Visualization Careers

Organizer:
Bill Lorensen (GE Research)

Panelists:
Chris Johnson (University of Utah)
Bill Lorensen (GE Research)
Tamara Munzner (University of British Columbia)
Will Schroeder (Kitware)
Terry Yoo (National Library of Medicine)

Visualization is still a young and expanding discipline with plenty of exciting challenges and opportunities for innovation. The recent NSF/NIH sponsored report on Visualization Research Challenges reinforces the contributions of the field and how the field will progress in the future. Within the field there are opportunities in industry, academia and government to establish and develop a career in visualization. This panel presents five approaches to careers in visualization.

Academic Center, Chris Johnson
Industrial Research, Bill Lorensen
Academic Research, Tamara Munzner
Entrepreneur, Will Schroeder
Government Scientist, Terry Yoo

Questions to be addressed:

- How did you get started in visualization?
- What was your motivation? Fame? Fortune? Save the world?
- Why did you end up where you are?
- What do you like/dislike about your choice?
- What concerns you about the future of visualization?

1. POSITION STATEMENTS

1.1. CREATING AND LEADING A RESEARCH CENTER OR INSTITUTE

Chris Johnson
Director,
Scientific Computing and Imaging Institute
Distinguished Professor,
School of Computing
University of Utah

If someone had told me back in 1990, when my research "team" consisted of one Ph.D. student and another Assistant Professor, that today my research

team would have grown into a research institute consisting of over 100 faculty, staff, and students, I would have laughed and said "no way"!

So how did it happen? The short answer is partly through early success, later by design, but mostly because I was able to attract a great set of amazingly talented people who have worked together to create a collaborative, multidisciplinary research team. Then, there is the final, most important ingredient: Lots of hard work.

Creating a great research team sounds easy: Attract top level people who can collaborate effectively, provide these people with cutting edge facilities, and provide a conducive, supportive atmosphere in which really smart people can work together to do amazing research. However, accomplishing these apparently simple goals is challenging.

What are the pros and cons of creating a large research center or institute? There are a large number of positives: a large research center enables you to work with a large number of talented people, to tackle large-scale, real world problems, to configure teams to work on a large variety of research topics, and to acquire support for needed software and hardware infrastructure, etc.

Certainly there are also some negatives: increased administrative load, increased need for larger amounts of funding, and the need to master all those practical management and financial skills you didn't learn about in graduate school.

During this panel, I will expand upon all of the above issues and discuss both the "pros and cons" and the "how tos" of starting up and maintaining research centers and institutes.

1.2. A LONG AND STEADY PATH

Bill Lorensen
Graphics Engineer
General Electric Research

In 1967 I started a summer job at the US Army Watervliet Arsenal Maggs Research Center. This was my first job that was related to my training as a Mathematician at Rensselaer Polytechnic Institute (the summer before I was a short order cook). The Research Center had an analog plotter that was driven by an IBM reproducing card machine. That summer, I generated simple plots of mathematical formulas. From then on, I was hooked on graphics and have spent the last 40 years in the field. In 1968 I joined the Arsenal as a full-time, Research Mathematician and spent the next ten years building expertise in computer graphics, numerical analysis and scientific programming. These were the early days of computer science and most everything was learned on the job.

In 1978, I started my second (and final) job at GE's Corporate Research and Development Center (CRD). Initially, I worked in the central computer organization doing contract programming for CRD scientists. I sensed that the then-emerging field of computer graphics would have an impact on all of GE’s

businesses and worked to introduce state-of-the-art computer graphics technology into the research lab and the company. In a short time I was able to establish my own research projects. I did research in 3D medical imaging, molecular modeling, scientific visualization and object-oriented software as it applied to computer animation.

My GE career has been technically and financially rewarding. An industrial research lab sits somewhere between an academic position and an advanced engineering position. On the one hand we have difficult problems posed by the Company. On the other hand, we have the luxury of time to think and invent new technology. The demands of doing research and producing usable results are always challenging.

In fact, most careers (and much of life) involves trade-offs: family versus work, research versus products, employer demands versus personal development. A successful career balances the trade-offs.

The most rewarding part of my career has been the personal relationships that I have made within the Company and in the external community. These relationships, more than anything else, made me a successful researcher and a valuable employee.

Recently when I was asked in a GE interview,

"What's the best advice to give an early career researcher at GE Global Research?"

My reply*,*

"Establish yourself technically both within and outside the Company. Find others who share your interests and work with them regardless of where they sit in the organization. Become active in professional organizations like the IEEE or ASME. Attend the society meetings, work on committees, review papers. The external exposure is great for you and the Company."

1.3. ACADEMIC FREEDOM

Tamara Munzner
Assistant Professor
University of British Columbia

For me, one of the greatest attractions of being a professor is the intellectual freedom. In an industrial or government setting, a project can be vetoed by anybody above an individual researcher in the organizational chain of command. The individuals in that chain can change overnight, and then even long-standing policies can be reversed. Having a specific project, or worse yet a long-term program, be snatched out from under you when you're still passionate about it is frustrating and demoralizing. In contrast, if I can convince any single funding source on the planet that a project is worthwhile, then I can pursue it. Of course, not all ideas pan out equally well, but the decision-making is mine.

When pondering which career path to take after graduate school, I realized that I didn't want to have to switch jobs in order to switch datasets. On the other hand, I would rather switch jobs than switch fields. If you enjoy

doing interesting cutting-edge things in general, many industry or government jobs are a good match. My desire to stay with field of visualization in particular was the main reason I chose to become a faculty member, with the explicit understanding that fortune is now less likely to come my way.

Visualization necessarily requires collaboration with people that have data and questions about it. One approach is to concentrate on one or few domains, becoming almost a specialist yourself. I've chosen the opposite approach of collaborating with people in a broad set of domains, with visualization being the thread that runs through all of the projects. I got started in this area by working with topologists at a summer job in 1990. I have been opportunistic about finding areas where three criteria are met: the datasets are large, the questions are clear, and the funding exists. The list of application domains now includes computational linguistics, networking, web site design, and bioinformatics. The opportunity and necessity of constantly learning about new fields is one of the most vibrant aspects of this career path.

I also enjoy the synergy of thinking about many projects simultaneously, by working with multiple students. However, at this point in my career, I have deliberately chosen to keep the size of my group relatively small, so that I can stay heavily engaged with the details of the research. One of the reasons I chose to work in Canada rather than stay in the United States is that there is much less institutional pressure to build a large empire.

1.4. MAKING A GO OF IT WITH VISUALIZATION

William J. Schroeder, President
Kitware, Inc.

Visualization has been a natural outgrowth of my interest in numerical simulation. I have particularly enjoyed geometric computing which naturally gives rise to methods in graphics and visualization, and often forms the basis of many visualization algorithms. To me visualization is about amplifying human potential, much as Fred Brooks coined in his use of the term "Intelligence Amplification" IA (as contrasted with artificial intelligence AI).

My entry into the world of entrepreneurship was serendipitous. While I enjoy creative research activities, I particularly enjoy sharing knowledge with others, working as a part of a team, and taking risks--whether it's chasing a new idea or turning conventional business models upside down. To me, ideas are relatively easy to come by, it is the refinement of ideas into useful tools and applications where the real challenge (and fun) lies. Thus it was inevitable that these influences converged and I left the world of research to focus my energies on solving and delivering real-world solutions in an entrepreneurial setting.

Fundamentally visualization is about teaming, since visualization necessarily requires a source of data. In our company we remind ourselves of this constantly, since our teammates are typically our customers, and we

endeavor to maintain a customer-centric attitude. Most of the time we enjoy working with such customers since we see new ideas and applications, but the challenge of managing budgets while delivering results can become stressful. Flexibility is also mandatory, because business demands often drive us in unexpected directions. The key is to remain open to the opportunity that every customer brings, with an eye towards the long-term strategic interests of the company.

The most surprising aspect of my position is the creative nature of the business process. Our use of an open source business model causes no lack of confusion among customers and program managers. Often our business model is met with suspicion, as people wonder what the catch is. Once we demonstrate that we are truly trying to balance public good versus financial reward, we find that our customers and collaborators are energized by the model. Such enthusiasm has other benefits as well, for example, we find that we can attract and maintain outstanding employees, and other organizations enjoy teaming with us.

1.5. PUSHING THE EDGE, BUT NOT FOR PROFIT

Terry S. Yoo
Program in Three-D Informatics, Head
Office of High Performance Computing and Communications, NLM, NIH

A career in government research, while not for everyone, has some advantages for the visualization specialist with a specific interest in particular discipline or domain specialty. Often, a government lab is dedicated to research in a relatively narrow field, depending on the agency or institution. These areas can range from oceanography and meteorology at NOAA, astronomy or aeronautic engineering at NASA, medicine and biology at NIH, environmental health at EPA, ballistics and logistics at ARL, energy resource research at LLNL, or visual analytics for homeland defense at PNNL, to name a few examples. In exchange for marginally more secure funding (labs often have to seek internal support for their research, though less intensely perhaps than their academic counterparts), researchers must focus on solving problems and addressing issues faced by their home institutes and agencies. The government track does not have the same clear career progression of academic positions such as from assistant to associate to full tenured professor, and it seldom matches the financial rewards found in private industry. However, government research is frequently secure, steady research work on dedicated scientific problems.

A hallmark of government research is that it often pushes the edge of the research envelope. Many companies are restricted from performing basic research, electing instead to fund only those areas that promise future profit. By its nature, government should avoid competing with the private sector and instead apply its resources on projects that are beyond the horizon of product development in forward thinking explorations for the public welfare. Efforts such as the Visible Human Project generate anatomical studies with

resolutions that challenge the computer science community and provide excellent resources in medical research and education, but without being driven by a profit motive. Landing probes on Mars expands our understanding of the solar system, but yields few new business ventures. Government research is seldom driven by a strong business model but rather by desire to add to human knowledge and to improve scientific investigation. A love of science, not money, and a high personal threshold for bureaucracy are qualities that are rewarded in government research.

2. BIO SKETCHES

2.1. CHRIS JOHNSON

Professor Johnson directs the Scientific Computing and Imaging Institute at the University of Utah where he is a Distinguished Professor of Computer Science and holds faculty appointments in the Departments of Physics and Bioengineering. His research interests are in the areas of scientific computing and scientific visualization. Dr. Johnson founded the SCI research group in 1992, which has since grown to become the SCI Institute employing over 100 faculty, staff and students. Professor Johnson serves on several international journal editorial boards, as well as on advisory boards to several national research centers. Professor Johnson has received several awards, including the NSF Presidential Faculty Fellow (PFF) award from President Clinton in 1995 and the Governor's Medal for Science and Technology from Governor Michael Leavitt in 1999. In 2003 he received the Distinguished Professor Award from the University of Utah. In 2004 he was elected a Fellow of the American Institute for Medical and Biological Engineering (AIMBE) and in 2005 he was elected a Fellow of the American Association for the Advancement of Science (AAAS).

2.2. BILL LORENSEN

Bill Lorensen is a Graphics Engineer in the Visualization and Computer Vision Lab at GE Research in Niskayuna, NY. He has 40 years of experience in computer graphics and software engineering. Bill is currently working on algorithms for medical image analysis and scientific visualization. He is a co-developer of the marching cubes and dividing cubes surface extraction algorithms, two popular isosurface extraction algorithms. His other interests include computer animation, color graphics systems for data presentation, and object-oriented software tools. Bill is the author or co-author of over 60 technical articles on topics ranging from finite element pre/postprocessing, 3D medical imaging, computer animation and object-oriented design. He is a co-author of "Object-Oriented Modeling and Design” published by Prentice Hall, 1991. He is also co-author with Will Schroeder and Ken Martin of the book "The Visualization Toolkit: An Object-Oriented Approach to 3D Graphics" published by Kitware in 2004. Bill holds thirty US Patents on medical and visualization algorithms. In 1991, he was named a Coolidge Fellow, the highest scientific honor at GE Research. In 2004, Bill received the first IEEE Visualization Career Award. In 2006, Bill was elected a Fellow of the American Institute for Medical and Biological Engineering (AIMBE).

Prior to joining GE in 1978, he was a Mathematician at the US Army Benet Weapons Laboratory where he worked on computer graphics software for structural analysis. He has a BS in Mathematics and an MS in Computer Science from Rensselaer Polytechnic Institute.

2.3. TAMARA MUNZNER

Tamara Munzner became an assistant professor of computer science at the University of British Columbia in Vancouver in the summer of 2002. Her current research interests are information visualization, graph drawing, and dimensionality reduction. From 2000 until 2002 she was a research scientist at at Compaq Systems Research Center in Palo Alto, California. She completed her PhD in computer science at Stanford University in June 2000, where she also received a BS in computer science in 1991. Between 1991 and 1995 she was a member of the technical staff at the University of Minnesota Geometry Center, with the research focus of mathematical visualization. She has also worked at Silicon Graphics Inc, Microsoft Research, and the supercomputer company ETA Systems. She was the IEEE Symposium on Information Visualization (InfoVis) Program/Papers Co-Chair in 2003 and 2004, and is currently a Member at Large of the Executive Committee of the IEEE Visualization and Graphics Technical Committee.

2.4. WILL SCHROEDER

Dr. Schroeder is President and co-founder of Kitware, Inc. Kitware is a small company providing open source software tools and expertise in 3D graphics, visualization, medical image analysis, and quality software process. Will's role at Kitware is to identify technology and business opportunities, and to obtain the necessary support for Kitware to meet these opportunities. Dr. Schroeder is principal developer of the Visualization Tookit (vtk.org) software, and continues to provide technical leadership in prestigious projects such as the Insight Segmentation and Registration Toolkit (itk.org) and the NAMIC NIH National Center for Biomedical Computing (na-mic.org). Dr. Schroeder graduated from the University of Maryland as a mechanical engineer; and then obtained a M.S. and Ph.D in applied mathematics from RPI while working full time at GE.

2.5. TERRY YOO

Terry S. Yoo is a Computer Scientist in the Office of High Performance Computing and Communications, National Library of Medicine, NIH. As head the Program for 3D Informatics, he is an advocate for open source software, open access publications, and open sharing of data. His research explores the processing and visualizing of 3D medical data, interactive 3D graphics, and computational geometry. He is also the project officer who conceived and managed the development of ITK, the Insight Toolkit, under the Visible Human Project. Previously as a professor of Radiology, he managed a research program in Interventional MRI with the University of Mississippi. Terry holds an A.B. in Biology from Harvard, and a M.S. and Ph.D. in Computer Science from UNC Chapel Hill.