hats and put them in the office and said, "Everybody should be encouraged to go over and walk around the construction site. We have the okay. We have their permission, as the future inhabitants of the building, to go walk around and look at it as it goes up. You just have to wear your hard hat and make sure you have a wallet with an ID in case somebody asks." So we did it. People would just make a point, on a regular or irregular basis, when they had a half an hour, just to wander over and see what's going on over here. How's it coming together? How does the space feel and do the rooms feel right? Do the ceilings feel right? And so it became a process much more reminiscent to what it was like building my own home [laughs] than you usually have in an institutional building. There's this crazy separation in which the planning and design people do the building. And they design it and make all the decisions. And you, as the future inhabitant, are meant to stand back and be patient and then be incredibly grateful when you move in. And that's just not how we did it.

And like I say, I actually was building my own house at the time. And so it was a very similar kind of experience of actually getting to recognize some faces. Who are the contractors who look after the lighting and the electronics? Who do we have to talk to about this and find out what we can do? Because I discovered in my own construction experience that the people building the house make the best decisions they can. But no plans are so detailed or at least if they are detailed, the detail's not there at the moment when somebody has to make a decision, whether they're going to do it one of three or four different ways. And so if somebody there with a stake and a sense of the vision is on the spot and can say, "No, no, this is actually the way I would like it," then the building will be better. And the people building it will be very happy to do it that way. The people building are not out to be lazy or cut corners or make a bad building. They want to be able to point the building out to their family and friends and say, "I worked on that."

CP: And please the client.

RM: Exactly. And please the client. So we took this very much to heart and worked pretty closely with all levels of the building planning and construction. And again, Chris and Greg especially just went to meeting after meeting after meeting after meeting during the whole phase of construction and just kept it on track and made sure that what came out was something that worked for us. And it's been incredibly gratifying on so many levels. Obviously, people walk in and it's eye-catching and right away they notice it. But then people who've been here longer say, "It's just a great building."

CP: It's comfortable.

RM: Yeah. I don't know exactly why but I just love to work here. It's just a great building to be in. And then we get people visiting from other places, who've heard about it or seen it and they want to know more because they're building something or planning something on their own campus. So we semiregularly give tours to visitors who just want to know about the building and how we came up with this idea, for example, the fact that we have these "wall talkers" on the cupboard doors in my office. "Who thought of that?"

So I think we just take that sort of combination of wanting to be innovative, wanting to be open to new ideas, and a commitment to the details, as well as the grand vision, and we implement

all those things in everything we do.

CP: And it's part of the supportive environment, too.

RM: Exactly.

CP: You've got five espresso machines. You have Ping-Pong tables. You have the best equipment people can have.

RM: Yeah, I mean, we're fortunate in that computers are cheap. And we depend on computers. So when somebody needs a new computer or there's just a problem we can't solve with the hardware we have, then we're actually in a really nice position to realistically be able to afford something better, replace things fairly often, and kind of go with the natural turnover of these devices.

My biomedical colleagues, some of them have devices they've had for 20 years and they still work great. But they were unbelievably expensive, would be unbelievably expensive to replace, literally millions of dollars to replace. And so they don't have that luxury. They have to make do with something that's 10 or 20 years old because nobody has several million to spend on replacing it.

So in a sense we're in a good position. And it's always been clear to us that even when workstations were 20 and 30 thousand dollars, it always was clear to Chris and to me that hardware should not be the barrier.

CP: It's an investment that pays off.

RM: Absolutely. You have to put the right tools in people's hands. They just can't do state-of-the-art computing without state-of-the-art computers. And so we just always worked hard with vendors, with whatever opportunities we had, to try to keep at least enough resources around. And certainly we would share them and find new ways to utilize them fully. And we continue to do that. And we continue to review. We're not a home of supercomputing per se. There have been times when we were at the larger end of computer capacity nationally. But we're nowhere close to that. But that's actually fine because that's not the type of scientific computing we do. And there are big resources available, run by the national labs and available at other institutions, that we can access for those particular situations. But it turns out, for a great deal of what we do, really high-end computing is not an essential piece. And so creating the right sort of equipment environment is actually not a big deal financially. I think it's more of an attitude thing. When you look at the bottom line, when you look at the actual cost of all these things, it's ridiculous that people have to scramble and live with old computers. There's no rationale for that.

CP: You mentioned you pay good salaries to the staff. And the staff, too, of course, support the individuals, the individual researchers, so they have a delightful environment, they have good equipment, and they have staff support, which I assume makes them more productive, which means they get more grants, too.

RM: Yeah. It all fits together. We all have homes in departments, so we discuss this with our colleagues in those departments. And one of the things we notice is that we're given a great deal more time to think about the science and the actual core ideas of the research grants we write than our colleagues, because we have a staff that provides so much amazing support for all the other pieces. It's not unusual for a grant to be, I don't know, 100, 120 pages, of which 13 pages are the actual scientific content, and the rest is other material that is more or less important and is essential to even submitting a grant. But it's enormously helpful to have people who can gather all that for you and put it into reasonable shape, whether it's a budget or the biographical information you have to collect or whatever. And so, yeah, having high-quality staff is just essential for that.

And my experience at least is that we have the best right now, that every department is respectful and sometimes envious, depending on the personalities. But they respect and appreciate that we do have an incredible staff and that it does turn into higher success rates. And we do have higher success rates. The numbers support that. We do better than most other entities, in terms of our success rates with grants. So I think the evidence is there.

And we try to be scientists. We try to evaluate the balance between the staff system we have and the number of grants we write, the number of people and all that. And we certainly tune those things. And there have been growth and reductions over the years in support staff and more importantly, an evolution of what it is they need to do. So the grants that we're writing now are very different from the grants we wrote 10 years ago. And we have to have a staff who are able and willing to move with that. We used to submit boxes full of paper. That would be unheard of today. And that means that the whole pipeline has to change. And we have to know, what are all the right technical and whatever constraints we have to live with? And the agencies constantly add new pieces to a grant application. So NIH has just required, as of a year ago, that everybody specifically address the rigor and the reproducibility of their proposed science. And if you don't have staff around who are staying on top of these requirements and can remind the PI, "Oh, by the way, there's that section now, too," or will go and get the latest documents from the NIH or NSF website and say, "Here are all the pieces you need for this proposal," then mistakes get made and grants get turned down before they're even reviewed because they don't have the right pieces. So all that has to be there. All that has to fit together.

So we identify good staff. We try to keep the ones who are effective. We send them to training. They know they're appreciated. I think one of the things that we're incredibly clear with faculty is that we cannot abuse our staff. We have to respect them. And we know their value. And I think that's what they would all say, is they feel that respect. And I know that any lack of respect or mistreatment, really never comes up but I think it would be something we would be incredibly concerned with if we got any sense from staff that faculty or students weren't respecting them.

CP: From the recent university staff awards, you're doing something right because three of the individuals are from SCI, which is pretty impressive.

RM: Yeah. We want people to be successful and recognized and satisfied.

CP: Well, I think for our next session we will talk about the future of SCI.

RM: Okay.

CP: Thank you very much.

RM: Sounds great. Thank you.

END OF INTERVIEW 1 WITH ROBERT S. MacLEOD

Robert S. MacLeod

An Interview by Christine Pickett
20 December 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3430
SCI Interview 7, Interview 2 with Robert S. MacLeod

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS DECEMBER 20TH, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING ROB MacLEOD, ASSOCIATE DIRECTOR OF THE SCI INSTITUTE, FOR THE EVERETT L. COOLEY COLLECTION.

CP: In our previous interview we discussed the early days of SCI and also some keys to the success of SCI. And so I'd like to pick up on the keys and then talk about the future of SCI. What role do you think personality has played in the success of SCI? You can go back to the early days, with your personality and Chris's, how they meshed.

RM: I think the personalities define any group. They're a key part of the whole story. And I see it in every group I've been affiliated with. SCI was a chance for Chris and me to express our personalities, in terms of how we do science, how we interact, and how we live our work. We don't really see boundaries between the two. I think that personality is what makes a place. It's very important to not try to homogenize it and not try to cover every different personality or even assume that every single personality is going to fit well in any organization. I think everybody is more comfortable finding an organization that works for them than they are living in an organization that has been so homogenized that everybody nominally fits but nobody actually fits. And so I'm sort of proud of the personality that SCI has, and I think it makes it easier in lots of ways for people who come to SCI to discover whether or not they fit. If they do fit and it resonates with them, they recognize it as home and they settle in very quickly and do very well. Similarly, if they discover, after usually a short time, that it's not really their style, then, ultimately, they're better off finding a place that is their style. Ultimately, we achieve that ideal of, to my mind at least, a working ideal, of having a place to work that is so comfortable that, while not replacing home, is sort of an extension of home. It doesn't feel like we change personalities when we go to work every day. It doesn't feel like we have to pull ourselves together to walk into the workplace every morning. Instead, we get to the workplace and see, okay, this is where I can operate. This is where I fit in. The people around me know the style. And everything just flows from there.

So I think personality in people is incredibly important. And every account you read of other organizations underscores that idea, that it's all about the people. I like to think that it's not a judgment or a quality evaluation of people but much more a fit question, a style question, a way of operating, that other organizations that operate differently from SCI can be fabulous places. I don't criticize them or envy them. I'm proud that there are other types of organizations that work, and really happy for those who find their place there and can be productive there. Diversity is what makes life interesting, and it plays out at all different levels.

And so, having a place as arguably unusual, in some regards, as SCI is just a plus for those who find it and recognize it as home. For those who need another home, I wish them the absolute best of luck in finding that.

CP: A couple traits that have come up in other interviews are the loyalty that the senior administrators here have to the staff, to the students, and to the faculty, and also the respect, mutual respect.

RM: Yeah. I think that's something we always felt was important. Chris and I, right from the start, knew that respect was going to be key. And again, we're all part of different institutions and different groups, different entities. I think it clearly is a huge benefit that we see every day here at SCI, that by showing respect and recognizing people's contributions, that they feel encouraged, they feel motivated, they contribute even more and they feel better about their contribution. And we try to reward that as much as we can. We try to create a climate in which they feel the love, so to speak. They feel that respect hopefully and know that it's real and it's consistent. It's not something we do out of obligation, as much as genuine respect. We know how it takes a varied team to put together big projects, and so there is no unimportant person in the team.

There can be a weak link in a team. That's a whole different problem and one that we have to address. I teach students how to write proposals, and one of the messages that's really hard for them to absorb—sometimes it's hard for young faculty to really appreciate—is that oftentimes projects will fail or succeed based on not the strengths of the project but the weaknesses of the project. One has to make sure there are no weaknesses. So, one can't be in denial of weak elements of an idea, of a system, of a plan, of a course I would teach as a professor. Everything matters. Every piece of it matters. The strengths have to be there, and they obviously carry a lot of the weight, but a project that has flaws will ultimately fail based on those flaws.

We have to take this very comprehensive approach, in

which everybody plays a role, everybody contributes, everybody feels like they can contribute and will be respected for that contribution. It's a philosophy that I've recently seen articulated. I wish I could say I thought it up and we knew going into this 25 years ago that it was important. But there's been a wonderful success in the British bicycle racing world, strangely enough. And it came about because of a strategy that the leaders of that competitive cycling environment decided to implement, and they called it "marginal gains". They simply said that success doesn't come from a single huge advantage, a single superstar, or a single element of a program that just overwhelms everything else. In this day and age, it's very highly competitive—and in which there are many people trying to be successful. So success really comes from a very comprehensive view and literally identifying every single aspect that can make a project work or a center work or an organization work and simply ignoring nothing, dealing with small improvements, maybe even tiny improvements, in every single aspect, and that those small improvements add up to make a group function overall just that bit better than everybody else functions.

CP: And it's a stronger foundation.

RM: Yes, it creates a strong foundation. It makes us always aware of all the pieces so things don't get forgotten. I think, by extension, people either don't get forgotten—hopefully less forgotten at least. And so, we are always aware of all the people and elements of a project, and try to work on each one of those. Respect for the people and their ambitions just comes naturally as part of that larger approach of, like I say, what they coined as marginal gains.

CP: How do you envision the future of SCI?

RM: This is a very interesting question.

CP: Big question.

RM: Yeah, it's a big question. We're all getting older. Well, some people are getting older. Some of us have actually convinced ourselves we're getting younger or at least holding our own. But, yeah, things are evolving, and things are changing.

CP: Just numbers, too.

RM: Yeah, the numbers. And even if the numbers are stable, there's turnover. I mean, for the first time this year, we have one of our senior faculty going into a phased retirement, and that's a totally new concept for us. We've never faced that before. That will bring with it challenges and opportunities, as always.

We have always tried very hard to bring in new, young faculty, to let their energy contribute to the place and let them take us into new directions. We want them to find a balance between belonging to the larger organization or vision and pursuing their individual ambitions. I think that's the success that we will continue to build on.

It will be interesting to see what form the future takes. I guess I always feel that the strength we have comes from collaboration and interaction and working together. And that will be the piece that I think I would fight hardest to preserve, even as small subgroups or good-size subgroups get organized within the larger umbrella of the institute and work specifically together in certain areas of technology or scientific application. To maintain what is important about SCI, there has to be this opportunity and drive to be constantly interacting and constantly exploring new ways to apply what we do in areas that bring us together, finding ways to

Rob MacLeod at the Cardiovascular Research and Training Institute (CVRTI), 1999.

recognize how people within SCI can contribute to a single project. That's a strength we've always managed to leverage and I think will be a key one.

The counterpart, or the other organizational structure for that, is kind of the creation of semiautonomous subgroups within the institute. I think that may serve a purpose, but there's always a risk of a little too much autonomy, a little too much separation, and missed opportunities. They can be missed, not out of malice, not out of secrecy, not out of any sort of intent, but simply by the fact that we don't have an opportunity to interact and see what each other is thinking about, learn what each other is driven by.

CP: Which is almost the definition of SCI, that spirit.

RM: It really is. Yeah, it really is.

CP: I see that.

RM: So I think preserving that spirit in whatever means we can, that'll be the challenge, to figure out new means to identify those opportunities, to have people at the leadership level who recognize connections between people who don't actually recognize those connections themselves. Oftentimes, everybody's busy down in their own respective trenches, working very hard on their own research, and don't recognize the opportunity to work together on something that will take them both that much higher.

CP: So you need the directors to continue to be matchmakers, essentially.

RM: Yeah. It's always been great that we've had senior management, leaders in the group, who've had enough time and the energy

Donbin Xiu presenting in China, 2016.

and the drive to continue to try to identify those opportunities and pursue them. We don't just tell people to get together, we try to lead best by example and are constantly participating in these kinds of collaborations that take us into strange and wonderful places. And I think that spirit is what's key to SCI. That's what, above all else, I think needs preservation, support, protection, and invigoration so that new people coming in recognize what it means to be part of an organization like this.

I remember years ago a conversation with a new faculty member who was quite concerned that being part of SCI meant we all had to use the same software. And I assured them that no, that was not the idea at all, that the relationships were formed on a whole different basis and not because we all nominally use the same software, that that's both too constrictive and restrictive and much too narrow, that the really fun things happen and the really productive things happen when there is an intellectual contribution from both sides and some sort of joint decision. The vehicles, the tools, which software we use, should be incidental in lots of regards. We shouldn't be driven by that. We should be driven by how we can find interesting challenges that leverage the sum of the capabilities that we have at SCI.

I think recognizing those opportunities is going to be most important, and making sure that those turn into tangible benefits. One is always driven by incentives. So if the incentive is stronger to be isolated and form a small group and grab what there is and hold onto it than the incentive to be more generous, to work on a cooperative basis and realize that there's actual benefit for the individuals who are part of a larger project—if we can't manage that balance properly, then we will fail. That remains the challenge.

And these ideas are challenging to scale. Obviously, when you grow to a certain size, it becomes virtually impossible to know what everybody else is doing. That's a challenge we have to deal with. We have constant discussions. We'll have another one just after the new year starts in the form of a faculty retreat. And one of the constant questions is, how big should we become? What should our collective ambition be?

CP: Chuck Hansen said he no longer knows everybody in SCI.

RM: Yeah. Oh yeah. Yes. That is very challenging. And we'll have to discover, I guess, what is the level of knowledge that has to be shared? I don't know the details of even some of my close collaborators and exactly what they do in every aspect of their work, but there's a level at which we do interact and we do know what each other is doing, and that's the level of shared interest. And as long as we can define those levels and maintain those levels, then I think we'll continue to have a healthy culture. It's like everything else; most animosity and most wars ultimately come out of ignorance.

CP: Yes. And perceived differences where none exist.

RM: Exactly. And if we really understand each other and really focus on our shared interests, the rest will sort itself out.

CP: What collaborations—you were talking about the new areas. Give me some examples of new areas where SCI might start exploring.

RM: Sure. There are some great ones out there. I mean, literally yesterday, Ross Whittaker and I met with one of the local cardiologists, a leader in treating a form of heart disease that we honestly haven't studied, even though the heart is my longstanding love in science. But there's a whole world of heart ailments that revolve around what's called heart failure. We had the head of the heart failure group from the cardiovascular medicine division down to visit yesterday and had a wonderful hour, hour and a half, just sharing ideas, them explaining what it is that drives them. What are the challenges of this particular group of patients? This is a disease that's growing at the same time that many other diseases in the domain of cardiology are actually reducing in incidence. It was, and always has been, really fun to sit down with somebody like this and then ponder how we could find a way to help each other.

CP: A whole new collaboration is born.

RM: Exactly. I was sending an email this morning to a colleague I know through an organization I belong to; we're on the same board of a group that runs a conference. And we've never actually worked scientifically together, but one of the papers that we discovered yesterday, that was important for this field of heart failure, this colleague is a coauthor on. So now I'm emailing him and saying, "Okay. We've worked together in this organizational capacity. Now it looks like we can actually do some science together." So these new projects always uncover interesting links and relationships that you can then leverage to pursue fun things.

So even in this domain that we've arguably spent a lot of time exploring, for me, 30 or 40 years now, something new can arise. The disease is not new. What's new is the interest in it. What's new are also the opportunities for new therapies. So the reason people are excited about this disease is there are new therapeutic opportunities that nobody expected. And, of course, the rush is then to optimize them, make them work for as many patients as possible, to understand their mechanisms, to understand why it works in the first place. And that's a really incredibly enthralling and exciting part of a new project. Projects and pursuits like this kind of have an arc. They have a life. And it's always fun, I think, to have a mix of projects, some that are mature and that have a certain momentum and that are moving in a good direction, and then some others that are new and may or may not pan out. There is a high risk, but they are at a really exciting phase, when there're new developments coming out almost monthly in the literature or at conferences, and it's moving very quickly, and it's very hard to keep tabs on it all, but it's very exciting to do so and try to identify opportunities where we can play a role.

So I think we'll continue to see these sorts of projects. The

brain is a whole other domain that is somewhat new for us. We're fortunate enough to have a really outstanding faculty member in the institute who's pursuing this topic. And there are just so many exciting opportunities that involve computation in the brain that I think are drawing a number of us into this new direction. And again, there are lots of exciting new science and new therapeutic opportunities, new ways to deal with a huge variety of diseases through computing.

CP: You've been working with Alzheimer's and Parkinson's.

RM: Yeah, exactly. So there are these domains that are related to motor neural diseases overall. Some of these techniques have shown some promising signs, even in depression, things that are sort of difficult to measure, and this is part of the challenge of a condition like depression. And so, this is technology, again, where we can play a role. I mean, this is always the challenge. There're lots of new medical developments all the time. Lots of other developments in other areas of science. And not all of them lend themselves to what we do here. But I think it's essential for us to be always on the lookout for ways where our approaches, our knowledge, our expertise can feed into some other emerging technology or emerging science and help facilitate it and accelerate it. And I think that's the role we've played—that's really our purpose. And so, those projects will, by definition, be coming on a constant basis, and that's a really exciting thing to still see and still participate in.

CP: And that will include, of course, national and international collaborators as well.

RM: Absolutely. Science has always been international, but what's different is that science is now internationally linked. So before it was at a frequency of maybe once a year you get together at a conference and discover what they're doing in London or Germany or South America, and now it's happening constantly. It's a daily exchange.

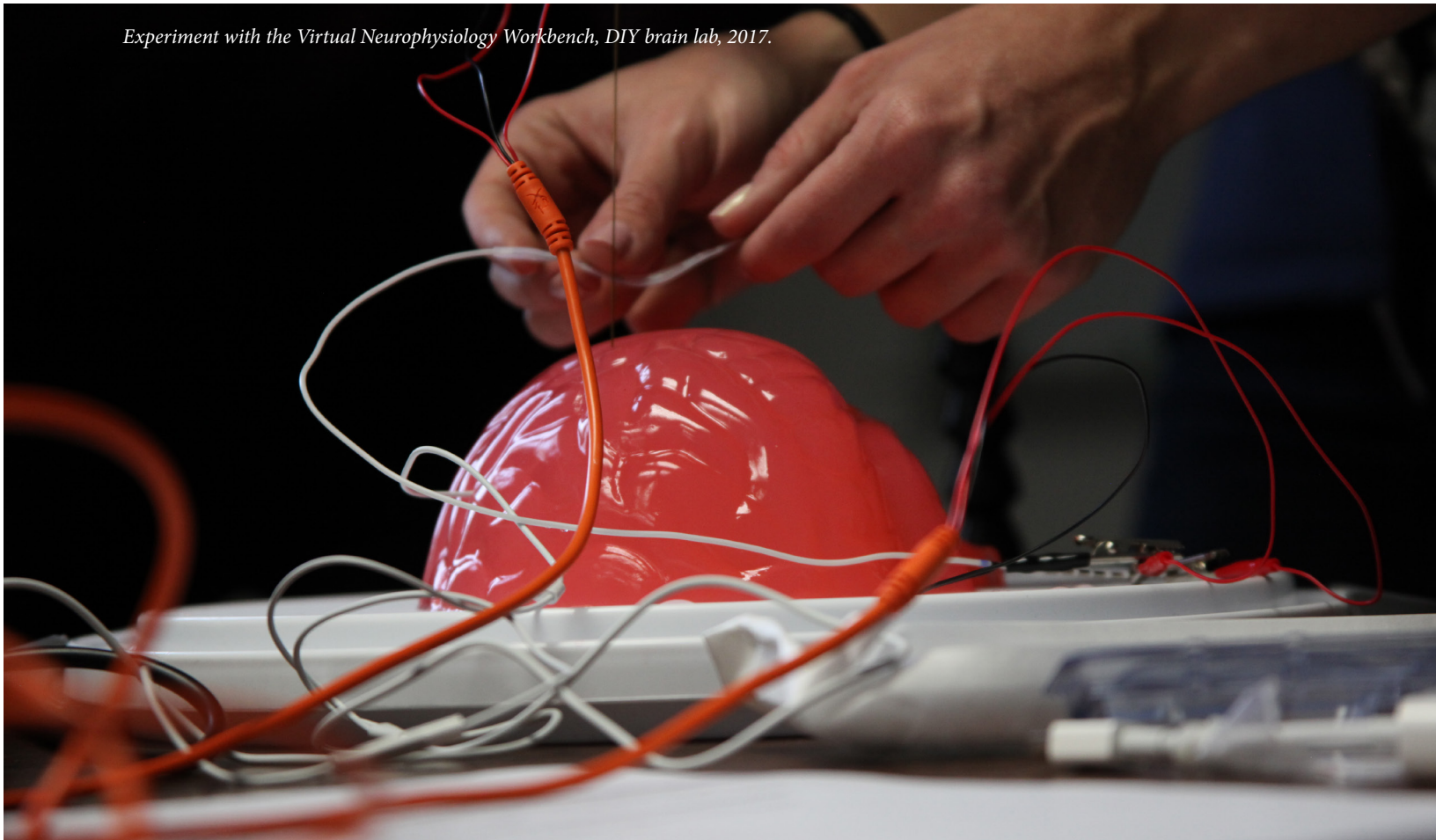
CP: Which is wonderful.

RM: It's fantastic. It's, on the one hand, overwhelming, but on the other hand, is terrific to be able to actually build momentum to seriously take on collaborative projects. You can't really collaborate when you see somebody once a year, as in the old days. Now, you can collaborate when you do see colleagues physically once a year because in between you can be having constant communication through other means. And this is what the Internet, communications, and that computer infrastructure has bought us. So lots of new projects become possible that we couldn't even have dreamt of before. That makes the whole scientific world shrink down so that every little discipline is like its own little town. And they just happen to be physically and geographically spread around the world, but it's still a small, little town. And it's great. You can get to not only know people in your little town but you can keep up with them on a regular basis, whether it's email or Facebook, all the social media tools. We really can pursue some interesting projects, so that geography doesn't matter.

And one of the other benefits is, in the world of science, that the English language has, by no real control or manipulation, become the common standard. I think perhaps this is because it is easy to learn, I don't know.

CP: It's supposed to be easy for science.

RM: It has become the dominant language in science. This is how we all communicate. And so that just facilitates the interaction; it's wonderful to see that some language has emerged. I expect whatever that language was going to be, I would've learned it—it's easy because it's happened to be English. But I've seen enormous



Experiment with the Virtual Neurophysiology Workbench, DIY brain lab, 2017.

progress, since I was a 16-year-old living in Germany, enormous progress in the linguistic abilities of the world in general. Certainly the scientific world now has simply tacitly agreed English is the easiest language for us to communicate in. Let's just all get over it and do it.

So now it's flipping around to the point where when I teach students how to write I have to remind them that it's wonderful that we have English as this common language we can all use, but we also have this incredible responsibility to make sure that our English is easily and clearly understood by a non-English-speaking majority. Because it's not a minority that we're writing to anymore. The majority of people who read our scientific output will be nonnative speakers. And again, that shifts the whole responsibility around. We're fortunate, on the one hand, but I think we have to take the lead on the other hand and say, "We're going to continue to refine and define the standards of communication for science."

CP: The responsibility of it.

RM: Yeah.

CP: One thing I admire about SCI writers is they avoid needless jargon. Lots of scientific terms that are very difficult but no jargon. And that's why you communicate.

RM: Maybe it's the fact that Chris's wife is a writer and appreciator of language. We've always had this notion that communication was important. We recognized that early on. Maybe some of it comes, too, because I spent a long time living in Europe helping scientists with their writing. I was not the translator, but I was the person who proofread everything that came out of this entire institute, when I lived in Austria. And I learned there, I think, a deep appreciation for both the challenges and the benefits of deciding on what the language should be. I also learned to appreciate the need to find simple, clear terminology and not to get lost in jargon. So I think both Chris and I brought that sensibility together.

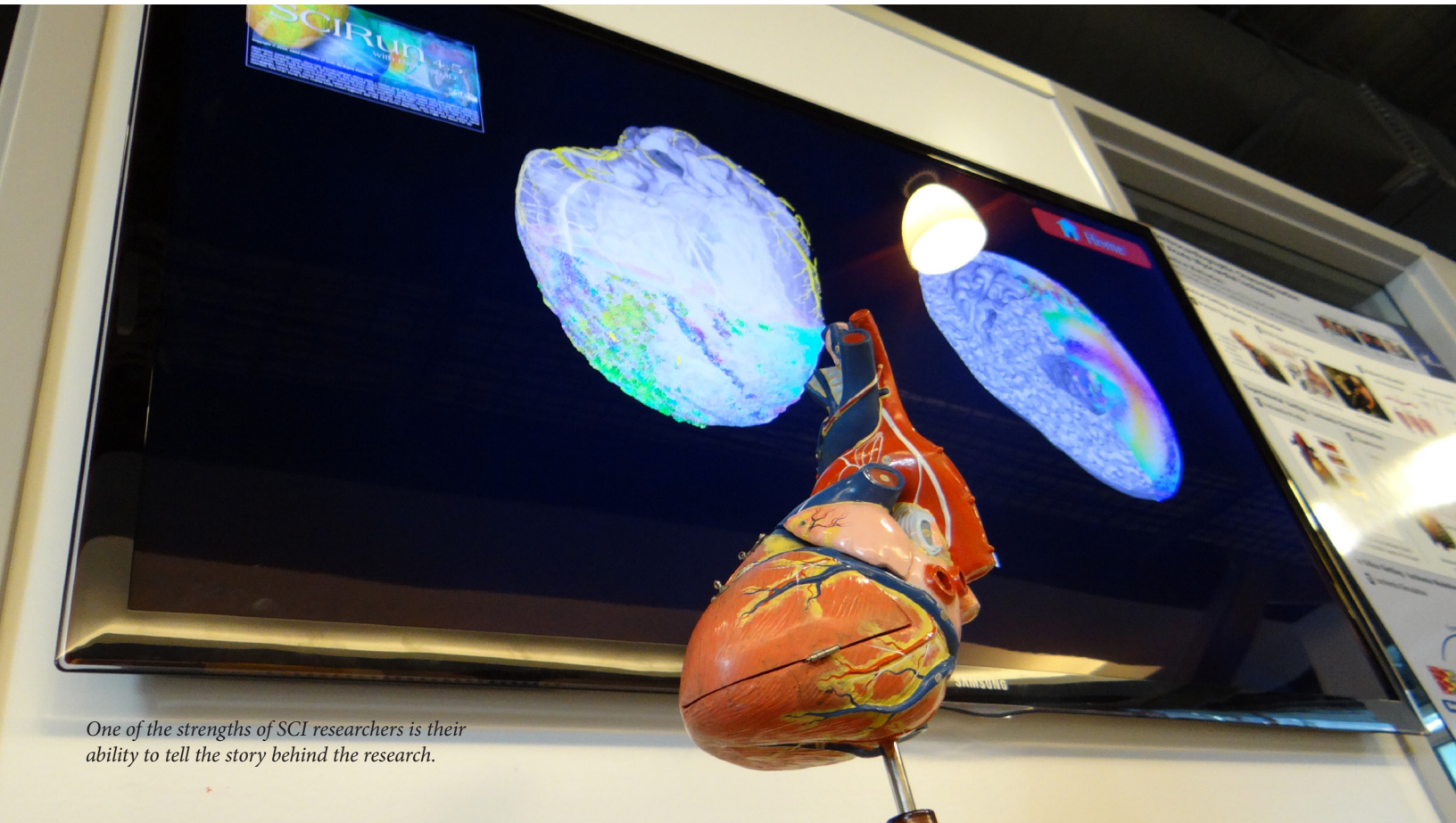
And we were also doing something that was a little weird and wonderful 25 years ago. We were living in a world full of jargon and terminology (computing) that only a small group of people actually understood.

CP: They call it "reading and quoting circles."

RM: Yeah. The impact of this technology, this computer technology, was exploding, and so the associated terminology flooded out of this small core. The challenge then became how you make this accessible. You have all this crazy computer-based technology to explain to people who want to learn. You have this great opportunity and know it's important. And so, we found ourselves in that unique position of, almost by default, being the ones whose job it was to translate these ideas, these concepts, into terms that the rest of the scientific community, if not the broader community, could appreciate. We wanted them to see, "Oh, this is why I would need some aspect of computer technology. This is what it will actually buy me. And this is what these words mean that I read in the ads or hear specialists spewing forth." So, yeah, I think we've always had that appreciation of the importance of communication and the importance of choice of language and the endless goal to simplify as much as we can get away with.

CP: Students always ask, since I'm reading as an outsider, "Am I telling a good story? Am I telling a story?" Which is really nice because that's what the reader needs is a story.

RM: Yeah. I think there's been a real resurgence—and I wish I could say that it was led by academics, but I actually think it was led more by business—to recognize that the storytelling approach is one that works in lots of arguably unusual settings. You wouldn't think when you stand up in front of a scientific audience, or even when you release a new product to a marketplace, that you're in the



One of the strengths of SCI researchers is their ability to tell the story behind the research.

mode of storyteller. But I think we've learned over the last 10 or 20 years that all humans have a natural affinity to storytelling. It's an effective means of communication.

CP: We understand it.

RM: We understand story. We understand story structure, story arc. We understand the need for that closure that comes at the end of a story. All those elements that make a great story. And I think those now have become part of the lexicon. They're part of what we now teach people. There're books written about this approach to communication. There's a whole industry that's developed around that task of taking storytelling practices and bringing them into areas of discourse that were not traditionally storytelling. Scientific discourse was seen as something much more formal than just telling a story, of course.

CP: But now it's more accessible because of it.

RM: Absolutely. Those words like "storytelling," and all the elements that are involved in it, come up more and more often in a real range of settings. And you see it in the presentations and good conferences, and I think it's terrific. I think it just makes it more accessible to everybody.

CP: What are your final thoughts about SCI? How would you like to sum it up, what this wonderful institution is?

RM: It's been such an incredible part of my life. And I guess, as with all amazing things in one's life, it becomes most clear when seen through the lens of other organizations. So I think I've learned to appreciate what we have achieved and appreciate its uniqueness more because I've also interacted with other organizations. I've literally created other scientific centers and been part of departments but also other research institutes, and that somewhat distant view, I don't know if it's created true objectivity, but it has created appreciation and made me even more committed to what we've done here and more committed to what we still have to do. I think there's a model here that I have seen work, and so this is why I'm so supportive of this whole initiative because I think understanding why it works, capturing it, describing it, making it accessible as a model to other people, not as the model for everything but at least to know that this is one way to do things, is enormously valuable. And I can only say I wish everybody as much fun and satisfaction and sense of achievement in their careers as I've had with mine. And a huge part of that has definitely been this wonderful journey that is SCI. Steve Jobs said that our work is incredibly important. I'm very loosely paraphrasing. Our working lives, our careers, are incredibly important parts of us. And we should never give up until we find the right career and the right path and the right way to fulfill that aspect of our lives. And I think that perspective is very true. I think most other aspects of life tend to fall into place if we can have a career that actually works in this setting, that doesn't drain us, that actually builds us up.

CP: In which you take joy.

RM: That's right. And that feeling is absolutely essential in order to have anything like the satisfaction that we've had. And so the point is not to go out and find another SCI or create an identical model to SCI but to find a setting in an environment and an atmosphere that works for each individual, and that's really the higher goal. And we're just one example of a couple of crazy guys thinking they could pull it off. So I don't feel like we made it happen as much as we let it happen.

Rob MacLeod explains cardiac modeling during SCIx, 2011.

CP: What a journey, huh?

RM: There's hardships, of course, but the overall plan, the overall concept, has never felt strained or it's never felt like that was hard. I think we knew, somewhat intuitively, how we were meant to operate, and we just had to figure out how we take what we started as two people and scale it up to be more people and still keep those essential elements. And I think those are the elements we've talked about throughout these conversations, and it sounds like some of the other conversations, these elements of communication and respect and enthusiasm and a certain style of operation. So I guess my highest level thought is to encourage everybody to try and do the same thing, either create their own if they can't find what they want, but never be satisfied until they've really found a setting in which they can feel very comfortable and fulfilled. There's no reason why, for most people in this life, especially professionals like us, who have the training that gives us mobility, to settle for anything less. And I think if we continue to set those high standards for ourselves, then we'll have great careers, we'll have great lives, and I think, overall, we'll make a positive impact, which is what we all want to do.

CP: Thank you so much.

RM: You're very welcome.

END OF INTERVIEW 2 WITH ROBERT S. MacLEOD

Chuck Hansen

An Interview by Christine Pickett
2 September 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3395
SCI Interview 8, Interview 1 with Chuck Hansen

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS SEPTEMBER 2, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING PROFESSOR CHUCK HANSEN, ASSOCIATE DIRECTOR OF THE SCI INSTITUTE, FOR THE EVERETT L. COOLEY COLLECTION.

CP: This Everett L. Cooley oral history project interview focuses on the unique culture of the University of Utah's Scientific Computing and Imaging Institute, or SCI. Several of the institute's key players are contributing to this discussion of SCI. As an introduction to each, we are including a brief bio.

Dr. Charles D. Hansen, associate director of SCI, the Scientific Computing and Imaging Institute at the University of Utah, is a professor in computer science, and one of the inventors of FluoRender, an interactive rendering tool designed especially for neurobiologists. He was elected to an Institute of Electrical and Electronic Engineers, or IEEE, Fellow in 2012, and received the IEEE Technical Committee on Visualization and Computer Graphics, VGTC, Technical Achievement Award in 2005. He is the recipient of five IEEE Best Paper Awards in the last decade.

Chuck has authored 16 books and book chapters, 58 articles in peer-reviewed journals, and 102 refereed papers in conference proceedings. He has been a reviewer or editor for numerous journals and conferences, served on the executive committee of both IEEE VGTC and SIGGRAPH, the Special Interest Group on Computer Graphics and Interactive Techniques, and been the co-chair for 16 conferences. He has been the advisor or committee member on dozens of master's and doctoral committees, provided service to the University of Utah on departmental, college, and campus levels through his work on various committees, and been the recipient of numerous grants, including from NASA, the Department of Energy, or DoE, the National Science Foundation, and the National Institutes of Health. Chuck's research interests include large-scale scientific visualization and computer graphics.

First, thank you very much. This will be a great contribution. Chris Johnson has told me, in some detail, the story of hiring you, his first faculty hire. What are your recollections?

CH: So it's kind of a funny story because it wasn't really planned. And that's my view. So I had known Chris for many years, and I had had several of his students down to my research group at Los Alamos National Laboratory, where I was heading a research group on visualization. One fall, Chris called me up and said, "I've got this DARPA grant. I need to hire a postdoc." My father-in-law, who lived in Ogden, had terminal cancer and my wife wanted to spend the final year of his life back in Utah. So I told Chris, "I don't know any postdocs who are looking for a job. But if you want someone more senior, I've got a reason to spend a year in Utah," and so he worked together with another faculty to come up with enough of a package to entice me to take a leave of absence from Los Alamos National Laboratory and come up.

So, I came up. The intention was to spend one year here and then go back to my research group, but when I came here, Chris and I started writing some different center grants. We got the first NIH Center for Bioelectric Fields funded. There was a DoE center that was funded from proposals that we worked together on. When the year was up, Chris said, "We need to make you a tenure track faculty offer." I wasn't sure that's what I wanted because that wasn't planned, but I had had so much fun the year here that we never went back to New Mexico. I turned down my leave of absence and told them I was quitting. And that research group, I still interact with them. We have projects with them, but I've never looked back. It was the best move.

CP: How many years here?

CH: It was '97 when I moved here as a research professor. And I became tenure track in '98, so I've been here for 19 years now.

CP: And what year did you become the associate director?

CH: I became associate director right after the institute was formed.

CP: That's what I thought, yeah. Long time.

CH: It's been a long time. So when I was here, when I came here, Chris was faculty in computer science. I was faculty in computer science. There was the Scientific Computing and Imaging Center, which was one of the State of Utah's Center of Excellence programs. With these new national centers that we had funded from the National Institutes of Health and Department of Energy, the university said, "Why don't we form a research institute, since you're so interdisciplinary?" And that's how the SCI Institute was formed.

When it was formed, it was Chris Johnson and Rob MacLeod and myself. There were only three. Chris was the director and Rob

and I were associate directors, and the faculty, because it was pretty flat.

CP: Package deal, the three of you.

CH: That's right. I've been an associate director my entire career with the institute, but I view it as just another voice. Chris likes to have me on the executive committee because I speak my mind, and he sometimes appreciates the opposing views. It's worked out well.

CP: Well, he said that you have set the tone for all subsequent faculty. In other words, you were the standard against which all other faculty hires were measured.

Chris has defined what everybody does, certain roles. What is your specific role, in contrast, for example, to Greg and Rob?

CH: So, we don't have assigned roles as associate directors. It's more of idea generations of where the institute should go, what are the day-to-day things that come up that we have to talk about in our executive committee meetings. But there's no specific role per se, but to think about what the future of the institute is and how to help achieve that. Early on it was what areas we should hire in. It was Chris and Rob and myself deciding what growth we should have. The associate directors made all of those decisions. Now that the institute is tens of faculty, everyone has a voice, so the faculty decides more than the associate directors.

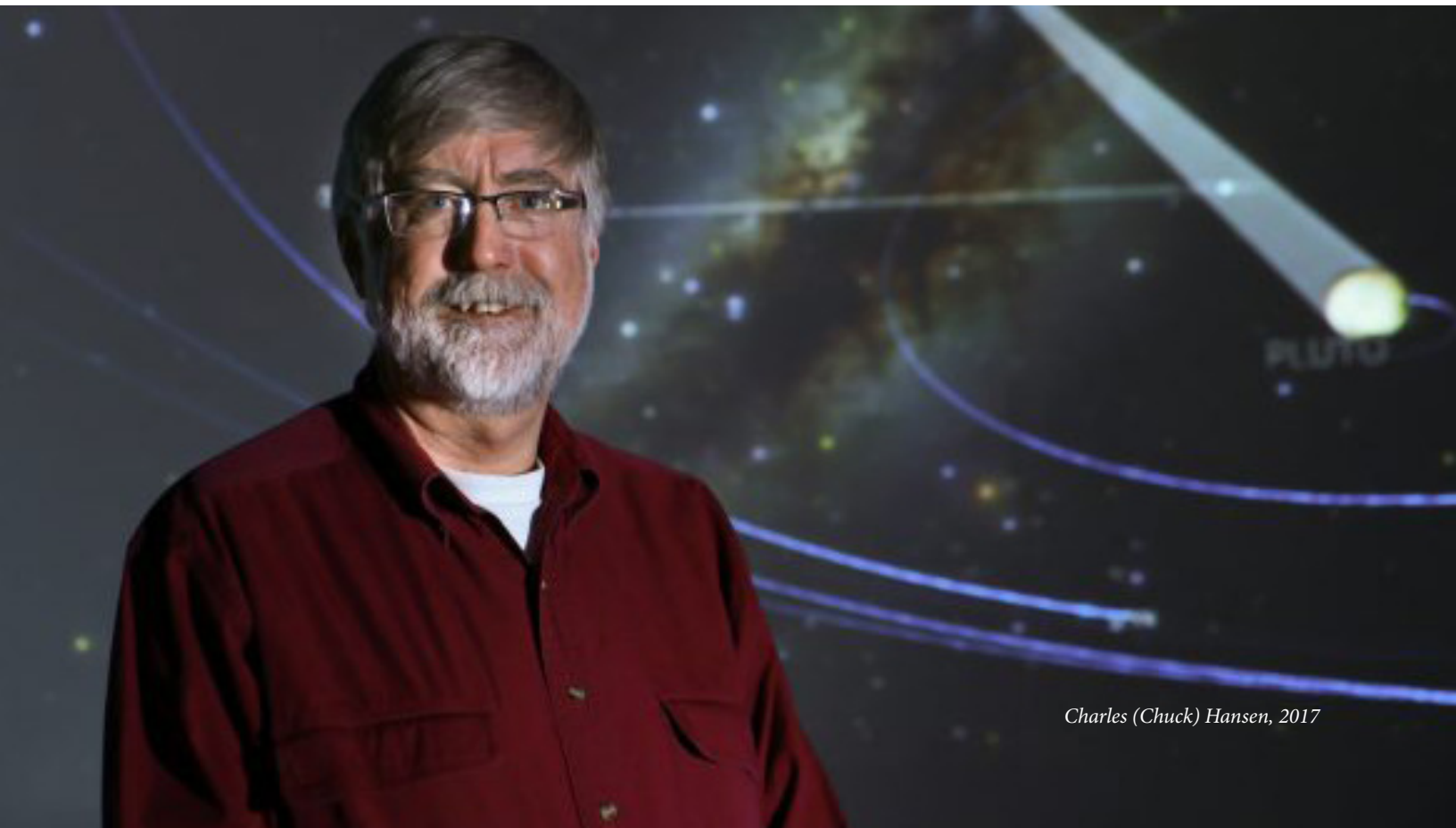
CP: Chris has mentioned that he learned, early on, a certain strategy for success, with four basic points: hire the best people, never sacrifice quality, put the best resources in the hands of the best people, and create a supportive environment. I thought it would be a good idea to use that as kind of the framework for each of the associate directors, to get different perspectives on these strategies. It seems that there's a very unique culture at SCI, and these four points contribute to that culture. So I put this question to Chris and to the associate directors. How have you gone about attracting the best people? In other words, what is SCI's recruitment strategy?

CH: Yeah, so when I joined the faculty here, it was before there was an institute, of course. I remember we were at a conference, the IEEE Visualization Conference, the fall of 1998, right after I joined the faculty, and someone asked me, "Why did you leave Los Alamos and go to Utah?" And I said, "Well, I have a goal to make the SCI group the world's best visualization group." Chris told me later that he overheard that, and it was the exact words he wanted someone to say.

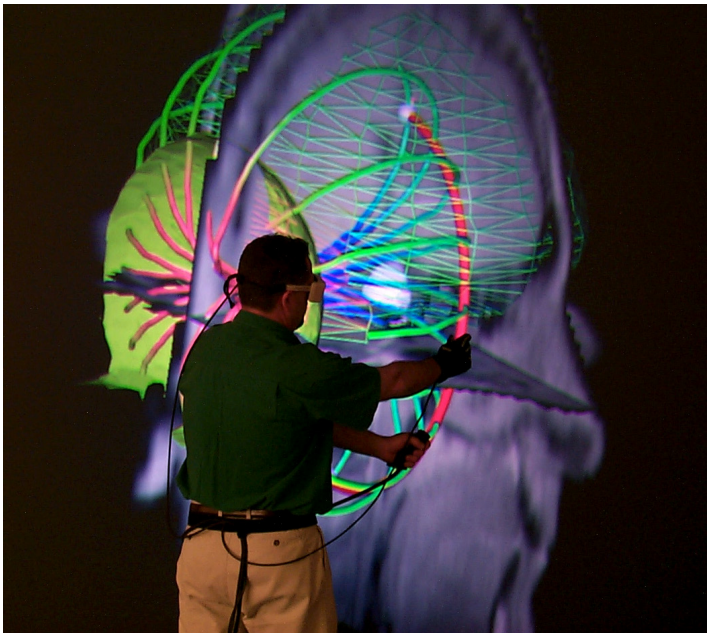
So, you know, I think that the key point is that there's a saying in the business world that type A people or grade A people hire other grade A people, and grade B people hire grade C people. The goal is to always try to hire people that you think are smarter than yourself, and then you surround yourself with super high quality. I think that every hire that we've made has exemplified that.

The institute is this unique, interdisciplinary group, and it always has been: with Rob MacLeod from bioengineering; Chris, who really has a background in physics but is a computer science professor; myself, who was trained in computer science, and that's really my field. It was interdisciplinary to begin with. Very collaborative. Everyone worked with everybody else, it seemed, at least in the beginning when we were smaller. We worked on proposals together. We worked on research projects together. We guided students together. We published results together. There're not a lot of places that have that interactivity among faculty. There're no silos here of faculty members with their own group who don't talk to other groups.

We made a conscious decision, early on in the institute, not to have faculty labs, that our student space would be shared student space, so that my students in computer science would talk



Charles (Chuck) Hansen, 2017



Greg Jones (early 2000s) interacting with one of the SCI Institute's first virtual reality systems. In this image, he is interacting with the visualization of an epileptic seizure simulation.

to Rob's students in bioengineering, and there'd be this cross fertilization of ideas across field boundaries. I don't know other places that have that characteristic, so I think it's fairly unusual.

CP: That's what David Pershing says, too, that it's very rare.

CH: It's very rare. And David Pershing, when the institute was formed, was dean of the college, and helped push the institute idea through. He was the dean who hired me, in fact [laughs]. And he's moved up through the ranks.

CP: Yes. [laughs].

CH: Through the ranks, and is president now. And, you know, I've traveled the world. I have colleagues at top research groups in many different countries. I've gone and spent time in these labs, as both a postdoc at INRIA in France and also when I was in France on sabbatical leave at a different INRIA research group in France, and another sabbatical at a couple different research groups in Germany. I've been on advisory boards for schools in the UK. And they're different. They don't have the breadth of faculty working together as a group, and I think that's what makes SCI a very special place.

CP: You know, it seems that any successful company that you look at, national, international, something contributes to make it special. And SCI has accomplished that.

CH: I think SCI has. I said my goal was to make it the number one research group in the world—and I think we are. I've had colleagues from other countries tell us that they aspire to be like SCI, which is great. But it's not just that people work together, but we're all friends. Everyone's friendly, and there're no overt conflicts. Everyone's working towards the common good, and I think that that has contributed to it.

CP: I agree, coming from outside. And I landed in my dream job here. But what I first noted is the spirit of collaboration, the camaraderie, the incredible courtesy and respect everyone shows one another.

CH: You know, we've had things in the group, back when we were in the Merrill Engineering Building, before we moved into Warnock—One of our grants created a DoE Center that enabled us to purchase a large-scale computer that we used to drive a high-resolution projection wall. We had to cut the building open to get the glass in. But the lab that that was in was a very nicely designed space. Having a nice environment to work in also contributes to it, and the Warnock Building is a gorgeous building. A lot of thought went into, how do we make a space that facilitates collaboration?

So you notice, in my office, there're no whiteboards, but in the hall, outside, there are chairs, beanbags, a huge whiteboard. So when we want meetings, we can go outside in the hall and collaborate.

CP: Sit in the beanbag chairs.

CH: You're not trapped in someone's office. We wanted light to flow to the inside of the building, so all the student bullpen spaces are glass lined. There're comfortable chairs to go sit in and read if someone wants to. There are nice conference room spaces for people to have meetings in. And all that has contributed to it.

CP: And for you, your office provides, what, you said the second best view of the entire valley?

CH: I think it does. I feel blessed to have this. And not everyone agrees on everything. So you'll notice—I don't know if you've noticed this, Christine, but on the fourth floor, all the offices have acoustic tiles.

CP: I hadn't noticed that.

CH: And on the third floor there are no acoustic tiles. Because when we were designing the building, there was a discussion of, "Do we want the open space or do we want the soundproofing?"

CP: Oh, is that why it's quieter up here?

CH: And that's why it's quieter on the fourth floor.

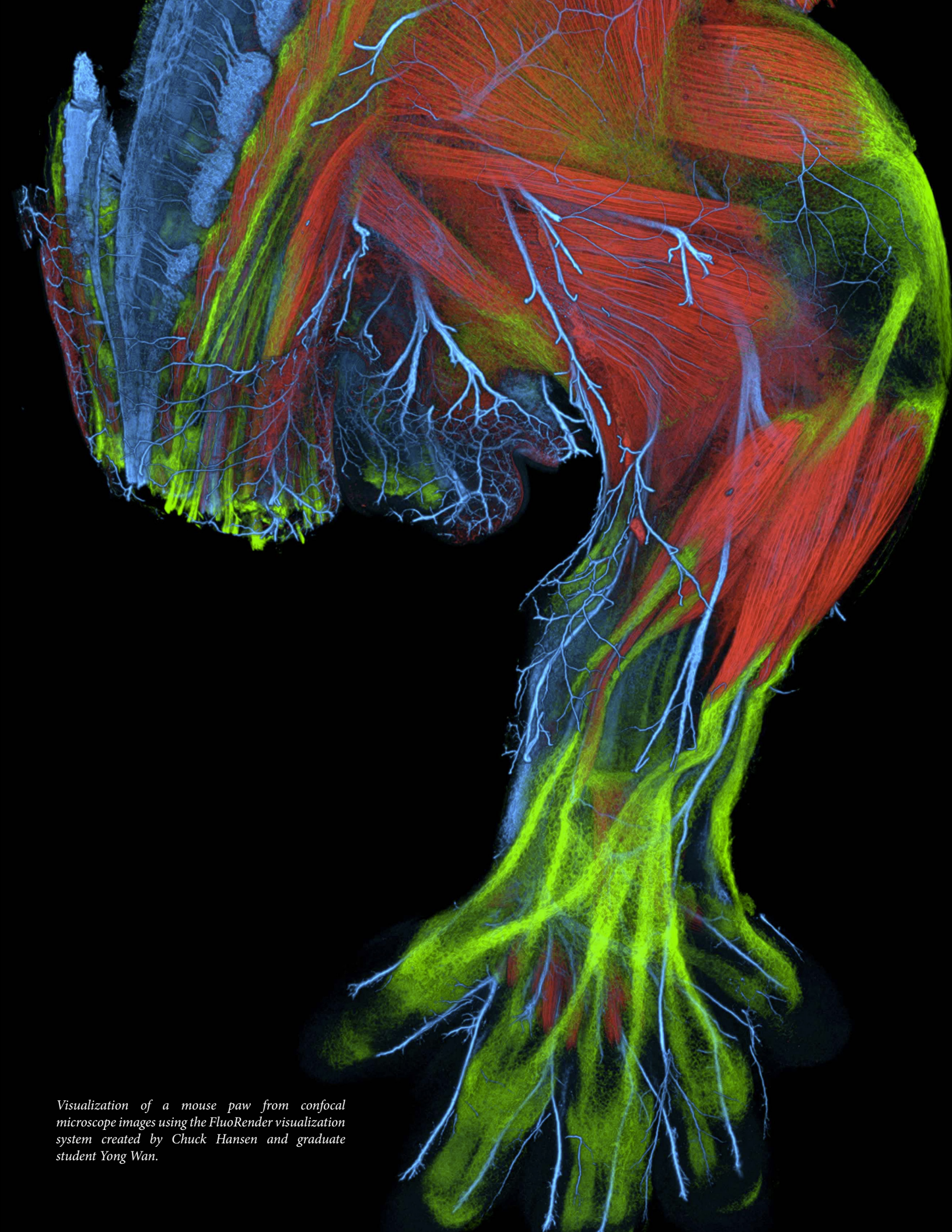
CP: Because I was in Greg's office yesterday and it's not quiet.

CH: It's very noisy. And, you know, I prefer the quiet working space. Other people, like Chris, wanted the open ceiling, the more industrial look. So we compromised and said, "One floor will be open and one's going to have acoustic tiles."

CP: Well, returning, for just a minute, to hiring the best people, will you provide me some examples of your successful recruitment strategy, either recent hires or in the past? Somebody who comes to mind.

CH: Yeah, so there was a faculty member who's left us to go to NYU, to start a center there, Claudio Silva. When Claudio was first on the job market, after doing his postdoc, he and his wife both applied here. I knew Claudio from my days at the Department of Energy because he was working with Sandia National Lab in New Mexico and I was at Los Alamos National Lab. We had similar research interests. So, we knew each other, and when he applied I said, "We really want you to come here." His wife was in databases, and I couldn't interest the computer science faculty to hire someone in databases at that point in time. I called him up and said, "Claudio, I can't solve your two-body problem, but we really want you to come." He said, "We're a package. We're moving together," so they went to the Oregon Graduate Institute.

I was at a meeting at Pacific Northwest National Labs after



Visualization of a mouse paw from confocal microscope images using the FluoRender visualization system created by Chuck Hansen and graduate student Yong Wan.

they had joined the faculty. There was a faculty member from this university, and she said, "Yeah, you know, Juliana, Claudio's wife, is this incredible researcher, but we don't know about Claudio. Is he any good?" I just said, "Oh my gosh, he's an incredible person." And I had the opposite opinion talking to the computer science faculty, that we knew Claudio was good but we really didn't know his wife. They went there for a couple years and they were not too happy. I told Claudio, "Why don't you come to Utah and join our faculty and we'll make sure Juliana's appointed as a research faculty? And once people see her and know her, they'll want to hire her." So they both came, and of course she was hired as a tenure-track faculty—and she's a star and Claudio's a star. Him being in the office next door—we were still over in the Merrill Building at that point in time—it was one of the best hires that we've made.

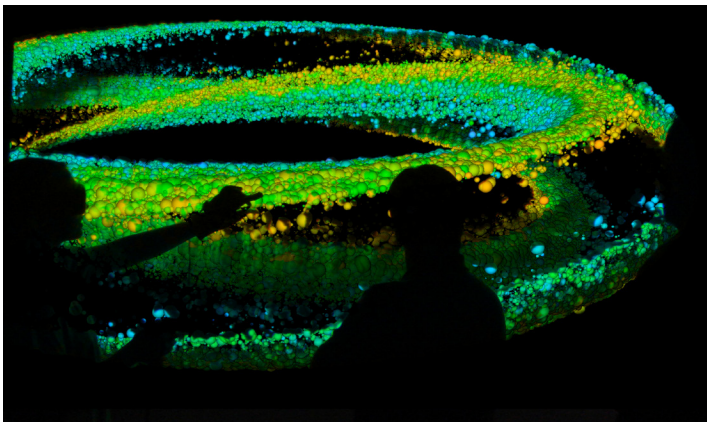
Now, he's gone on. He's left SCI to go to NYU with his wife, and formed a big research center there, which is great. But the fact that we tried to get him, he got away, then we got him back again, was really great.

CP: Yes. That's what I wanted to hear was how you achieved that. How about the recruitment of staff and graduate students?

CH: So, staff is interesting. Our staff here is really great. We have an incredible administrative staff. And our facilities, the computer administrators, are also great. Deb Zemeck, who is one of the lead administrators here, was working at Evans and Sutherland. She applied to come to work at SCI, and she was hired. The first week she was here she sent an email at midnight, and Chris said, "Look, this is the kind of administrator that we want, who is so interested that they'll work day and night." And if Chris says I set the caliber for the faculty, Deb sets the caliber for the staff. All of the staff are incredibly enthusiastic, pitch in when things have to happen. We've been lucky to have great staff.

Students are a little bit harder. We have to recruit internationally to try to get the best students. Frankly, a lot of students don't want to come to Utah because they don't know about it, and they're less inclined to go to someplace that they don't know about. But we've had really great students. I've had two Fulbright Scholars. Pascal Grosset was one and Mathias Schott was another who have applied. We looked at the materials and said, "These guys look great." Then when they came in we got them involved in research projects early, and they both excelled at being grad students.

The same is true for US students. The college brings the students out for a visit. We try to show them that Utah has a great



Visualizing a series of atomic particles that are part of a 3D simulation of magnetically confined fusion energy. Such research is essential for the development of new energy sources.

environment for doing research, for doing graduate studies. But it's an incredible environment for outside of work, with the hiking, the skiing, southern Utah, the camping, the biking. If you're an outdoors person, this is—

CP: This is the place.

CH: This is the place. I think that a combination of people who like the outdoors and like the research environment is how we attract the great students that we have.

CP: You know, it just seems that there are expectations of what a faculty member or a staff member or a student at SCI is supposed to do, to blend in, and to have these high standards, and it creates this amazing environment.

CH: No, it does. And, you know, the fact that we have several espresso machines helps because people go down—It's not an instant cup of coffee.

CP: No, that's what impressed me the most.

CH: You have to wait and so you strike up conversations with people there. There's a space for people to sit down and have lunch, rather than go back to their office. All of that contributes to this collaborative space that SCI is, and it really is a unique collaborative space.

CP: I agree. Once you have recruited the best people, whether students, staff, or faculty, how do you retain them? Specifically, faculty, though, in this case.

CH: So, you know, we have not had many faculty leave. Claudio and Juliana left. They were from Brazil. They both did their PhDs in New York, at Stony Brook. They wanted to live in the big city, and Salt Lake's not New York City. When they were given the opportunity to go to NYU, it was a great opportunity. Claudio asked me if I wanted to join them, and I just said, "No." I, myself, don't want to live in the big city. I love it here, and it's hard to imagine an environment like SCI. They found, when they went somewhere else, it's hard to have the environment, the support, campuswide, that SCI gets.

We haven't lost many faculty, so I don't think it's hard to retain them. Claudio and Juliana went. Guido Gerig followed them. Steve Parker was a faculty member who went to work for nVIDIA. He's a vice president there now and has done extremely well. But there's not a big turnover of faculty. People like the environment. I think that everyone working together, that the environment that the SCI Institute provides, is the—

CP: That's the glue.

CH: That's the glue. It's what the retainment plan is.

CP: Yes. One of the other points that I had talked about with Chris is not sacrificing quality. That must be a bit of a balancing act. How do you achieve that?

CH: You can talk to my wife and she will tell you I'm a perfectionist about everything. It's true that quality needs to be number one, and so that's the way we live our lives. Students, I think, learn that that's what's expected, and learn that that's how you are successful, so they also strive to produce nothing but quality results. I think it's just second nature to the type of people we hire. Again, we hire the best we can find. They're all world leaders. All of our faculty have just been world leaders.

When Claudio came here, he wasn't doing great at Oregon Graduate Institute. He was by himself. His wife had other people working in her research area. When he came here, his career took off. It just really accelerated and blossomed. I've seen that with every faculty member we've hired, whether they came in straight out of a postdoc or a PhD or whether they moved here from a different institution, the environment breeds success. And that's a positive thing.

CP: Absolutely. I noticed that among the graduate students, especially a lot of the international students, their dedication to learning, for example, to improve English or whatever, is amazing.

CH: It is amazing.

CP: They just keep on going until they get it.

CH: Yeah. And they understand that to be successful, that's required in the scientific world.

CP: Chris was telling me about some guy who was sleeping under his desk because he was—

CH: Yeah, Gordon.
[both laugh]

CP: Because he was working around the clock and he was just always there.

CH: Yeah, there was a short article in either *Science* or *Nature* about it. The geekosphere is what they called it.

CP: Oh, really? How funny.

CH: When we were over in Merrill, one of my students reconfigured dividing walls in a lab to build a little cave with a couch that he could sleep in. And we had the projection wall. We had a projector set up quite a ways behind it because the [projector] throw distance needed to be large to fill this large screen. And the students put a futon in there. I remember one day we were giving a demo and this shadow rises off the bed and stretches; it was one of the students. Woke up, did not realize there was a demo going on.
[both laugh]

CH: But I think students work hard, and that's to be commended. They're not forced to. We don't tell them that they have to, but they work day and night to get results.

CP: You know, I've noticed, reading all the acknowledgments in the dissertations, they all recognize what they have here.

CH: Yes, I think so. I think that they have friends or family who are at different schools, and they trade stories at conferences. They realize what a special place this is.

CP: They all comment about the support of their chair particularly, and the committee members, but also the amazing resources they have available.

So, you've already touched on the resources but I thought we might explore that in a bit more depth because the resources here are phenomenal for supporting the faculty and the students.

CH: Yes, they are.

CP: What Chris has mentioned, not just the physical resources but the fact that there is staff support for the faculty, to allow them to do what they're supposed to be doing, research-wise. So, could we discuss that a bit?

Gordon Kindlmann, 2004. This image appeared in an article in Nature *entitled "Destressing in the geekosphere."*

CH: Yeah, so the administrative staff here is the top administrative staff I think you'd find anywhere on campus. A lot of what we do is research that costs money. You have to pay students, you have to buy equipment, and cover our summer salaries. In order to do that, you have to obtain external funding, mostly government funding from the National Institutes of Health, the National Science Foundation, the Department of Energy, NASA, whatever the government agency is that's supporting the research. In order to get the funding, you have to write proposals. And both writing proposals and managing the budgets when they come back is something that takes time away from doing science. The administrative staff here is incredibly good at putting the boilerplate parts of the proposal together. They have to be trained to learn it, but once they learn it, they can do it, and we can focus on the technical contributions, which makes writing proposals easier. Then when we get funding, they help with the accounting management, which, frankly, I'm not very good at. But having the support staff to guide us there is almost a luxury. The students love our administrative staff, also. Deb keeps candy in her office. Students pop in for a candy bar when they want to. The SCI café, with the coffee machines or tea or the fridge with sodas, is something that contributes to the environment. We're not like Google or Facebook, where we feed them lunch and dinner, but we try to have perks that make them happy.

CP: It's a very comfortable environment.

CH: It's a very nice environment. So when I first came here, one of the first things I did is I told Chris, "We need to have an espresso machine."

CP: So this came from you, huh?

CH: So he and I pooled our money together and we went and bought it and put it in the lab. Students loved it. And that machine got used more than it should've been because it was just a homestyle machine. Then we upgraded to a more expensive machine when

Left to right: Professor Orly Alter meets with graduate students Katie Aiello, Nicolas Bertagnoli, and Theodore Schomay.

that one broke. Then it wound up one was not serving the needs. As the institute grew, we had to keep adding them. That environment of not only having a nice machine but having high-quality ingredients makes a difference.

CP: Oh, it's an amazing service.

CH: Yeah, so I go to different research groups. I was just in Sweden this past summer as part of this NASA project. They had espresso machines but the beans were not good. When the group wanted to go have a coffee, we walked down the block to the local café.

CP: This rivals any place in Salt Lake.

CH: Oh, it does. It's good. And, yeah, I think that summarizes SCI. Put high-quality ingredients together, you get a great product out, whether it's the coffee in the machines or the research and the professors and students, or whether it's the support staff to support everything.

CP: Yes. And, you know, the greater the productivity, the more grants, and it just all feeds back in together.

CH: Yeah. It does, yeah.

CP: And the final of the four points. This is kind of a summary question, obviously. How have you created such a supportive environment?

CH: I can't take credit for it. I don't think that I've done anything special. Chris is an amazing leader.

CP: He is.

CH: He goes out of his way to help others achieve their goals. And that's been great. I can't think that I have had the same impact. Maybe I have. I don't know. But having him as the director of the institute really has led to the success of everybody here, from the students, to the staff, to the faculty.

CP: It seems a very generous environment; the faculty are very generous with others.

CH: I think that's true. First of all, we don't have single PI research. We work as groups. Some people call it hunting in a pack, which sounds too aggressive. But we work as a group. When a junior faculty comes in, they're not on their own. They have a built-in, collaborative structure for getting their research done. We wouldn't hire someone who didn't want to work in that type of environment. I think that's what attracts such high-quality faculty to come to SCI.

CP: One of the comments that David Pershing made was, "Why doesn't everybody do this?"

CH: Yes, that's a really good question. And some people have. So I have a colleague, Tom Ertl, who runs a research group in Stuttgart. The German model is you have one professor in an area, and you'll never hire another one until he dies. They don't have this concept of an interdisciplinary group. Well, you know, Tom has visited us and has collaborated with us. He was given an offer to leave his university to head up a big industrial research center in Germany. He convinced his university to have a research group that was like SCI, where they could hire more faculty in visual computing. I can't say he modeled everything after SCI, but it's a very similar environment.

Why don't more people do it? Well, they may not have the support of the administration, which is key.

CP: That is key.

CH: And it takes a unique talent to be so generous with everybody else.

CP: I think it takes a real commitment.

CH: And not everybody does that. Typically, faculty compete with each other instead of working together. It's strange, but that's the way the academic world has been built.

CP: That's the way it operates.

CH: The fact that Dave Pershing saw that combining different departments into the same building and providing support to form a research institute at a university level has—SCI wouldn't be what SCI is without that support. SCI wouldn't be what SCI is without the leadership and generosity that Chris has provided. And it wouldn't be SCI without the collegial environment that the faculty have, the easygoing staff who are dedicated and work as hard as they do. It permeates through all the levels.

CP: I wonder if David Pershing would've continued to provide the support had SCI not become what it became.

CH: I think the answer is no.

CP: Yeah.

CH: I think it was an experiment, and it was a successful experiment. But it was clear what the expectations were, that we were to be world leaders. If we had not achieved that, I think the experiment would've failed, and the administrative support would've dissipated.

CP: He said that SCI enhances the reputation of the entire campus.

CH: I hope it does. I certainly think, within our field, we're respected throughout the world, certainly. People ask us to be on advisory boards, come and give keynote lectures at conferences or other institutes. They look to us as leaders.

CP: He mentioned a few on campus: SCI, of course, and I think the Huntsman Cancer Institute and the Hinckley Institute of Politics.

CH: Yeah. I think all of those have been stars and successful research institutes. There's more than that. There's Cardiovascular Research and Training Institute, which is very successful. The Combustion Engineering Institute, which is very successful. The Energy and Geosciences Institute. I think all of these are all great. I wouldn't single one out.

CP: No, that's true. I think you're right, though, that there is some model of competition in academia. With the great success of SCI, you'd think that that would be the model instead.

CH: I think that it's hard for other universities to break out of the mold. It takes someone with vision and leadership. And Dave Pershing helped push SCI forward, both from his time as dean, to when he became senior vice president, to continuing on as president of the university. I think that that administrative support at other institutions just doesn't exist. It puzzles me why, because if it's worked so great here, it should work somewhere else.

CP: It should.

CH: I have colleagues at other schools, I'm not going to name them, who have tried to build a SCI-like institute at their institution, and faculty fight against it tremendously.

CP: Why?

CH: That's a big question. Why would you not want your other faculty to be successful? Maybe it threatens them that their little research group would be overshadowed by a big research center. I don't know the answer to that. But it's clear to me that support has to come from all levels, both among the faculty within the institute, among the departments where the faculty are residing. Because, you know, I'm a faculty in computer science. My academic home, my tenure, is in computer science, the School of Computing. My students all get degrees from the School of Computing. My teaching is all in the School of Computing, but my research is within SCI. I think that other places… faculty fight against it. I just don't have a good answer. I don't understand why, because it's worked so well here. But it's not the typical academic model, and maybe change threatens people.

CP: So maybe that type of individual in SCI wouldn't be where they wanted to be.

CH: Yeah, I mean, probably not. Yeah.

CP: Because they wouldn't want the spirit of collaboration. They would want to be—

CH: Yeah, they'd want to be by themselves.

CP: Superstars on their own.

CH: Which is fine. There's nothing wrong with that. That's a different model. I like working with people, which is what I've always done. So from my days having a research group at Los Alamos National Lab, which, make no mistake, that's a physics lab. Physics is number one there. But working across field boundaries is what made that a great national resource. I loved my job there. I didn't leave because I didn't like it. As I said, I really wasn't planning on leaving.

CP: Here you are.
[both laugh]

CH: And SCI is a very similar environment, which is fun. It makes coming to work fun.

CP: Well, here we come to the big question. We'll see if we can get through it in this session. If not, we'll continue. But how do you envision SCI's future? You've touched on this a bit. But, say, going out five, 10 years.

CH: Yeah, so the future is hard to predict. I can predict the past pretty well.

CP: [laughs] A skill you've developed.
[both laugh]

CH: But, you know, I can't say that there's an ideal size for SCI.

CP: That's interesting. I hadn't thought of that. Yes, the size.

CH: I just don't know. When we started in 1998, with Rob and Chris and myself, would I have thought we'd have 17 faculty and over 200 people in the institute? No. I wouldn't have. I would've said, "No, that's nonsense. We'd never be that big."

I think that as we've grown, we've also grown in the research areas that we focus on, so it's not just computational medicine or visualization. By hiring Ross Whittaker, and others, like Sarang Joshi and Tom Fletcher and Tolga Tasdizen, we have probably the strongest medical imaging group west of the Mississippi. It's an incredibly strong group. Hiring Martin Berzins and Mike Kirby, we have an incredibly strong, high-performance computing group here, also. And, as we've grown, we've become leaders, not just in one field, but across many fields. What's the next big field that SCI's going to grow into? I'm not sure I could predict that. But I'll say that whomever we hire is going to be a world leader. This place will make their careers better, and they will make SCI a better institute.

CP: But you continue to develop new collaborations, right?

CH: Sure.

CP: Constantly?

CH: Constantly, and it's a lot of fun.

CP: You mentioned size. Do you think there's an optimal size? Say it grew to 700, would it change the nature of SCI?

CH: I think it used to be I knew everybody. I'd go to the coffee machines, I knew everybody's name. Now I don't. There are a lot of people, 200 people. I don't know them all. I know my students and postdocs and people in my area quite well. But it's big enough now that I don't know everyone. If it got to be 700, my question would be, would the faculty know each other?

Professor Ross Whitaker talks about geometric modeling during IBBM, 2014.

CP: And would they be able to function the way they are now?

CH: Yeah. And I think there's a limit in size, based on collaborations. And it's worked well. I think we're at a good size. I can see us growing to maybe 25 faculty, but if we became 50 faculty, well, suddenly we're—It's hard to envision that many faculty with common interests, just because there are so many. I don't think there is an optimal size. We were successful when there were three of us. We were successful when there were five. We were successful when there were 10. We're successful now, with 17 faculty. Will we be successful at 25? I would say yes. Do we have a plan to get to 25? I would say no. We're still growing. We're space limited. We're full in the Warnock Building. I think if we had to split between different buildings, it would impact the collegiality environment that SCI has just because of the proximity. I would hope that that wouldn't happen.

CP: But you can continue to develop new collaborations because that must be kind of like a process of attrition; for example, there's not the focus in a certain area and so you develop another area. Is that the way it works?

CH: Well, so, I think collaborations come from common interests. It's true, when I first came here—I don't collaborate with some of the people I did when I first started. Some of them are not even on campus. They've left. And I have new collaborations, like Gabrielle Kardon in the med school in genetics. She saw some other people using the FluoRender tool, and she got excited about it. So we started talking, and now she's a very strong collaborator. I didn't go seek her out. She didn't come seek me out. She saw something that interested her. She had interesting problems that we thought we could help with, and it grew into a good collaboration. I think that that's what makes SCI successful is the ability and the interest of working with different people on different projects.

CP: David Pershing brought up something that is a pretty scary thought: what happens if he retires or Chris retires?

CH: Yeah, so we've had this discussion at the SCI faculty retreats. We don't talk about retiring because I don't think either of them are going to do that. But we do talk about Chris getting run over by a truck, which is not something we want. But if something happened to Chris, what would happen to the institute? The plan would be, because we've discussed this, you do an international search for the next leader. It could be someone in the institute. It could be someone from a different university who could come in and lead it, but I think the institute would continue and thrive, even without Chris.

We'd have to hire someone who has the same traits. Whoever directs the SCI institute needs to have the generosity, the collegiality, the giving of support, and providing a supportive environment that Chris does. But I think the institute would live beyond that.

CP: The good news is probably all of you have that so engrained—in all the associate directors—that whoever was new would soon see…

CH: Right, yeah.

CP: I would hope that that would be the case.

CH: Right. And so I hope that Chris doesn't get run over by a truck. I know for a fact he's not going to retire in my lifetime. I'm older than he is.

CP: I'm probably older than all of you.
[both laugh]

CH: And I hope that Dave Pershing doesn't retire but—

CP: Yes, that's what I said to him. It's just not an option.

CH: Yes. Well, I'm more worried about him being poached by a bigger university that could offer something that Utah can't.

CP: He seems to love it here.

CH: He seems to love it here but I watched this through the years. Presidents seem to stay for a while, then go. And typically, they go somewhere else that gives them a different opportunity. I'm glad that Dave's risen through the ranks.

CP: He's a rare case, though. I mean, he's just gone through each of the steps. He was my boss.

CH: I didn't know that.

CP: Yes, he was the associate dean of the Graduate School, way back when.

CH: I didn't know that. Interesting.

CP: That's when I first met him.

CH: So it is rare that someone moves through the ranks on the same campus. Because, typically, they'll move through the ranks by going to a different campus.

CP: By jumping, yeah. But he's done it all here.

CH: Yes, and he's been great. So Dave's first graduate student, who did retire this past year, was my sister-in-law.

CP: You're kidding.

CH: No.

CP: Who?

CH: Her name is Patti Case. She had an engineering energy firm that's thriving here that she started with her brother, The ETC Group.

CP: What year did she graduate?

CH: I don't know the answer to that because when I met my wife—and I met her in '83—Patty had finished. So it was before '83. And Dave Pershing came to her retirement party.

CP: Isn't that wonderful.

CH: Yeah. It was really nice to see him there. So it's a small world.

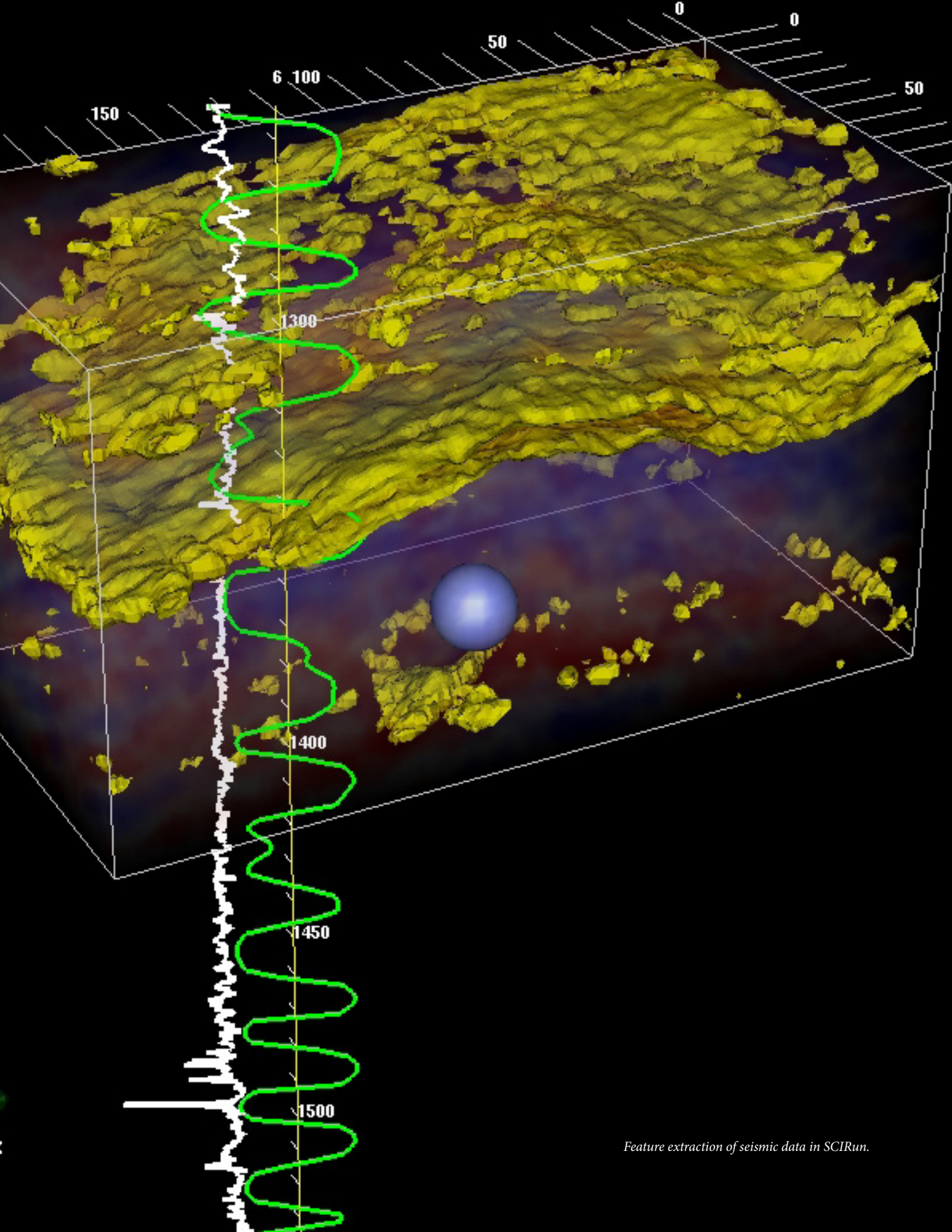
CP: It's a small world. And he's another rare individual, I think. Very generous human being.

Well, thank you so much. This has been a great addition to this project.

CH: Well, I look forward to seeing the project completed and hearing what everybody else thinks.

CP: I know. We'll get it all together. It should be fascinating.

END OF INTERVIEW 1 WITH CHUCK HANSEN



Feature extraction of seismic data in SCIRun.

Chuck Hansen

An Interview by Christine Pickett
7 November 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3395
SCI Interview 9, Interview 2 with Chuck Hansen

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS NOVEMBER 7TH, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING PROFESSOR CHUCK HANSEN, ASSOCIATE DIRECTOR OF THE SCI INSTITUTE FOR THE EVERETT L. COOLEY COLLECTION.

CP: We finished our previous interview with a discussion of the future of SCI. I'd like to explore this topic a bit more in today's interview. In a recent interview, Greg Jones mentioned the possibility of building centers within SCI. So the SCI administration would help share the load of the center administration, but the center would set its own agenda, autonomous in that respect. I'd like to get your opinion about this future for SCI.

CH: I think it really depends on what the faculty want. There are two models within SCI for these centers. And centers are focused on research topics, and they can be interdisciplinary, involving people outside of SCI. One example is Rob's CARMA Center, the arrhythmia center. That's a center that is a center by itself. It's not under SCI, but it involves SCI personnel working with them. Then there's CEDMAV, the Center for Extreme Data Management, Analysis, and Visualization, Valerio's center, that is within SCI, and uses this model Greg was talking about of having SCI administrative resources aid with the center. As it scales up above some amount, it would have its own administrative staff and work like that.

Again, I think it depends on what faculty want. If they want to build a center for their ego or for their international recognition, it's a model that works well. So the center starts out within SCI as just a research project within SCI. As it grows bigger and bigger, it becomes too big of a burden on just the SCI administrative staff, so the center would have to expand its administrative staff, but it's still under the SCI umbrella. I think it's a good model, if people want that.

CP: How many SCI faculty are in each center and how many outside collaborators?

CH: So that's a good question. I'm not sure of the makeup of the CEDMAV Center, though I'm a member of it. It involves other faculty who are within the School of Computing who are not SCI faculty. So I can't put a number on that. I think rather than thinking of numbers of people it's easier to think about topics.

The CEDMAV Center is for large-scale data analysis and visualization and data management. Valerio and I have a grant through DoE to work on in situ visualization for some next-generation scientific computing languages. That grant is through the center because it fits within the center profile. Then, there are other grants that we have that are not part of the center because they don't fit within the center profile. So it's really topic bound.

CP: Topic driven.

CH: Yeah.

CP: Do you have, not just collaborators on campus, but do you have international collaborators with it, too?

CH: With this center I don't. Valerio likely does, but I don't.

CP: But there is that potential.

CH: There is that potential. But we have international collaborators on other projects. We have this nice NASA project that's funded with the American Museum of Natural History that involves Anders Ynnerman's group in Sweden. But that's not part of the center; it's just a project.

CP: Are there any centers that you and the SCI administration are thinking about for the future?

CH: Again, it's driven by research interests of faculty. I don't know of any that are in the works. And it's not a top-down thing, where the SCI administration says, "We should have a center in X," and then encourage someone to found it. It's really driven by faculty interests, and how big of a group they want to have. Because a center implies that it's bigger than just collaborative research. Some people want to have a really large group that is bigger than smaller projects, and for that, centers make perfect sense. As SCI grows, with the number of people, I could see that there could be more centers that are formed.

CP: That seems to be the logic behind it, as SCI grows a way of kind of dividing things up.

CH: Well, it gives people the chance to develop their own career, and to lead a larger effort within SCI, instead of competing with SCI, so I think that it's a good model. But it's really driven by faculty wishes. Some faculty may want that. Others may not. I don't really have an interest in forming a center. I think it would be an administrative burden that I'd just as soon avoid. But other people

think it's important for their careers and are willing to put that effort into it.

CP: Such as some of the younger faculty might regard it as a way to kind of spread their wings.

CH: Exactly. But still be within SCI. It doesn't make sense to have a competitor to SCI within the University of Utah.

CP: So this is a benefit to SCI.

CH: It's a benefit to SCI.

CP: If it's under the umbrella of SCI.

CH: Exactly. Yeah.

CP: We talked last time about retention of faculty, and so, for some, it might work.

CH: Yes. If there was no chance—if somebody's career path and goals in their research life are to head a center or an entity of research, and they don't have the possibility of doing that, then they'd have to go somewhere else, because they're not going to have another SCI. But they can do that within the SCI umbrella. The CEDMAV Center is an example that is a center within SCI, but it's a center. Valerio leads it and sets the direction for it. It's a chance that people wouldn't have to go somewhere if that's the reason that they wanted to have a center, and the opportunity exists that they can.

CP: So that center is self-administered, still under SCI.

CH: It would still be within SCI. As a center would grow, it would become a burden if the SCI administration handled all of the center things. It would just overwhelm the SCI administrative staff. That wouldn't be fair to them or fair to the rest of SCI. So, as a center grows, they would start adding their own administrative staff. They'd all be SCI staff members, all within SCI, but they'd be focused on working on that center. We haven't seen that take place yet, where a center has its own administrative staff. They currently share the administrative staff within SCI. But I could see, as the center grew, it could outgrow the capabilities of the staff, and then they would have to add their own.

CP: So we were talking last time about maximum numbers at SCI. But maybe this is a way to counteract some of the problems that if you try to keep SCI as it is but the numbers kept on growing, maybe centers would—

CH: It's a model. I don't think it's the only model. I can see SCI doubling its faculty size and still being the Scientific and Imaging Institute. I don't think that necessarily centers are a requirement for growth. I think that, really, they're driven by faculty interest. And as you have said, if somebody wants to have a center and there's no opportunity here for it, then that's a negative. And having the ability, if there is an interest to have a center, is a positive. I think that it's a model for growth but it's not the model for growth.

CP: Right. That makes sense. And Greg mentioned it would retain the open, collaborative environment that SCI has.

CH: It does. And faculty can participate in center activities and participate in other SCI activities that are not part of the center. That certainly is going on now. And there's no competition, no bad feelings about it. It's just the natural flow of research.

CP: Well, this seems like a perfect opportunity, while we're meeting, for any summing up about the culture of SCI from you.

SCI associate director Chuck Hansen joined the then Center for Scientific Computing and Imaging in 1997.

CH: So SCI is a place where everyone gets along. It's rare to find an environment where there's such collegiality. There's not a competition among faculty. There are not conflicts among the faculty. There is mutual respect across the board. And I think that's a unique culture.

CP: I agree. And it seems like an easy thing to do, versus the conflict.

CH: It sounds easy but—

CP: It sounds easy but, I know, a lot of work has gone into it.

CH: Yeah. And I honestly can't put my finger on what would cause that or not cause that, except personalities are really good, and we've had a great set of faculty, even those who have come and moved on, like Steve Parker and Claudio Silva and Juliana Freire. They all fit within SCI. And when they left, they left on good terms.

CP: Yes. Thank you very much.

END OF INTERVIEW 2 WITH CHUCK HANSEN

Greg Jones

An Interview by Christine Pickett
1 September 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3390
SCI Interview 10

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS SEPTEMBER 1ST, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING GREG JONES, ASSOCIATE DIRECTOR OF THE SCI INSTITUTE AND THE UNIVERSITY OF UTAH'S ASSISTANT VICE PRESIDENT FOR RESEARCH, FOR THE EVERETT L. COOLEY COLLECTION.

CP: This Everett L. Cooley oral history project interview focuses on the unique culture of the University of Utah's Scientific Computing and Imaging Institute, or SCI. Several of the institute's key players are contributing to the discussion of SCI. As an introduction to each, we are including a brief bio.

Greg Jones, an associate director of the Scientific Computing and Imaging Institute, is also the University of Utah's assistant vice president for Research, and an adjunct assistant professor of radiology in the School of Medicine at the U. He served as state science advisor to Utah governor Jon M. Huntsman from 2005 to 2007, the director of the Utah Economic Clusters Initiative and the managing director of the Governor's Office of Economic Development (GOED), also in the same years, and the executive director of research at the Moran Eye Center from 2007 to 2011. He was awarded the Medal for Science and Technology by Governor Huntsman in 2007. Greg's activities at SCI include management of several research centers, the development of external funding sources, and oversight of SCI's accounting group, information technology group, and members of the media development team.

First, thank you very much for contributing to the discussion of SCI.

GJ: Certainly.

CP: Chris Johnson has commented frequently on the crucial role you play in the daily functioning of SCI. As one of the associate directors, what is your particular role or roles in the institute, and how long have you been in this position?

GJ: If you equated this position to something in industry, you would call it the operations officer. So operations in SCI is the fundamental role of the associate director, and that includes accounting, payroll, finance, pre- and post-grant award management, grant preparation, IT, software development, and of course the media and the outreach. Those operations, the daily grind of the SCI Institute, that's really my role, to manage that.

CP: And you have an MBA, right?

GJ: I have an MBA, yeah. Now, that management at SCI is really a foundation of the SCI culture. I say that my job is probably the easiest job in SCI to do because I have an expert set of staff members. Erica Adamson's our accounting lead. She has a master's degree in accounting. She's just about finished with her CPA. She knows university accounting like almost no one else, and so when I say I manage accounting, Erica tells me what she needs to do her job as an expert, and I supply those resources. So I don't have to direct accounting, I just have to resource the accounting.

The same thing is in payroll and personnel with Magali Coburn, the same thing with Nathan Galli in media, the same thing with Nick Rathke in IT. If someone needed me to do any IT for them whatsoever, they might as well use an abacus, but if Nick needs a resource to do IT, he's an expert and I empower that expert with the resource. That's my job, empowering the staff to do their jobs.

CP: That's a really important thing we're talking about, too: the support of the excellent staff.

GJ: And each staff member realizes they're an island. The accounting expert, Erica, is our accounting expert. There's no one in our group who is going to help her answer an accounting question, so she has to tell me what she needs to be able to answer every accounting question as the expert. Each person in our group—pre-award, grant management, IT—knows they're an island in SCI, and they are the true experts and there's no backup for them.

When we bring new people into SCI, our hardest conversation is saying, "By the way, the pressure of your position, the pressure on your expertise, to be the expert, is unlike other places." It takes them a good solid six months to a year to come up to speed to the level of expectation SCI has for its administration, so that's my job.

CP: You've also mentioned your support of the research that goes on here as one of your roles.

GJ: I'm a scientist by training. Part of what I do with Chris is we look at ways to reach the ideal of SCI, which is to be greater than the sum of the parts. The way we do that is with, hopefully, building a grander vision, a grander impact statement than we would do as single researchers. A lot of times what that means is asking the re-

searcher, the faculty member, to expand their vision of what they're doing, and where it could impact, and what it's about, and who they could work with to do it, and how much larger a vision they could have by working with another person or persons.

Now, in the early days, as a small group, we did that as a group. That culture has built to where you don't actually have to go to the researchers and say, "What's your vision? What's your impact?" That's the way SCI has been built, is to think that way. That's through Chris's leadership. I help enable that leadership or actuate that leadership. And again, it takes faculty members I'd say two to three years to become a SCI faculty member as they start realizing that this is the view of SCI.

CP: Understanding the culture.

GJ: Understanding the culture, and the crazy effort it demands to view a bigger vision and such a tough transition period. So this isn't about tenure. It's not about getting research grants. It's about doing something with those things, that's part of it, but something larger, and that's a frame shift oftentimes.

Now that SCI has developed that culture over the years, my job is really about how do I help resource or enable that culture, and how do I sit with faculty members or provide opportunity for them at times? Most of them provide their own opportunity, but occasionally I bring in groups with ideas that would use a SCI Institute line of research to broaden that idea, broaden the research. And making those opportunities available through meeting other researchers, corporate collaborators, whatever, anything I can do to help researchers see a larger vision of their research.

CP: So enhancing the collaborations.

GJ: Yeah, and it's just feeding into that culture, and the faculty drive that culture. Chris's leadership created that culture. And my job, just like with the staff, is to enable that culture to really realize itself.

CP: How long have you been doing it?

GJ: I joined SCI in 2000. I don't remember how many people we were, probably about 35 to 40 at the time.

CP: And it's over 200 now, right?

GJ: It's over 200. And, yeah, the faculty members have increased by quite a few. I left in 2005 to go work in the state for a couple years and then came back in around I think 2009-ish, 2008, 2009. I came back part-time, and sharing with the Moran Eye Center and SCI, and then finally came back full-time in 2011.

CP: Chris Johnson has discussed a strategy for success that he learned, early on, of four basic points: hire the best people, never sacrifice quality, put the best resources in the hands of the best people, and create a supportive environment. I'm thinking that perhaps we can frame our discussion today of the culture of SCI in terms of these four points. I put this question to Chris and now to you: How have you gone about attracting the best people? In other words, what is your basic recruitment strategy?

GJ: Faculty-wise, that's the easiest recruitment there is, right? We got lucky in the early days and recruited excellent faculty, start-

Greg Jones, 2016.

ing with Chris, building the mission, and then Rob MacLeod and Chuck Hansen and Ross Whitaker. These are all leaders in their fields. So recruiting faculty to work with—great faculty—it's really the faculty who do the recruiting, the faculty and their reputation. And people want to work with these folks, so the recruiting is easy. The State of Utah is a beautiful place to live. The University of Utah is a great university. Getting people interested in coming here to work with the faculty in SCI is the easy part of recruiting. Identifying the people we want to recruit and that we go after is the difficult part.

For a typical faculty recruitment, you say, "We need an assistant professor in this area. Let's put an ad out. We get 20 applications and we pick the best out of those 20." This is not the way SCI recruits. SCI says, "We have a faculty position. Let's see who's out there whom we collaborate with and we know their reputation, we have friends who have worked with them, we've worked with them. We want that person." And then we go recruit that person, and so it's a different recruitment strategy. It's very specific. We define areas relatively narrowly that we want to fill that SCI can leverage and that position can leverage SCI. The hardest part of our recruitment is finding the person to recruit.

CP: Will you give me a couple of examples of successful recent recruitments, recent or in the early days, too?

GJ: Yeah. So I think one of my favorite recruitments was a young PhD student who came out from Brown University and started working with some of our visualization crew. And that young faculty member turned out to be extraordinarily sharp and very collaborative. Remember, this is a PhD student, so not a postdoc who had built a nice body of research, but wasn't a star yet by any means.

CP: Who was it?

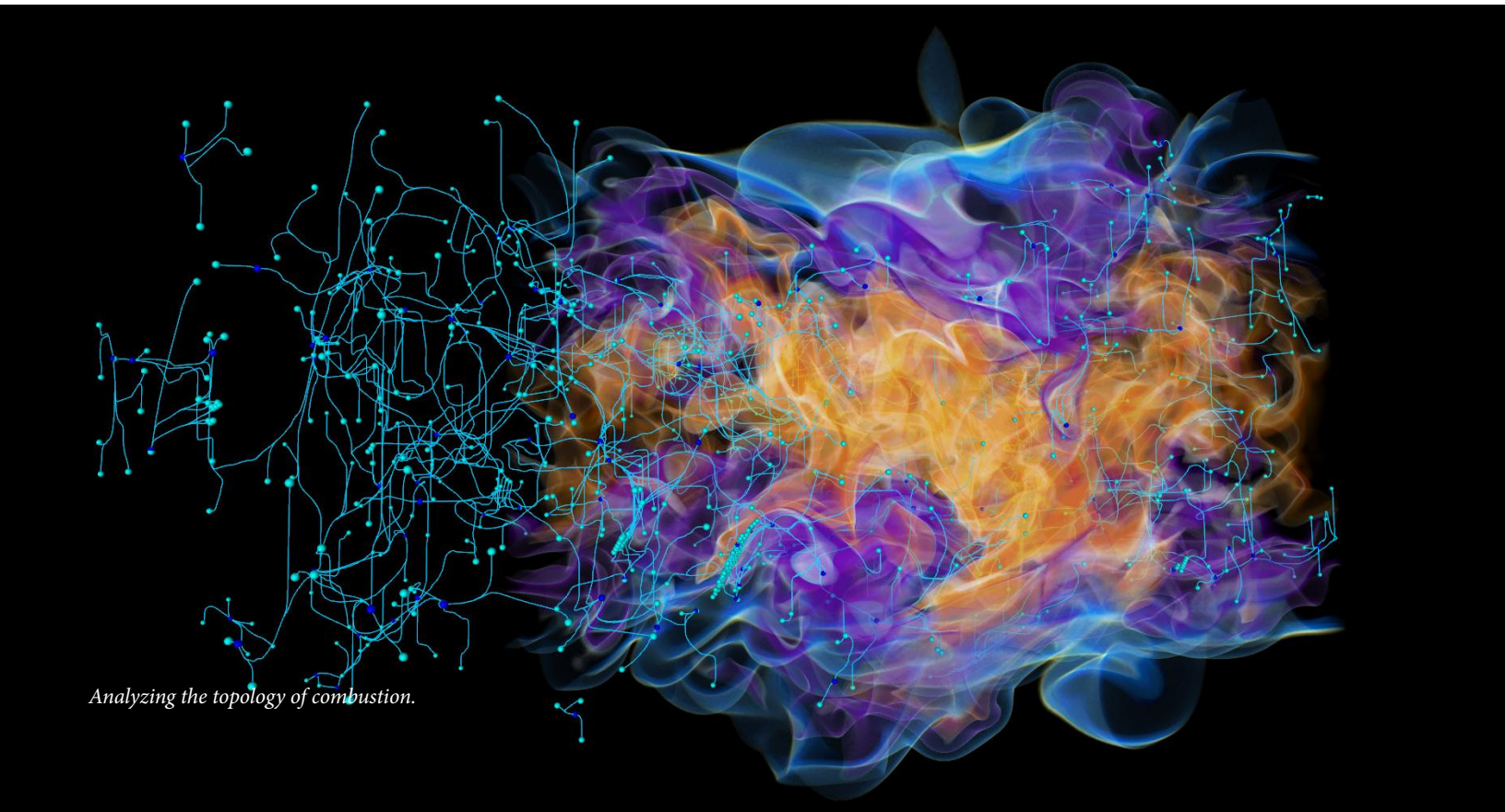
GJ: This was Mike Kirby. Mike Kirby's the assistant director of the School of Computing now. He's a full professor. But we started recruiting him two years before he graduated. He collaborated with us, came from an excellent group, so we knew his pedigree was good, but just a super sharp young guy and phenomenal collaborator, working with one of our research scientists. The research scientist said, "Man, this guy's really sharp." We started paying attention. And he was a faculty recruit to the SCI Institute. That's a great example of how we do it.

Another two examples are Chris Butson and Miriah Meyer, two different trajectories. They came up as graduate students in the SCI Institute. I actually sat on Chris Butson's committee. And he's really creative. Chris, from the very get-go, had an exact project he wanted to complete in mind. We all said, "That may not be possible." He did it anyway. Then he started chasing his career at Cleveland Clinic as a postdoc and in Wisconsin as faculty, and really making great strides. We've known him for 10 plus, 15 years or so. Easy recruitment. Once he came up on the market, we'd been watching where he's been the whole time, recruited him right away.

Miriah Meyer, same thing, we watched her through her time with the *Chicago Sun Tribune*. She did a stint with that. Then she went to Harvard. And watching her, when it was time for her to jump to a faculty position, we made sure we were heavy in the competition to get her here.

Steve Parker, another great example. He was a graduate student here at the University of Utah, and then did his postdoc here, research professor, and then assistant professor. To be able to stay at one institution and do all those steps in your academic career is extremely rare. To do your PhD and then get recruited back to be faculty is not common.

So ignoring the standards of academia and recruiting the best people resulted in Miriah Meyer, Chris Butson, and Steve Parker. Steve Parker's now in senior leadership at nVIDIA, and created things like SCIRun and the Real-Time Ray Tracer and the software architecture supporting CSAFE (Center for the Simulation of Accidental Fires and Explosions—a large DoE project). Those people, even though their pedigree wasn't the normal pedigree of go some-



Analyzing the topology of combustion.

where, do your postdoc, go somewhere, do your graduate school, blah blah blah—and Steve coming up all the way through the ranks and never having to leave—for each of those recruits, to have that kind of a not typical pathway, Chris went to bat and forded the waters to make sure they could get promoted within here, or recruited back here, or championed them. Once Chris decides that's a great person to be at SCI, it's just at all lengths to get that person into SCI.

CP: So that's how you get the best people.

GJ: Absolutely.

CP: How about the recruitment of staff and graduate students?

GJ: Yeah, that's one of the hardest things, because we fight for graduate students with MIT and Stanford and all the big boys, and those are tough battles to win. We do a lot of recruitment at the meetings, the VIS meetings, the supercomputing meeting. We take a booth to those meetings. We're not a university. We go as the SCI Institute at the University of Utah, so the SCI Institute is recruiting graduate students. Then we have to work with the departments to get those graduate students in through their recruitment process, and so that's a really tough area.

We do a yearly retreat. We arranged for Ken Joy from UC Davis, who has had an amazing run of graduate students, to talk at a SCI retreat. He's one of our advisory board members for our NIH Center. I was asking him, "How have you ended up having such good graduate students?" And he said, "Oh, I have a whole methodology." When he announced his retirement, I said, "Hey, now that you're retiring, would you come to our faculty retreat and lecture on your methodology for recruiting graduate students?"

CP: And what is that methodology?

GJ: That methodology is a really hands-on, high touch with the graduate students. He recognizes them. He talks to professors before, like at the IEEE Visualization Conference (VIS): "Hey, good professor friends of mine, what are your top students? Are they coming to VIS? If they are, I want to meet them. And I want to send them a letter telling them about my lab." So it's an early and often kind of recruitment of the best students that his colleagues have.

We haven't quite engaged that methodology, but that's how we kind of think about graduate students: what are we going to do different from just be a good university? How do we use the SCI brand and what do we do as a way to reach those students sooner? That's something we're contemplating, and we just haven't enacted it yet—but we're getting there.

CP: Well, you have an excellent crop of graduate students.

GJ: They're good. And the SCI reputation helps that. The University of Utah reputation helps that, also, and the fact that we're here in the West and it's a great place to live. We have a lot of students who want to ski and rock climb and mountain bike.

CP: I've heard from several of your graduate students what a great environment it is.

How about staff? Do you do any active recruitment?

GJ: We do active recruitment. We've even used recruiters for some of our software developers. And for the other staff positions, we're a pretty small staff. I think we're maybe 15 total. Our turnover is really, really limited. We haven't had to do much recruiting. In fact, over the last couple years, most of the recruits would come through my office. I would interview them, and that was the primary decision process. What we've done over the last two or three years, as the staff has gotten more senior and such, is they are now interviewing and hiring people under them. That's a new trend for us.

At the opening of the Warnock Engineering Building, left to right: Pat Tresco, Rob MacLeod, Martin Berzins, Mike Kirby, and Chuck Hansen, 2007.

What we focus on, in the interviewing process, is really the question of making sure the candidate doesn't just try to get the job but tries to tell us if the job fits them. So we really emphasize with the candidate, "Don't sell us on you. Look at the job. We'll describe the job. Explore with us how you fit into that job. And then you can decide if this is the right job. And then we'll decide also if we think it's the right job for you. But don't just get the job."

We try very hard, early on in the interview process, to describe the culture of SCI and how the first six months for a new employee in SCI are really, really difficult. Really difficult.

CP: This is all so familiar. I mean, that's my process here. It's been wonderful.

GJ: Yeah. We don't have a really solid infrastructure for a new employee to understand. It's an amalgam.

CP: It is the fit. Understanding the culture and fitting in.

GJ: Yeah. Enveloping into that culture. And it takes months. We try to describe that to people, that your first six months here won't be that fun.

CP: They're hard.

GJ: They're really hard, but we will support you and try to make sure you have every opportunity to fit. And once you're in, you're SCI family. But it's not for everybody.

CP: No, I can imagine.

GJ: So our interview process is we think this person's good. We think they'll fit our culture. We think they can develop the skills to be an expert in an area we're hiring in. And then we're patient. And patience is a very funny thing. The faculty are not patient, so we have to be patient for the faculty. There's a lot of defense of new staff members that goes on for the first nine months to year, of the staff members—

CP: Oh, really?

GJ: Oh, absolutely. "This staff member's not delivering. I don't think he or she is going to work out." "Hold on. We're working with them." "We think you guys—maybe you're too gentle and we need to decide faster." "Hold on, respect the person will get there. If we hold the person three months too long and they really still don't work out, we'll feel better about making that judgment call than if we do it too soon." That's a negotiation we have, relatively unsuccessfully with faculty.

CP: [laughs]

GJ: I think if you ask any faculty member, I tend to make the when-a-staff-member's-not-working-out call way, way, way too late in their eyes. I've really tried to map the way we treat staff and such to the way Chris works. One of the things—and we'll get into this with Chris's personality—but one of the fundamental pieces of Chris is his loyalty to people he works with. He's extraordinarily loyal. It's probably misplaced loyalty. It's probably too much. But I want that loyalty that has been so successful in building the faculty that SCI has to trickle down to the staff.

So before we cut a staff member for not working out, we go to the limits to figure out how we can make this work.

CP: It probably pays off, too.

GJ: I think it does. I think it does.

CP: I agree. Because then you get loyal employees.

GJ: You get loyal employees.

CP: It goes both directions.

GJ: And we have multiple deals. We have a couple employees who work from home on Fridays because they have certain family things. The way we look at that is we don't care where you work from. We don't care when you work. We just need the work. And so, yeah, we try to find good people and then we're loyal to those good people and we make their job as pleasant as we possibly can, as long as we can pressure them until they almost can't think of anything else but SCI. It's an evil trade. We'll give you a great job, but we'll take every ounce of energy you can possibly give us.

CP: I think it's a great tradeoff myself. [laughs]

Anyway, once you have attracted the best people, how do you retain them? This is the crux of the matter, isn't it?

GJ: This is the crux of the matter. So software developers, we try to give them interesting projects that they have a lot of self-determination on what they do. On a technical level, if you look at our technical teams, faculty, graduate students, staff, it's not really clear who's who. Any person in a meeting may lead at any given time. We try to take that kind of hierarchy out and just do it as multidisciplinary teams. The staff members aren't just code monkeys that go code. They're part of the science exploration. They're part of what we're doing. Staff, the same way. We're a flat organization. We don't have a lot of bosses because we have a lot of experts, and experts don't need bosses, they just need resources. The main retention we use is respect. And when you're going down a trail with a horse, you give the horse its head. Everybody in SCI has their head. They get to make decisions on their day and how they handle their day and what they do and the way they do their job.

And our job, as management, is to simply tell them where we're heading, and then supply resources so they can achieve their job in that direction we're going. I think culture retains the people more than anything. We may pay a little bit more aggressively in our staff positions than the rest of campus. That helps. But money has never kept somebody.

CP: No, I don't think so.

GJ: I think it's culture. The more aggressive pay is just an expression of the culture.

CP: What's been clear to me at SCI is there's a certain expectation. And if you meet it, then you're part of this environment. I think that's the motivation, too. That encourages people, I think.

GJ: People want to be part of something that's special. They want to be part of something that's unique.

CP: Yes.

GJ: And SCI's a unique place. The people who are SCI make it unique. Once you groove in with us, you're part of this. You're part of the unique culture. And we have a crazy leader in Chris. We wear T-shirts and shorts and flip-flops. It's a unique culture, and it doesn't matter how you dress. It matters your expertise and your capabilities. And that's the culture we've tried to build. Your capabilities matter.

CP: You've done so successfully. Going on to the next point. Not sacrificing quality must be a bit of a balancing act, economically and in other ways. How do you meet this goal of not sacrificing quality?

GJ: Oh, that's a great question. Occasionally we have faculty slots that stay open longer than we want because we won't just fill them. The searches take a little longer. You don't have a list of 20 to just tick down. If someone says no, then you don't just go to the next one—you start the search over. To maintain quality without unlimited funds usually means you have to give up time. Time is, I guess, our currency that we buy quality with. And then just dedication. Dedication and time are what make up the whole difference. And we are academics, so the funds aren't unlimited.

The hardest group to retain is our software developers.

CP: Oh, really?

GJ: Yeah. I was walking in downtown Salt Lake a couple months ago and I ran into one of our previous developers, who was excellent. And I said, "Oh, I haven't seen you in a few months. Who are you working for now?" And he's working for Facebook, he's a Facebook employee, making a Facebook wage, living in Salt Lake City. He's a master's-degree-level CS guy. Great developer. That's who we're competing with, so we're not even competing with the local firms. We're competing with Facebook and Google. And our last two developers who left both moved to California, one to work for Oculus Rift and one to work for another fast-growing startup. And they were both really, really good.

We acknowledge, with developers, that we're not going to get to keep many of them for 10 or 15 years. We're going to keep them for three to four years, five years maybe. I think Brigham, the last one we just lost, we had him for five years. We escalated his wage as fast as we could, given the fact that we pay on grants and such. So we can't compete with Facebook. We can't compete with Oculus Rift. But we can give them a really nice ramping experience to where they understand the top-end graphics, the top-end image processing, supercomputing. And then the companies that want that expertise strip us of those guys because they offer them a great

wage and a great new job. We just acknowledge that the way for us to maintain quality is to take developers young, get them up to speed really fast, give them challenging, exciting projects, and then help them find the next spot to go to.

CP: And that works for your workflow.

GJ: It works. It's a little bit laborious. And it's a little bit clunky.

CP: But it's a reality.

GJ: But it's the way we have to do it. Quality means time. That means we have to spend more time working with them, and training early on, and being patient in the first couple years. It's a lot like graduate students. They come in with a set of skills but we need more. And so we get a sweet spot of two to three years where they're really killing it. We train for two years, get three years of great work—and then off they go to a great job.

We see that in our scientific staff. Dave Weinstein's a great example. Dave was with us for 10 years. He did his PhD here. Then he was a technical manager for a number of years. Went to a spinout that was a SCI spinout. We lost him after those 10 years. Now he's the director of professional virtual reality for nVIDIA. He was a staff member, not a faculty member. He was a student, but eventually staff. Even watching them spinout and achieve really significant stuff is part of the way SCI works.

CP: Is faculty retention easier?

GJ: Faculty retention is to some degree easier.

CP: Oh, some degree.

GJ: Some degree. When we talk about the future of SCI, we'll touch on this. Our faculty are alpha males and females. Always being within a group may be a little too homogenous or may not have enough leadership for them. They may want to exercise more of their leadership capabilities. So we see Ross Whitaker is the School of Computing director. Mike's the assistant director. Martin Berzins was the School of Computing director. There's that style of academic leadership that's available. Sometimes they want a larger research vision, leadership. For example, Claudio Silva was a phenomenal visualization researcher. His graduate students were just uniquely talented, and he had such a good eye for recruiting graduate students.

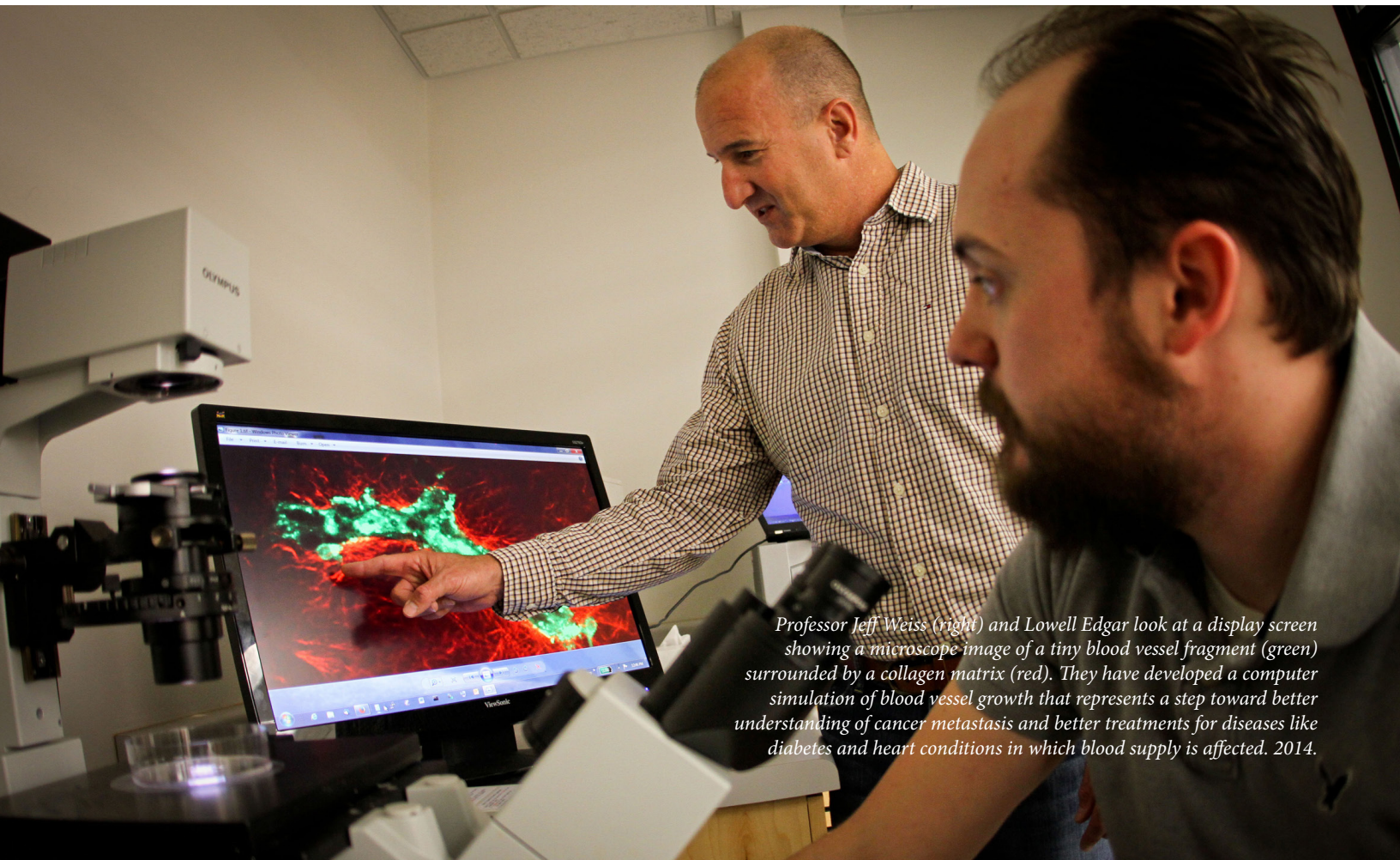
CP: And he left?

GJ: He's at New York University, with his own center. Watching Claudio leave and try and negotiate his retention and such was a lesson in, it's not just money and a great entity in the SCI Institute, but how do we enable a Claudio Silva to stay here and still be able to be a Chris Johnson? What do those mechanisms look like? That idea, as our faculty move into—we have a lot of associate professors and full professors now. And they're saying, "What am I going to do with my career when I've got these academic milestones, now I want to strike out and have a leadership piece?" How do we enable that in our institute model? How do we support that? The growth of SCI is looking down the road that way. At the same time, how do we have a succession model for Chris when he retires at 104, or whenever he retires?

CP: Yeah, that's what David Pershing says, about when he retires.

GJ: Yes, exactly.

CP: Sometime in the next 40 or 50 years.



Professor Jeff Weiss (right) and Lowell Edgar look at a display screen showing a microscope image of a tiny blood vessel fragment (green) surrounded by a collagen matrix (red). They have developed a computer simulation of blood vessel growth that represents a step toward better understanding of cancer metastasis and better treatments for diseases like diabetes and heart conditions in which blood supply is affected. 2014.

GJ: And you don't want to replace him when he retires. You want to smoothly replace him when he doesn't have the energy to be the Chris Johnson SCI needs. But you also want to be able to have him have a role that is additive and rewarding but may not have the constant travel, pressure. Succession isn't just replacing Chris, but it's how do we enable Chris to have a career that doesn't just wring him dry in the later years?

Yeah, so how do you cycle Chris Johnsons? Each faculty member here has the potential to be a leader in their own right and you have to support that piece of each faculty member.

CP: He's a rare individual, you know.

GJ: And we have 18 of those.

CP: Yes, of course.

GJ: How do you reward that personality and still keep the SCI Institute a viable entity without losing everybody? Retention is actually one of our top challenges. We just lost Dongbin. We're still wondering how we lost Dongbin to Ohio State. I mean, the offer from Ohio State was phenomenal. It's an endowed professorship. All that kind of stuff. But we have to figure that out. Because that's what we compete with. As soon as they're here at SCI and they gain enough reputation, recruiting offers come for all these faculty.

CP: Yeah, because this does enhance reputations.

GJ: Absolutely. So that's a tough one.

CP: Another tough one maybe: So now you have the best people but you need to put the best resources in their hands. How do the resources contribute to the success of SCI? Well, I mean, all the resources and computing resources, of course, but this incredible environment.

GJ: Yeah, if you look around the SCI Institute, the exposed concrete floors, the exposed ceilings, when the Warnock Engineering Building was built, these floors were planned to be institutional tile and we had dropdown subceilings. We had to realize that the graduate students we compete for, we're competing with startups for these graduate students. They want to be in the free soda, free coffee, funky building, creative environment. We actually took the architects we were working with and we toured the Pixar building in northern California and the lobby and such, and said, "We want this building and the way it works to influence how you design the floors we have in the Warnock Engineering Building." Our lobby has elements of that idea to it. That's where the exposed concrete and exposed ceilings came from.

State officials and some of the university officials were like, "We don't want exposed concrete. It's going to crack. It's not going to look as good old as it does new." We had to fight for each finish. We had to fight for the office sizes. We had to fight for everything in this building to create this unique culture. We're a unique culture and our building and our environment are going to reflect that. Championing that in the administrative and bureaucracy fields is not always that comfortable.

And for the other resources—one of the hardest things is—in 2000, a unique resource was a superfast, big, flashy SGI computer. If you bought one of those and put it in the middle of the room and let the students hack away on that thing, they did amazing things. Back then, it was really easy to recognize what the fastest, newest, coolest technology was. There were only a few companies creating these things. Now, technology's moving so fast, what is the fastest, greatest, newest technology? Is it the new nVIDIA box for deep learning? Or is it the Oculus Rift visor? Or is it a visualization table? There are so many moving parts now to resource that it's getting harder and harder, but one thing stays true: if you buy enough toys for the kids to play with, they will do things that you never imagined. And that's a running theme in SCI: do whatever you can do to get the fastest, best, newest stuff, the shiniest toys, and let really, really smart people play on them. And they'll create new research directions that the faculty, that the leadership of SCI never envisioned. So that's part of the resource. It's just getting so much more expensive and so much harder to find the cutting edge.

CP: But lower in things that I think really help students, too, this bank of incredible coffee machines. That's what impressed me the most when I walked in there. And Ping-Pong tables.

GJ: Yeah, those are all reflections of Pixar, really.

CP: Yeah?

GJ: Yeah, absolutely. The Ping-Pong table, pool table were a Pixar thing. We used to have a foosball table up on the top floor. That was so loud we moved it to the basement. We've discussed a pool table, but we just haven't ever gotten one in because, again, it's kind of a noisier thing than Ping-Pong, for whatever reason. But, yeah, we walked the Pixar lobby—and the culture of that lobby, around the games, the Ping-Pong tables. We knew coffee was important from the old building. We only had one coffee maker. But meeting people at the coffee machine is a huge deal.

CP: This is impressive.

GJ: And so we buy the coffee makers. There was a set of emails that went around just recently regarding the new big coffee maker we have. Because it's more like a Mr. Coffee machine than anything we've ever had before. Someone said, "We should save money by buying a bun station with the Denny's style coffee." Chris sent out an email, "You can get a Mr. Coffee machine in SCI when I'm dead."

CP: [laughs]

GJ: So, we do particularly emphasize small things in SCI. The couch and areas and the way whiteboards are everywhere. And every lab in SCI has translating outdoor light.

CP: Yes. Natural light, yeah.

GJ: Absolutely. So the environment has to be as unique as the people we recruit, and it has to be as healthy for them as possible. So, yeah, the fight with the architects on how to eliminate modesty panels so we get more light coming through. The coffee machines that everyone asks us, "How do you buy those?" Well, we buy them from our gift fund that we contribute to. Because those are important elements of SCI that keep us unique. Sometimes they're looked at as frivolous but they're—

CP: But they're not.

GJ: They're building our culture.

CP: They keep people happy.

GJ: That's right.

CP: I think in almost every dissertation I've looked at, in the acknowledgments, of the students I mean, in addition to thanking the faculty and the great support they received here, they acknowl-

edge the resources, the incredible environment in which they've been working. So they notice.

GJ: Absolutely. And the central part of SCI is the café and the extra chairs sitting around. It's not just a break room.

CP: No, it's a café.

GJ: It's so students and faculty and people can just sit there and talk and trade ideas. There are whiteboards right next to it so they can write ideas. It really is lessons we took from that collaborative space at both the Merrill Engineering Building—we had a small area for this and we saw it utilized a lot, especially around the coffee machine—and then we went to Pixar. And Chris talking with Catmull and such just reinforced that you've got to put the culture in the building to get the people to really be better than the sum of the parts.

CP: Right. Well, the final of the four points. This is maybe a summing up. How have you created such a supportive environment? Specifically, how do you support the faculty, support the staff, support the students? I think that's everything we've been talking about.

GJ: Wow. That's a great question. In the first few years of SCI, we were all a lot younger, and we were a lot more emotional. We weathered each other is a way to think of it. We realized, over the years, how important these relationships were in not only having friends at work or colleagues at work you enjoyed working with, but the fact that we did want to see our work be more than the sum of the parts.

Over the years, what we've seen develop—and Chris has led this, SCI has led this for Chris, I've led this, Ross has led this, everybody's led this at one time, and the SCI Institute has almost demanded it from us—as the culture matured. When we were kind of in the adolescence of SCI, the culture was pretty raw, just like an adolescent would be. And now, if you listen in on meetings and such, even when faculty disagree, the tone of respect, the language used, the words used, are all really focused on offering the respect we have for one another.

CP: Yes, I think that's very true.

GJ: And it voids the harsh statements. So if you vehemently disagree with somebody, our language has become, our culture has become—we still start with the respect of that individual over the years we've worked with them, and that leads the conversation. That's something we've learned as a group.

So how have we built that culture? For whatever reason, we stayed together through the adolescence of SCI, and we learned to respect each other and really value the principles of SCI. And it's not on purpose. It's developed because somehow we managed to stay together during the hard days.

CP: Well, I think that's the important thing we're going to cover: personality. There are the resources, the support from the president's office, and so forth, all these things that have contributed, but clearly personality is a big issue that we're going to discuss.

GJ: Yeah, I'll say the fundamental piece of all that, that allowed us to mature as a group and find this—Right now it's some of our most challenging times and it's also some of our most rewarding times. When we were doing visualizations that no one else did in the world, and we were thinking of scientific computing when scientific computing was just a raw topic and visualization was raw, it was really easy to see why SCI existed. Really easy. We were doing unique work. That obviousness of SCI's mission is much more difficult to find now. So what's SCI's research mission? What are we doing as we become more multidisciplinary and the fields we've worked in are now mature? And where are we going next? Technically, that's a really difficult question, and it's a challenging question for SCI, where that was the easy question in the early days. How do we work together was the hardest question in the early days. Now we know how to work together. So now what are we working towards? The challenges of SCI have changed along with the culture. It's a really fascinating time.

The one thread that really enabled us to find this working rhythm was that loyalty of Chris Johnson to—and we'll hit this in the personality—not to SCI but to the individuals of SCI. Now, his commitment to SCI's a whole different thing. But that loyalty to the individual is the foundation of SCI.

CP: He seems to have great affection for everybody with whom he works.

GJ: Absolutely. And there will be times where we go, "Wow, this person's just not working." And Chris will say, "Let me work with them." And, "This isn't working." "Let me work with them." And, "Hey, I can't work with this person over here." "Try it again." So the loyalty card is really significant, and I think that may be the thread that held this together during the early days of SCI, where all our personalities were a little bit more raw and challenging with one another.

CP: Wonderful. I think we've got a fascinating discussion ahead of us.

GJ: Yeah.

CP: You've got great thoughts about the personality and the future of SCI. So we will cover those in the next sessions.

GJ: Super. Did I hit the points you were looking for?

CP: Yes.

GJ: Oh, good.

END OF INTERVIEW 1 WITH GREG JONES

SCI's superb coffee makes frequent appearances in the acknowledgments of dissertations, papers, and presentations—and fuels most major breakthroughs.

Greg Jones

An Interview by Christine Pickett
3 October 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

U-3394
SCI Interview 11 - Interview with Greg Jones 2

American West Center and J. Willard Marriott Library Special Collections Department, University of Utah

THE DATE IS OCTOBER 3RD, 2016. WE ARE ON THE UNIVERSITY OF UTAH CAMPUS, THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE. CHRISTINE PICKETT IS INTERVIEWING GREG JONES, ASSOCIATE DIRECTOR OF THE SCI INSTITUTE AND THE UNIVERSITY OF UTAH'S ASSISTANT VICE PRESIDENT FOR RESEARCH, FOR THE EVERETT L. COOLEY COLLECTION.

CP: We are picking up today where we left off in our previous interview, with a discussion of the role of Chris's personality in the success of SCI, and the future of SCI as a separate topic, but interrelated.

Two questions, then: How has personality contributed to the success of SCI? And how do you envision the future of SCI? As we've discussed, the two are clearly related. So I'm going to sit back and let you tie the two together.

GJ: Yeah, so Chris's personality and the future of SCI: like anything, the future of SCI is defined a lot by the history of SCI. And that history, and how we've changed as both an institute, as individuals, with this collaboration we call the SCI Institute, that history really defines where we can go, and what we've learned to define where we want to go.

So early on, Chris was very much a multidisciplinary scientist. His academic career is an interesting, nontypical, nontraditional academic career. But from the get-go, when he started SCI, collaborating with Rob MacLeod, it was clear that he was going to use his background in physics and computer science in a different way than just studying computer science questions.

CP: So kind of a broader view.

GJ: Much broader view. So he started with cardiac. Not being a cardiac expert, he started working with a cardiac expert, and not just building things the cardiac expert could use, but finding a cardiac expert who was also interested in Chris's domain. So Rob MacLeod's ability in computer science and engineering wasn't just as a cardiac person, but deeply involved in computer science. And then Chris, picking up the biomedical with the fact that he's an expert in computers, but more so an expert in physics and math, that combination—so the overlap was significant.

One of the things you see when Chris collaborates and when SCI collaborates is that the overlap with our collaborators is really significant. They share a passion for the research we do. We share a passion for the research they do. And if we try to just, let's say, lease out our capabilities, or stretch way beyond our expertise, where the people we're working with don't share our expertise, it becomes really difficult to have that meaningful collaboration. So that's part of—

CP: Yeah, that's an interesting distinction between leasing out and collaborating.

GJ: Yeah, so we're not a service group, we're a collaborative group. A lot of that was driven by who Chris recruited early on, and having significant overlap with each faculty member who has come into the SCI Institute. That desire to have meaningful relationships and meaningful work together has driven, in my opinion, Chris's research. But that's what drives the build of SCI.

Oftentimes, when you see a collaboration start up, it looks like the collaboration starts because there's a good grant out there to get, rather than we have overlapped interests. So part of our job now, when we grow, is to keep that heart of deep overlap, deep working relationship that Chris built SCI on, and keeping the faculty—because we think that's a solid foundation to build research on—keeping the faculty reminded of the fact that, as we grow, those deep collaborations are what work well for us. And that's probably just because of how we were built, because of the way Chris viewed research.

The other side of Chris's personality is he just enjoys working with everybody. He enjoys meeting with everybody. He enjoys talking with everybody. There's no researcher I've met who can get Chris to not enjoy working. I'm not sure how to say that. But Chris doesn't have a scientific enemy out there. He just enjoys working with everyone. And he's broad-minded and doesn't offend easily, scientifically. He's just an open collaborator who's really easy to work with. And he never judges other scientists on their scientific acumen; you don't hear: "This person's not a great scientist." You never hear that. It's just always, "Let's keep working together." He's a really receptive collaborator, and so SCI has become really receptive with whom we collaborate. There's not a lot of hard judgment on your science, the collaborators' sciences. If the collaborator's interested, brings an interesting problem to us, then that's a great start to a working relationship.

Then, one of the most striking pieces of Chris's personality and that has built SCI is his—and I've mentioned this before—his loyalty to people he recruits or hires or, just in general, his students and even his collaborators. His loyalty is really significant. So how that maps into SCI is once you're SCI, you're always SCI type of

idea. So that allows us, when we hire someone—and, as I've mentioned before, a new hire here gets put on an island and it's a really tough island to survive—we don't walk away from that person early—it's really long term, staff, students, and, of course, faculty. We tend to hang on and on and on and work until that person fits the job and we've tailored the job to fit that person.

Chris does that with faculty, and because Chris does that with faculty and staff, myself for instance, that's how we treat staff when they come in. So SCI as a whole is extremely loyal to SCI. Sometimes—

CP: And students, too, of course.

GJ: Students. Everybody at SCI. For the students, we really work to find the right place, the right advisor, the right job, the right equipment for people to succeed in SCI. That sometimes sets us up with maybe a little more expensive payroll because we tend to hang on to people. Sometimes that SCI loyalty, that SCI personality, people look at it as being kind of that Homer personality. We think too highly of ourselves. It's not that we think so highly of ourselves, but that we think highly of the people, the collective of SCI. We think highly of our colleagues, our employees, our staff, our students, our faculty. We think highly of each person, and that results in us thinking highly of the ensemble. That mutual respect and loyalty that Chris gives permeates SCI, and that's part of why we all think SCI is great, because we think the components are great. Let me be frank, SCI as an administrative unit has as many, if not more, problems that any group this size would have. But, the people in SCI are great.

And so how do we expand SCI and keep that, which I think is one of the strong points of SCI, that loyalty and that openness to collaborate, how do we expand that and keep it whole? At the same time, when Chris collaborates, when he writes a grant with you, you need to be ready for emails at any given day, any given time, and text to be thrown around. And your best text will go to Chris and Rob and Ross and Chuck, in the early SCI days, and will come back almost unrecognizable, and somehow you have to have the confidence to be able to write quickly, to ideate very quickly, and robustly, to where your ideas can be attacked and your writing can be attacked, but you know they're not attacking you.

There's a quote out there, "Attack the idea, not the person." That lives robustly in SCI, where ideas are hammered out very quickly and you've got to stand up to your ideas and stand up to people's challenges of those ideas, ready to make the idea better, ready to make the writing better, the grant better. And that really can be done because you know that loyalty sits there. We can take a paragraph of anybody in SCI and tear it up, add to it, change it, and that person knows, "I'm respected. It's okay what happens with my writing."

CP: People are secure in their opinions.

GJ: They're secure in their opinions. So how do you give new faculty—how do you keep them in that space when they go out? What we've started contemplating is actually building centers within SCI where the SCI administration helps share the load of the center administration but the faculty member can go out with a couple more SCI faculty people and start setting their own agenda with the center, where they get to start defining how their administration supports them, what direction they take. We're looking at centers revolving around, for instance, supercomputing and materials. How do we build the materials of the future using computer simulations? And a center based on that idea, which is broader than what SCI thinks, or narrower depending on how you view the centers. It's going to go down a specific research trajectory. It's going to gather what we will, I think, call SCI affiliate faculty. It won't be actual SCI faculty but will be members of a SCI center. And that set of investigators, SCI faculty, can now start their own idea in SCI space, and have financial commitment from the university via the SCI Institute that enables them to chart their own course.

Greg Jones, PhD, joined the SCI Institute as its first associate director in 2000.

We think sharing that administrative mode and the direction of the center, and making sure there are at least two or three faculty for each center who are SCI faculty, will keep that really open, collaborative, respectful community that SCI is built on. And so really—

CP: Great idea.

GJ: I hope so. I hope so. It's brand new. It's a brand new way of thinking of centers. And at SCIx one of the things we're planning on doing, I hope, is to highlight a couple of the ideas that centers are starting to kind of come around, highlighting those in SCIx, with some students doing poster sessions on those. What I think it does, though, is by sharing the risk and sharing the commitment to those centers with SCI, that it keeps the things Chris has started this group based on, that mutual respect, openness, the collaboration, pressure on the ideas, that's—we talked about quality last time. One of the pieces of quality that I hadn't even contemplated until we talked was the thing we push hardest on quality—we have a nice building, we have great furniture, we have supercomputers, and we hire quality people, but we demand ideas leave SCI or get proposed that are quality ideas and have been challenged internally. So that challenging of each other's ideas without challenging each other is a critical piece of SCI. That's the piece we're really

In conjunction with the University of Utah visit of the Dalai Lama, monks meet with Greg Jones (back right) on May 31, 2001. Front center: Khenpo Konchog Monlam Rinpoche, a venerated monk and teacher of Tibetan Buddhism.

trying to make sure goes forward as these centers shared with SCI go out and find their own areas.

And we've lost faculty. I mentioned last time Claudio Silva. How do we give a Claudio Silva, our next Claudio Silva, the room to spread his or her wings, build their direction and research, but supported by us? I hate the fact that Claudio had to go off on his own and recreate everything we've already done here.

CP: And with these centers, that wouldn't have to happen.

GJ: With these centers, they don't have to leave the infrastructure of SCI, but they can define their own center. And then, as the centers grow, we'll see if they evolve into larger centers that live outside of SCI or institutes or whatever.

CP: But still related.

GJ: But still related. We hope this center idea within SCI, and these affiliated faculty, are a way to grow the SCI footprint, but most importantly, the SCI character in research, because we think it's a really nice way to do multidisciplinary research.

CP: That's amazing. That's a great idea. So it would also increase the external collaborations, too?

GJ: Absolutely.

CP: Nationally and internationally?

GJ: Absolutely.

CP: Because all of those would have their own little collaborations they would set up.

GJ: Their own little electron clouds that would grow. That's right, that's the idea. Chris, we, made an early bet that scientific computing simulation and being able to visualize and interact with our simulations was going to catch fire and be a moving force of technology. And it's certainly turning out that way. So, for us to keep doing that, as all fields start adopting this way of using computers and computer simulation, different people interacting with data differently, to be as broad as the adoption of what we've been researching for years means we have to come up with a scaling model that's beyond each faculty member having collaborations, right? It's each faculty member. How do we empower those collaborations to generate yet more collaborations? It really is that idea, as technology we thought was risky 15, 20 years ago, is becoming adopted, now we have to scale with that adoption.

CP: So rather than one person and his or her collaborators, it would be a group with many more.

GJ: Many more collaborators. That's right. So one of the things, if you look at the SCI mission, we want to impact daily living. This impact can't be done without scaling these collaborations. I guess, if you really nailed down on it, Chris's desire to have an impact with this type of technology is the driving force of what SCI is and what its expansion will look like.

Chris's loyalty to and respect for people is another huge piece of what we have to keep in these multidisciplinary collaborations because scientists are pretty insecure oftentimes. A physicist looks at a chemist and says, "Oh, physics is harder, more important than chemistry." And the chemist looks at the physicist. Then a mathematician comes in. Heaven forbid you're a soft science person coming into that room, right? So how do we respect individuals and respect their commitments to their fields? Chris has been really fundamental in that, in the way he respects and holds loyalty to people. Then this desire to have deep relationships with your collaborators is another big piece. Those three big pieces are huge.

Then there's the piece of Chris that is—once he decides this is the mission and you're a part of the mission, he will relentlessly champion for you. When you see Chris give a talk out in the international community, on the SCI Institute, you're hard pressed to find his work inside that presentation. You get to see what everybody's doing. You get to see SCI. And you get to hear a few names mentioned. But it's an amalgam of research that is the SCI Institute. Chris isn't presenting Chris Johnson and his research, ever. I've never seen him present that. I've always seen him present the SCI Institute. When I've worked with other centers or institutes, that's the single hardest piece to find, is a lead who is completely committed to the group, not just committed to the group unless it threatens his or her lab. So Chris's commitment to SCI, and his loyalty to SCI—he takes SCI's ideas, and they're the SCI Institute's ideas, they're not his research anymore.

CP: I was just thinking, I've read his Gould Lecture several times, and that's particularly true of that.

GJ: Absolutely.

CP: It's such a great vision of the future.

GJ: It's a future of the whole collaborative institute. Chris is celebrated as the director of SCI, but Chris celebrates SCI when he talks. And that is unique among all the people I've seen, is Chris somehow doesn't seem to have an agenda when he talks about the SCI Institute when he presents our work. The work is the agenda, and anybody else out there doing that work is the agenda. And somehow he just resonates scientific computing and imaging is the agenda, not the SCI Institute doing that.

CP: I may have mentioned this, but he said at one point that his goal is to have all the faculty here have the same awards that he has on his wall.

GJ: Absolutely.

CP: Which is so nice.

GJ: And when it comes raise time or recruitment time, Chris is in the dean's office, in the president's office, trying to get the right position, the right wages for everybody so they can just get back down to work and not worry about that. His championing in that regard is really phenomenal. I'm sure it causes weird wage-scale problems across campus, but Chris ignores that and champions the person.

CP: But this is a good investment.

GJ: That's right. We think so. We like to think so.

CP: It sounds like the president thinks so, too.

GJ: Yeah, I think the president agrees. But Chris is dedicated to the person. Absolutely. When I say, for instance, "Hey, this particular person, SCI may not be able to afford," Chris will say, "That's my decision, not yours. I get to decide that we're going to afford that person." And he always goes for the person, and costs be damned. So we have to figure out a way to satisfy that style of commitment to people, but that's our job. That commitment to people is really Chris's single strength, the commitment to people, with respecting people, respecting their contribution to the project, their contribution to SCI, the loyalty to those people, that even when they really aggravate him, they're SCI, or they're a collaborator. And we're going to get through the aggravation and find the fruit. I've seen him, over and over, when I'm ready to walk away from someone, Chris is always pressuring to reengage. He's relentless on that commitment.

CP: Returning to the idea of centers. In terms of SCI expanding, are you thinking of faculty expanding? And how might that change the nature of SCI?

GJ: Well, it's always interesting. We've had, since 10 years ago, when we were 10-ish faculty, we've said, "How big should SCI be?"

CP: Okay, that's the question.

GJ: Twelve faculty, 15 faculty, 20 faculty. And we've arrived at numbers along the way, but there always seems to be something interesting we want to do that we should recruit another faculty member for.

CP: You can't accommodate it without changing.

GJ: Right. We can't accommodate it without changing because there're more and more places that we want to go. I'll give a for instance. I'm pressuring to think of expanding. Utah happens to do carbon composite manufacturing really, really well.

CP: You've been working with that.

GJ: I've been working with that since I was in the governor's office. I think one of the things that would tie us to mechanical engineering and the national level of simulation and carbon composites is to pull in a faculty member who specifically addresses simulation in carbon composites. I think it would fit nicely between Mike Kirby and Mike Czabaj down in mechanical engineering and would make us a really interesting place in that domain. And that just happens over and over again.

Statistics. We want someone in statistics to help us with all the data we're getting. We want someone in simulation who does this or we want someone in imaging processing who's focused on this. Machine learning is another great field. We have a lot of images. We're working a lot with them. We're doing some machine learning. We should get another faculty member in machine learning to make that kind of tease out and get a critical mass. As scientific computing evolves into all these different areas of application, we see pieces that we want to expand in with it. And that almost automatically becomes, we should hire another faculty member in that area.

CP: I see that.

GJ: So we've stopped saying, "How big should SCI be?" And we're starting to say—

CP: As big as it needs to be.

GJ: —"What should SCI do?" And, "How do—"

CP: For the applications.

GJ: That's right.

CP: Because you're doing work with atmospheric science, geophysics, the mapping. Amy Gooch on agriculture.

GJ: Yeah, the agriculture came out of nowhere. We were just interviewing farmers. And there was apparently a large agricultural community needing tools that we could help develop. Yeah, there are so many collaborations.

And that's another reason we're thinking of this affiliate faculty. We can't grow our faculty body fast enough to keep up with the emergence of all these fields. Can we start having faculty who have a strong commitment to SCI and the way we do research but aren't necessarily resident in the SCI Institute?

CP: So the centers would be an umbrella for that?

GJ: Yes. Yeah, that's the thought.

CP: Wow.

GJ: Yeah, so you might see a person from material science here on campus join SCI as a SCI affiliate. Then we would manage grants around that affiliate, thinking of, if you're SCI affiliate faculty and you get a grant with us, we treat you just like you were SCI. The support you get in writing the grant, managing the grant, etc., would all wrap into that. So you'll be, in essence, SCI faculty on the grants that you're writing with our centers.

CP: You'd have faculty lining up to do it.

GJ: I think so. I think so. We want to be really careful that every SCI affiliate faculty is really, really critically built to SCI and the way SCI does research and the collaborations. Not meaning they have to become a SCI member or something but that they really are contributing and SCI's contributing to them robustly. We're really studying that idea of what a SCI affiliate faculty member would be and what are the metrics we are trying to achieve.

We started one center already: the Center for Extreme Data Management and Analysis and Visualization, CEDMAV, with Valerio Pascucci. That was our first center, and we have a model there. A lot of what we're doing is saying, "Okay, how can we take that first center, refine that, and really think about how to power these forward?" That's part of what we're doing. So we've had one center spin out of SCI as kind of a faculty-led center that wants to do things in addition to SCI. And we're saying, "Okay, how do we help power that forward? What do we take from our first couple years with that center and do for the next centers? How do we improve the model?" It has been fascinating.

SCIx open house event, 2011

CP: So some SCI faculty, not affiliates, but the SCI faculty, they might belong to multiple centers?

GJ: Yes. I expect they would. Yeah, almost assuredly.

CP: Quite a bit of overlap.

GJ: Yeah.

CP: So, envisioning the future—David Pershing, of course, has been a huge champion for many, many years. What happens if he takes a job elsewhere?

GJ: That's a great question. We've been debating that.

CP: I mentioned to him that he probably could never retire because he needed to support SCI.

GJ: That's right!

CP: Is there somebody in the wings, do you think?

GJ: Well, we have standing letters of agreement with Dr. Pershing. And hopefully those letters will help us move to the next person. But there's always—the next person will have a certain agenda of how they want to grow the campus and how they want to maintain research. A lot of it will have to be that our programming, these centers, the SCI Institute, we really have to ask ourselves, and we do this, especially when we present to Dave once a year, what do we give the campus that's unique and needs to be supported? So if it's just, "How do we make sure the university is supporting SCI?" then we're on really tenuous ground. If we think we are not a free institute for the university to have, we're an investment, what does that investment have to give back to the university to be important? Not just to Dave, who's supported us for years, but to the next person in that role. And right now, what does it have to be to be important to the provost, to the vice president for Research, to the Health Sciences vice president, senior vice president? What do we have to be to be important to them?

We've looked at that, and one of the things that we've noticed is we don't have as many collaborations with the Health Sciences campus as we would like. In my mind that means we're not serving the Health Sciences campus as well as we could. So we've worked with John Phillips, who is the core director; cores, like microscopy core, and small animal imaging core. And we've started up a core called BIDAC, which is all about biomedical imaging and analysis. So we've helped create a nascent core. We've made a contribution to that. Vivian Lee and John Phillips have made a huge contribution to that. And we're saying, "Can SCI and the way SCI does stuff be an important part of the core environment?" So a solid service component. SCI as a service component is something we hadn't contemplated 10 years ago. Over the last two or three years we're saying, "What service can SCI also be to the campus? And if we start a core on this, how much contribution, commitment does it need from SCI, other than just providing a great atmosphere? And how useful is it to the core system?" We're asking those questions all the time. What can SCI give back to the campus or how can SCI be valuable to the campus? A for instance is the TVC's (that's technology, venture and commercialization) software development center (SDC) we helped co-found several years ago. The SDC was based on the idea of having professional software developers (SCI has 10 of these types of professionals) take research code from graduate students, postdocs, and faculty and turn that code in to robust, usable, almost production code.

CP: David Pershing indicated that the presentation every year was geared that way, from SCI.

GJ: Yes.

CP: And he also suggested that the senior VPs for both upper and lower campus share his commitment to SCI.

GJ: I think we've seen really strong commitment.

CP: That they speak with one voice in terms of their support.

GJ: We've seen commitment. And so we're just starting to explore, for instance, with radiology, with Satoshi Minoshima, the new chair there. Is there a way to combine what SCI does and radiology does with their evolving research vision and build an imaging alliance here in Utah, similar to the cluster work we are doing with material sciences? Can we build kind of an uber specialty for Utah, not just the University of Utah but Utah in general, in medical imaging? And we think there are grounds for that so we're going to start with a couple of technical pushes as we see how the collaboration builds.

CP: Which would be a boon for the state.

GJ: Absolutely. I think we'll start with a couple of seminars over the next year and then a SCI Institute radiology retreat. I was just in Satoshi's office last week talking about how to structure this. Can we build that to really evolve the whole imaging community here? Which, of course, would be great for SCI. But it's also our way of using what we do nationally and internationally and bringing it back home and really powering up other groups along with us. Yeah, so we'll see.

We pressure that ideation of, how do we commit to campus, and find that we have collaborations with radiology. But is there a next level to where we can have more spinout companies

coming out of that and more depth of relationship with them? Can we get beyond writing collaborative grants to writing really collaborative, larger grants that go out 10 years into the future of radiology? One of the questions I asked Satoshi is, "What does radiology look like in 10 years, in 15 years? Where do you want your radiology department to be? And how can SCI help you in getting there?" That's what I hope the seminars focus on, is here's where radiology's going. We bring some international people thinking on those thoughts, and we have a retreat. Then we come back and at the SCI faculty retreat we say, "How do we serve that mission?" Whether it's whom we recruit or how we write our next set of grants with radiology. Or do we just start getting out in the community more looking for that edge of radiology? That's part of what it is, I think, is exploring, with other parts of campus, rigorously, what their futures look like.

CP: At what rate are your national, international collaborations growing? Because what you're saying, the campus and the state, clearly, there is a lot of growth there.

GJ: Yeah. This last year has been a really, really solid collaboration year. So we have a new collaboration with Europe on imaging and visualizing space, the known universe. They're trying to visualize and make a simulation out of visits to Mars and just different space flights. That's called The Open Space Project. That's an international collaboration, and national. Then our NIH Center continues to go strong.

And we've gotten more funding agencies. We're now funded by the Department of Homeland Security, with an on-campus collaborator, looking at nuclear proliferation. And Liz Jurrus, who just left for DITRA, did the groundwork to start that collaboration. So, yeah, I think our grants are growing this year, which is really difficult to do. It's a really tough environment to win grants.

CP: Will your international collaborations be affected by Brexit?

GJ: Hard to say. It really depends a lot on—I don't think Brexit will necessarily affect it. Individual governments. Each one has their own flavor of the way they fund science. I don't see the commitment to science changing. I don't see it growing or decreasing significantly in any of the countries. It's very similar to ours. We don't see a significant increase. Maybe a slight decrease over the years, just with inflation and the programs staying flat since the Bush Administration.

CP: This is probably a difficult question, but we mentioned what if David Pershing moves on. What if Chris cuts back on his workload?

GJ: That's a great question.

CP: Or retires.

GJ: Yeah. I have no answer for that right now. We've been discussing it over the last couple years, last two years. We've said, "What does a SCI succession look like?" I think there are a variety of avenues for that. You can imagine, if Chris stays in for 10 more years and we have six centers that are up and running, that SCI becomes an administrative center for those centers, and those centers are their own leadership. Or we find someone with a strong leadership potential who wants to take the mantle that Chris has and we put this person in next to Chris over five years and train them. I think those two extremes are actually finding a replacement and ramping them up over a couple years, or saying, "SCI as its services and its faculty as a whole are now leading SCI by leading their own centers." I think those are the opposite ends of the spectrum. We're exploring that spectrum to see, what is a good succession plan for SCI and the SCI environment to live on without the particular leaders in place?

CP: Do you think SCI would change? Obviously it would change, but in what ways might it change with somebody other than Chris?

GJ: It's a great question.

CP: We're talking about personality.

GJ: Great question. So, in the early days, we viewed Chris as a magnanimous dictator.

CP: [laughs]

GJ: In the fact that he defined the qualities SCI was going to deliver on. And if you fell short of that quality, it was challenged. In the early days, Chris had a lot of energy, as we all did, to challenge one another. We probably challenged each other a little too personally, a little too hard. And then, over the last few years, we've grown that respect quotient I've talked about to where we've realized—and it's a learning thing—we've all realized that what is really important about SCI is each other and the work that we each can do and the people. So that learning, that respect-based collaboration with one another—and when someone new comes in, bringing them into that fold. That's when I said it took faculty, you know, two to three years to really groove into what SCI's about. It's the fact that you can let go of fear because you're going to be respected because you're part of what we recruited to SCI. That's the culture of SCI.

If Chris were to retire next year, the focus for SCI would be, let all the research change, let all the way we do things change. If that individual respect and the respect of what people can contribute back to the whole are kept in place, everything else can change.

CP: And odds are that that would continue, because everybody buys into it.

GJ: Everyone buys into it. We also don't want to work in a place without that. So I do think that continues.

CP: So you have all these people here already committed to it.

GJ: That's right. The kernel of SCI I think Chris has built. I don't think anybody coming in to lead SCI would be tolerated who broke into that kernel.

CP: So it lives on.

GJ: Right. So I think that piece of SCI will stay firm. How SCI works, where it sits, even what it's called, who knows what that becomes with the next leader of SCI. But that working in a highly multidisciplinary, respectful environment, I do believe that's a solid cornerstone that Chris has put down and everything SCI does is built on that cornerstone. I think it's a big enough cornerstone and solidly deep enough in the earth that it will continue on. And that'll be the magic of SCI.

Thanks.

END OF INTERVIEW 2 WITH GREG JONES

KATHARINE COLES

An Interview by Christine Pickett
13 December 2016
Salt Lake City, Utah

Everett L. Cooley Collection
University of Utah Scientific Computing and Imaging Institute (SCI) Oral History Project

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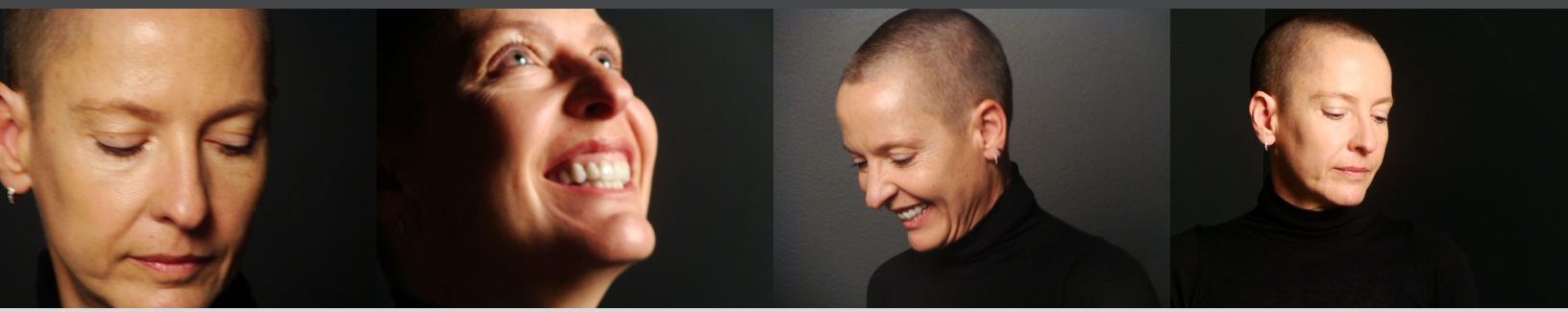


Katharine Coles named Utah State Poet Laureate by Governor Jon Huntsman Jr. in 2006.

THE DATE IS DECEMBER 13TH, 2016. WE ARE IN THE HOME OF KATHARINE COLES AND CHRIS JOHNSON. CHRISTINE PICKETT IS INTERVIEWING KATHARINE COLES, POET, NOVELIST, EDITOR, UNIVERSITY OF UTAH PROFESSOR OF ENGLISH, AND THE WIFE OF SCI DIRECTOR CHRIS JOHNSON, FOR THE EVERETT L. COOLEY COLLECTION.

CP: This Everett Cooley oral history project interview focuses on the unique culture of the University of Utah's Scientific and Computing Institute, or SCI. Several of the institute's key players are contributing to the discussion of SCI. As an introduction to each, we are including a brief bio.

Katharine Coles earned a BA at the University of Washington, an MA at the University of Houston, and a PhD at the University of Utah. She is the author of several collections of poetry, including *Flight*, 2016; Utah Book Award winner *The Earth Is Not Flat*, 2013; *Fault*, 2008; Utah Book Award winner *The Golden Years of the Fourth Dimension*, 2001; and *The One Right Touch*, 1992. She is also the author of the novels *Fire Season* and *The Measurable World*.

Dr. Coles is the co-PI of the Poemage Project, which develops software for analyzing and visualizing sonic relationships in poetry. She served from 2006 to 2012 as Utah Poet Laureate, and in 2009 and '10 as the inaugural director of the Poetry Foundation's Harriet Monroe Poetry Institute.

At the University of Utah, Dr. Coles has directed the Creative Writing Program, codirects the Utah Symposium in Science and Literature with mathematician and biologist, Fred Adler, and serves as series editor for the University of Utah Press, Agha Shahid Ali Poetry Book Award.

She has received grants and awards from the National Endowment for the Arts, the National Endowment for the Humanities, the National Science Foundation, and the Guggenheim Foundation.

So, today, let's start with the early days of SCI, or the predecessors to SCI. What are some of your memories of those days?

KC: So many of them occurred on the deck of the old 1890's farmhouse that we bought in Sugar House, which was the first house that Chris and I occupied together. We moved in on my 30th birthday. There were a lot of evenings during which Chris and Rob MacLeod and Prasad Gharpure, Chris's first PhD student, and Steve Parker, his second, and other early, early people in Chris's group—it wasn't SCI yet—would be sitting outside, probably almost always drinking a beer, maybe eating pizza, and doing the planning and dreaming that young people do when they are starting out on some sort of big endeavor. To me, those memories are sun-dappled and warm and a little bit romanticized, the way that they are when you look back. We were all very young.

CP: Very young—and exciting times.

KC: Yes, exciting times. There we were in uncertainty, but with all of this possibility in front of us.

CP: And you were both just starting in your careers.

KC: We were both just starting out, as a couple, too. We were engaged in June, bought the house in August. Then we got married that fall. I defended my dissertation one week, he defended his the next week, and we got married the week after that. So we were literally right on a cusp—even though Chris already had his faculty appointment at Westminster, and we certainly were both working at that point, there was a sort of line we crossed just then, from nascence into something resembling the beginning of adulthood and

the beginning of responsibility, I guess you would call it.

CP: Chris mentioned in an early interview that the social evolution of SCI reflected the administrative, and so in those early days you would host all the SCI parties in your little house in Sugar House.

KC: It's funny, because it seemed like a big house to us at the time. It was maybe 2,300 square feet, this old farmhouse. We hosted all of these informal—people get together and have a chat but also—

CP: He said you did all the cooking, too.

KC: I did all the cooking, even for the more formal parties. At the beginning there, I was rolling hors d'oeuvres with my little fingers. And I have to say, these days we don't do so much of that [laughs]. We occasionally have a small dinner party. At the beginning, it was maybe six or eight people, and then it was 12. And maybe when it hit about 20 people, I said, "Okay, so this is the year that we're—"

CP: The catering?

KC: Pizza. I would go out to Wasatch Pizza because they didn't deliver at this point. We'd call in an order, and I would run out and get the pizza and bring it back. And then, it was actually when we moved to this house, almost 20 years ago, that the catering started.

CP: Chris said it was Rico's.

KC: It was Rico's. We had somehow made the acquaintance of and became friendly with Jorge, who owns Rico's. And we said, "Do you do catering?" He didn't really at that point, but he said, "Sure. Sure I do catering." So for some years Rico catered all of those SCI parties. And then SCI outgrew this house, because it's not a huge house. It's just the two of us. It's nice for entertaining, but not huge. That was when we moved to Memory Grove Memorial House.

We still have regular get-togethers, pretty much once a month, and sometimes quite a bit more frequently—Chris says we're signed up for every other week the spring semester. At first, we had only SCI faculty over. We started the first year we were on sabbatical at the same time from the university, to give him a way to keep in touch with his faculty. Also, I didn't know this until later, but he saw it as a way, during a time when we were both intensely busy, to keep me in touch with what was happening with SCI, without him having to sit down and tell me every day. It was very helpful. I heard about events from different people and different points of view. Eventually, we started inviting members of the English department to come, and we gradually expanded to invite faculty and administrators from different units and areas on campus. And it is still the case that you tend to get clusters of computer scientists in one corner and English faculty in the other corner—

CP: Just so they can understand one another?

KC: But also, people are excited to be together and not in a meeting room on campus. The good news is that they actually enjoy each other and they're happy to have this opportunity to mingle together. And gradually, there has been more and more intermingling between the faculties. In fact, I think some of the young faculty members in English and SCI are on—you know these quiz clubs and groups that they have?

CP: I've read about some of them.

KC: Yeah. Who knew? The young. Some of them have become friendly enough to be on the same quiz groups in bars, which I think is fantastic. Miriah Meyer and Michael Mejia, who's a young writer in the English department, are on one of these together. So, if our hope has been to facilitate a certain amount of cross-disciplinary conversation, that is also happening, but we don't mind if our faculties just enjoy each other, too.

CP: That's lovely. Well, the Memory Grove one this year was my first, and very memorable, and very big.

KC: There are a lot of people, right, who come to that.

CP: There are 200 in SCI, and then everybody—one of the students I know brought her five children.

KC: Right. And kids are welcome. Even with our little SCI faculty get-togethers, very often there are children at those. We just warn people that we don't cover our electrical outlets and they're on their own for that kind of stuff. And my dean was there at the Memory Grove event. I have my little list. My chair gets invited.

CP: Well, I had been hesitant the two previous years, but not anymore. It was great fun.

KC: These invitations are not proffered grudgingly, or lightly, at all. For us, it's all about the sense of collegiality that is fostered—and, again, pleasure is really important to the endeavor, on both sides.

CP: Yeah, for me, it was a matter of, for the first couple years, because I'm working electronically with people, I hadn't met so many people.

KC: Oh, yeah.

CP: Now it's a different situation. And it was quite an affair. It was lovely.

KC: And, because Chris really tries to hire only nice people—

CP: They're all nice, yes.

KC: It turns out to be a fun thing to do.

Chris Johnson and Katharine Coles, 2009.

CP: Absolutely. Well, let's turn to what may be a difficult question. Let's discuss how you and Chris have supported each other professionally over the years. You have two very full and demanding careers.

KC: One thing that he does for me is provide in-house tech support. And for a poet, this is invaluable. I have to say, I don't know what people do, who don't have a top-level computer scientist available and on call.
[both laugh]

KC: Of course, he has full tech support at the institute, so when we run into things he doesn't himself know how to do, he can send out a couple of emails and we'll get the information. This has actually brought me into the technological age with my work much more quickly than most of my colleagues, even though, I have to say, I'm not a gadget freak and I don't really care about technology for its own sake, at all. Sometimes, especially early in our marriage, Chris has brought home different kinds of gadgets and handed them to me. And his claim—you can ask him about this—was that he always knew that a gadget would be successful if I started to do something with it and eventually wandered off with it and he would never see it again.
[both laugh]

KC: The Palm Pilot was the really pivotal one. He had handed me all kinds of PDAs before that, and I would say, "Nope. Got a calendar. Got an address book. Don't need this." The Palm Pilot, I looked and I said, "Huh. A camera and mahjong?"
[both laugh]

CP: Can't be beat.

KC: Can't be beat. And I wandered away with it. And he never saw it again. Here's my Apple Watch—he brought me an earlier E-watch, and I gave it back to him within 24 hours. He always says he knows where to invest [laughs] if I adopt something. So I have this wonderful access to technology. The other side of that is that he understood, I think wisely, really early on, how important communication is to what he does. I don't know if you've ever seen him give a talk. You should if you have an opportunity. He gives a—

CP: Just brief ones. And I'd love to hear a full talk.

KC: Yeah. He gives really delightful talks. He's really attentive to the arc of the story, to how he puts that together. And there are other things that I can praise about the talks, and I will.

CP: Greg Jones says that he's absolutely generous in all his talks.

KC: Totally generous.

CP: He doesn't use the first person singular. It's always first person plural.

KC: And he always uses the talks to highlight the work of multiple different people in SCI. He always says who they are. If he happens to be intimately involved in a research project, he'll always say, "This is a project that my graduate student X is doing that I've been helping with." He always puts it in this way. Another thing he started to do really early on was to end the talk with a slide that contains the pictures of everybody in the institute.

This is something important that I learned from him. I'm new to PowerPoint, believe it or not [laughs], because, you know, poet. But when I started to do work that required collaboration and PowerPoint, from the very first presentation, anyone who was involved got a picture on the slide at the end, and especially anyone who wasn't in the room. Julie Lein and I have often presented together, but since she moved to Alaska it has more often been possible to get Miriah Meyer and Nina McCurdy in the room so that people could actually see them and talk to them. That was always the first priority. Then whoever wasn't in the room would get the picture on the slide, or if possible a Skype presence. Chris taught me that.

CP: I think that's so lovely.

KC: The way in which Chris enacts his values in the presentation is so important. And now I'll work my way back to my original point, which was that he understood, from the beginning, how important communication was going to be. This was almost 30 years ago, a time when proposals and papers were written in the passive voice. You will remember.

CP: Of course.

KC: It made them almost unreadable. Anyway, maybe even before the actual wedding, but certainly in the first three months of our living together relationship, he asked me to edit something for him. I said yes, but I said, "You have to let me really do it because otherwise it's going to be too frustrating." As soon as I was into the first paragraph I said, "I need to change everything. You just need to believe me."
[both laugh]

CP: Trust me.

KC: Yes. And when I came back, I had taken the passive voice and made it active. He said, "We can't do that. It's against the rules in my field." And I said, "If you want me to do this, then you have to believe me." And he sent it off and it got accepted. We really worked together to figure out how far we could go with that—because if you're going to tell a story and make it a compelling story, you can't tell it in that way, in the passive voice.

CP: So this is where everybody at SCI probably got that, from you, this whole notion of telling a story. Ross Whitaker tells all his students that, too. And I bet it came down from you.

KC: It may have—

CP: To tell a story. And the students will say to me, "Make sure that I'm telling a story."
[both laugh]

KC: "I have no idea what I'm talking about or how to tell it as a story, but can you make sure that I'm doing that?" I do think it's such an important thing to teach. The thing about a story is that it requires a protagonist, and it requires a narrative arc. It requires all of these things. And it really requires, on the granular level, that one sentence attaches to another, in a way that flows and that expresses action, activity, cause-effect. You and I have both seen so many pieces of writing, especially out of the sciences, that don't do that.

This is one thing that Chris really committed himself to, and that makes him exceptional. He had a poet in house, who was editing all of his papers and proposals for him. A lot of people would just leave it at that and think, 'Okay. I'm set for life. I never really have to learn how to do this.' But Chris learned how to do it

himself and make the writing his own.

Pretty early on, though, I realized that there would be whole chunks, especially coming from his graduate students, I wouldn't have to dig into at all because there was no point. I would just circle a section and say, "The graduate student has not yet figured out what she's talking about, so this is falling apart. Tell her to figure out what she's talking about and redo it and come back." You know how this is. You can't clarify the meaning because you're just guessing, right? You're just guessing. And you could be guessing right. You could be guessing wrong.

CP: I do the same thing. "I don't know what you mean; it's not clear."

KC: Very often, you don't know what they mean because *they* don't know what they mean yet. Here's where the graduate student doesn't know yet, or sometimes even the faculty member hasn't actually really thought through something. They have to finish the thinking themselves. Chris took all of this as an opportunity. You may notice that all the faculty at SCI use "which" and "that" properly.

CP: Yeah, they do pretty well. Some of the students don't.

KC: The students don't but the faculty do. I take complete credit for that.

CP: Very good.

KC: [laughs]

CP: It makes my job so much easier [laughs].

KC: Chris came to me and said, "Why are you changing all the "whiches" and "thats"? And I said—

CP: It matters, though.

KC: It totally matters.

CP: Especially in science.

KC: Especially in science, right, where precision is so necessary.

CP: Because it has a totally different meaning.

KC: Totally different meaning. And I said, "Here's the rule." And he got the rule, and he taught it in the institute, and they all know it, the faculty.

CP: And do you know the other one they do pretty well with, and it matters, too, especially in that area, is "while." Because if it's a temporal meaning, it totally changes the sentence.

KC: It completely changes the sentence.

CP: They do really well with that.

KC: There are all these little conventions in which scientists tend to default into something that's not quite English. The other value we developed was, even when you're writing science, you need to write in English.

CP: Yeah. Full sentences.

KC: Full sentences, etc. He was not hard to convince, but I did have to really be firm about the idea that if I didn't understand the paper—and especially since he does such interdisciplinary work, you can't just default to one field's jargon—then more important people than I am wouldn't understand it either. On any given grant or review committee for his work he could have a mechanical engineer and a physicist and a physician, and they don't speak each other's highly technical language, and they may not get all the math, so you can't make up for deficits in English by throwing in equations. So when they write to each other they need to write in English. I would say, "There's going to be somebody sitting on that committee, if you're using this jargon or that jargon, who's not going to understand it. Let's just agree that if I don't understand it, it's not done."

CP: I think you've done a brilliant job with that then in SCI because they use technical terminology but very little jargon.

KC: Right. And technical terminology is important. Precision—

CP: But that's something you can look up. Jargon, you're on your own.

KC: Yeah.

CP: Jargon has a unique slant to it. Totally different.

KC: Yeah. And you start to realize this when—I've been doing this work with Miriah.

CP: Yeah, fascinating.

KC: Which has really been great for me. I got a piece of writing

Annual SCI party at the home of Chris Johnson and Katharine Coles, 2001.

from the computer scientists using the word "formalism." I emailed them and I said, "You need to explain to me what this word means to you. It means something really specific to me in my field, but I'm pretty sure that it's not even remotely the same thing [laughs] that it means to you." They actually decided it was the wrong word and chose a different one. But you can really see that even in computer science and poetry you can have the same words being deployed in really, really different ways. You know how this is, when you're editing, sometimes I'll circle something and say, "I really want to change this, but I need to know what it means to you."

CP: That's what I do. I question. I don't assume that I can even make a correction. I say, "What do you intend?"

KC: Yeah. Unless I know. And the kinds of changes that I would make would be the kinds of changes that would clarify the relation of one sentence to another sentence. It turns out to be really hard for new scientists to do: instead of saying one thing and then something else and then something else, telling a story, building a relationship of ideas in language that has to be rational [laughs].

CP: Well, look at the success rate SCI has now. And I'm sure this is largely due to your input, but they're published constantly.

KC: Constantly. And they get grants.

CP: In the top international journals. At least, working with the students I don't see that anything has been outright rejected. They come back with a few comments from reviewers, most of them valid, a couple not, all of them answerable.

KC: I don't want to take all the credit for that because Chris really understood, I think, intuitively, from the beginning, that communication was going to be vital to what he wanted to do and to his success, and maybe particularly because he was embarking on interdisciplinary work and he kept finding himself in rooms where he had to explain one person to another person. He started to realize on his own that the communication was going to be the glue that would hold everything together. When we started to work together on the writing, he went in full—he just jumped right in, and not only embraced what I was trying to do but also embraced his opportunity to become a really world-class communicator himself. And as you know, they do it mostly without me, now. Chris might bring me in on a really high-stakes letter or overview, but the rest he now keeps in house.

CP: The interviews with him are truly amazing. First, his phenomenal memory. I can't even fathom that. But he tells the story.

KC: Yeah. It's true.

CP: A full story. There's an arc.

KC: He can articulate how they built the organization over time, the different directions and steps that they took. He can remember the arc partly because he is such a visionary, so that early on he was already projecting forward. He was already seeing how things were going to be constructed. Most of us, and I include myself in this, tend to take opportunities as they arise day by day, but he was really thinking, 'How do I build the future that I would like to live in?'

CP: That's a really good point. He is a visionary. And I hadn't really put it in those words, but he is. We were talking about the future of SCI. I'd had this discussion with others, but his take on it is so expansive. He sees limitless possibilities for the future of SCI.

KC: For him, it has always been a future that hasn't been imagined yet, that is his to create. I think he still sees limitless possibilities for the potential for computing and technology to have an impact all the way across the campus, across disciplines, and in society. This was what I put into a high-stakes letter I helped him with recently. I woke up at 4:00 in the morning thinking, 'How can we communicate Chris's vision of computing in a way that will be really attractive to this potential donor?' When I got to the letter in the morning, my goal was to be very specific about how, within the SCI vision, computing can have an impact and an influence, not only where we expect it to in chemistry and genetics and the close relatives to computing, but also, for example, in poetry.

CP: Yeah, in poetry, in business.

KC: And in the culture as a whole. For good, and as we've seen with this election, also for ill. And so, if I were to have influence on that future vision—well, he's already started to talk about how he's going to incorporate a larger ethical component into the work. He's an incredibly ethical man, and I think he already thinks about ethics in relation to medicine, especially in relation to how

Annual SCI party at the Memorial House, Memorial Grove, 2014.

visualizations and simulations can influence actions that may have consequences, and also in relation to building bridges. And he's incredibly compassionate, which is one of the reasons that he came into this work through medicine. He has always wanted his work to do good in the world. But I think that the capacity for computers to have larger cultural and political and societal impacts is something that an institute like his could also be addressing and thinking about. So that's the poet's [laughs] vision.

CP: Thinking of the ethics of it is kind of frightening, in a way.

KC: Yeah. So as they pursue big grants and endowments, etc., I believe this should get an office.

CP: It should.

KC: Down the road.

CP: This is a perfect transition for a discussion of Chris's personality and the success of SCI. You and I briefly discussed the "golden rule" and the "no asshole rule." Why don't we start there? Get your opinions of those. And then we'll go into a few more of the traits that have been identified by some of his codirectors.

KC: If I can sort of loop the marriage back into this, too, when he hires somebody he invites me to the dinners. He doesn't say, "Should I hire this person, or should I not hire this person?" but I go along. And this is not universally true. In my department, spouses don't go to recruiting dinners. I always thought it was just because he liked to hang out with me, and that's probably part of it, but—

CP: I think it's a well-rounded perspective to do that.

KC: It is a well-rounded perspective. And I think there are a couple of motivations behind it. One, my presence ensures that it's not going to be five geeks talking about technology the whole time.

CP: [laughs]

KC: And in one way, that's a kind of a break for the person who's under consideration, but it also allows Chris to see the human side of this person and whether the person is able to open out and spend a couple of hours talking about and thinking about other things. Does the candidate have the capacity to make him or herself available to somebody who's so different, and is the person curious and open about things outside the technical work?

CP: You can tell a lot about the personality.

KC: An important question is whether the person is curious enough. This can be really hard to tell within the context of a day of highly technical discussions, because it's one thing to be technologically engaged and it's another thing to have the larger curiosity that really drives the SCI ethic, that causes a researcher to think outside a narrow, predefined box. Chris himself is deeply curious, which is what moved him from general relativity to heart and brain research to research on fire and explosions and on down the line. He wants to hire people who are also deeply curious and will bring that openness to the work, because that's one way that you get beyond where you are and into something else.

It really defines Chris as a person, that openness and curiosity. And it also drives what he is trying to do with the institute and so shapes the decisions he makes about the kinds of people he wants to bring in. And it fits into the "no asshole rule" [laughs]. All of these things fit together. He's looking for people who are thoughtful and ethical.

Members of the SCI Institute's Visualization Design Lab out on one of their group runs. Pictured are front row (left to right): Jennifer Rogers, Professor Alex Lex, Professor Miriah Meyer. Back row (left to right): Sean McKenna, Ethan Kerzner, Pascal Goffin, Alex Bigelow.

Mike Kirby is one of my favorite people. When we have our SCI Fridays, he and my chair, Barry Weller, tend to be the first people who show up. Especially before he was sick, Mike would often arrive before the stated time and help me set up because he had a book that he had read that he wanted to ask me about or he wanted to know about what I was reading. He's a lovely man. We learned very early on that we disagree politically, on almost everything, and yet we have the most beautiful and kind and civilized conversations. We've learned that even though our politics end up in different places, we share the same ethical and moral core values and core center.

CP: That's all that matters really.

KC: It's really all that matters. And it's so lovely to have people like that in your life, who can keep teaching you, 'Oh, people I love disagree with me on these things that I might otherwise have thought were really core or fundamental.' It turns out that they're not, that the core is in this other thing. Chris is truly committed to intellectual diversity, and his faculty reflects this. He is also really good at identifying and understanding and embodying and internalizing the values that he wants to inculcate into the institute, and then, by his demeanor and behavior, expressing and radiating those values, including bringing the faculties together on a regular basis.

CP: We also should discuss the "golden rule." I'd mentioned that I came across it in reading the student handbook and was amazed, at any department in any university, that this was part of the handbook. They don't read that way. That was one of the things that Chris addressed: do unto others as you would have them do unto you. It really works that way at SCI.

KC: It does really work that way. And it's kind of a miracle that it does because I do know that there—

CP: These are aggressive professional people.

KC: And they work in a very—I know that there a lot of people in the world who think that in academia we sit around and eat bonbons and paint our toenails, but these are the hardest working, most ambitious, most motivated, and therefore most stressed out people on the face of the earth. You see these moments where peo-

Chris Johnson, 1995.

ple have to navigate stress and conflict, and at SCI they do it really well. I certainly would see it when working with Miriah because Chris taught me how to collaborate. Poets don't collaborate. [both laugh]

KC: We go into our little rooms and shut the door, and six months later we emerge blinking, with a little sheaf of poems clutched in our hands. We're just not really collaborative animals. When I engaged myself in working in collaboration with a SCI faculty member, Chris was my model for how to do this. And I was always stressed and worried about making my deadlines (because we don't have poem deadlines the way scientists have paper and grant deadlines) and treating divergent ideas with openness and respect and really working to understand my colleagues across differences in methodology and vocabulary, all of that. A lot of the stress comes from not wanting to let other people down, or at least it did for me. I think that Chris would rather live in a world where the stress comes from wanting to rise to others' expectations than from whatever that narcissistic, internal impulse is. The best thing that happened to me in the collaboration was when Miriah, at one point, apropos of, as far as I could tell, almost nothing, looked at me and said, "You're the best collaborator I've ever worked with." And I thought, 'I don't even know how to do this' [laughs]. It was because I had watched Chris and seen how conscientious he was, and I wanted to rise to that level of responsibility and never be the one who was making everyone else late or frustrated. All the more because I am the director's wife, of course—I wanted my collaborators to be happy to see me because of our work together, not stressed out because I am married to the boss.

CP: That's what's so good about the culture there. That's the feeling you get.

KC: Yes, you feel that everybody is thinking, 'If I'm late on this, then that person is late and that person is late.' Everyone's worried about the collective goal, and asking, what's my role in that? And how do I make sure that everybody is able to be successful? Or, if they're going to be unsuccessful, it's not because of me [laughs].

CP: Chris has commented, "I don't think it is the environment for everybody."

KC: That's right.

CP: I think that some people would not want to collaborate in that way. I can see how even for some staff it would not be the type of environment they would want, because there's a lot of individual responsibility if you decide to work at SCI.

KC: A lot of individual responsibility and a lot of responsibility to be alert to what's happening around you and to step in and step up.

CP: Yourself and then to everyone else. And that may be a burden for some people.

KC: I think it is. I mean, the whole premise, the "do unto others," it means you actually have to be tuned in to what others need from you at a particular moment. Again, back to marriage—Chris and I just celebrated our 27th anniversary.

CP: Congratulations.

KC: Thank you very much. And this is something that I think you also have to learn within the context of a marriage, that it's actually your job not to have your own back but to have the other person's back. In order to engage in that fully, because if you're watching your partner's back your own back's left exposed, and you have to trust that the other person's going to cover you. It's a delicate and fragile and risky thing to do. It's risky to do personally, and it's risky to do in a professional situation. It requires absolute trust. The trust creates a structure for allowing the possibility for maximum risk, which is how you get maximum results. It's the only way that you can really do it, either personally or professionally.

CP: When I was first in that environment—the first six months—I knew I loved it but it was quite a struggle for me to make sure that my skills were going to meet, for example, learning to edit in LaTeX.

KC: We had no doubt they were [laughs].

CP: Greg Jones said recently, "Well, you learned it so quickly." And Corinne Garcia had told him, "She didn't learn it quickly. She spent every night for six months practicing editing in LaTeX." So that it would look like I knew it.

KC: Oh my gosh. Learning LaTeX is, by the way, the thing that I never did. I made Chris give everything to me in Word [laughs].

CP: You know, I love it now. I have learned to do whatever they want me to do. Mike Kirby, going back to him, I don't know him that well, but I love working for him.

KC: He's a lovely man.

CP: Because he comes up with novel ways—right now he's doing a book and he has two, I think, German collaborators. And so, I do all the editing in LaTeX for one version, and then there have to be deeper comments, obviously, all these sentences that we were talking about. And so, I have another system, and they're done in tandem. It's really wonderful. But he's just great to work with because—

KC: He's a very innovative thinker.

CP: Very innovative and very courteous.

KC: He's courtly, even.

CP: Yeah. All his emails are so mannerly, so lovely.

KC: Yeah.

CP: It's an interesting environment. It really is. Couldn't be better.

I want to mention a couple of the other comments about

Chris that I've heard. And I'm sure you're going to have even more insight than the codirectors did on his personality.

KC: Am I staying on track?

CP: Yeah. We're doing great.

KC: Okay. Great.

CP: So, we've touched on this. You touched on it a minute ago. But Chris's generosity to others. He says that when he became a senior professor and researcher the biggest turning point for him was realizing that everything was about other people, how he can help other faculty and students. And he has said that at some point in everybody's career he wants them to have the same wall that he has, covered in awards. I think that's amazing. So tell me a bit more about his generosity, if you will.

KC: That expresses it as well as anything else. He's the first person I ever heard talk about the concept of academic children and grandchildren, which is something—

CP: Yeah, he's mentioned his grandchildren.

KC: Which is something that I've really picked up from him. We always say, "Oh, no, we don't have children. We have graduate students." Which I don't mean in a patronizing way at all. The great thing about having students who are adults when they come to you is that they're real collaborators in their shaping. It becomes the mentor's job to understand and support the student's own vision and goals. Part of the generosity in teaching is permitting them that scope—and with junior faculty, too—the scope and the space for them to be fully enabled by the mentorship that you give them, and to take that mentorship and to use it in the way that is going to be most productive for them. A mentorship that is really controlling, about shaping the mentee to your own will and vision, is not necessarily the most generous kind.

CP: So confidence, too, in the abilities.

KC: So trust, right? Once again, that ability to give to somebody else your time and your intention and your passion and your intellect and not completely control what they're going to do with that but trust them to take it and do something with it that is going to be a complete and wonderful surprise to you, and that will, in some ways, go in different directions and far beyond anything that you would ever have expected them to do. We can go back to Miriah, who is just a brilliant young person. Getting gradually less young, as we all do. She came to Chris a number of years ago, maybe even when she was still a graduate student, maybe just as she was finishing her PhD, and she said, "I've got a fellowship," I think at the *Chicago Times* in Chicago, "to do science reporting." A lot of mentors who have an idea of how careers go would have said to her, "That's the craziest thing I've ever heard. Don't do it." Especially given how talented she is, and how much SCI had invested in her scientific education. Chris said, "Well, that sounds pretty interesting." Then he said, "Talk to Kate about it." When I learned that her interest was rooted in her ethical sense that scientists need to communicate their work to the citizens who support them, I was actually really excited about it, and I expressed to him how excited about it I was based on his own values of communication. I said, "Listen, if she wants to be an academic, she'll come back and be an academic. Think of the skills that she will bring back with her. On the other hand, if this turns out to be her path, then great. It's her path." So she did it, and she loved it while she did it, and she learned a lot, and then she came back to academia and did a postdoc at Harvard. And then she came all the way back to SCI, and she brought with her everything she had learned along the way, including an incredible ability to listen and interpret. These are journalists' skills, but she practices them every single day in her work, which she is uniquely good at in part because of this detour. Another thing about Miriah is how, as an assistant professor, she came full in on this poetry visualization work, which was a kind of crazy thing to do. I know that her official faculty mentor was actually kind of discouraging about it, thought that it would be a distraction from her bringing in big grant money and achieving the very rigorous benchmarks for tenure in her field. We got grants but, you know, humanities. They were smallish. He really was covering her back—he thought the poetry work would be an impediment to bringing in big grant money and solving big problems and doing really splashy stuff. Well, Miriah's graduate student, Nina, who is brilliant as well, solved an open problem in computer science, which was necessary to create the tool that we wanted. And along the way Chris said, "Yes, she has to do this other stuff, but if she's passionate about this project, she should do it." She committed some of her own research money to it, and really was remarkable in it. And, by the way, I don't think Chris ever thought he'd wake up one day and find me working on visualization, but he both supported me – he was really helpful when I had questions—and also stayed out of my way.

CP: That's another trait that's been mentioned, respect for individuals.

KC: Right. Which I think I've just tied together with generosity. I think those two things really come hand in hand.

CP: I do, too. And everybody has commented on his respect for students, staff, faculty, his collaborators.

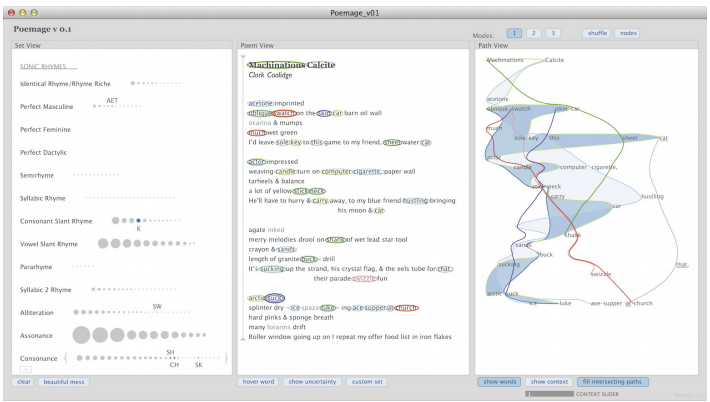
KC: I really think that's true. And he's so calm. This is the thing—

CP: Isn't he though?

KC: He's so calm. And I like to think that I'm respectful, too, but it can be hard to communicate full respect if you're not calm.

CP: Yeah, that's true, isn't it?

KC: That calm is part of who he is naturally, but he has also learned to cultivate and to default to it, because young men are not



Digital Humanities collaboration. Poemage is a visualization system for exploring the sonic topology of a poem.

as patient as they might like to be.

CP: So he really is as calm as he appears.

KC: He experiences stress, but he's acquired the ability to exude calm in a stressful situation, and even to default to calm. I think he's learned that it helps him think more clearly and it gets him out of the stress, so it's productive. He knows from experience that when he gives way to stress and abandons calm, the results are less likely to be good. He is amazingly disciplined in that way.

CP: Another trait we've discussed: he's absolutely loyal. Greg Jones has said that sometimes he might be too loyal because he doesn't believe just in second chances but third and fourth, as many as it takes. I don't think you can ever be too loyal, but I'll leave this to you.

KC: He's deeply loyal. And certainly he's been incredibly loyal to me. You don't stay married for—well, I guess people do stay married for 27 years without being loyal. And I think that he's learned we live in a world, and he lives in a world, in which sometimes loyalties come into conflict. But once he puts his eggs in your basket he will keep them there as long as he possibly can. He's loyal and committed to every member of SCI. His loyalty to an individual will take a backseat only at the moment at which it's threatening other individuals in that institution.

CP: Which is part of the "no asshole rule."

KC: Which is part of the "no asshole rule."

CP: You have to have a certain behavior.

KC: And it has occasionally been the case that he has had to—much against his desire—let go of people, sometimes people who are within SCI and sometimes people who are affiliated in other ways. But in the cases when that's happened—and there have only been a handful of them over all those years, only a handful—it's been not until other individuals and even the institution are visibly under threat from the person's irresponsibility. This is what makes Greg nervous, I am guessing.

CP: That's pretty much what he was saying is that Chris will take it right to that moment.

KC: He will take it right to that moment. And then, at that moment, even so, he'll try to figure out how to make sure that that person lands well. And some people will allow you to do that for them [laughs] and some people won't. But he will go, really, to an extreme to try to make that happen, and lose sleep over it. I'm sure he's calm at work about this. But at home—when he really has to let somebody go, that's an agonizing thing for him.

CP: One of the other comments that Greg has made recently is that Chris has built such a very strong foundation for SCI, that probably nothing could rattle it. If he decided—I can't imagine him ever retiring. That's what David Pershing says. He just has to stay in place forever. But the future of SCI is assured because the foundation is, according to Greg, so very strong.

KC: I will trust Greg about that, but his wife says that he needs a succession plan.

CP: It might be tough, though.

KC: I'm dealing with ancient parents. But Chris's mother died at 57, which is our age now. I love Greg for saying that the foundations are so strong, but one of the things that you've been hearing in all these interviews is how central Chris, as a person, is to the operation of the institute. And I think that's true. It will need in time to become less true.

CP: I see your point. That has been very apparent. Not everybody has said the same thing, but I've interviewed all of them, so I've seen different sides. But Chris is kind of the lynchpin of everything. It all revolves around his personality.

KC: And it's only recently that he's brought in—who is it? Is it Ross and Rob?—to create an administrative structure, along with Greg, right under and around him, to let and help others help him be responsible for the future of the institute, which means to their own futures. For years and years, it was really just him and his strong personal ties with the people he's brought in and supported, but without a hard formal structure. I've been nagging him about this for at least five years, "You need to be thinking about this." But we're both people who—we don't have wills [laughs].

And I agree that SCI will outlast Chris. But it's so powerfully identified with him. Even as he sends more and more emissaries out. He used to go out and do all the promotion and talks and all that kind of stuff himself. Then the time came when he started to send other people out to get that face time, and it worked, for him and for them. But as long as and to the extent that SCI and Chris remain coidentical, there's a succession problem.

CP: That's a question that I had early on. Would it be SCI without Chris? It would be something different. I think it will be something different.

KC: I hope it will be a wonderful something different. But I think that to ensure that, at least for a period of time, the values that have driven the institute continue to be its values, you need to have a plan in place.

CP: I totally agree. I see your point now.
[both laugh]

CP: I do. I don't know—who knows if people have the right combination of traits to do that.

KC: Chris is—he's unique, right? As will be those who come after. So, SCI will be different. But it would be great if it were different in as powerful, as generous, as respectful, as innovative a way.

CP: A lot of very successful companies, for example Apple, with that succession it is very different. I think it's good. I agree. I think it can be done.

KC: But, you know, Steve Jobs saw to that.

CP: Yes, that's true. Okay. I'm converted.
[both laugh]

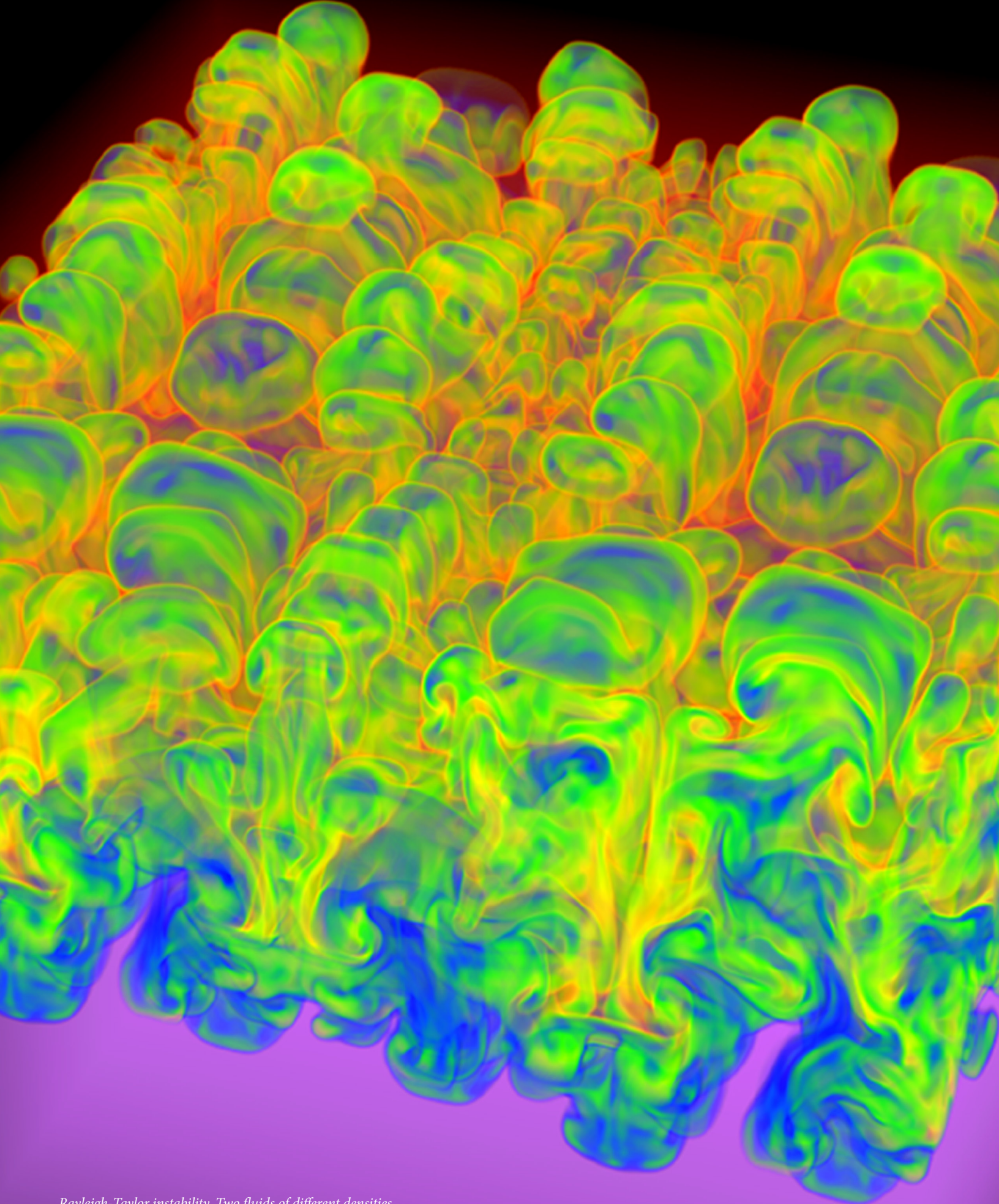
KC: The good news is he probably has plenty of time. But it is time to be thinking. You don't want to be scrambling when you're 75 and can't quite do it anymore.

CP: Thank you very much.

KC: Did we finish everything you need to do?

CP: Yes.

END OF INTERVIEW

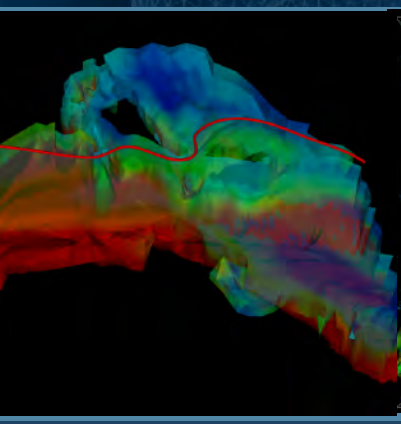
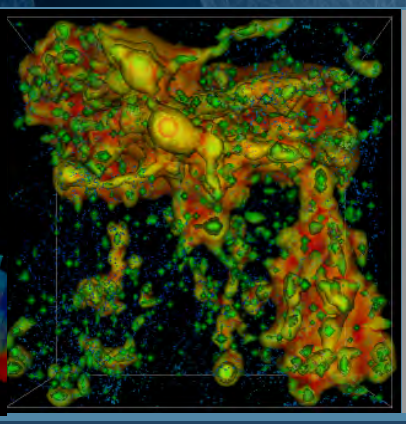
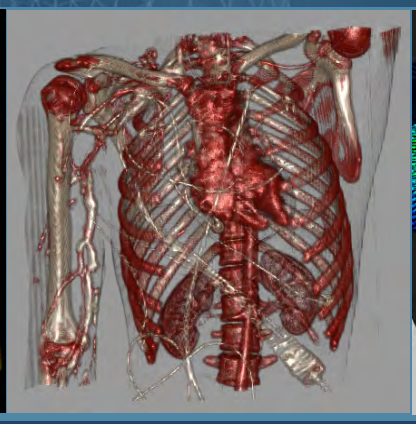
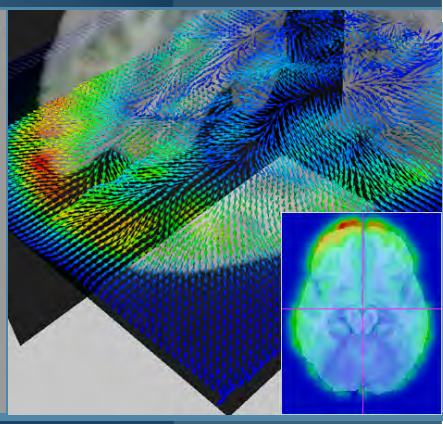


Rayleigh-Taylor instability. Two fluids of different densities are mixed simply by the weight of one on the other.

Appendix

2008 Research Brochure

SCI INSTITUTE

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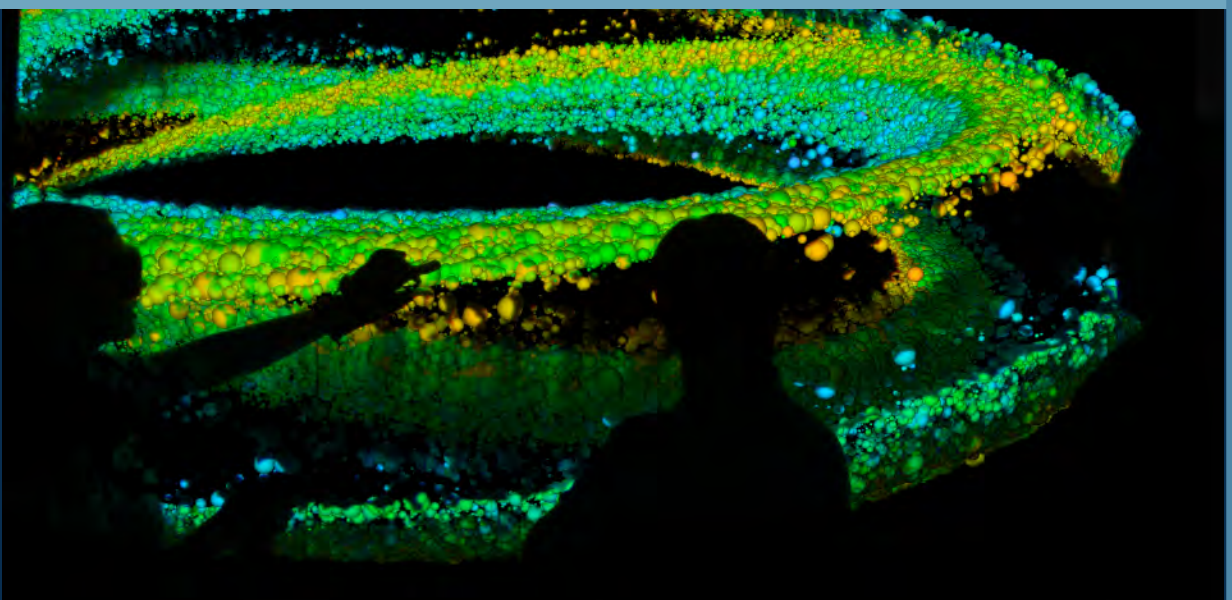
CONTENTS

If we want to reach critical mass, the only way is to work and collaborate with each other. And that is where we gather our strength.

- Mario R. Capecchi

Visualizing a series of atomic particles that are part of a 3D simulation of magnetically confined fusion energy. Such research is essential for the development of new energy sources (data courtesy Stephane Ethier of the Princeton Plasma Physics Laboratory).



THE UNIVERSITY OF UTAH

SCI

The campus of the University of Utah

THE SCIENTIFIC COMPUTING AND IMAGING INSTITUTE

The Scientific Computing and Imaging (SCI) Institute is a permanent research institute at the University of Utah. Directed by Professor Chris Johnson, the Institute now consists of over 100 faculty, students, and staff. The faculty, drawn primarily from the School of Computing and the Department of Bioengineering, is noted for its breadth of collaborations both nationally and internationally.

The SCI Institute has established itself as an internationally recognized leader in visualization, scientific computing, and image analysis. The overarching research objective is to create new scientific computing techniques, tools, and systems that enable solutions to problems affecting various aspects of human life. A core focus of the Institute has been biomedicine, but SCI Institute researchers also solve challenging computational and imaging problems in such disciplines as geophysics, combustion, molecular dynamics, fluid dynamics, and atmospheric dispersion.

SCI Institute research interests generally fall within four core tracks. The first track involves research into new techniques for scientific visualization and the development of visual analysis tools to facilitate understanding of increasingly complex and rich scientific data. The second focuses on tech nical research into computational and numerical methods requisite for scientific computing. The third track involves creating new image analysis techniques and tools. The final track emphasizes research and development of scientific software environments. SCI Institute researchers also apply many of the above computational techniques within their own particular specialties, including fluid dynamics, atmospheric dynamics, biomechanics, electrocardiography, bioelectric fields, adaptive techniques, parallel computing, inverse problems, and medical imaging.

The SCI Institute currently houses the NIH Center for Integrative Biomedical Computing (CIBC) and the Utah Center for Interactive Ray- Tracing and Photo Realistic Visu alization. The Institute is also associated with several addi tional national research centers, including the DoE Center for the Simulation of Accidental Fires and Explosions (C-SAFE), the DoE Visualization and Analytics Center for Enabling Technologies (VACET), the DoE Scientific Data Management Center, the DoE Center for Technology for Advanced Scientific Component Software (TASCS), the NIH National Alliance for Medical Image Computing (NA-MIC), and the NIH Center for Computational Biology.

A particular aim and hallmark of SCI Institute research has been to develop innovative and robust software packages that are made broadly available to the scientific community under open source licensing, including the SCIRun scientific problem solving environment, BioPSE, BioImage, BioTen sor, Seg3D and map3d.

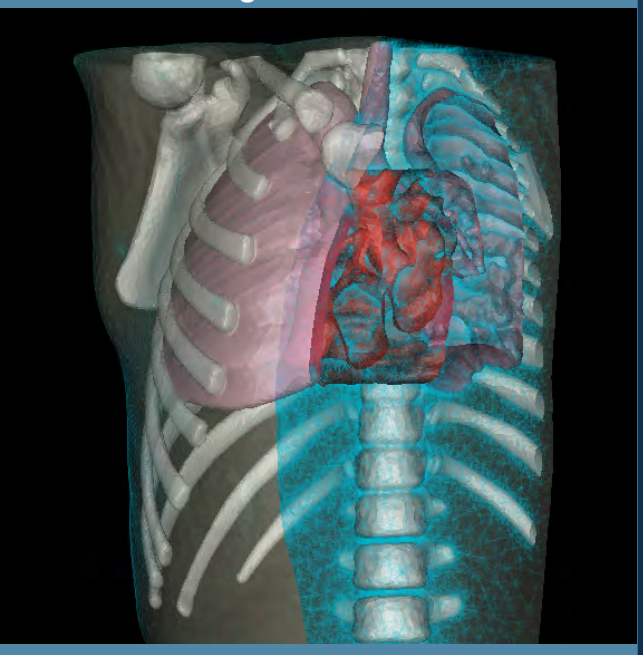
For more information about the SCI Institute:

www.sci.utah.edu

Scientific Computing

Numerical simulation of real-world phenomena provides fertile ground for building interdisciplinary relationships. The SCI Institute has a long tradition of building these relationships in a win-win fashion a win for the theoretical and algorithmic development of numerical modeling and simulation techniques and a win for the discipline-specific science of interest. High-order and adaptive methods, uncertainty quantification, complexity analysis, and parallelization are just some of the topics being investigated by SCI faculty. These areas of computing are being applied to a wide variety of engineering applications ranging from fluid mechanics and solid mechanics to bioelectricity.

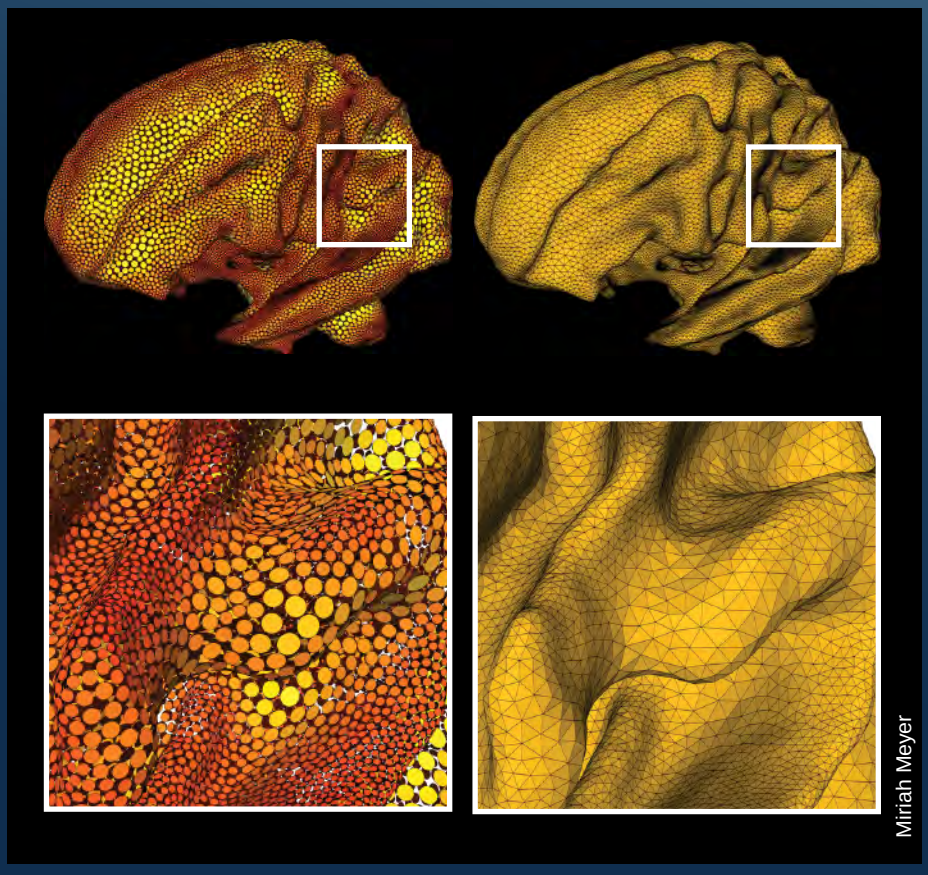
Building Better Meshes



Conformal, adaptive multimaterial meshes will allow efficient, high-quality simulations on patient specific models of cardiac defibrillation.

Dynamic Particle Systems for Adaptive Sampling of Implicit Surfaces

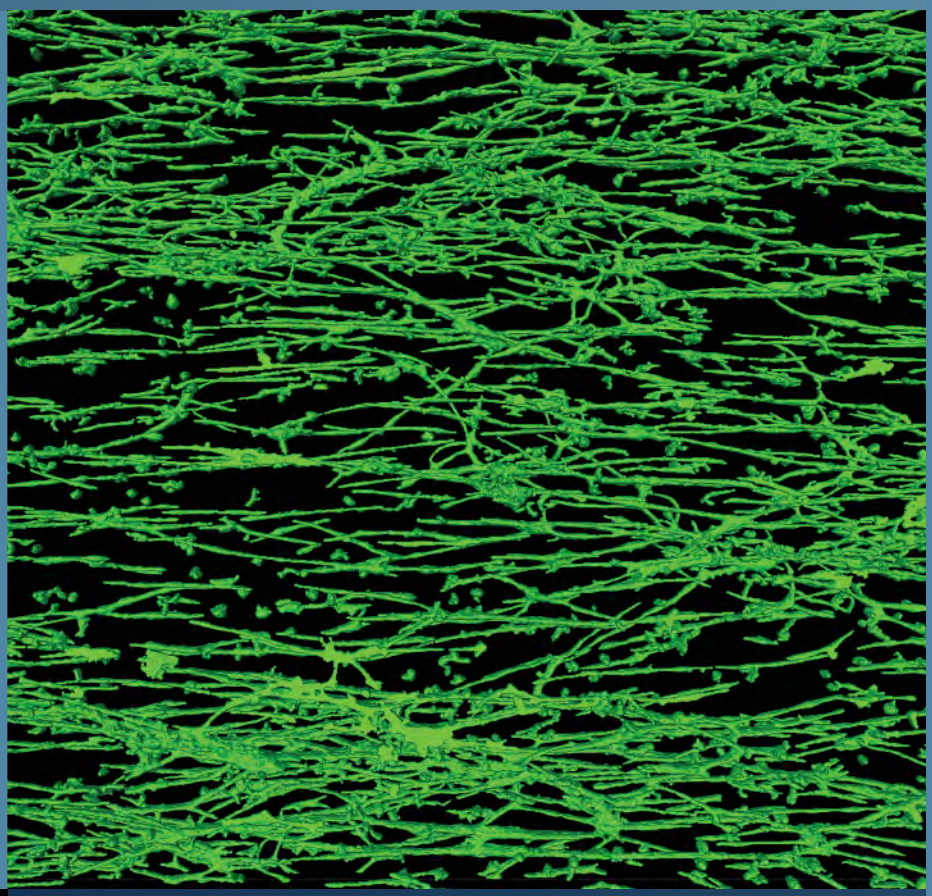
The generation of a set of point samples is a ubiquitous requirement in many mathematical and computational problems from shape statistics, to mesh generation, to visualization. Dynamic particle systems are an intuitive and controllable mechanism for producing very even distributions of points across complex implicit surfaces. Controlled by only a few constraints, these systems can robustly provide nearly-regular packings that smoothly adapt to surface features. The constraints cause particles to first stick to the zero set of an implicit function, and then to move across the surface until particles are arranged in minimal energy configurations. Adaptivity is added into the system by scaling the distance between particles, causing higher densities of particles around surface features. The end result is an adaptive, yet very regular, set of surface points.



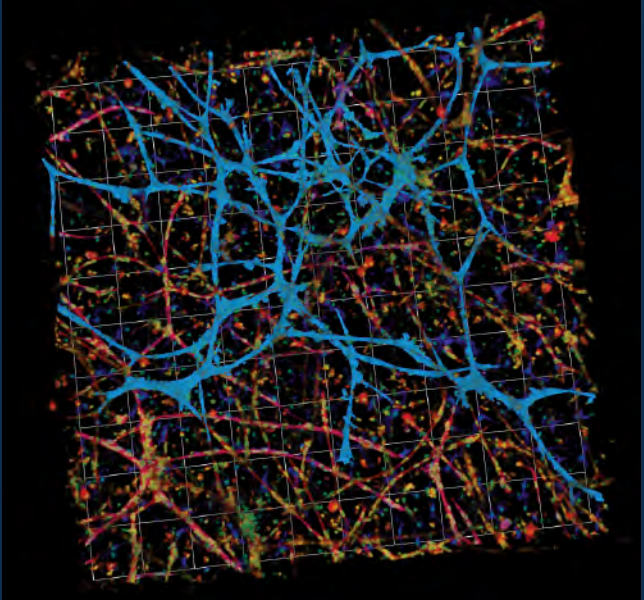
Particles on the brain and the resulting tessellation. The surface is a reconstruction of a white matter segmentation.

Computational Biomechanics

The technical field of computational biomechanics involves the development and use of tools in computational mechanics for applications in biology and medicine. Our research focuses on the development of finite element and meshless methods to examine the mechanics of soft and hard tissues. We have created techniques to build subject- and patient-specific computational models of soft and hard tissues directly from biomedical image data such as CT, MRI and confocal microscopy. We have also formulated new constitutive models and numerical implementations that capture the nonlinear, anisotropic and viscoelastic properties of biological materials such as ligament, tendon, cartilage, meniscus and myocardium. Our last focus has been to capture the unique boundary conditions associated with biological systems such as residual stress and position-dependent anisotropy.



Clay Underwood



Volume rendering of confocal image data for angiogenesis showing the largest continuous structure (blue).

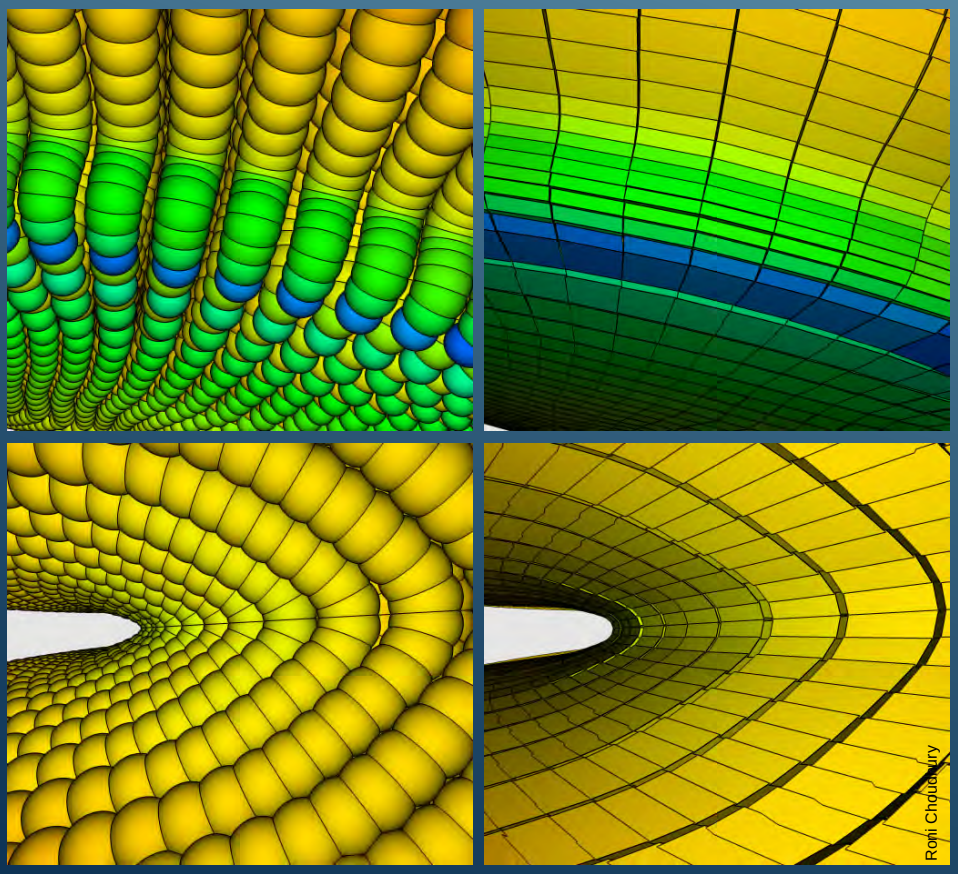
The Mechanics of Angiogenesis

Angiogenesis, or the formation of new blood vessels, is a critical part of tissue growth and healing processes. It is well known that the endothelial cells that compose angiogenic microvessels are acutely sensitive to mechanical loading and boundary conditions, but the exact role of mechanics in angiogenesis is poorly understood. By elucidating the underlying mechanisms of this process, we hope to identify strategies for inducing, directing, and inhibiting the process of microvessel sprouting and elongation. Toward this end, we have developed computer models based on confocal image data with multiple fluorophores to elucidate the mechanisms behind angiogenic growth and interaction with the extracellular matrix.

Above: Z-projection of a 3D rendering of microvessels grown in our in vitro model. Endothelial cells within the microvessel cultures were stained with a fluorescent conjugate and three-dimensional image sets were obtained using Laser Scanning Confocal Microscopy. The growing microvessels have become aligned along the horizontal axis only due to the boundary conditions applied to the 3 dimensional collagen matrix in which they are grown. In this case, the matrix was anchored to fixed supports at each end of the horizontal axis. We are currently modeling how these microvessels are able to orient themselves under these conditions.

Visualization

Scientific visualization, sometimes referred to as visual data analysis, uses the graphical representation of data as a means of gaining under standing and insight into the data. Scientific visualization research at SCI has focused on applications spanning computational fluid dynamics, medical imaging and analysis, and fire simula tions. Research involves novel algo rithm development to building tools and systems that assist in the compre hension of massive amounts of scien tific data. Interactive forms of visual ization are superior to static or pre recorded animations as they allow the user to control the nature and perspective of the views and thus provide better cues with which to explore complex relationships in the data. Thus, much of our visualization research focuses on creating efficient, responsive interactive displays.



Visual Cues for Geometric Features

Top images: The spheres falsely imply that the corner of the cylinder lies along the green particles, while the hexahedra show that actually, the corner occurs in the blue particles, and the green particles show a slight bulge just above it. Bottom images: Hexahedra show the geometry of high curvature areas more clearly than spheres can through shading cues that suggest surfaces directly.

Physical Models for the Polarized Scattering of Light

The change in polarization state due to the interaction of light with the surface and beneath the surface of an object has become increasingly important in realistic image synthesis of materials such as metallic, iridescent and pearles cent paint, skin, hair and cosmetics. This paper presents a model for the anisotropic scattering of polarized light based upon the physics of light; which is capable of calculating both partial and complete polarization using a combi nation of Jones and Mueller calculus, as well as incorporating self shadowing effects.

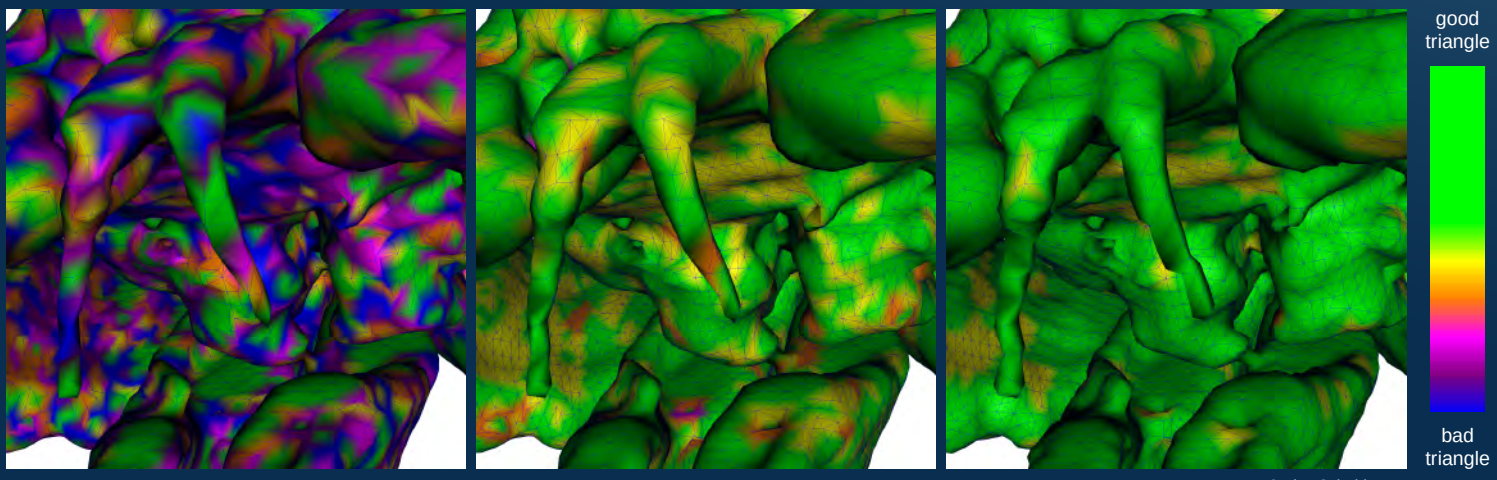
Left: A translucent dragon statue that is made of a type of nephrite jade simulated using the new theoretical reflectance models for surface and subsurface diffuse scattering. Right: Illustrates how smoothly polished a simulated nephrite jade dragon statue appears, which enhances the soft appearance of the statue and the visual realism of the image. This is due to a combination of reflectance properties from the surface scattering, the subsurface specular and subsurface diffuse scattering of light from the material.

David Brayford

Dragon and Buddha statues. The Buddha is made of a multilayered material simulated using the new anisotropic theoretical reflectance model. The images in the left column were rendered without a polarized filter, while images in the right column were rendered with a polarizing filter.

Edge Groups: A New Approach to Understanding the Mesh Quality of Marching Methods

Marching Cubes (MC) is the most popular isosurface extraction algorithm due to its simplicity, efficiency and robustness and has been widely studied, improved, and extended. As part of study to improve MC results for applications in scientific comput ing, we have developed a new classification scheme called “Edge Groups”, which helps improve the quality of resulting surfaces. This formulation allows for a more systematic way to control the quality of triangles that make up the surface and is general enough to extend to other polyhedral cell shapes.

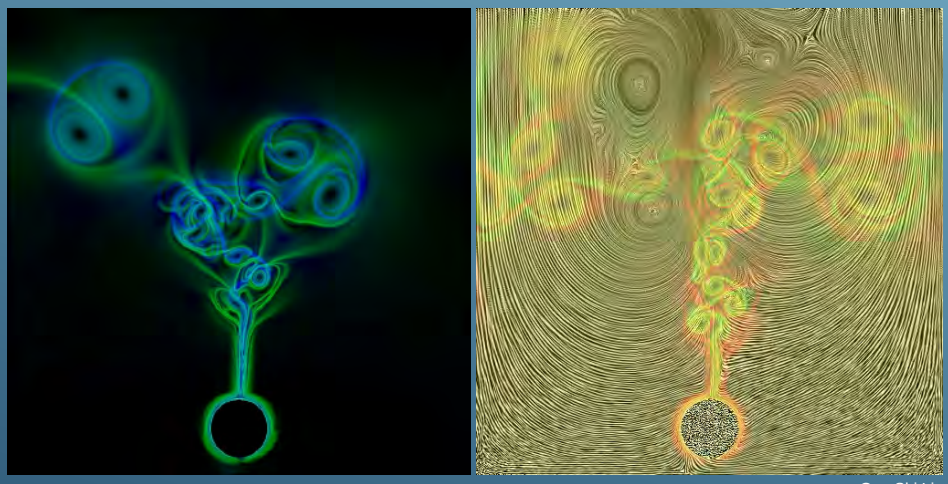


Carlos Scheideger

Comparisons on enlarged sections of a complex dataset. Left: MC using original table. Middle: Macet (an example of a triangle quality improvement technique that modifies the inner computation of MC) using original MC table. Right: Macet using displacements and the new MC table. Triangles are color-coded based on the radii-ratio quality.

Visualization of Coherent Structures in Transient 2D Flows

The depiction of a time-dependent flow in a way that effectively supports the structural analysis of its salient patterns is still a challenging problem for flow visualization research. While a variety of powerful approaches have been investigated for over a decade now, none of them so far has been able to yield representations that effectively combine good visual quality and a physical inter pretation that is both intuitive and reliable. Yet, with the huge amount of flow data generated by numerical computations of growing size and complexity, scientists and engineers are faced with a daunting analysis task in which the ability to identify, extract, and display the most meaningful information contained in the data is becoming absolutely indispensable.



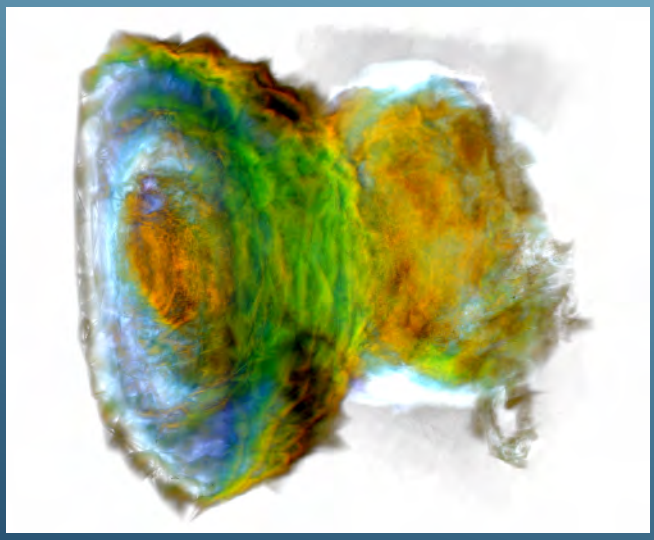
Guo Shi Li

Comparison: Direct FTLE visualization (left), and a combination of both FTLE and UFLIC (right).

Direct Volume Rendering

Creating insightful visualizations from both simulated and measured data is an important problem for the visualization community. For scalar volumes, direct volume rendering has proved to be a useful tool for data exploration. With the use of a transfer function, scalar values can be mapped to colors and opacities to identify and enhance important features. Though some automatic techniques have been developed for transfer function specification, the exploration process still involves tuning the parameters manually until the desired visualization is produced. A great deal of research has recently been performed to assist the user in this specification task with interactive widgets. These tools generally assist the user by allowing them to create and manipulate widgets over one or more dimensions of histogram information of the data.

The user interface for interactive transfer function specification is shown for the time-varying Turbulent Jet dataset using a 2D time histogram.

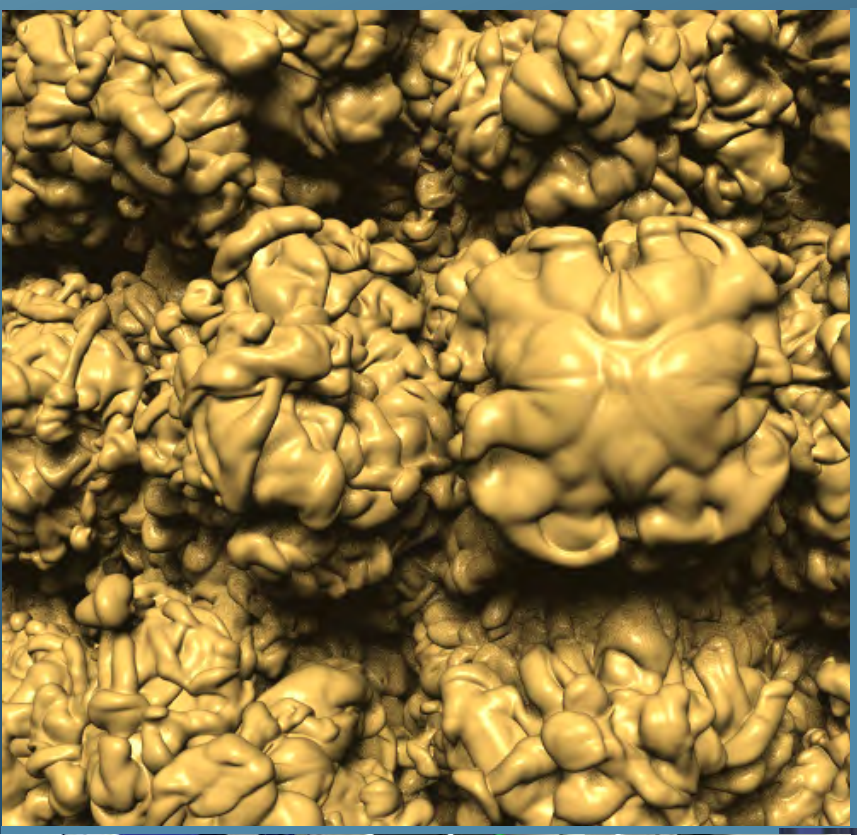


Erik Anderson

Steve Callahan

Direct volume rendering example showing several different transfer functions. The data set comes from a computed tomography (CT) scan of a chest.

Interactive Ray Tracing



Interactive ray tracing research (IRT) at SCI focuses on developing new algorithms and other optimizations for ray tracing complex scenes at multiple (15 or more) frames per second. Driven by applications in scientific visualization and traditional graphics, IRT uses only CPU resources to render datasets of hundreds of millions of polygons or tens of gigabytes of scientific data. Due to it's lower complexity, IRT can actually outperform even high-end GPUs for large datasets. One large user of IRT is the University of Utah's Center for Simulation of Accidental Fires and Explosions, which employs our tools to visualize complex datasets consisting of millions of particles representing an explosive device subjected to a fire. In addition to performance for large datasets, IRT enables use of more sophisticated shading techniques that enhance realism for graphics applications and help convey complex spatial information in scientific datasets.

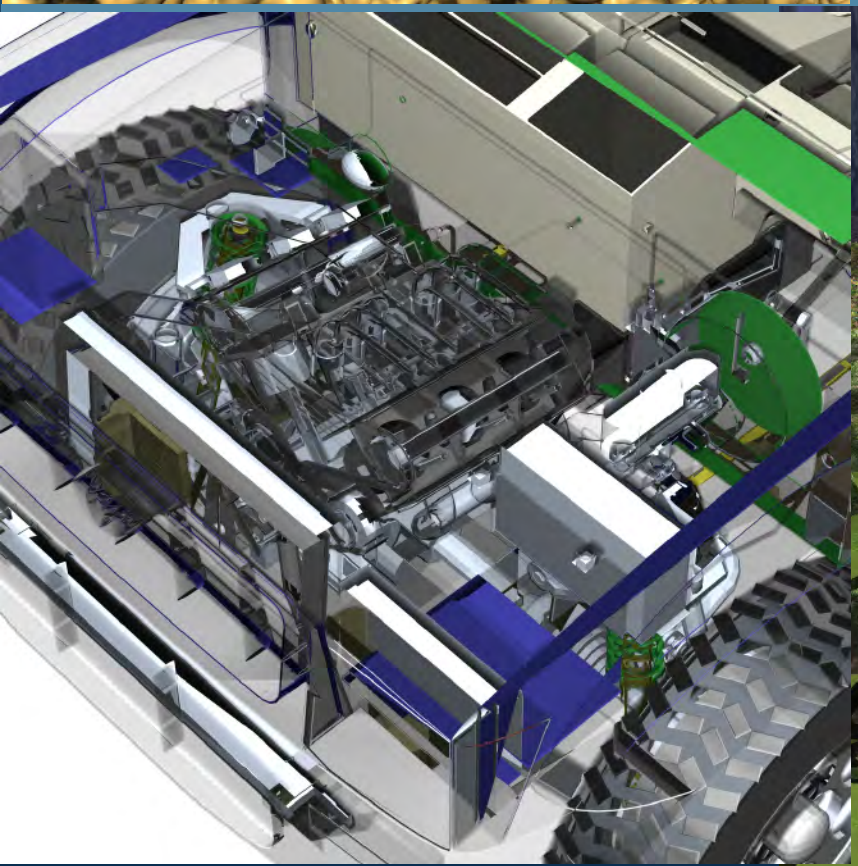
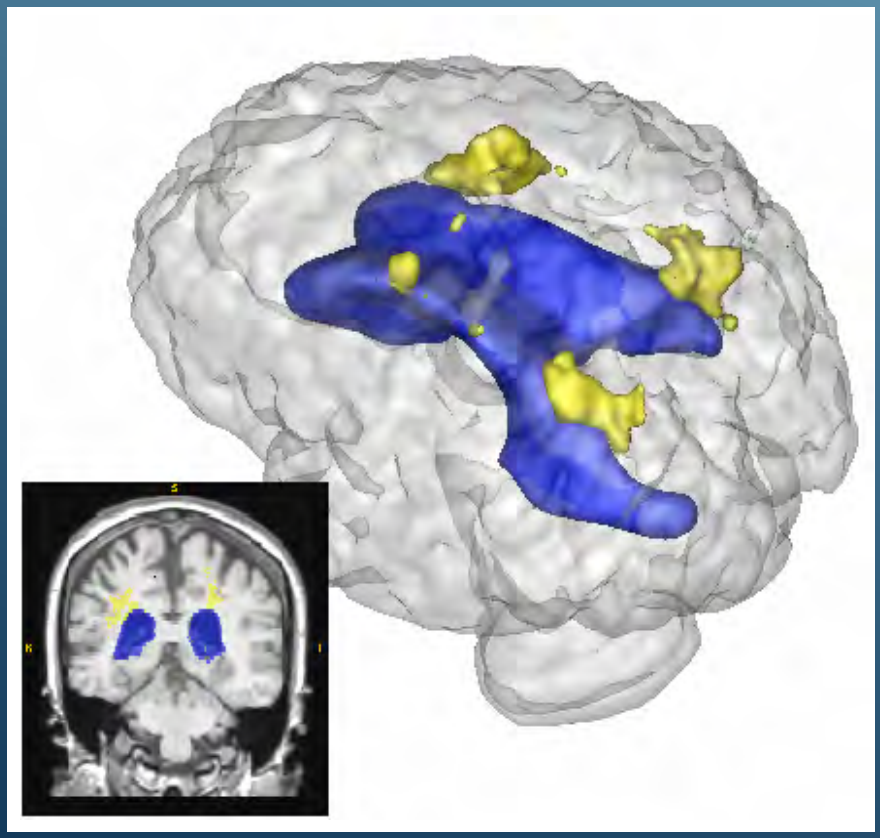


Image Analysis

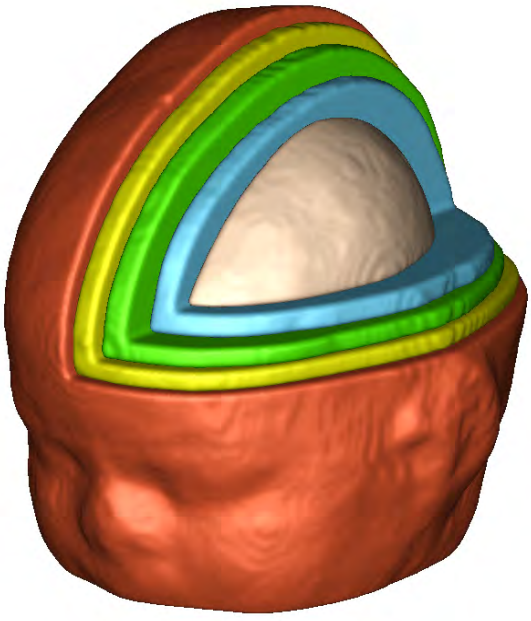
SCI's imaging work addresses fundamental questions in 2D and 3D image processing, including filtering, segmentation, surface reconstruction, and shape analysis. In low-level image processing, this effort has produced new methods for modeling image statistics, which have resulted in better algorithms for denoising and reconstruction. Work with particle systems has led to new methods for visualizing and analyzing 3D surfaces. Our work in image processing also includes applications of advanced computing to 3D images, which has resulted in new parallel algorithms and real-time implementations on graphics processing units (GPUs). Application areas include medical image analysis, biological image processing, defense, environmental monitoring, and oil and gas.

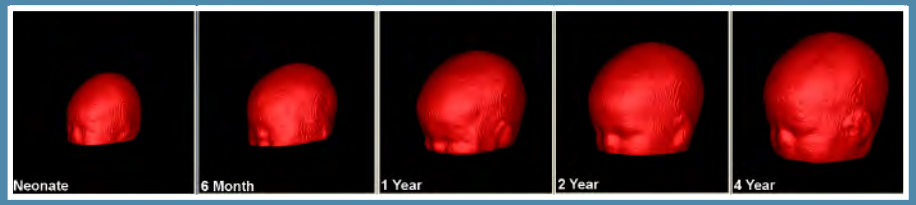


Marcel Prastawa

Brain Lesion Analysis

Quantification, analysis and display of brain pathology such as white matter lesions as observed in MRI is important for diagnosis, monitoring of disease progression, improved understanding of pathological processes and for developing new therapies. The Utah Neuroimage Analysis Group develops new methodology for extraction of brain lesions from volumetric MRI scans and for characterization of lesion patterns over time. The images show white matter lesions (yellow) displayed with ventricles (blue) and transparent brain surface in a patient with an autoimmune disease (lupus). Lesions in white matter and possible correlations with cognitive deficits are also studied in patients with multiple sclerosis (MS), chronic depression, Alzheimer's disease (AD) and in older persons.





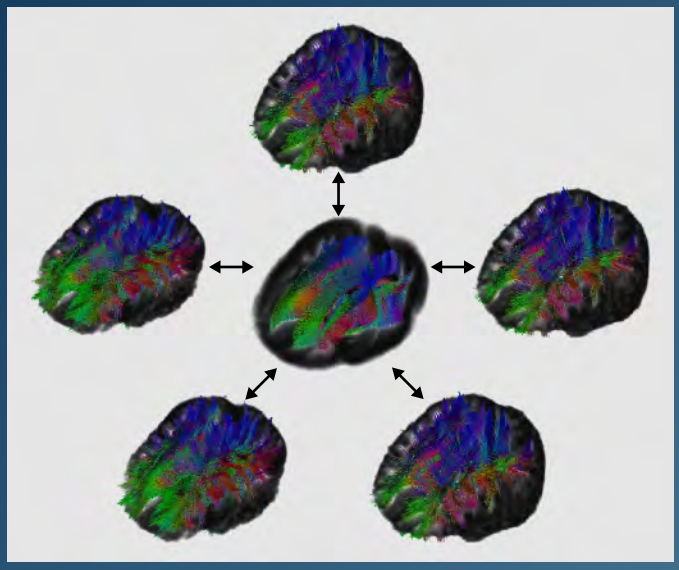
Sylvain Gouttard

Infant MRI Head Coil Design

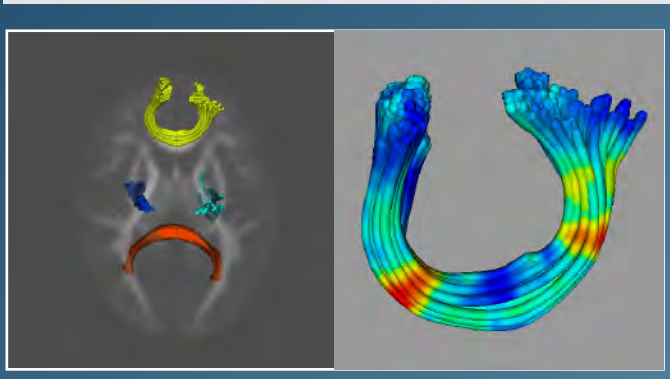
Improved MRI methodology for infant imaging: We study head/brain growth and create statistical models of neonates, 6mo, 1yr, 2yr and 4yr. Based on these models, the MGH group creates new parallel coils for the scanner. We then get these parallel images and combine them back with new signal processing.

Diffusion Tensor MRI Population Analysis

Diffusion tensor magnetic resonance imaging (DT-MRI) is relatively new imaging technique which provides new insight into the structure of brain white matter by measuring the local diffusion of water in the brain. In this project associated with the national alliance for medical image computing (NAMIC) images are combined from a population, as shown in figure 1, into a template atlas which reflects the average properties of the population. White matter bundles are extracted from in the template atlas to serve as a coordinate system for measuring diffusion properties and how they differ between populations. In a study of neurodevelopment in association with the CONTE center at University of North Carolina Chapel Hill, an atlas was developed based one subjects at one and two years of age. Figure 2 shows fiber bundles extracted from this template atlas. Statistical comparison of the diffusion properties between one and two year olds indicates significant changes the may reflect underlying changes in myelination and axon development. Figure 3 shows differences in the fractional anisotropy (FA), a measure of diffusion tensors which is thought to reflect axon development, from one to two years. The red regions indicate the largest increase of the FA value.



Casey Goodlett



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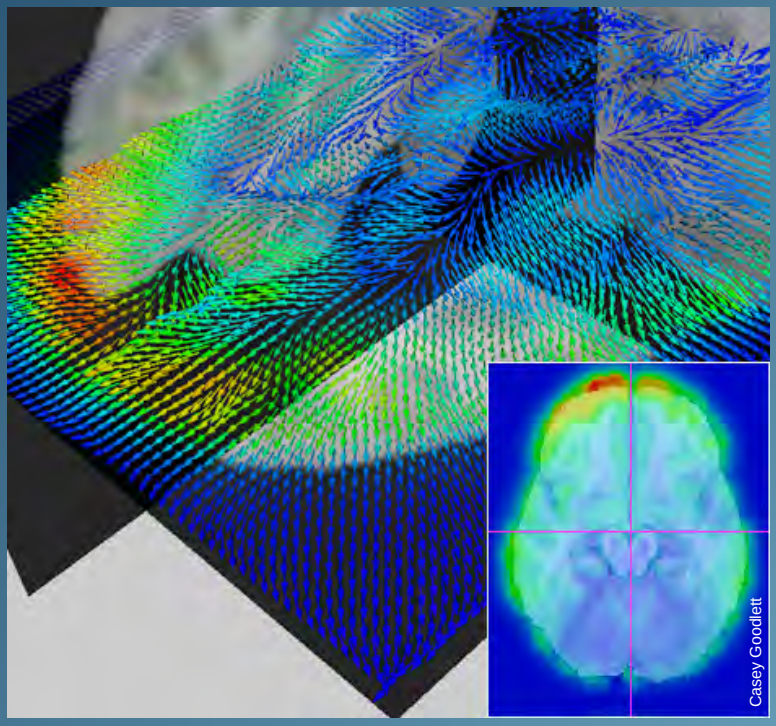
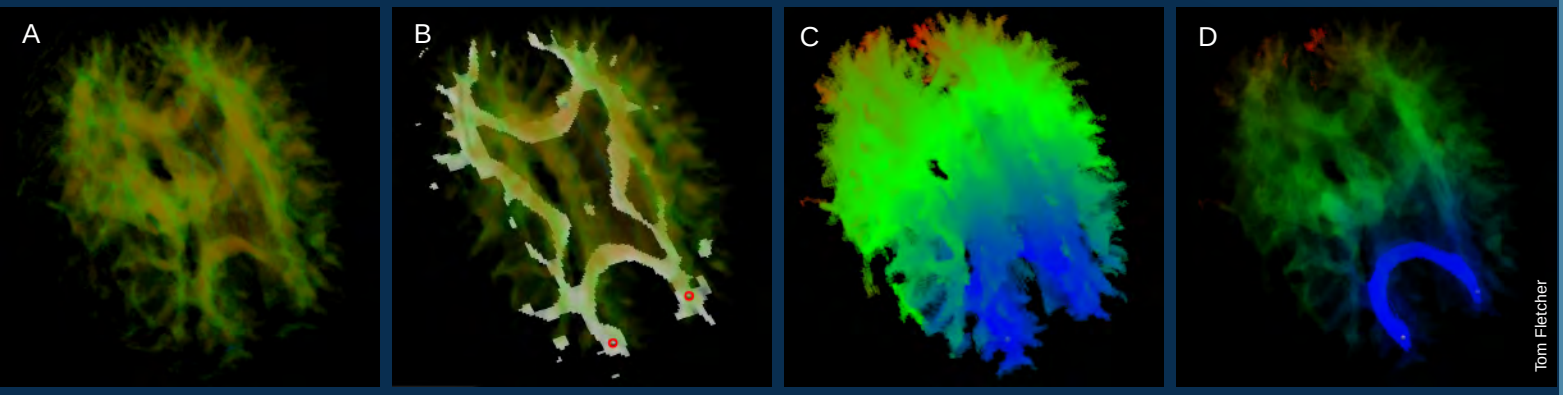


Longitudinal growth of a population of infant brains from two to four years of age. Red and green mark regions of largest growth. Studying the early developing brain is of utmost interest for a better understanding of the variability of normal growth and of changes of growth trajectories in children at risk for mental illness.

The goal of this form of visualization is to identify the voxels in the diffusion tensor MRI volume that trace out paths linking two regions of the brain based on an optimization algorithm. The resulting paths may show the paths of functional communications between different parts of the brain.

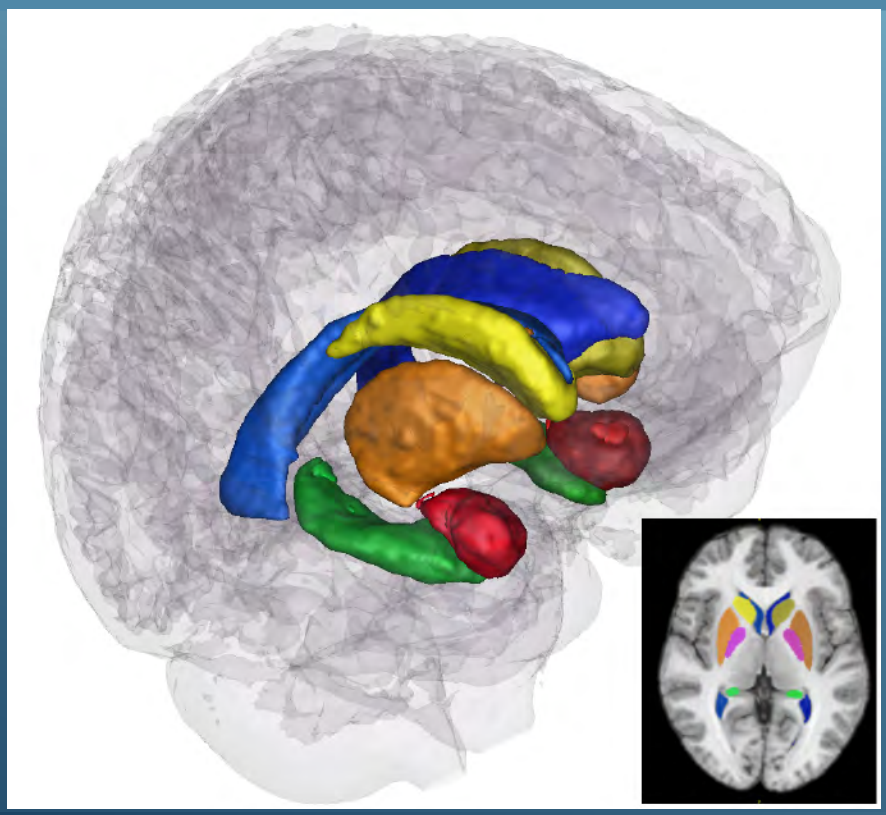


A) Input DT-MRI volume; B) Seed points (marked as red circles); C) Cost volume (blue to red : low to high); D) Volumetric path along genu (blue).

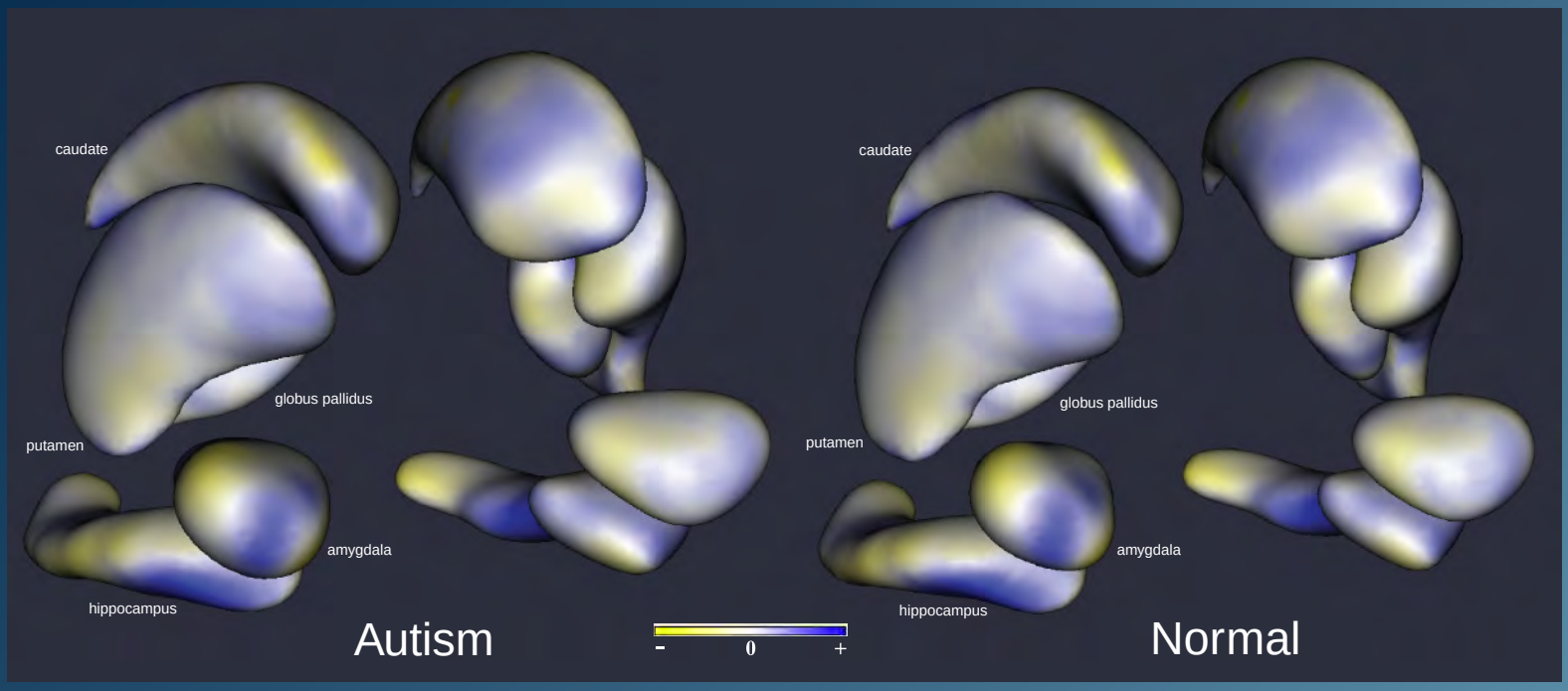
Extracting Anatomical Structures

The ability to create accurately segmented three dimensional models from imaging devices such as MRI, PET, CT, and others is crucial to the under standing of structural development.

The right image shows the result of automatic extraction of anatomical structures from a patient MRI using software developed by the Utah Center for Neuroimage Analysis. Measurements of subcor tical brain structures are of specific interest in study ing structure-to-function relationship. Research in autism, schizophrenia and Alzheimer's disease is particularly interested in volumes and shape of hippocampus (green), amygdala (red) and caudate (yellow). Below shows the segmentation of skull, white and gray matter.



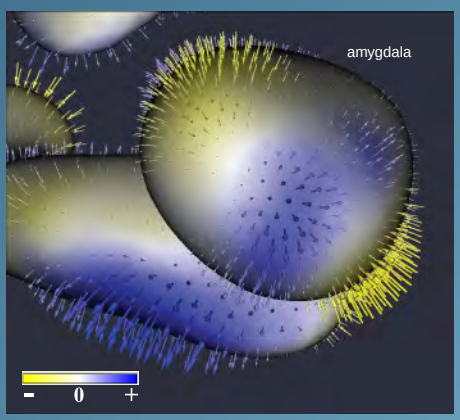
Sylvain Gouttard



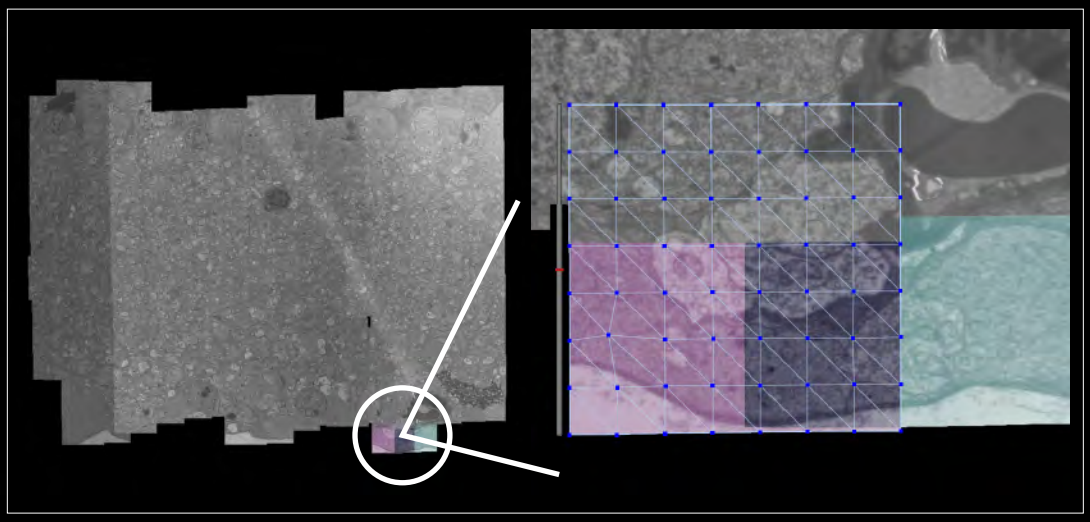
Josh Cates

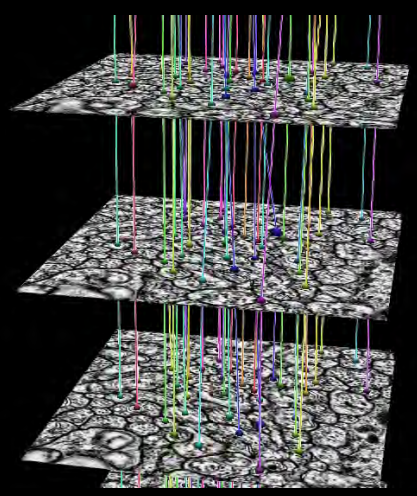
Shape Analysis of Neuroanatomical Structures

We have developed a new method for constructing statistical representations of ensembles of similar shapes that uses particle systems to represent surfaces non parametrically and optimally sample surface point correspondences. We used this method to generate models for two clinical datasets: normal vs. Autistic neurological development. Hypothesis testing on these models using a non parametric permutation test of the Hotelling T-squared metric (including false-discovery-rate (FDR) correction) reveals significant group differences. Colormap indicates the magnitude and direction of the linear discriminant.



Axon Tracking in Serial Block-Face Scanning Electron Microscopy





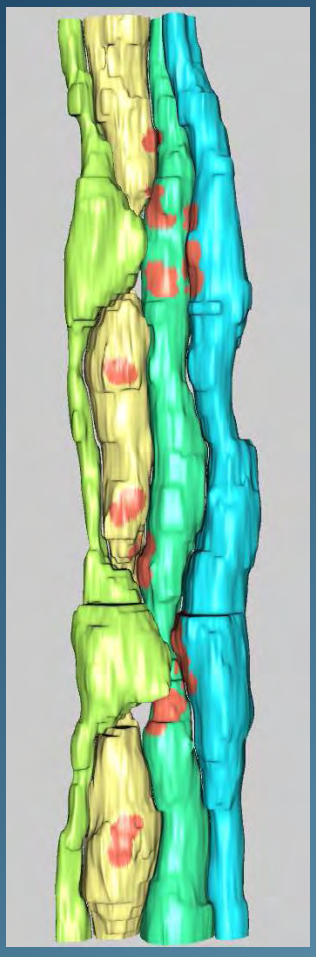
Tolga Tasdizen, Ross Whitaker, Robert Marc, Chi-Bin Chien, Bryan Jones, Liz Jurrus, Pavel Koshevoy, Samuel Gerber, Melissa Hardy, Winfred Denk

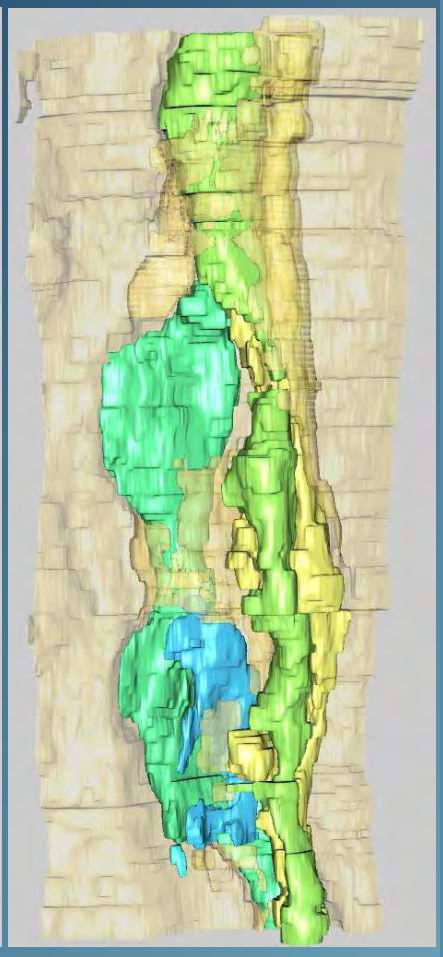
We address the problem of building three-dimensional connectivity maps for neurons from sectional electron microscopy. Sectional data consists of a stack of very high-resolution, two-dimensional images that are oriented to capture cross sections of elongated neuronal processes. High magnification serial microscopy images have the potential to expand the field of neurophysiological modeling by providing ground-truth neuroanatomical data. However, their complexity and vast size make them impractical for human interpretation. This project aims at building automatic and semi-automatic tools to assist researchers in analyzing such data.

Semi-Automated Reconstruction of the Neuromuscular Junctions in the C. elegans

For a nervous system to function, it must be wired properly. Specifically, neurons need to find their targets and form synapses. The neuron maintains such connections for years, accommodating growth of the organism and making allowance for other neurons that synapse to access the same target. Fulfilling these functions make topological demands on neurons and their targets. To study this process we are reconstructing the neuromuscular junctions in the nematode C. elegans.

To determine the topology of this complex synaptic region we have reconstructed a segment of the ventral nerve cord from serial electron micrographs. The data are registered and assembled automatically and then reconstruction of individual neurons is performed using a modified path finding approach.





(a) 3D renderings of the four neurons competing for information from the muscles. The location of the synapses, which were extracted from user specified locations, are shown in red on the neurons. (b) Similar rendering of the muscles that run alongside the motor neurons.

Scientific Software Environments

SCIENTIFIC SOFTWARE ENVIRONMENTS

Software at the SCI Institute is developed in close collaboration with application users to satisfy real needs within their research communities. We use a robust, yet agile software process that is fully open-source to produce software environments that integrate leading-edge algorithms in image processing, scientific visualization, and scientific computing. Software products include the SCIRun scientific software problem solving environment for geometric modeling, simulation, and visualization; BioPSE for biomedical computing and visualization; Uintah, designed for combustion, computational fluid dynamics, and mechanical modeling which is implemented on large scale and distributed with shared memory architectures, map3d, an application to display and edit complex, three dimensional surface models and associated scalar, time dependent data; and VisTrails, providing data and process management support for exploratory computational tasks. Recently, the SCI Institute has been developing powerful, stand-alone applications. These software applications include ImageVis3d (formerly BioImage), a high performance volume rendering tool for image and other scalar volume data, BioTensor, a program that processes and visualizes diffusion tensor images, Seg3d, for volume segmentation and image processing, BioMesh3D, for creating tetrahedral and hexahedral meshes; and FusionViewer, for visualizing 3D scalar and vector magnetic fusion data

Software available for download

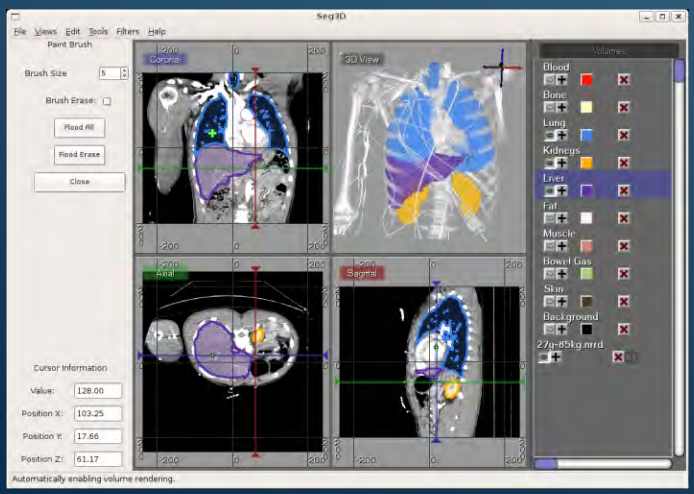
SCIRun/BioPSE (NIH)
ImageVis3d (NIH)
Seg3d (NIH)
BioTensor (NIH)
BioFEM (NIH)
map3d (NIH)
FusionViewer (DOE)
VisTrails (NSF)
FEBio (NIH)
PreView (NIH)
Postview (NIH)
WinFiber3D (NIH)
GAGSim3D (NIH)
WarpLAB (NIH)

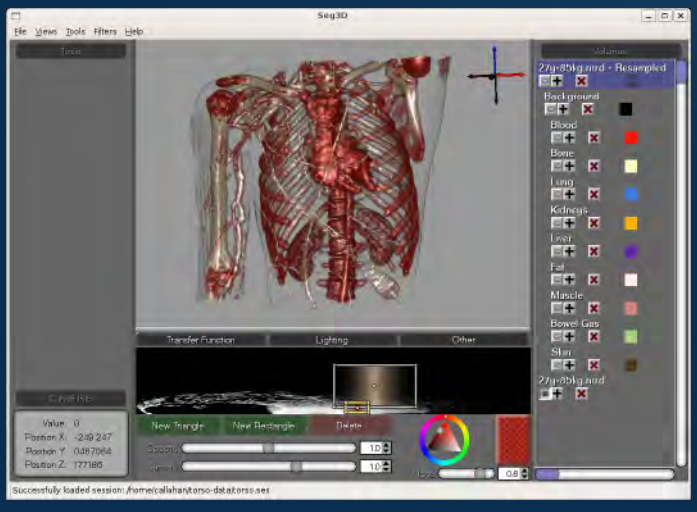
http://software.sci.utah.edu

Seg 3D

Seg3D is a free volume segmentation and processing tool developed by the NIH Center for Integrative Biomedical Computing at the University of Utah Scientific Computing and Imaging (SCI) Institute. Seg3D combines a flexible manual segmentation interface with powerful higher-dimensional image processing and segmentation algorithms from the Insight Toolkit. Users can explore and label image volumes using volume rendering and orthogonal slice view windows.

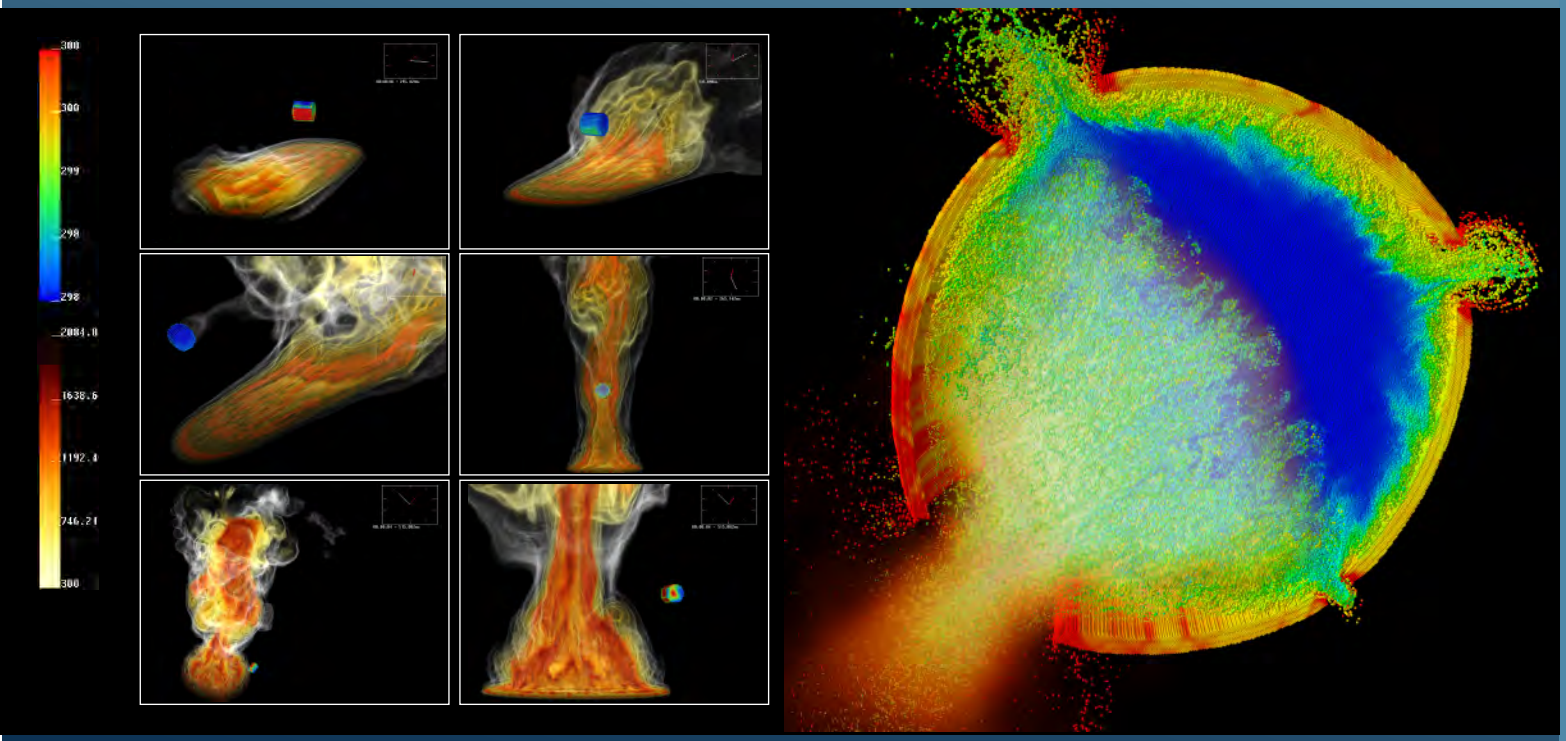
- Fully 3D interface with multiple volumes managed as layers
- Automatic segmentation integrated with manual contouring
- Volume rendering with 2D transfer function manipulation in real-time
- Image processing and segmentation from the Insight Toolkit (ITK)
- Real time display of ITK filtering output allows for computational steering
- 64-bit enabled for handling large volumes on large memory machines
- Supports many common biomedical image formats
- Open source with BSD-style license
- Cross platform: Windows, OSX, and Linux



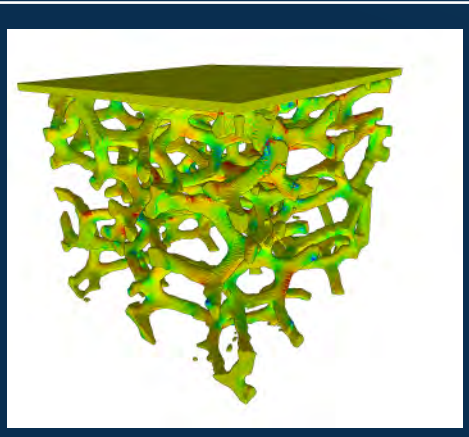


Uintah Computational Framework

A major success in our computing efforts has been the Uintah Computational Framework (UCF). The UCF is a component based software system with capabilities such as semi-automatic parallelism, automatic checkpoint/restart, load-balancing mechanisms, resource management, and scheduling. The UCF exposes flexibility in dynamic application structure by adopting an execution model based on software or "macro" dataflow. Computations are expressed as directed acyclic graphs of tasks, each of which consumes some input and produces some output (input of some future task). These inputs and outputs are specified for each patch in a structured grid. Tasks are organized in a UCF data structure called the task graph and assigned to processing resources by the scheduler. Load balancing is done by using a fast space filling curve algorithm.

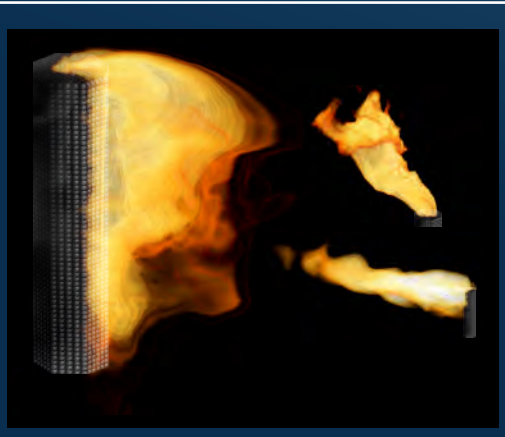


C-SAFE has under taken a sensitivity analysis of our fire/container simulations to study the effect of variations in a number of variables. These variables include 1) pool fire diameter (0.5 and 1.0m fires), 2) wind speed (0 and 4 m/s), 3) container position relative to the fire (in or next to the fire), and 4) fuel evaporation rate (1.6 and 6.4 mm/min). Below are visualizations of several of these simulations. During the first part of the simulation, the average heat flux from the fire to the container is calculated. This heat flux is then used during the heat-up phase of the simulation, leading to the explosion phase.



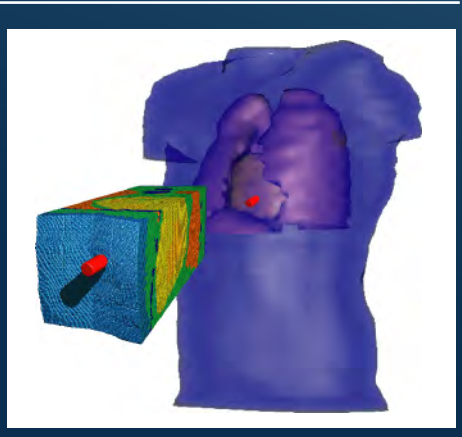
MPM Foam Compaction

Material Point Method simulation of compaction of a 1 mm cubed sample of reticulated foam. Initial geometry was collected via micro-CT with each voxel in the 3D image chosen to represent either the parent material, or void, depending on the image intensity. Individual particles are colored by equivalent stress.



Flare Simulations

Carried out on the LLNL machines LCR, Thunder, and ALC. Number of processors ranged from 54 to 120 depending on the domain size which was typically 1m x 1m x 3m and each simulation was resolved to 1 cm3. The prediction of the flame shape and tilt using large eddy simulation (LES) is consis tent with the experiments. The prediction of pollutant emissions is currently being studied.

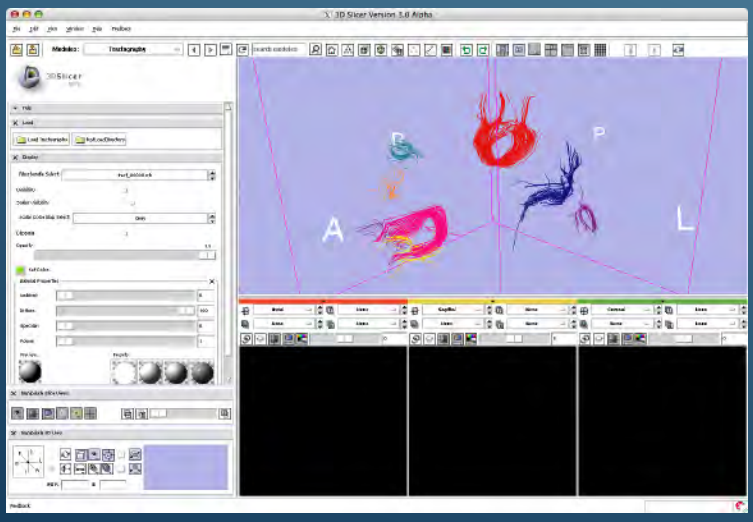


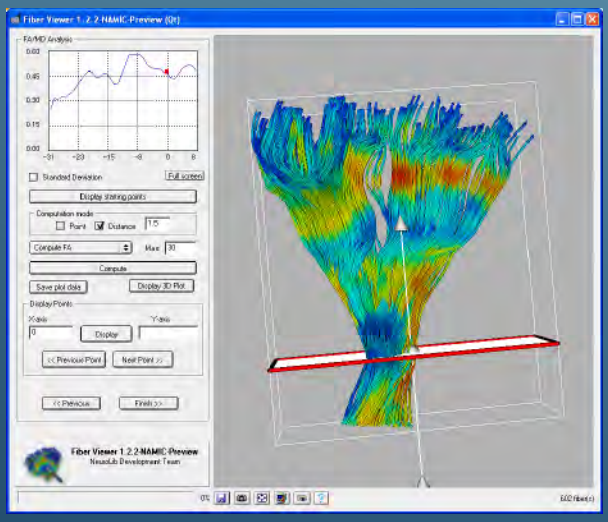
MPM Torso Injury Model

Initial configuration depicting an MPM simula tion of a bullet impacting a segment of the human torso. The segment is colored according to material types, including fat, bone, heart tissue, lung, blood and viscera. Because of its ability to treat large deformation and inter-penetration of materials , MPM lends itself well to these types of simulations.

Case study: 3D Slicer and FiberViewer

3D Slicer (www.na-mic.org) is an comprehensive, integrated, open-source environment for medical image visualization and analysis developed as part of the national alliance for medical image computing (NA-MIC) funded as a national center for biomedical computing (NCBC) through the NIH Roadmap for Medical Research. Slicer includes modules for segmentation, registration, diffusion tensor image (DTI) analysis, and many other features. In particular, the SCI institute has contributed modules for DTI analysis including regularization and smoothing. DTI analysis software from the NeuroLib library for neuroimage processing (www.ia.unc.edu/dev) such as FiberViewer has been made compatible with Slicer in order to allow an integrated analysis process. Clinical users are able to load diffusion weighted imgages into Slicer to perform preprocessing, tensor estimation, and fiber tracking. Data exported from Slicer can then be loaded into the FiberViewer tool to enable the study of diffusion statis tics along fiber bundles of interest. This provides a complete environment for end users to process DTI data for clinical studies.



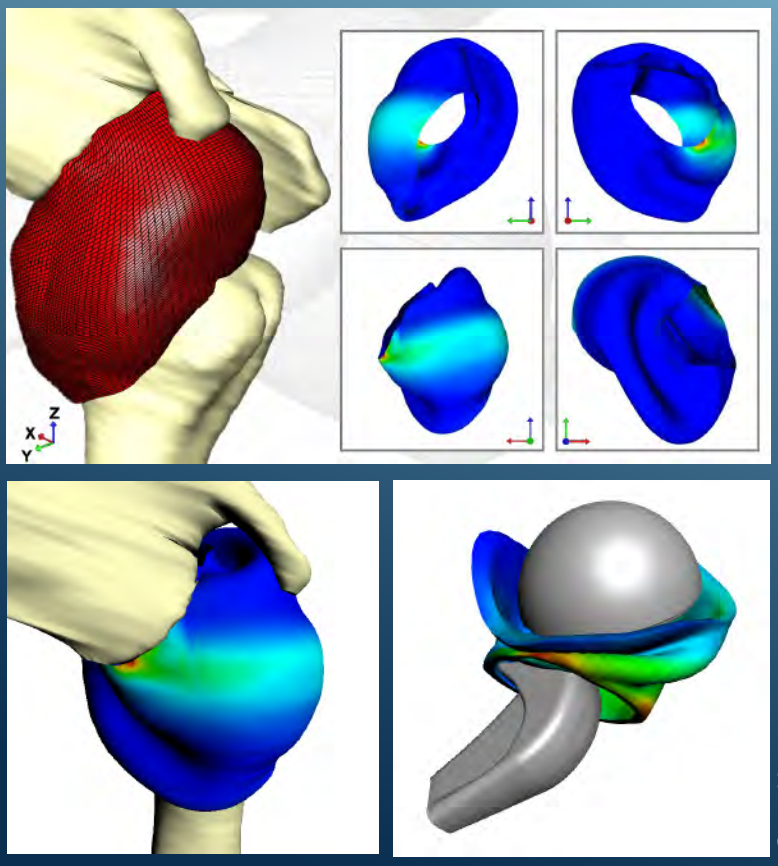


Case Study: FEBio

Computational modeling has become a standard methodology in biomechanics, both for interpreting experimental results and as an investigative approach. The finite element (FE) method is by far the most common numerical technique that is used for this purpose. Investigators have primarily used commercial software that is neither geared toward biological applications nor sufficiently flexible to follow the latest developments in the field. This lack of a tailored software environment has hampered research progress, as well as dissemi nation and sharing of models and results. To address these issues, we developed FEBio, a nonlinear implicit FE framework, designed specifically for analysis in computational solid biomechanics.

FEBio supports several non-linear constitutive models such as isotropic hyperelasticity and several transversely isotropic hyperelas tic models, which can be used to model materials such as muscles, ligaments, tendons. An active contraction model is also available for use with the anisotropic materials. This can be used e.g. to model active contraction of skeletal and cardiac muscle. FEBio also supports a poro-elastic constitutive model useful for simulating mate rials that consist of both a solid and a fluid phase (e.g. articular cartilage). Rigid bodies are available as well and can be linked together using kinematic joints or can be connected to deformable bodies. FEBio supports a wide set of boundary conditions, such as prescribed displacements, nodal forces and pressure forces. A general frictionless contact-model is available to support more complex boundary conditions such as sliding interfaces.

To facilitate problem development and post-processing of the results we have also developed a pre- and postprocessor, named PreView and PostView respectively. Both software programs offer the user a graphical user interface. All the software is available free of charge from our website (http://mrl.sci.utah.edu).



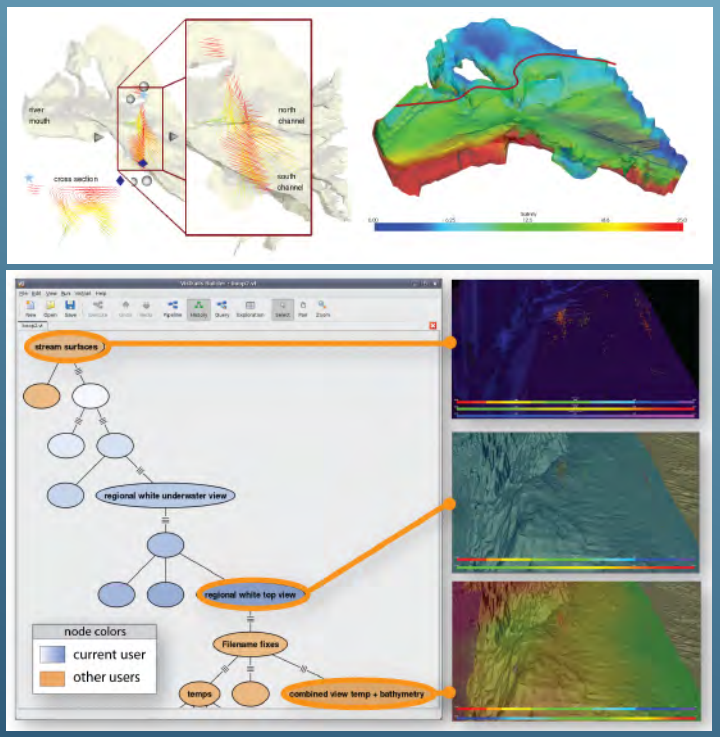
Top, bottom left: Finite element predictions of shoulder capsule strain during a clinical exam for anterior stability. bottom right: Finite element predictions of hip capsule strain during a test for total-hip implant dislocation.

Steve Maas

Case Study: VisTrails

VisTrails is a new scientific workflow management system developed at the University of Utah that provides support for data exploration and visualization. Whereas workflows have been traditionally used to automate repetitive tasks, for applications that are exploratory in nature, very little is repeated---change is the norm. As an engineer or scientist generates and evaluates hypotheses about data under study, a series of different, albeit related, workflows are created while a workflow is adjusted in an interactive process. VisTrails was designed to manage these rapidly-evolving workflows. VisTrails streamlines the creation, execution and sharing of complex visualizations, data mining or other large-scale data analysis applications. By automatically managing the data, metadata, and the data exploration process, VisTrails allows users to focus on the task at hand and relieves them from tedious and time-consuming tasks involved in organizing the vast volumes of data they manipulate. VisTrails provides infrastructure that can be combined with and enhance existing visualization and workflow systems.

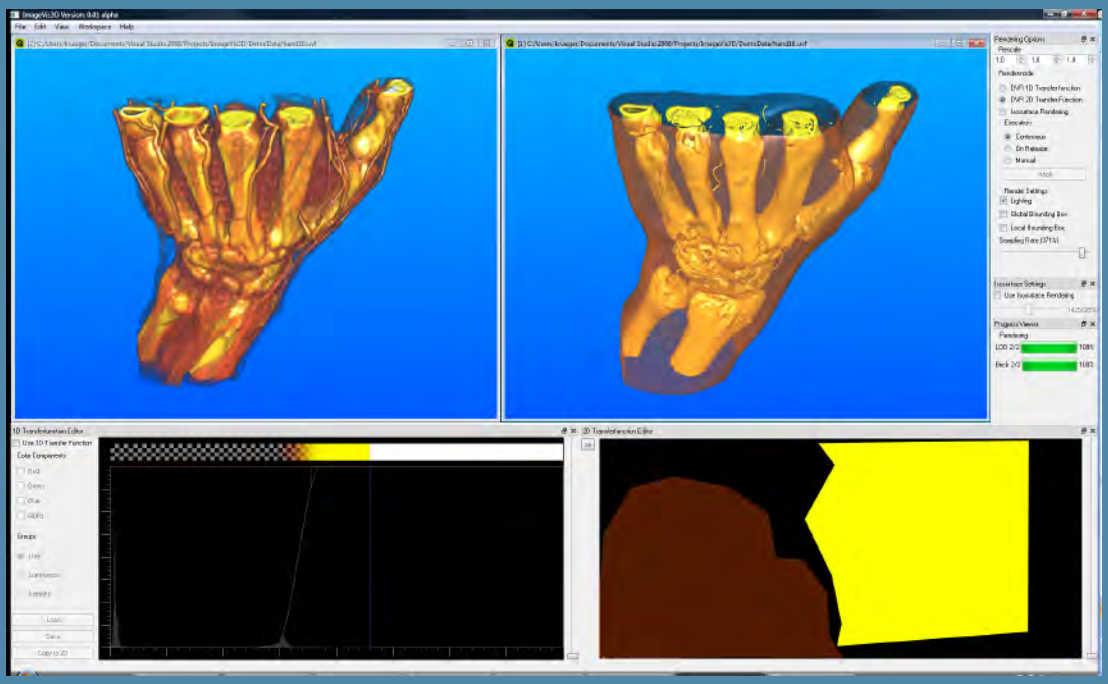
Although VisTrails was originally built to address the needs of exploratory scientific applications, the infrastructure it provides is very general. This became clear as the system was demoed to people from different domains, both from industry and academia. VisTrails has the potential to reduce the time to insight in virtually any exploratory task.

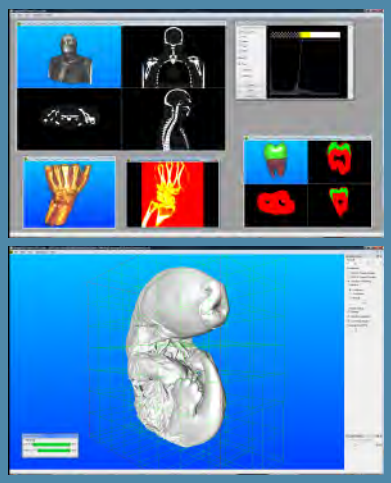


Top: The source of the upstream salt flux in the C-MOP River estuary model was difficult to find using 2D guess-and-check methods. By sweeping a plane through the field interactively, analysts were able to find the region of interest instantly. 3D visualization of the whole field provides a comprehensive view of the physics. Embedding a manipulable streamline and coloring by salinity illustrates the salt flux in an intuitive manner. Bottom: Users collaborate to generate visualizations. VisTrails captures all adjustments made to a workflow, producing provenance history that represents the workflow's evolution.

Case Study: ImageVis3d

ImageVis3D is a new volume rendering program developed by the NIH/NCRR Center for Integrative Biomedical Computing (CIBC). The main design goals of ImageVis3D are: simplicity, scalability, and interactivity. Simplicity is achieved with a new user interface that gives an unprecedented level of flexibility (as shown in the images). Scalability and interactivity for ImageVis3D mean that both on a notebook computer as well as on a high end graphics workstation, the user can interactively explore terabyte sized data sets. Finally, the open source nature as well as the strict component-by-component design allow developers not only to extend ImageVis3D itself but also reuse parts of it, such as the rendering core. This rendering core for instance is planned to replace the volume rendering subsystems in many applications at the SCI Institute and with our collaborators.





Left: the ct hand dataset rendered with a 1D and a 2D transfer function.
Above: though the name implies 3d, 2d visualizations are available.
Bottom: the monodelphis rendered as an isosurface with visualization of the bricking scheme. Data courtosy of Charles Keller.

NIH/NCRR

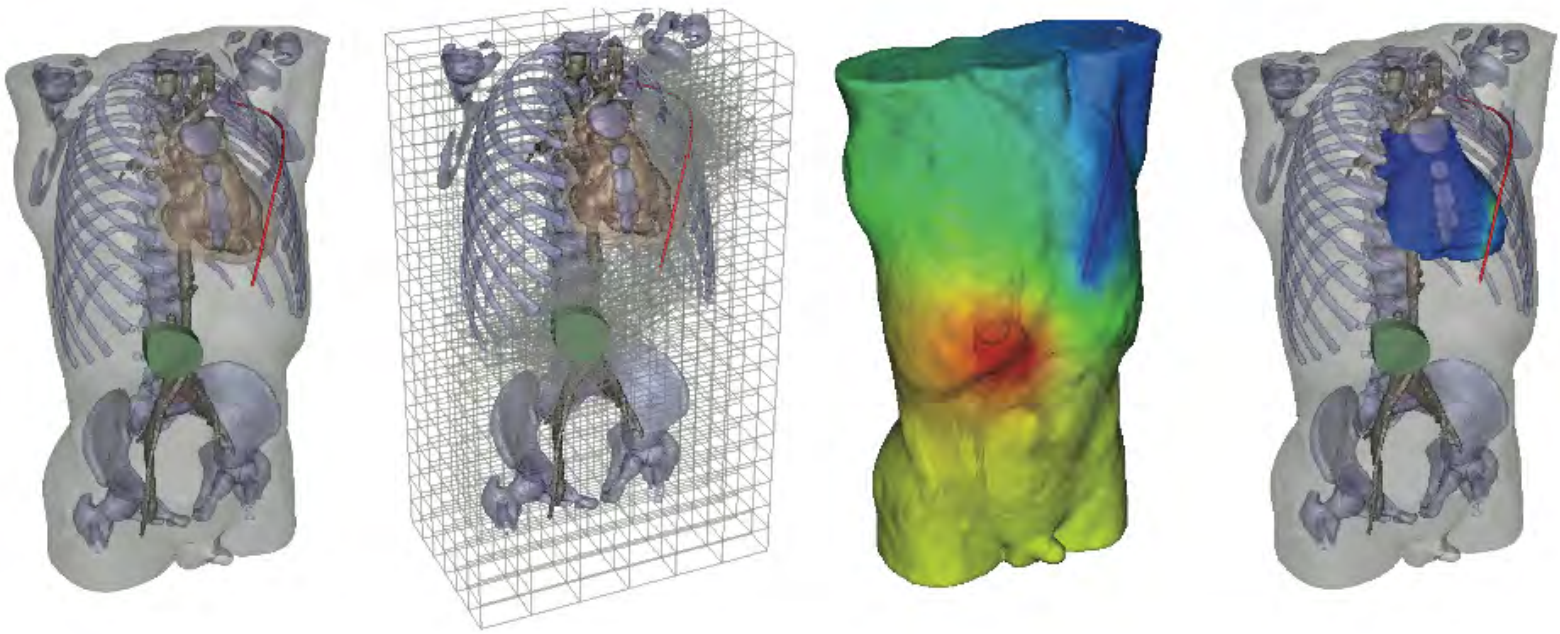
Center for Integrative Biomedical Computing

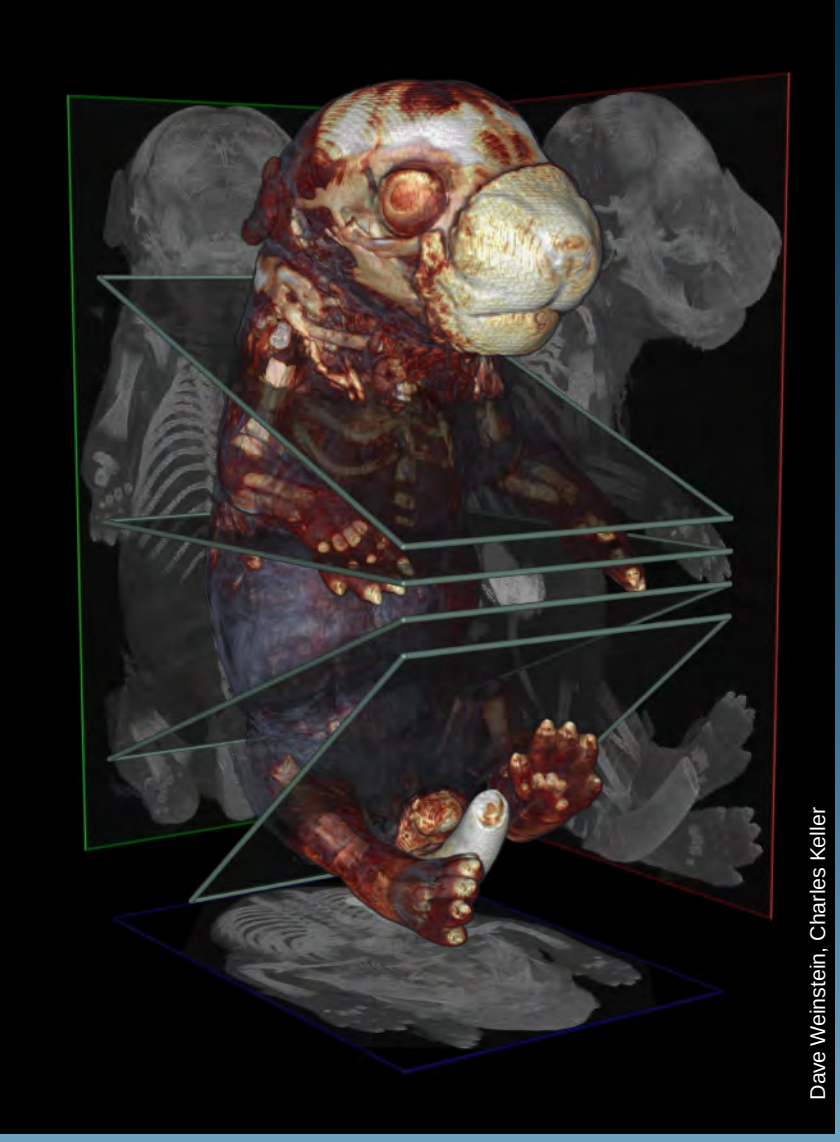
www.sci.utah.edu/cibc

The overall goals of the CIBC are the creation and dissemination of biomedical technology, algorithms, and software for the mathematical modeling, simulation, and visualization of physiological phenomenon applied to problems in clinical and biological research and applications. The Center provides unique computational resources supporting clinical and biological researchers both in fundamental breakthroughs in basic biomedicine and in application of new science and technology to health care. The Center develops software (SCIRun, BioPSE, Seg3D, BioImage, BioTensor, BioFEM and soon BioMesh3D and ImageView3D), distributes it freely to the biomedical community, carries out training, and supports formal and informal collaborators. The Center also carries out technical development and original research in several related areas, including three-dimensional image analysis, scientific visualization, biomedical simulation, bioelectric field problems, problem-solving environments, and software engineering. The CIBC has a strong, ongoing emphasis on software simulation of bioelectric fields, with clinically oriented collaborations in cardiac defibrillation and the diagnosis/treatment of epilepsy. In addition, the CIBC has expanded in recent years to include applications of statistical shape analysis and three-dimensional visualization to mouse genetics and neuroimaging and applications of image and geometry processing to cell biology.

Simulation Study of Cardiac Defibrillation in Children

Implantable Cardiac Defibrillators (ICDs) save the lives of patients with unstable heart rhythms and 100,000 patients receive these devices per year in the US. Their use in children is less frequent and less standardized than in adults so that determining efficient electrode placement is challenging and uncertain. We are collaborating with J. Triedman, M.D. at Children's Hospital Boston and M. Jolley, M.D. at Stanford University to develop interactive finite element (FEM) computational models to test electrode locations for their effectiveness in defibrillation in children. The models come from CT or MRI scans segmented into tissue types and then meshed for FEM. The system also includes a library of realistically shaped ICD case and wire electrodes and an interactive interface allows the user to easily place and move the electrodes in the model to evaluate different implantation locations. To date we have fully segmented three CT scans, from 2, 10, and 27 year-old subjects, and have created a database of approximately 100 suitable electrode locations per model, which we are testing for bioelectric field strength and homogeneity. Initial findings have included evaluating the effectiveness of standard locations in adults and novel locations in children.



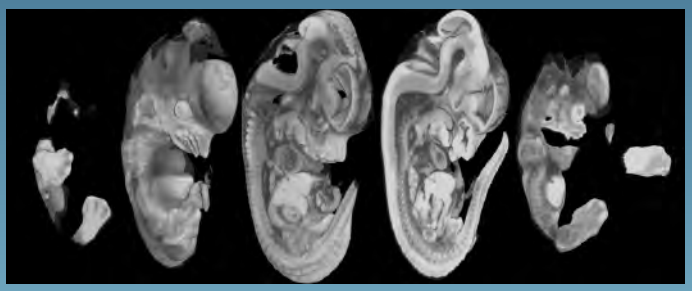


Dave Weinstein, Charles Keller

Virtual Histology

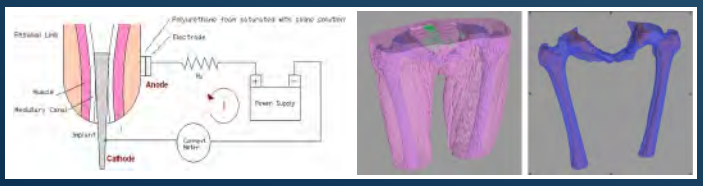
Virtual Histology™ is ideally suited for characterizing soft tissue and skeletal anatomy in developing embryos, fetuses and a variety of soft tissue specimens. The imaging reagent, designed for use with microCT, is differentially absorbed by the various tissues. As a result of the unique contrast enhancement, exquisite visualizations in 2D and 3D are possible.

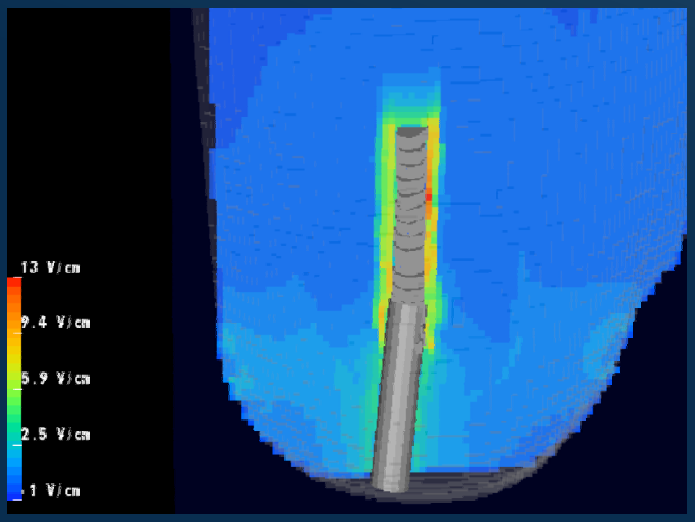
Comparable to a dissection microscope, Virtual Histology™ can provide greater than 6µm isometric voxel resolution enabling detailed analysis. It is an excellent methodology for the examination of fine structures in a range of soft tissue specimens. The crisp, clean images provide a degree of anatomic detail that approximates routine histology as viewed by light microscopy. The significant advantage is clearly the non-destructive nature of microCT-based Virtual Histology™ allowing the researcher to change the angle of view from axial, sagittal, coronal and even arbitrary oblique planes based on the anatomic feature of interest offering new perspectives on developmental defects.



Stimulation of Bone Growth for Prosthetic Devices in Amputees

Young, otherwise healthy amputees form a small but growing population of patients, many of them the casualties of combat, and there is a persistent need in this group for improvements in the fixation of prosthetic limbs. A recent approach to this problem is to embed metallic posts into the remnant bone of the limb and thus provide a stable fixation point that reduces the abrasion and contact wounds of the typical stump-and-socket prosthetic fixation. One drawback to this approach is the long (many months) healing time required for full embedding of the implant, a process we hope to accelerate through the application of an electric field across the interface from the bone to the implant. It is known that electric fields facilitate bone growth so that attachment of external stimulating electrodes could accelerate bone/implant attachment and reduce healing time. However, this is a novel application of the concept with no previous data to help determine optimal electrode location or applied field values. We are using patient specific, image based modeling to create simulations of the limb, the implant, and the spatial distributions of electric fields that result from application of surface electrodes.

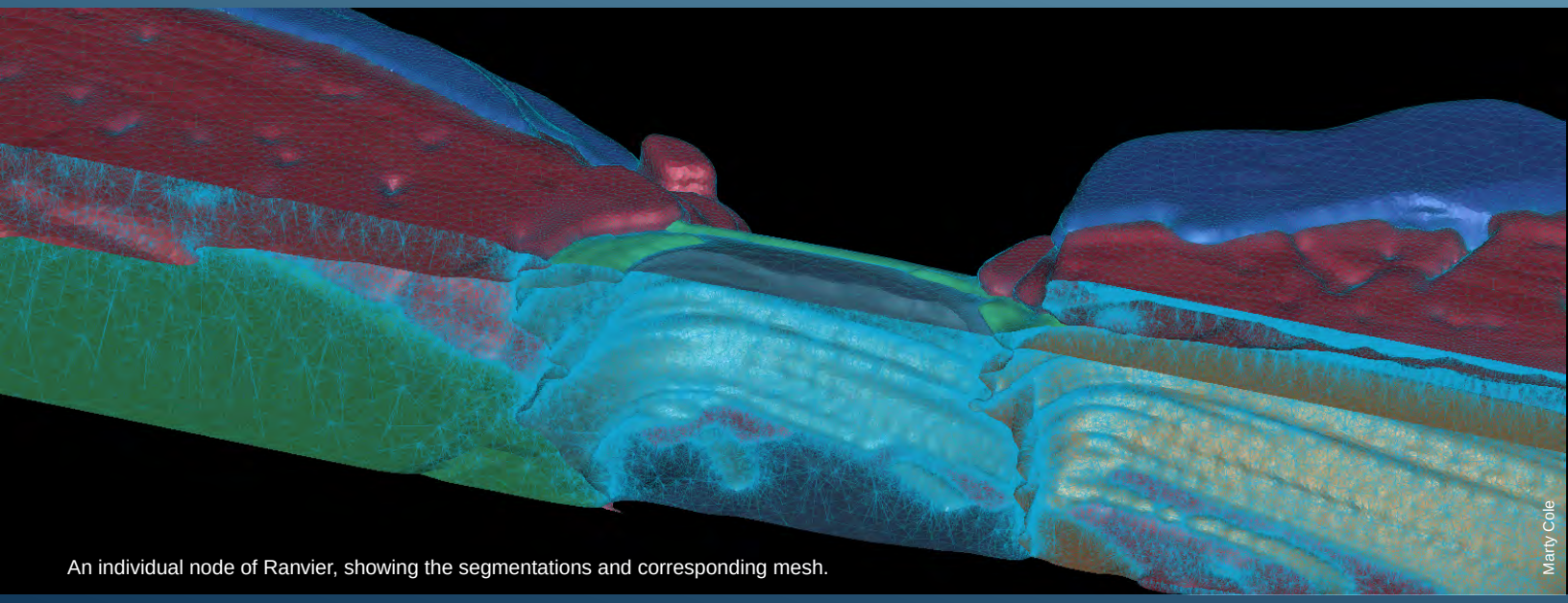




Center for Integrative Biomedical Computing

Cellular Structure and Function

The National Center for Microscopy and Imaging Research (NCMIR) at the University of California San Diego, is an NIH NCRR Biomedical Technology Research Center established to develop advanced, computer-aided microscopy for acquisition of structural and functional data. The CIBC is collaborating with NCMIR to develop image analysis algorithms and software to help biomedical researchers explore and understand structural and functional relationships within cells and tissues through a range of scales from macromolecular complexes to organelles and multi-component structures like synapses.

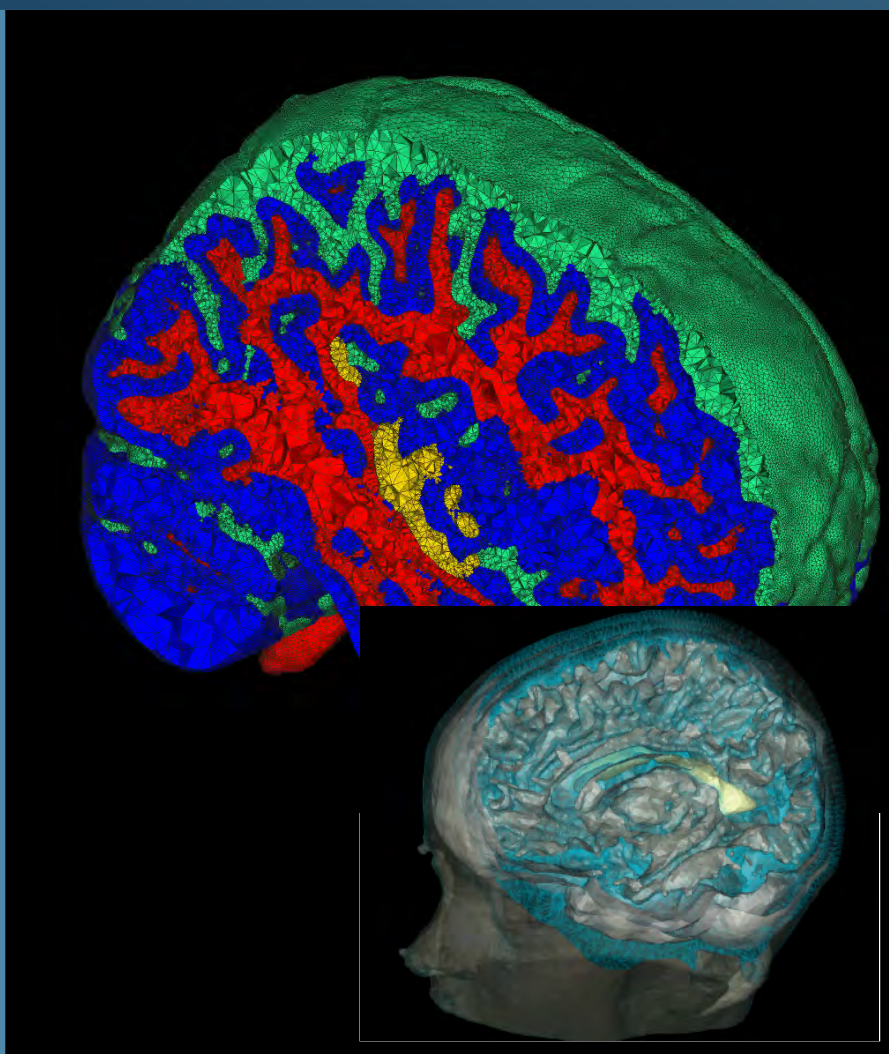


An individual node of Ranvier, showing the segmentations and corresponding mesh.

Marty Cole

Epilepsy Detection and MRI

The goal of this collaboration is to develop and validate a new approach to characterizing epileptogenic foci and thereby make curative surgery available to a larger population at an earlier age. We will achieve this by developing an optimized MRI and EEG analysis strategy to enable improved pediatric epilepsy surgical planning (ESP). The primary outcome of pediatric ESP is identification of epileptogenic foci in order to determine if the subject is a candidate for neurosurgery. The nature and location of these foci determine if they may be targeted for neurosurgical resection. Today, Children's Hospital sees two to four pediatric patients a week for extended evaluation. The pediatric ESP process of imaging acquisition and analysis, utilizing MRI and scalp EEG, is largely a qualitative process. The ambiguity of foci determination and localization increases the difficulty of carrying out effective patient care. However, recent technical advances in data acquisition for EEG and MRI, and most importantly in improved algorithms for patient specific post acquisition processing, offer the possibility of dramatically improved accuracy. This improved accuracy is made possible by the provision of stronger constraints on the inverse problem of EEG source localization and by the fusion of source localization data from EEG, conventional MRI and DT-MRI.



Marty Cole, Jeroen Stinstra

Imaging meets Electrophysiology to Help People with Heart Troubles

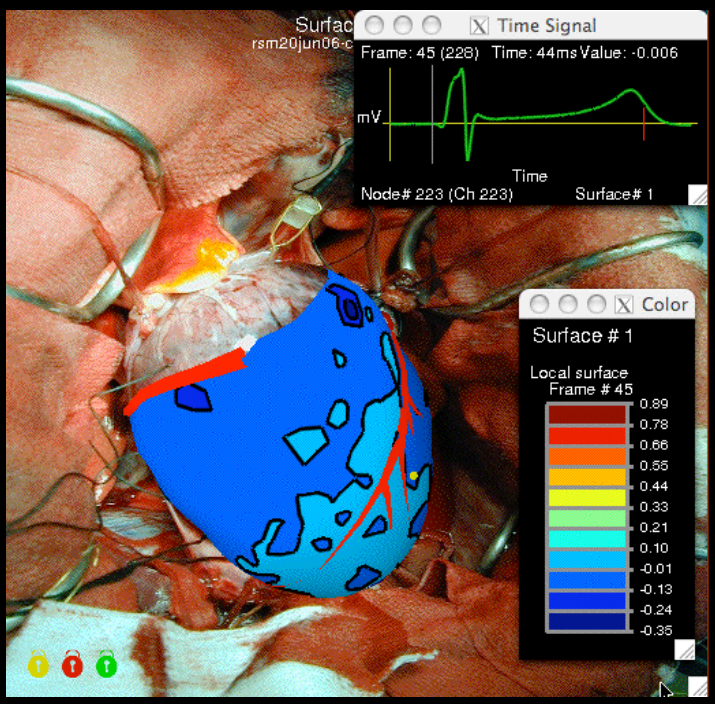
Atrial fibrillation (AF) is the most common—and perhaps most insidious—form of heart rhythm disturbance. In AF, the upper two chambers (the left and right atria) of the heart lose their synchronization and beat erratically and inefficiently, reducing the pumping capacity of the heart and elevating the heart rate, eventually leading to a stroke. The same condition in the lower chambers (ventricles) of the heart is fatal within minutes and defibrillators are necessary to restore coordination. In the atria, death is stealthy and occurs over years.

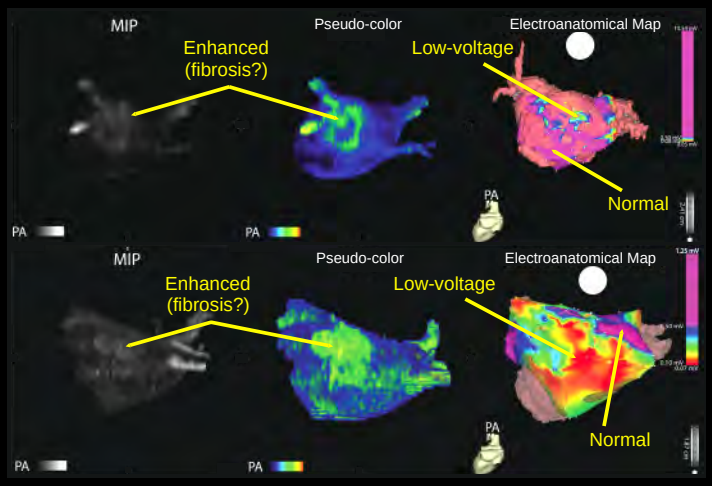
A group of scientists and physicians at the University of Utah is addressing the growing problem of AF through a combination of high tech interventional therapy, multimodal medical imaging, image processing and analysis, and computer science. The treatment known as “atrial ablation” requires that large areas of the posterior wall of the left atrium be rendered electrically inactive. This part of the heart is the origin of the fibrillation and by suppressing its electrical activity, the heart can return to—and, more importantly, stay in—normal rhythm. To carry out ablation, the physician, under image guidance, places a catheter in the left atrium and uses it to apply radiofrequency energy to heat a series of small spots on the atrial wall.

Medical imaging is at the “heart” of this project as it plays a role at all stages. The imaging specialists Drs. Parker, DiBella, and Kholmovski, all from the Utah Center of Advanced Imaging Research (UCAIR), have developed new ways of using magnetic resonance imaging (MRI) to visualize the walls of the atria, which are only a few millimeters in thickness, a task previously considered almost impossible in a beating heart. The cardiology team, Drs. Marrouche and McGann, then recognized that the MRI images of the atrial walls of some patients looked different from others and set the image processing team, Dr. MacLeod and specialists at the Scientific Computing and Imaging (SCI) Institute, the task of visualizing and quantifying these differences.

The results were striking and allowed the team to create a method that appears to identify and measure regions of the heart that are most altered by the AF. The resulting index can serve to differentiate between good and bad candidates for treatment. This discovery represents a potential breakthrough in treatment as there is no other way to determine suitability of patients before the procedure.

The team aims to transform the integration of imaging modalities and especially the role of MRI during the ablation procedures. MRI is the only modality capable of seeing the effects of ablation and thus has the potential to monitor the formation of the lesions that suppress unwanted electrical activity. MRI can also provide images of the lesions as they progress from acute injury to stable scars and thus offers the only noninvasive means to follow patient progress during the procedure and in the following weeks and months.





Top: Heart surface potentials rendered with map3d. The figure shows a single time instant from a real time animation of the electric potential (voltage) measured on the surface of a heart--a surface potential map--and visualized with map3d. The latest version of map3d allows the user to integrate an image of the actual surface (in this case of a heart) into the interactive display of time signals on that surface. Colors indicate voltage levels, as show in the figure legend and the time signal in the upper right hand corner shows with a vertical yellow bar the instant in time from which comes the single map.

Bottom: Comparison of delayed enhanced MRI imaging and electroanatomical mapping of patients undergoing treatment for atrial fibrillation. The rows of figures show posterior view of the left atrium from two different patients, both of whom suffer from atrial fibrillation that was treated with a technique known as pulmonary vein antrum isolation (PVAI). The leftmost image in each row shows the raw MRI data , the middle image in each row shows the same data but with color coding in order to enhance regions of fibrosis. The rightmost images show electroanatomical mapping with magenta indicating electric potentials of normal amplitude and all other colors identifying regions with reduced amplitude. Note the correlation between highlighted regions in the MRI and areas of low electric potential in the electroanatomical map. The images are available noninvasively while the electroanatomical maps require insertion of catheter electrodes into the heart.

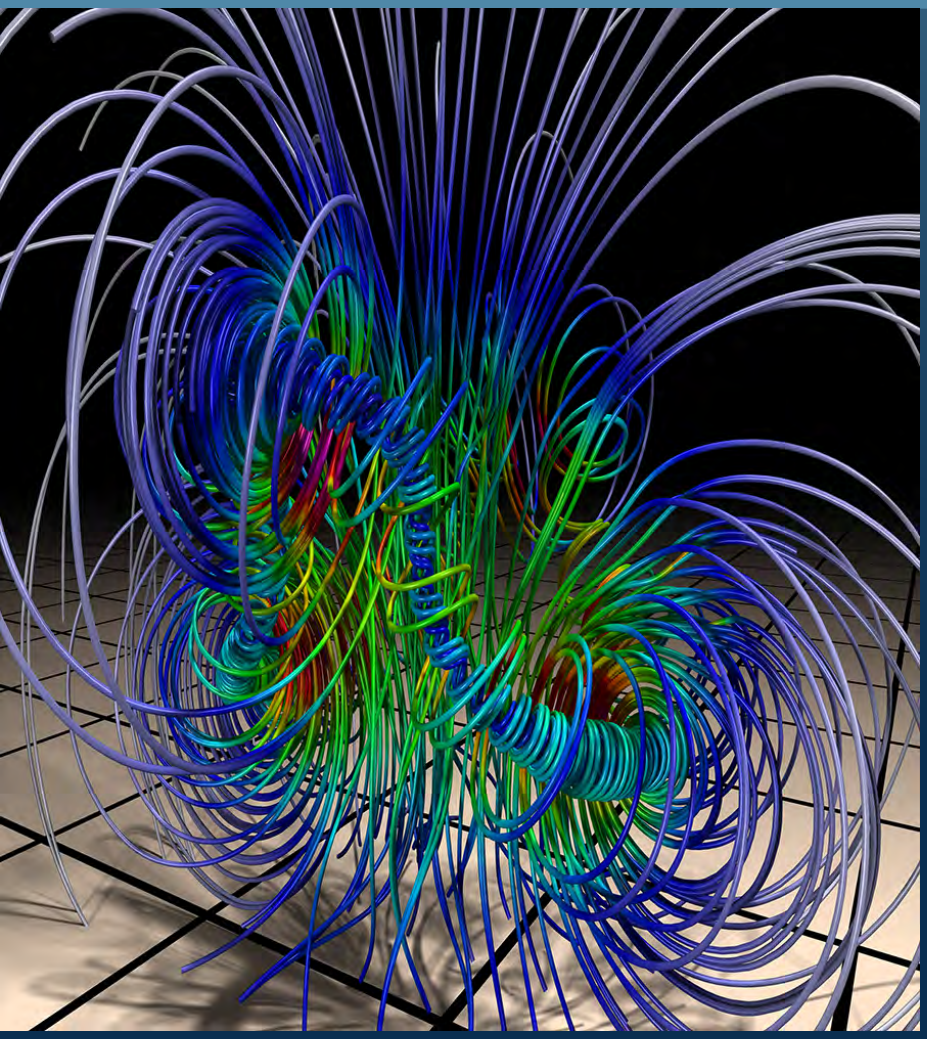
DOE SciDAC

VACET

Visualization and Analytics Center for Enabling Technologies

www.vacet.org

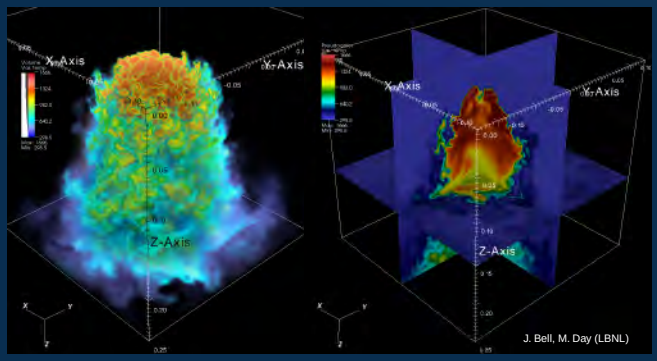
Visualization and Analytics Center for Enabling Technologies (VACET) was launched in 2006 as one of nine centers under the Department of Energy's Scientific Discovery through Advanced Computing (SciDAC-2). The Center focuses on leveraging scientific visualization and analytics software technology as an enabling technology for increasing scientific productivity and insight. Advances in computational technology have resulted in an "information big bang," which in turn has created a significant data understanding challenge. This challenge is widely acknowledged to be one of the primary bottlenecks in contemporary science. The vision of our Center is to respond directly to that challenge by adapting, extending, creating, and deploying visualization and data analysis technologies for our science stakeholders. With the combined expertise of SCI and our other partners, we are well positioned to be responsive to the needs of a diverse set of scientific stakeholders using a range of visualization, mathematics, statistics, computer and computational science and data management technologies.



Above: Streamlines visualization of two vortex cores merging. Image produced by Dave Pugmire (ORNL) using AMR data produced by APDEC's Chombo code.

Production Quality, Parallel Capable AMR Visualization

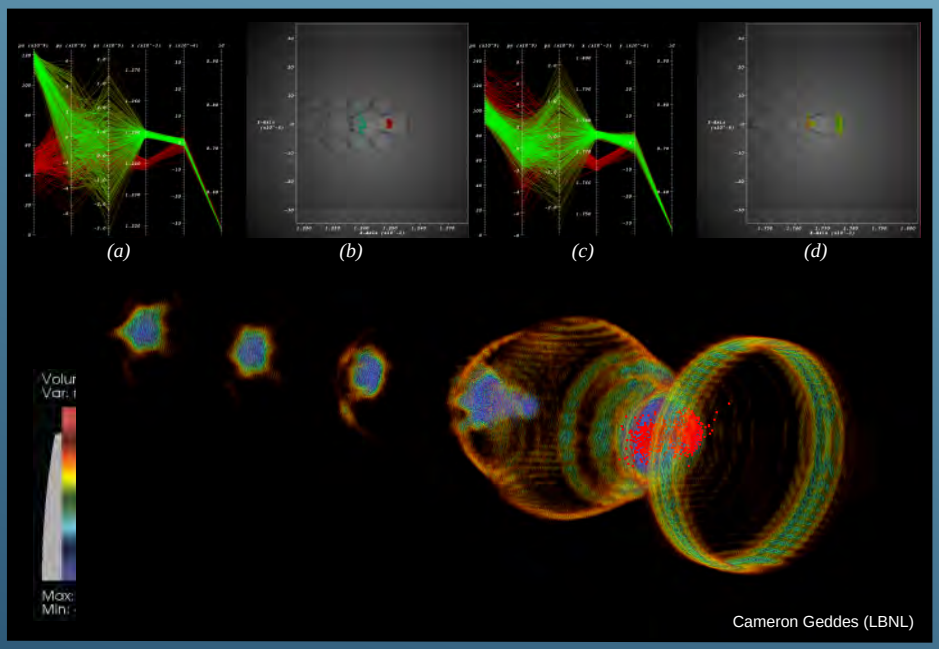
VACET are leaders in production quality, parallel adaptive mesh refinement (AMR) visualization and analysis software infrastructure. We have recently deployed such production quality AMR visualization software infrastructure to SciDAC scientific researchers. This result has numerous direct benefits to those researchers. First, it allows them to "buy rather than build", thereby resulting in a direct cost savings of scientific staff: they no longer need to develop and maintain AMR visualization software. Second, the VACET technology allows them to effectively use parallel computing infrastructure to perform interactive visual data analysis to help answer scientific questions in domains like combustion and astrophysics. Third, since the VACET technologies is deployed at DOE's open computing facilities as well as on the scientists' desktop, this result is an example of successfully bridging the gap across research, development and production deployment activities within DOE's science programs.



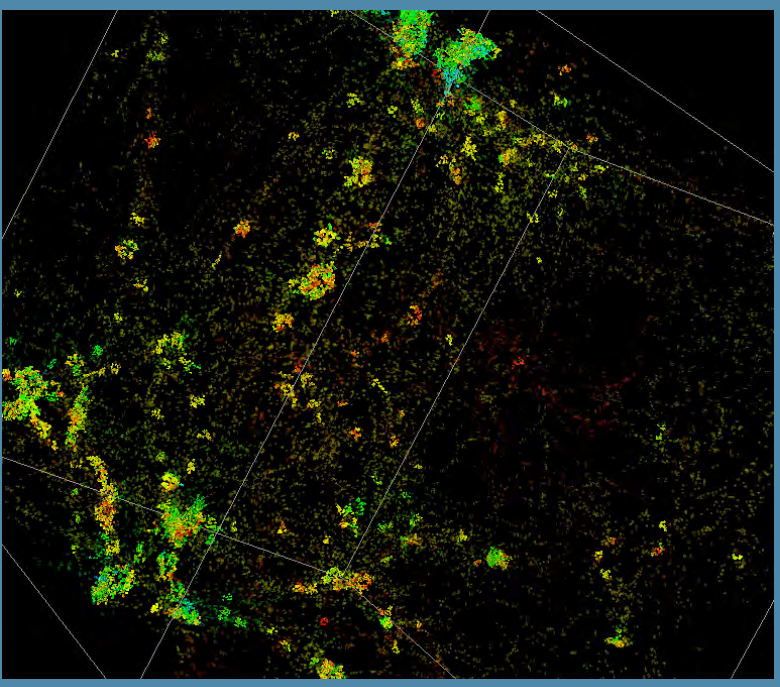
Right: Production quality visualization of an AMR simulation of a hydrogen flame. Sample data courtesy of J. Bell and M. Day, Center for Computational Sciences and Engineering, LBNL. Inset: (a) Streamlines visualization of two vortex cores merging. Image produced by Dave Pugmire (ORNL) using AMR data produced by APDEC's Chombo code. (b) Psuedocolor plot of a 2D mapped AMR grid. (c) Psuedocolor plot of a 3D mapped AMR grid.

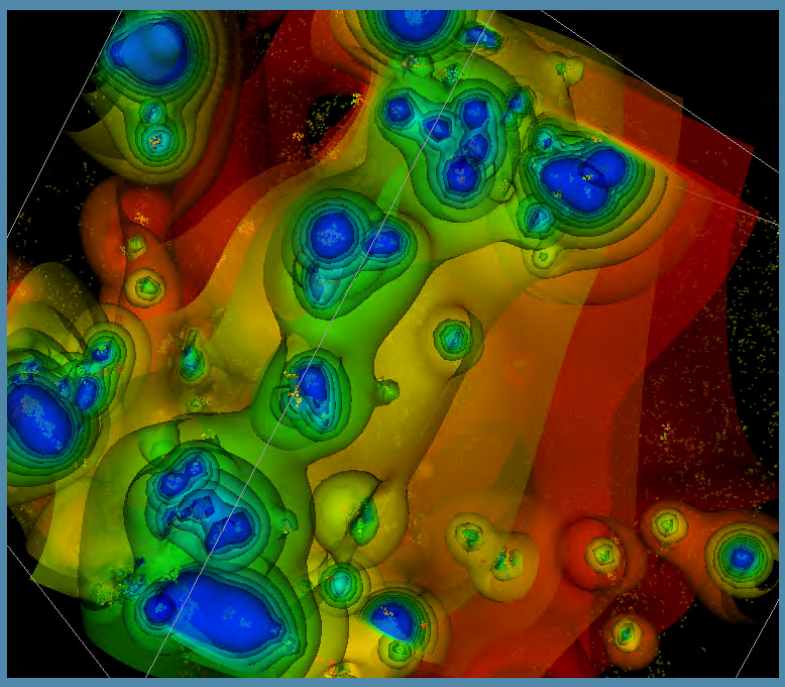
Accelerator Modeling: High Performance Visual Data Analysis

Laser wakefield simulations model the behavior of individual particles as well as the behavior of the plasma electric and magnetic fields. Output from these simulations can become quite large: todays datasets, such as the ones we study here, can grow to be on the order of 200GB per timestep, with the simulation producing approximately 100 timesteps. The scientific challenge we help address in this study is first to quickly find particles that have undergone wakefield acceleration, then trace them through time to understand acceleration dynamics, and perform both visual and quantitative analysis on the set of accelerated particles. In the past, accelerator scientists would perform the "trace backwards" step using scripts that performed a search at each timestep for a set of particles. Runtimes for this operation were on the order of hours. Using our implementation, those runtimes are reduced from hours to seconds.



Top: a) Parallel coordinates and b) pseudocolor plot of the beam at t 27. Corresponding plots c,d) at t 37. The context plot, shown in red, shows both beams selected by the user after applying a threshold of $px > 8.872\ 10^{10}$ at t 37. The focus plot, shown in green, indicates the first beam that is following the laser pulse. In the pseudocolor plots b) and d), we show all particles in gray and the selected beams using spheres colored according to the particle's x-momentum, px. The focus beam is the rightmost bunch in these images. At timestep t 27, the particles of the first beam (green in figure a) show much higher acceleration and a much lower energy spread (indicated via px) than the particles of the second beam. At later times, the lower momentum of the first beam indicates it has outrun the wave and moved into decelerating phase, e.g at timestep t = 37.
Bottom: Volume rendering of the plasma density and the selected focus particles (red)





Cosmology and Astrophysics

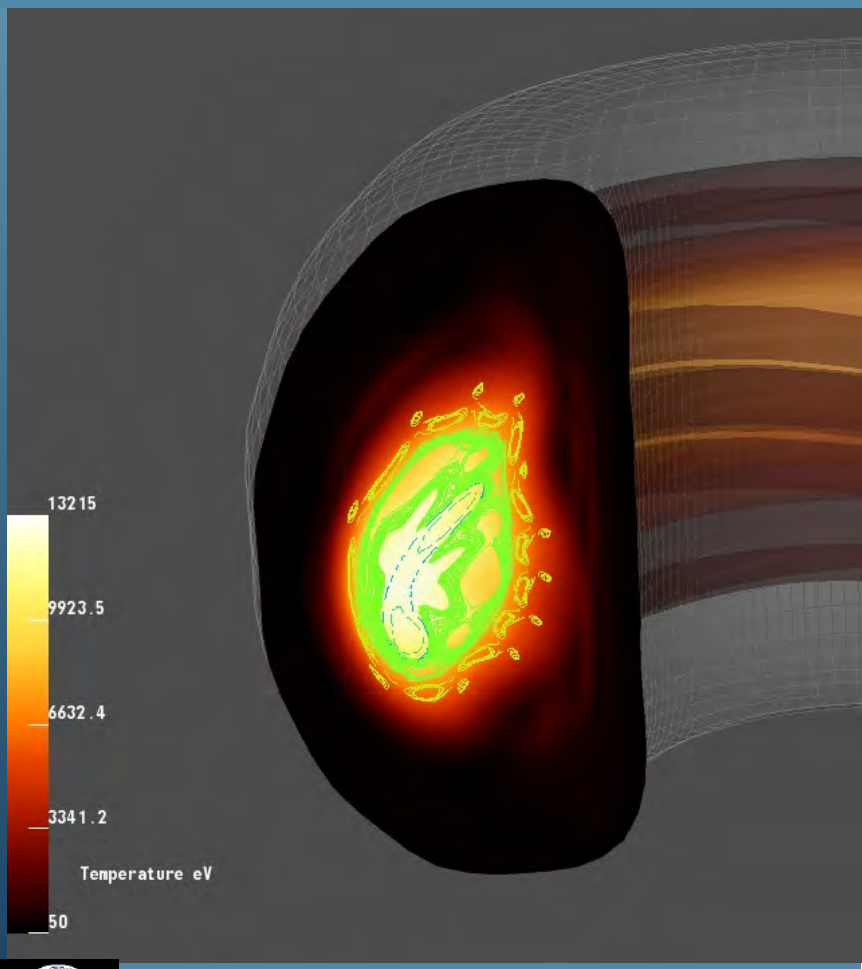
Understanding the explosive nature of stellar supernovae and the subsequent production of elements is one of the more challenging problems undertaken by SciDAC. The set of astrophysics efforts supported by SciDAC and our Center range from modeling supernova explosions to cosmology and early universe formation. The computational astrophysics projects produce very large, multi-field, time-varying data at DOE's open computing facilities and poses many challenges in visualization.

A simulation of the universe as it forms from the big bang until the present. The simulation code, Enzo, was run on a supercomputer at Los Alamos National Laboratory. Each galaxy is represented as a single particle. The multi-colored surfaces indicate different densities in space. Regions enclosed in orange and red, called halos, represent clusters of galaxies, while low density regions, called voids, are indicated by regions not enclosed in any surface.

VACET Visualization and Analytics Center for Enabling Technologies

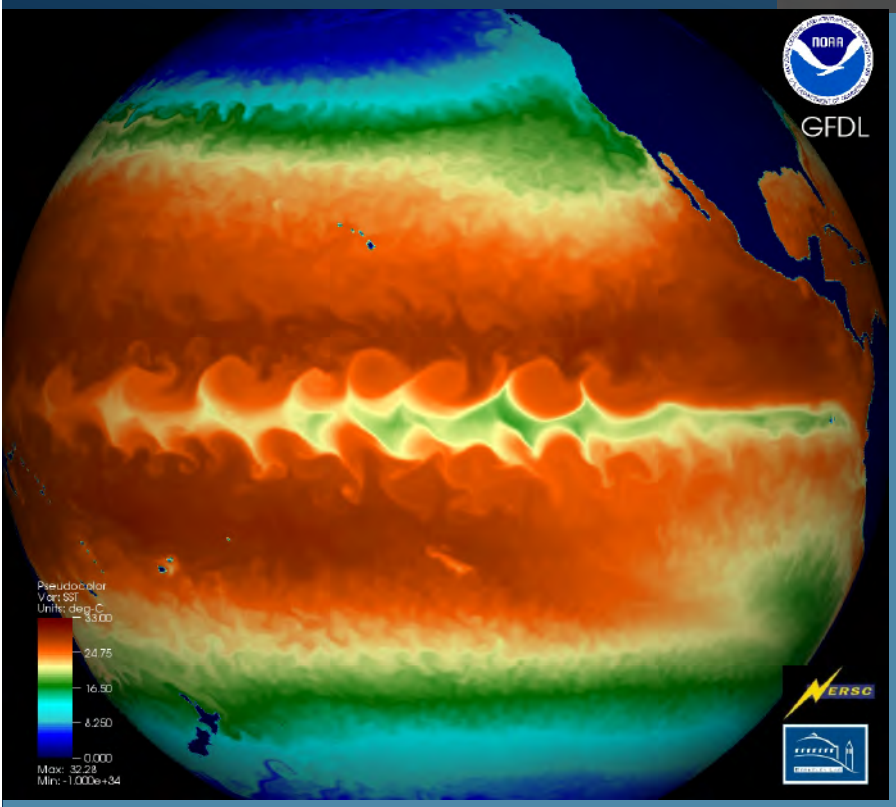
Fusion

Understanding the complex behavior of magnetically confined fusion plasmas is an important goal of DOE's many fusion projects. The fusion community uses many different simulations to model the effects of physical and electromagnetic phenomena that contribute to plasma stability and effective plasma containment. These phenomena include radio frequency heating, stellerator and tokamak geometries, magnetic field evolution, and eddy stability.



Right: **Visualization of the Magnetic Field and Plasma Temperature in D III-D Shot 87009**

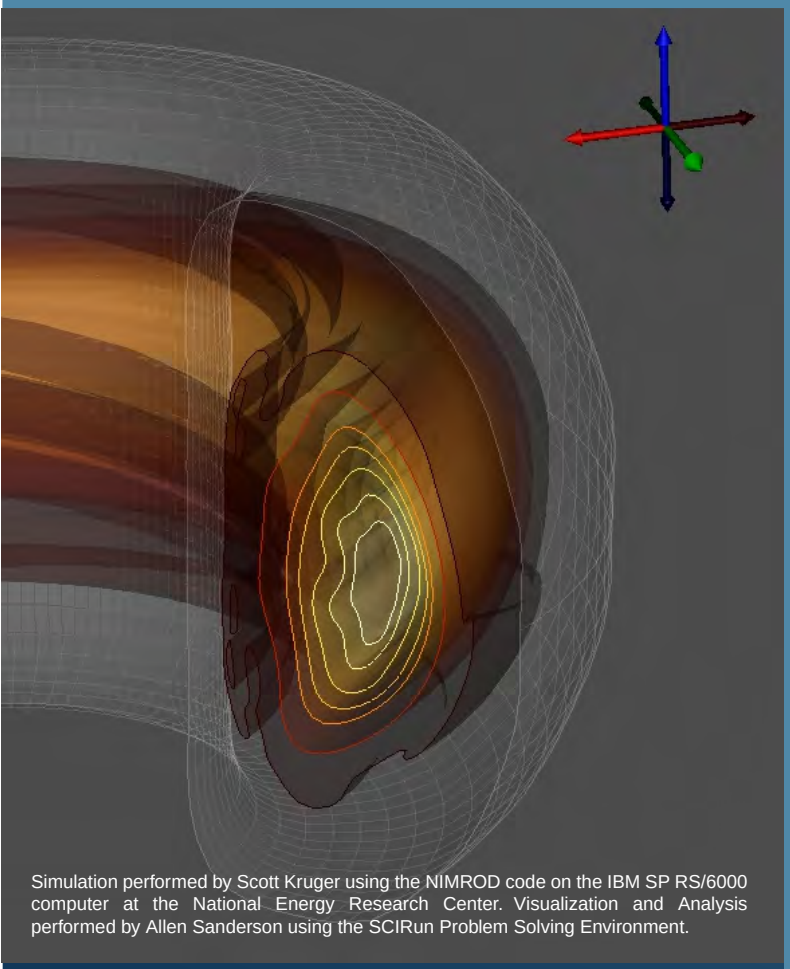
This visualization shows the break up of the magnetic field into a series of island chains, with a predominant 2:1 mode, left along with isosurfaces of the plasma temperature, right. The topology of the magnetic field is visualized using an analysis tool that produces a Poincaré map. Because the plasma equilibrates much more rapidly parallel to the magnetic field lines than perpendicular to the magnetic field lines, visualizing the magnetic field topology is necessary to the understanding how the plasma energy is deposited on the material wall. As the field becomes stochastic, the plasma cools rapidly. This cooling is highlighted by a series of transparent iso-temperature surfaces. Though the temperature profile remains as a series on nested contours they have deformed based on the topology of the magnetic field.



High-resolution models offer not only a closer look at physical elements of the climate, such as tropical storms, but they also enable researchers to conduct a more in-depth analysis of climate change as higher-resolution phenomena in the ocean and atmosphere are resolved. Winner of "People's Choice" award at SciDAC 2008.

Climate Visualization

The general goals of the climate research effort within SciDAC is to understand large scale climate change dynamics over very long time periods. To ensure confidence and accuracy in their simulations, climate scientists must couple many different simulation methods into a single “meta-simulation” that combine ocean, atmospheric, land use, vegetation, biochemistry, ecosystem dynamics, and other models. As a consequence, climate simulations often contain as many as 200 variables per grid point. Accurate simulations require a fairly short timestep between 15 minutes and 6 hours. Performing hundreds of years of simulated time results in hundreds of terabytes of data. Since the emphasis is on large scale climate change rather than regional weather simulation, the spatial grids are generally not very large. The data-intense areas are generally multivariate and temporal. However, computational climate efforts are increasing in spatial resolution to support regional models suitable for weather forecasting. So-called “ensemble runs” of a given climate model produce hundreds of different simulation data sets leading to a substantial challenges in data management and comparative analysis. Such simulations are expected to provide broad insight into the impacts of human activity over long time periods, provide policy-relevant information about energy policies, and help to predict the trends of natural disasters.

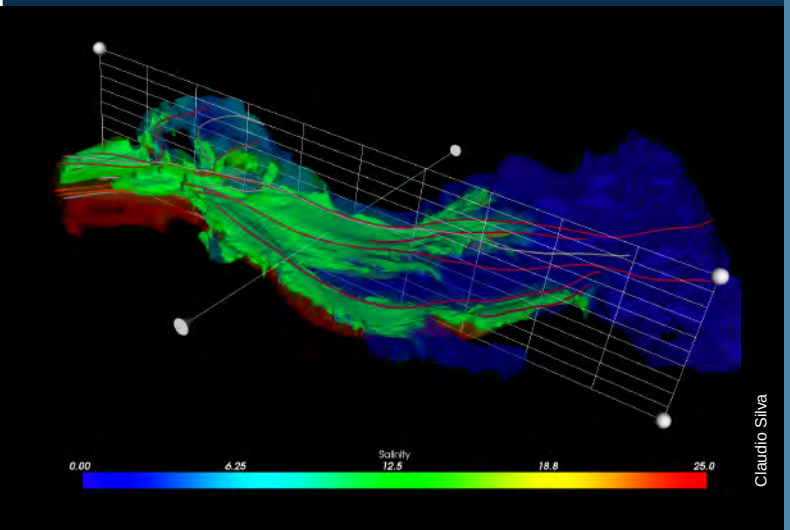


Simulation performed by Scott Kruger using the NIMROD code on the IBM SP RS/6000 computer at the National Energy Research Center. Visualization and Analysis performed by Allen Sanderson using the SCIRun Problem Solving Environment.

Environmental Management

DOE is responsible for cleanup and management of several facilities from the Cold War weapons production era as well as for monitoring contaminant behavior in groundwater waste disposal and storage areas. Simulations of groundwater flow are the basis for understanding and predicting environmental impact. These simulations also include multiphase and reactive chemistry components to capture the effect of water-based transport and the effects underground chemical reactions.

Below: CORIE is an environmental observation and forecasting system (EOFS) for the Columbia River. The goal of this multi-decade project is to predict complex circulation and mixing processes in a system encompassing the lower river, the estuary, and the near-ocean.



Claudio Silva

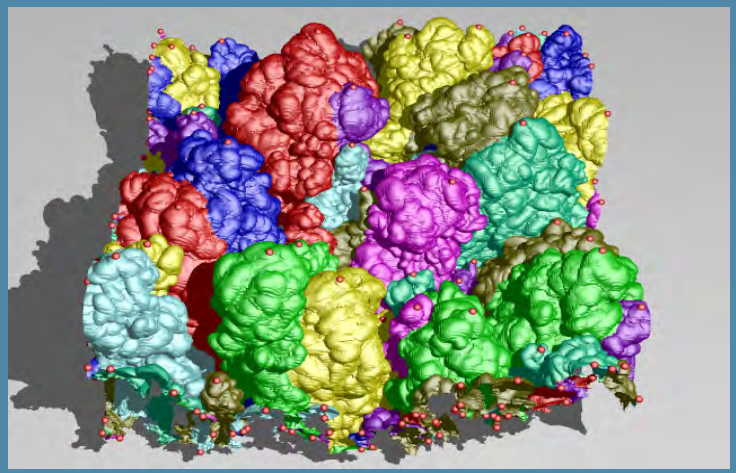
Topological Analysis Provides Deeper Insight into Hydrodynamic Instabilities

From *SciDAC Review,* winter 2007

The VACET group at Lawrence Livermore National Laboratory, led by Valerio Pascucci (now with Utah), has developed the first feature-based analysis of extremely high-resolution simulations of turbulent mixing. The focus is on Rayleigh-Taylor instabilities, which are created when a heavy fluid is placed above a light fluid and tiny vertical perturbations in the interface create a characteristic structure of rising bubbles and falling spikes. Rayleigh-Taylor instabilities have received much attention over the past half-century because of their importance in understanding many natural and man-made phenomena, ranging from the rate of formation of heavy elements in supernovae to the design of capsules for inertial confinement fusion. However, systematic, detailed analysis has been difficult due to the extremely complicated features found in the mixing region.

Members of VACET, the Visualization and Analytics Center for Enabling Technology funded under SciDAC, at Livermore developed a novel approach to the analysis of the complex topology of the Rayleigh-Taylor mixing layer based on robust Morse theoretical techniques. This approach systematically segments the envelope of the mixing interface into bubble structures and represents them with a new multi-resolution model allowing a multi-scale quantitative analysis of the rate of mixing based on bubble count. This analysis enabled new insights and deeper understanding of this fundamental phenomenon by highlighting and providing precise measures for four fundamental stages in the turbulent mixing process that scientists could previously only observe qualitatively.

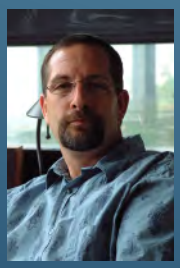
This work has been documented in a paper named “best application paper” at the IEEE visualization conference and later presented at the International Workshop on the Physics of Compressible Turbulent Mixing. Follow-up work also allowed, for the first time, direct comparison of two simulations based on different physics models, grid point resolutions, and initial conditions. Although comparison by superposition of the simulations could not yield a meaningful result, the new topological approach highlighted fundamental similarities through a multi-scale feature-based comparison. This, in turn, validated the lower resolution large eddy simulation with respect to the higher resolution direct numerical simulation.



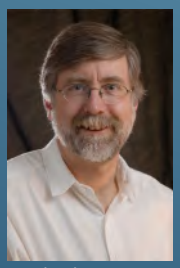
Valerio Pascucci

Faculty


Chris Johnson


Greg Jones


Rob MacLeod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We were excited to relocate this past summer to our new home, the spectacular John E. and Marva M. Warnock Engineering Building, named for University alumni John and Marva Warnock. The SCI Institute is the building's principal research occupant, with space dedicated to faculty, staff, graduate student offices configured to optimize interaction, and specialized research facilities such as the David Evans Visualiza tion Center, which will be a state-of-the-art research laboratory, collaboration, and presentation facility.

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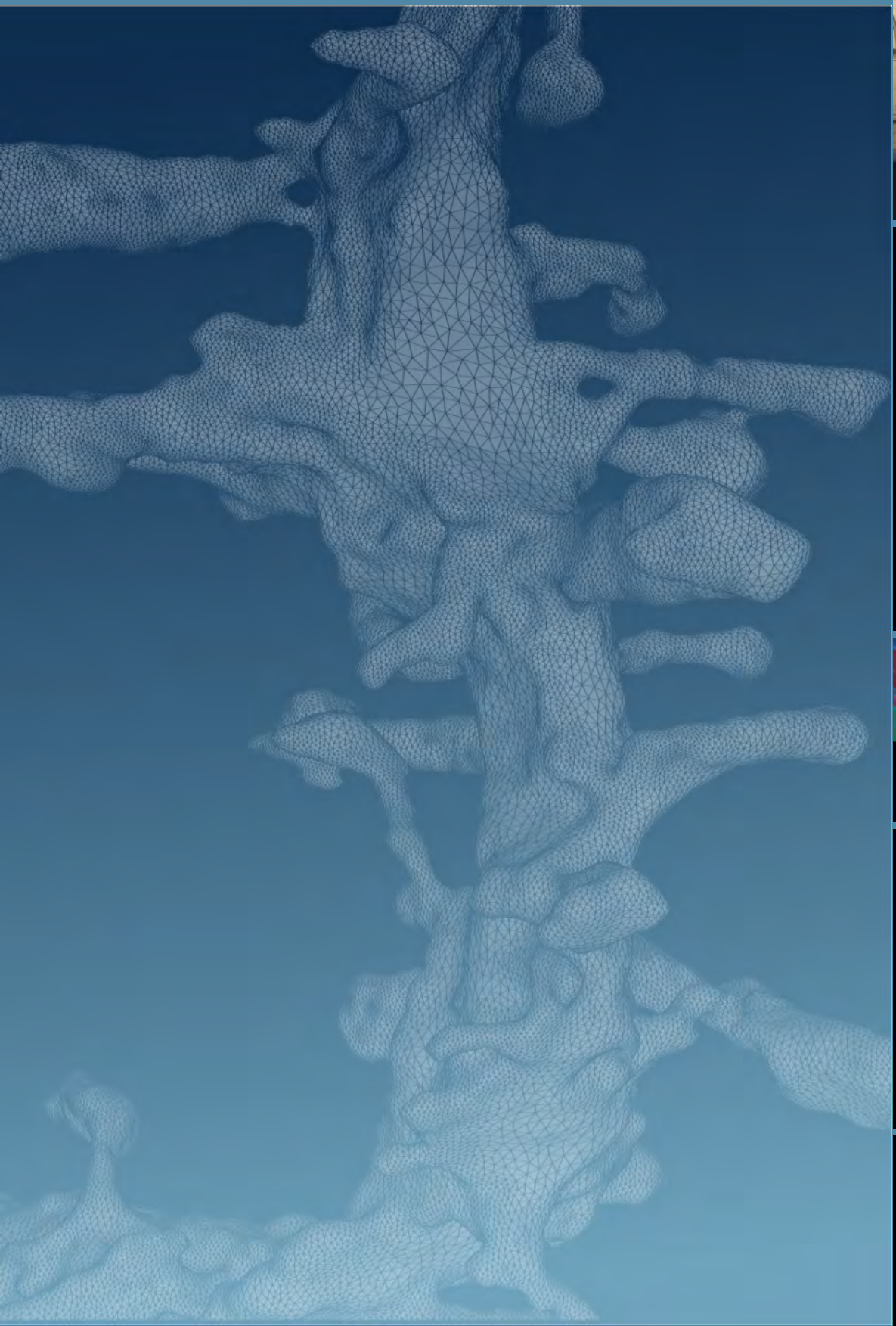

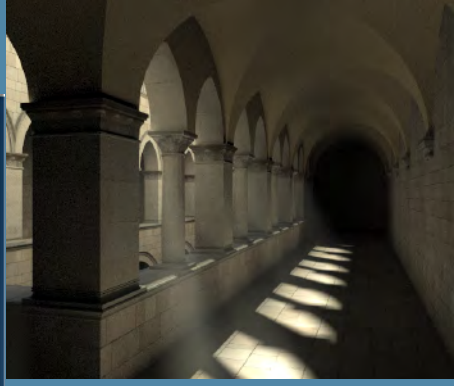

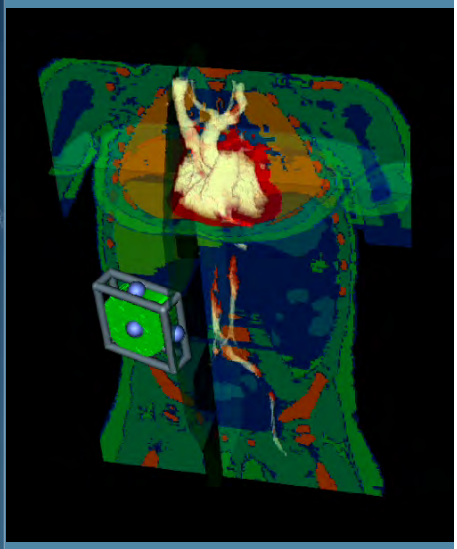

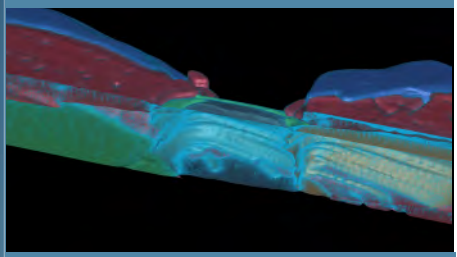

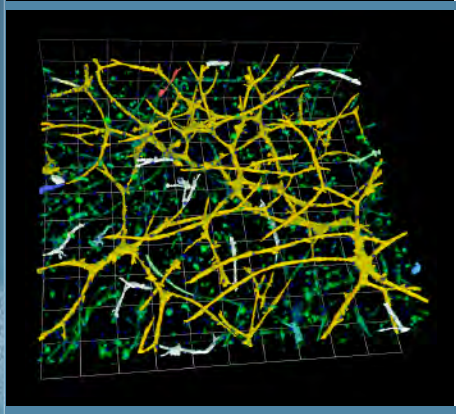

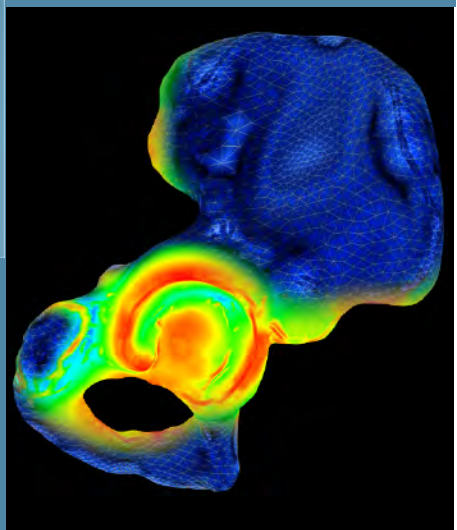

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