In October of 2008, the lab took a day off and went canoeing and kayaking down the Brandywine River. It was a glorious fall day and a lot of fun.

Letter from the Director, Norm Badler

Dear Friends:

What an amazing year this has been for us! We couldn't imagine what the new SIG Center for Computer Graphics would be like, even with the architectural renderings, until we actually got to move back into our space in the Moore School. Once everyone moved out and the demolition crew began to work, we knew that whatever was going to happen was finally, really, going to happen. We moved all the PhD students into a bright but cramped room in Hayden Hall and moved Amy Calhoun into a first floor office in GRW. The transformation that occurred in the Moore building during Fall 2008 was truly, well, transformational. Jan Allbeck documented this entire construction process in photographs, and gives us a personal guided tour of the new space in this issue. Even the entryway is new. The ramp has been brightly lit and animated with addition of the "virtual companion" wall of LEDs designed by the architects. We are deeply appreciative of the sponsors who made this transformation from virtual to reality happen: The Susquehanna International Group, Harlan M. Stone, Dawn and Tripp Becket, and Ramanan Raghevendran.

We are proud of our history and the many alumni who have passed through the computer graphics lab, the Center for Human Modeling and Simulation, and now the SIG Center for Computer Graphics. We profile some these in this issue: PhD Min-Zhi Shao, CGGT Brian Silva, DMD Becket Award winner Ariela Nurko, and former graduate student Ramanan Raghevendran. We also describe some ongoing connections we are making with the Art History and Anthropology departments in both courses and research projects.

In the Fall of 2008 we had an excellent visit from Dr. Jerry Tessendorf, Principal Graphics Scientist at Rhythm & Hues Studio. Jerry gave lectures in graphics and animation, and even contributed an implicit volume project for the CG course. This Spring we had a week-long visit from Professor Alan Chalmers of the University of Warwick, who illuminated us about reproducing accurate lighting models for ancient architecture and archeology sites.

Our SIG Center Associate Director Jan Allbeck has made us proud: with the completion of her PhD she will move on in the Fall to an Assistant Professor position at George Mason University. Check out her work in our book: "Virtual Crowds" published by Morgan & Claypool! Much of what CG@Penn stands for, and the operational utility of the SIG Center itself, is due to her. We will miss her but wish her the best in her new position!

These are exciting times for all of us. We hope this Newsletter conveys some of our enthusiasm and appreciation for our students, staff and friends.

Sincerely,
Norm Badler
Director
SIG Center for Computer Graphics

Check out the renovations on page 4!

Note from
Brian Silva, CGGT 2006

As I was wrapping up my undergraduate degree in computer science, my wife discovered that she had a somewhat distant connection to a producer at Pixar. She and her family worked their connections to get me an informational interview, during which I asked the producer, "where should I study computer graphics?" His answer: UPenn. And so I enrolled in the CGGT program.

My favorite aspect of the CGGT program was the balance between theory and practical application. I came into the program feeling a bit weak on my math skills, but became very motivated by the ways in which we applied the math we learned: writing the ray-tracer, the curve editor, the FK/IK solver, etc. By the time two semesters were complete, I felt confident enough to take on a fluid solver as my final project, and finished out the program feeling very good about my mathematical abilities.

The wide range of experience I gained in the CGGT program has served me very well as a Technical Director at the Walt Disney Animation Studios. On Bolt I worked primarily in the lighting department on projects such as optimization of particle rendering, interactive reflection placement using the GPU in Maya, and various pipeline tools. Since Bolt, I've had the opportunity to learn and write RenderMan Shaders, as well as authoring systems for the FX department to manage animated displays and lights. I must say that when people find out I attended UPenn to study graphics, they automatically put more confidence in my work.

My advice to current CGGT students: explore and dive into a variety of the different divisions of computer graphics. I've found versatility to be an enormously valuable quality for my own career, and it has also kept the work fresh and constantly interesting. That said, versatility needs to rest on a strong foundation, so work hard to get the most you can out of the fundamental courses in Graphics and Animation. Finally, get to know Dr. Lane, Dr. Badler, and Amy very well. They are all wellsprings of knowledge and experience and they truly care about their students' happiness and success. They can and will help you to achieve your goals, but you have to ask. Good luck!

Say hello to
Ramanan Raghavendran

I came to Penn in the fall of 1985 to become a computer science graduate. I'd gone through high school in India with a different college experience in mind (in India), and apart from all the cultural differences between India and the US, the much more informal, freewheeling and flexible undergraduate environment could have been a shock. It was not; and I thrived in large part because of the wonderful SEAS faculty, particularly Dr. Badler who was my long-suffering advisor.

As a freshman, I intended becoming an academic in computer science. Life has taken me in a very different direction, as it usually does, in part because of the flexibility that Penn and SEAS afforded me around coursework. I've spent most of my working career since Penn in private equity, after joining McKinsey and Company right after college. In the late 90s, I began to feel a strong impulse to combine my professional skills with my affinity for India and Asia, and so for the last 10 years all I do is invest in "cross-border" companies – businesses that somehow benefit from the growing linkages between developed and developing economies. Which is a roundabout way of saying that I've been trying for a decade to avoid freezing winters and boiling summers!

I've had a desire to apply for-profit principles to non-profit work since my first private equity job – the firm I worked for had created a foundation to do precisely that and that got me thinking about issues such as measurability, good corporate governance and team building in the non-profit arena. When I first started making private equity investments in India, I also co-founded a small "venture philanthropy" firm that provided capital to about a dozen charitable organizations in India with a view towards getting these organizations to think about all these managerial issues that most charities ignore. We had some success but much remains to be done. Founders of non-profits have very different motivations and backgrounds than for-profit entrepreneurs, and do not (and cannot) have the same incentives to implement what most successful business builders view as essential.

I've experimented with various forms of carrot-and-stick involvement with non-profits during this period, all around this desire to see more structure and process. My current focus is on prize philanthropy – the firm I run, Kubera Partners, has created a prize for the three best charities serving underprivileged girls in India. We co-sponsored the prize with a local foundation in India called EdelGive (in turn financed by a bank whose board I serve on). We just finished the jury process and have made our awards, and I must say that the first year's process appears to have been extremely successful, with a great selection of deserving charities. But these are long duration processes – we will have to track how these charities perform over time against the metrics that were defined for prize selection.

Fall 2009: Visualizing the Past/Peopling the Past

Course CIS 106 / ANTH 258 / ANTH 620 was first offered in Fall 2004 by Anthropology professor Clark Erickson, researcher Alexei Vranich and Norm Badler. Initially based on the ancient architecture of Tiwanaku, Bolivia, it is returning this Fall with a similar theme but focusing on a different civilization. Most people's information about the Past is drawn from coffee table picture books, popular movies, video games, documentaries about discoveries of "ancient, mysterious, and lost" civilizations, and tours often lead by guides of limited or even dubious credentials. How are these ideas presented, formed, and circulated? Who creates and selects the information presented in this diverse media? Are these presentations accurate? Do they promote or hurt scientific explanations? Can the artistic, aesthetic, and scientific realms be bridged to effectively promote the past? How can modern technologies be applied to do a better job at presenting what is difficult to experience firsthand? This class will focus on case studies, critiques, and methods of how archaeology and the past are created, presented and used in movies, museums, games, the internet, and art. Students will map, model, and interpret the sacred landscape of the Incas as a studio-seminar project.

The Art History and DMD Project

The Digital Media Design (DMD) program has demonstrated strong and successful linkages between Computer and Information Science in SEAS and Fine Arts in The Penn School of Design. With incentive and support from Penn Alumnus Harlan Stone, we were charged with exploring the extension of that success in new and exciting directions with the History of Art Department. We want to try to capture a new spirit of interaction and collaboration between those who study, document, reconstruct and preserve the past, and those who bring technological expertise and skills to modeling, simulating and animating structures, artifacts and people. A natural association exists: many DMD students take a minor in Fine Arts. The Fine Arts minor requires one CU in Art History. There is unrealized potential in making at least this required CU work to the best advantage of both DMD students and the Art History faculty.

The prime example of how this can lead to synergistic projects is a 3D modeling project that former DMD student Meng Yang undertook with Professor Renata Holod, connected with a course ARTH 217, Introduction to the Visual Culture of the Islamic World. Yang built a 3D virtual reconstruction of the Great Mosque at Córdoba based on drawings, plans and information on lighting supplied by Professor Holod. Yang created textures and colors appropriate to the surfaces, and animated a "fly-through" of the space.

Droid modeled and rendered by Kevin Chang (CGGT`09) for 3D modeling class

To further potential connections between DMD and Art History, archaeologist Virginian Badler interviewed several Fine Arts faculty, including Holly Pittman, Renata Holod, Michael Meister, and Ann Kuttner and Anthopologist Richard Zettler. She also participated in the 2008 Eurographics VAST (Virtual Reality, Archaeology and Cultural Heritage) Workshop. The interviews and some of the projects that may evolve from this investigation are being assembled in a report that will be made public once finalized.

One tangible result of this survey has been the week-long visit to Penn by Professor Alan Chalmers of the University of Warwick. Other derivative projects underway include measuring, reconstructing and rendering light emission from ancient glass candelas with flame lighting. More on that in the next issue!

# Thoughts on working at Imageworks from Ph.D. Min-Zhi Shao

During my second stint at Sony Imageworks, I worked on body motion capture for Beowulf. The mocap stage was of the size about half of a basketball court, surrounded with 250 Vicon MX40 cameras. The system could capture up to 20 actors on stage. On each actor, 80 body (and 120 facial) markers were placed. Additionally, there were in total 250 props (markered as well). Due to the complexity of this setup, the raw mocap data typically contained a large number of unlabeled, mislabeled, missing, and even out-of-nowhere noise markers. Cleaning them up manually would be a tedious and time-consuming task. My job was to develop a tool to automate the process.

It might be counterintuitive, but the labeling problem for body mocap turned out to be more complicated than that for facial mocap, because the human body motion is typically less coherent or constrained, and involves more degrees of freedom. For shots with multiple actors, there is the problem of segmentation, which is non-trivial. As a comparison, in the context of marker-based mocap, there are no local textures that the image-based feature matching and segmentation techniques often rely on.
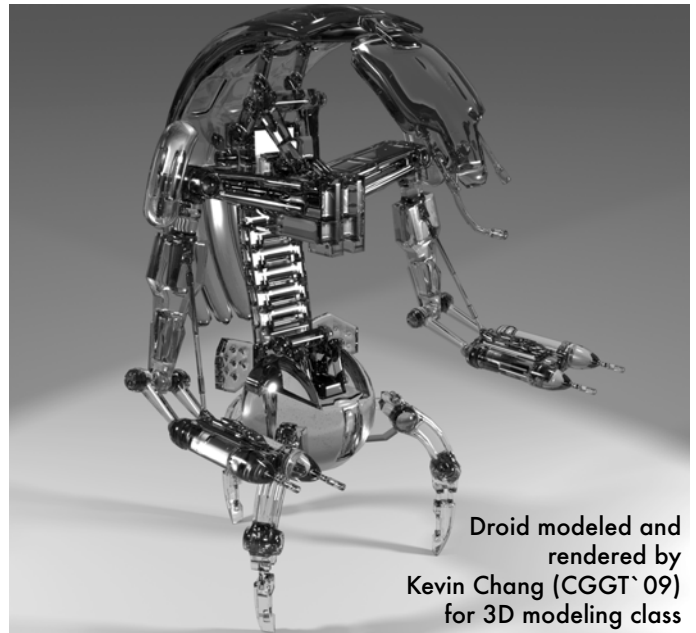
The marker labeling program that came with the vender's software was too unreliable to be of use, so we ended up treating the captured data as a point cloud (that is, a bunch of xyz's) with noise and gaps (due to occlusion, for example). Thanks to the fundamental research training I received at Penn, I quickly developed a label matching algorithm that was adaptive well to body-build, configuration and pose variations, and at the same time robust to corrupted data inputs. The program was able to consistently segment and identify individual actors, and match label markers for each one of them. Once the mocap markers were correctly labeled, they were fitted to skeletons and applied to rigs.

I also wrote muscle and skinning tools for character animation. In my earlier years at Sony, I developed production tools for camera calibration, 2D feature tracking, match moving, alpha matting, soft rotospline, vector and motion blurs, image editing, image warping, lens undistortion and rack defocus, various image filters for our in-house compositing software, and facial mocap. Looking back, one area I haven't worked on after school was my thesis topic – radiosity and global illumination; not even a single line of shader code. This may seem odd, but it's true!
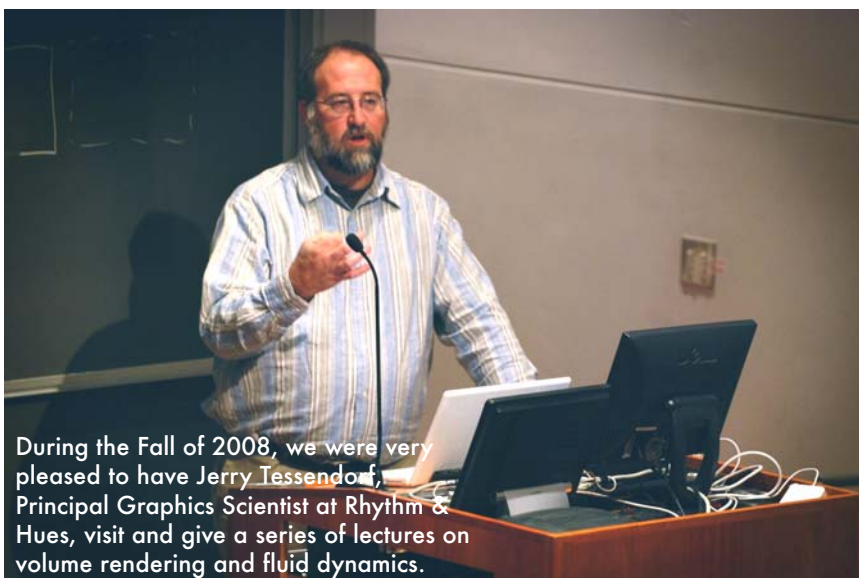
During the Fall of 2008, we were very pleased to have Jerry Tessendorf, Principal Graphics Scientist at Rhythm & Hues, visit and give a series of lectures on volume rendering and fluid dynamics.

# Tour of the New SIG Center for Computer Graphics

Above, we are outside of the newly renovated SIG Center for Computer Graphics. The front HDTVs display information about the SIG Center and the CG@Penn programs. We've decorated the glass panels with classic Mario decals. This has become a popular spot on the SEAS tours.
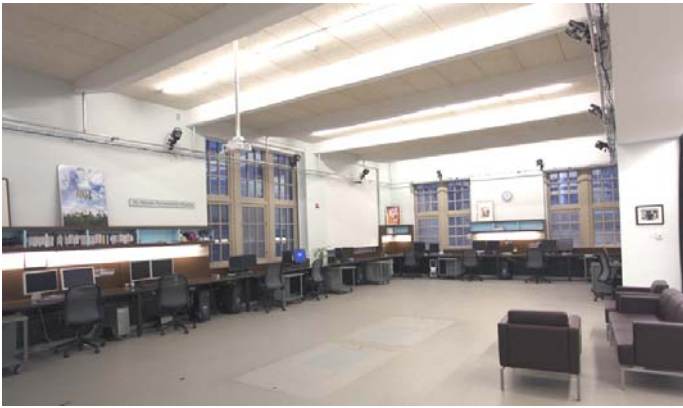

The Dawn and Tripp Becket Conference Room (picture, bottom left) comes with a built in projector and speakers that are wired to ports in the table and a 16 foot long whiteboard. We do like to scribble when we talk. Among the many meetings that are held here is our weekly reading group where we take turns reading, presenting, and discussing research papers.

In the above photo, we are just inside the door to the right. We have an area where groups can gather to discuss projects or have a bite to eat. The floor is made out of recycled tires. If you look closely, you'll see that we have a sink next to the huge refrigerator. The curtain can be pulled to hide the kitchen area from view. To the left of the kitchen area is the entrance to the conference room.
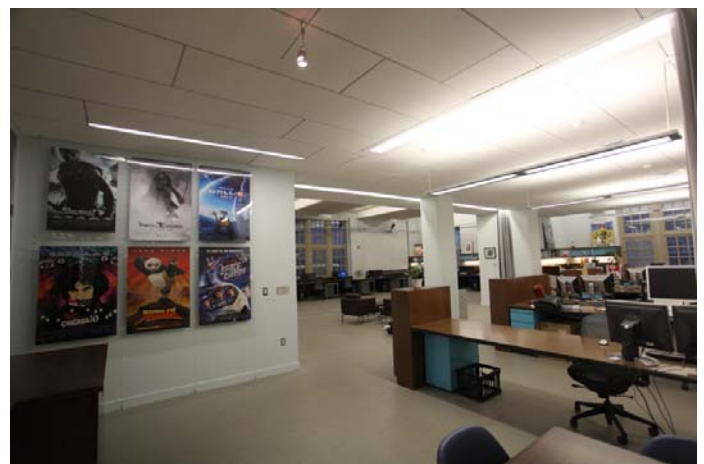
In the above photo we're back near the entrance to the lab looking southwest. To our left is a display of posters that CG@Penn alumni have worked on. The lab is full of posters of productions that have CG@Penn alumni's names in the credits. To our right is the Raghavendran Computational Laboratory where the Ph.D. candidates have desks and you can see one of our new west facing windows. Straight ahead is the H. Stone Animation Studio, which can be separated by a heavy curtain when needed.

In the picture to the bottom left, we can see the entrance beyond the Ph.D. desks to the left, the black curtain that separates the storage area from the animation studio in the distance, and the area that houses our printers, copier, and fax machine. Behind us is the office.

The animation studio pictured above includes many workstations, a comfortable space to sit and read, and a large motion capture area. The approximately 50' by 25' space is surrounded by 12 Vicon motion capture cameras which are automatically synched with data from two adjustable force plates embedded in the floor in the center of the space. You can also see a projector hanging from the ceiling. Behind us is a computer for controlling the motion capture system, a storage area, and a large screen that can be lowered for the projector to project onto. Since moving back into the space, the students have started having Movie Night. Once a week they set up the animation studio as a theater to watch a classic CG flick, an animated movie, or a special effects film: popcorn is included.

Above is the office of the Associate Director of the lab; at the time of this writing, Jan Allbeck. There isn't a great view, but the windows let in a lot of light during the day, and from where she sits, she can see a couple of the trees in the courtyard.

The renovations have basically completed. We returned to the space in January 2009 and pretty much love it all. The light and sense of space make it a much more pleasant place in which to work; not to mention the chairs which are supremely comfortable.   The open areas have also seemed to add to the already strong sense of community found among the members of CG@Penn. You can often spot people leaning their elbows on the bookshelves at the end of the Ph.D. desks to have a conversation or eating lunch at the front tables or wheeling around the lab to join in the latest debate about the merits of some CG movie, game, or programming construct (or to once again test Skiz's lack of ability to see certain colors).

We would like to thank the donors whose much appreciated generosity enabled us to renovate the lab. We would also like to thank the architects (Kennedy & Violich Architecture, Ltd.), the contractors (Murphy, Quigley Company), and the project team from Penn for their hard work, cooperation, guidance, and patience.

And the winner is... Ariela Nurko!

Citing her unusual level of engagement with computer graphics during her four years at Penn, Ariela Nurko was chosen as the 2009 winner of the Dawn and Welton Becket DMD Achievement Award.

As a freshman Ariela enrolled in our joint course with Anthropology, CIS 106, "Visualizing the Past/Peopling the Past." Her work in the class caught the eye of one of the faculty associated with the course, Alexei Vranich, who asked Ariela and fellow freshman Calley Levine to join him and a team of graduate students at the UNESCO World Heritage site in Tiwanaku, Bolivia. Their task was to begin creating virtual models of the site, and some of their work was later featured in the History Channel's "Digging for the Truth."

The next summer, Ariela was again the youngest of our Neil Braun Vanguard Animation fellows, where she spent the summer in Vancouver, working on the film "Space Chimps", with three other DMD students. Last summer Ariela interned at Pixar, where she will be employed upon graduation. This fall, Ariela and Calley Levine completed their senior project, "Set Mapper Deluxe," a Maya animator tool.

The Air Force Research Project

he "Virtual Coaching Agent for Team Training" research task was sponsored by the Air Force Research Laboratory's Logistics Readiness Branch (AFRL/RHAL) under the Technology for Agile Combat Support (TACS) contract. This effort represents the last in a sequence of projects that focused on investigating the design and evaluation of a new interactive software model to support technical (e.g., maintenance) training, as well as for use as an on-the-job task aide. The goals of this project were to:

- Capture the instructional experience of a course instructor in a computer (software) based training environment.
- Provide a mechanism for storing, archiving and efficiently accessing course materials, simulations, instructions, multimedia materials and instructional expertise.
- Utilize human model avatars as coaches, communicators (instructor surrogates), or simulated maintainers to instruct and illustrate correct and incorrect procedures and practices - especially cautions and warnings.
- Demonstrate and evaluate a software-based, team training environment for 24/7 instructional access, task preparation, individual practice, and team coordination as an adjunct to hardware trainers and hands-on experience.

HMS PhD students Ben Sunshine-Hill, Catherine Stocker and Joe Kider working with DMD students John Drake, Ian Perera, Samantha Raja and Grace Fong developed a prototype interactive software system called CRAM (Course Resource with Active Materials). This last project was to demonstrate and evaluate the utility of the CRAM system for supporting aircraft maintenance training in a specific technical training context, and to demonstrate the feasibility of simultaneous users interacting to accomplish a multi-person maintenance task.

The CRAM system is intended to support Air Force personnel receiving initial skills training in aircraft maintenance career fields to perform various maintenance procedures. It is intended that any procedure described in an Interactive Electronic Technical Manual (IETM) should be able to be converted into a virtual training procedure. For demonstration and evaluation purposes, the scope of the research effort focused on one particular training event in the F-15 Aircraft Maintenance Apprentice Course conducted at Sheppard AFB, TX, namely, the training of jacking procedures (raising the aircraft on jacks so that the landing gear can be serviced) for the F-15 fighter aircraft. The effort included: knowledge acquisition and data collection; development of methods and materials to support an evaluation of the CRAM system in the context of the chosen training scenario; design and development of CRAM software extensions and enhancements to support multi-user demonstration and evaluation activities; and the analysis and documentation of evaluation results.
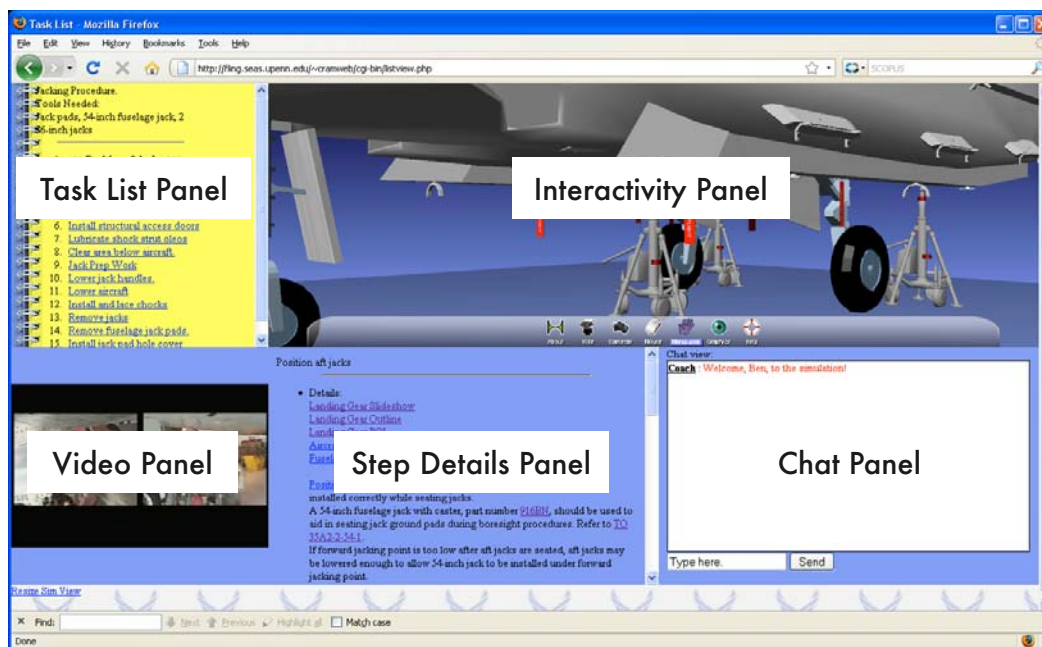
The Task List Panel displays the top-level sequence of steps and the present step. The Step Detail Panel displays additional details of the currently selected step. These details are taken verbatim from the official instructions, but may be supplanted with reminders and advice from the instructor, as well as whatever multimedia content is desired. This multimedia, when selected, plays in the video panel. This panel also contains a text box to allow trainees to ask questions and make content suggestions, to be reviewed later by the instructor. The Video Panel shows video and other multimedia content included by the instructor. The Interactivity Panel displays the interactive 3D world in which the procedure takes place. Trainees can move in the 3D world and manipulate objects using a control scheme familiar to them from 3D video games. During multi-trainee collaboration, other trainees are visible as avatars in this world. Additionally, the Virtual Coach agent appears in the virtual environment when necessary to give advice to the trainee. The Chat Panel allows trainees to communicate during multi-trainee collaboration, and its design reflects standard online "instant messaging" behavior. It consists of a text entry field to allow a trainee to type a message, which is then sent to all other trainees participating in the simulation. Past messages sent by all trainees are visible above this field, in chronological order. Additionally, the Virtual Coach uses this space to send messages to the trainees when that becomes necessary.

Through experiments designed and led by Catherine Stocker at Sheppard Air Force Base we found that both practicing virtually using CRAM and watching an instructor demonstrate a task in a video can improve an airman's knowledge of hazards significantly over reading about them in the written instructions. In addition, when given the choice of what they would like to practice on, participants overwhelmingly choose virtual practice or watching a video over reading instructions. A full report on this project will be available from DTIC later this year.

CGGrid RenderFarm

The SIG Center has acquired a renderfarm consisting of 57 working nodes: CGGrid. Each node is an Intel Xeon 3.06 GHz processor running the Linux distro openSUSE. These machines were generously donated to the SIG Center by Disney Animation after they upgraded their own renderfarm to 64 bit machines. CGGrid is currently loaded with Pixar's RenderMan and the open source Radiance renderer and is initially being used for several senior projects and funded research efforts. The SIG Center maintains a wiki with step-by-step instructions on using the machines as well as the installed renderers.

On April 28th, 2009, the SIG Center for Computer Graphics officially opened with a ceremonial dedication and cocktail reception.

Alan Chambers' Visit

Alan Chalmers presented an Art History Colloquium on April 3, 2009, sponsored by the Harlan Stone project. Alan is a Professor of Visualisation at the Warwick Digital Laboratory of the University of Warwick. His talk was called "Being Present in the Past"; it was an eye-opening event for both the art historians and computer graphics attendees. Alan's abstract: "There-reality environments (a.k.a Real Virtuality) are high fidelity virtual environments which provide the same perceptual response from viewers as if they were actually present, or "there" in the real scene being portrayed. A human's perception of the real world is more than just what we see, and thus these there-reality environments need to be multi-sensory and may have to include visuals, audio, smell, touch and even taste, to achieve the appropriate level of perceptual realism. This talk will discuss the technical challenges in creating and delivering such there-reality environments and show how these environments may significantly enhance our experience and thus understanding of ancient sites."

A few days later, Alan gave a second more technical talk in the SIG Center on *Realism in Real-Time*: "Computing highly realistic images of complex scenes in real-time still remains one of the major challenges of computer graphics. While real-time performance is typically accepted as 25fps and above, the definition of realism remains less clear. If we were able to simulate the physics of the real world to minute detail then it would be possible for us to achieve images which were physically correct. However, the amount of computation required for such physical accuracy of complex scenes precludes any possibility of achieving such images in reasonable, let alone real-time, on a desktop computer for many years to come."
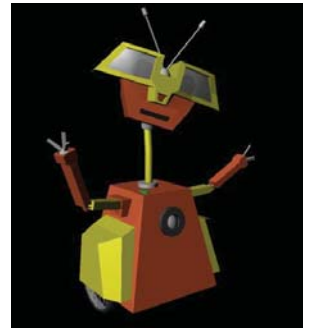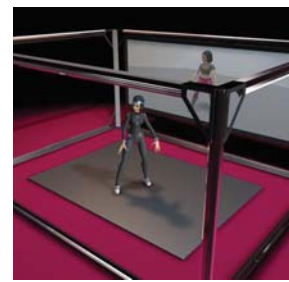
"The challenge seems even more demanding when we start to consider multi-sensory virtual environments. A key factor to consider though is we are computing images, and environments, for humans to perceive. While the human perceptual system is good, it is not perfect, and is often simply unable to cope with large amounts of simultaneous multi-sensory stimuli. This talk will discuss how we may exploit the human perception system to achieve virtual environments which are perceptually equivalent to the real world being portrayed. In these Real Virtuality environments, the human user will have the same experience as if he/she was actually "there" in the real world, without being aware of quality differences in the way in which the real sensory stimuli are selectively computed and delivered in the virtual world."

Goodbye from Jan

Greetings everyone,

   I think a fair number of you know who I am, but for those of you who do not, I am Jan Allbeck. As of this writing, I am Associate Director of the SIG Center for Computer Graphics (formerly HMS). I joined the lab as a Ph.D. candidate at the end of my first year at Penn (1996). In 2001, I also became a member of the staff. In other words, I have spent many years in the lab and met many truly amazing people. Some of you will be shocked, but hopefully happy, to hear that I have finally completed my dissertation and am graduating this Spring. I'll be leaving HMS and joining the Department of Computer Science at George Mason University as an Assistant Professor. While I am looking forward to moving on to new opportunities and new challenges, I will miss being a part of the CG@Penn community. I will forever carry with me a sense of pride from my association with CG@Penn. I have often been in awe of the people I have met here and their accomplishments, and would like to thank everyone who welcomed me into this community, shared with me their experiences and ideas, and showed me patience when I sometimes struggled.

   All the best,
      Jan

cg@penn