Steven J. Gortler; Education Statement

Three dimensional Computer Graphics is an increasingly important part of the computer science field and a computer science education. Many of the leading Computer Science programs, such as MIT, Stanford, and the University of Washington just to name a few, have large multifaculty programs dedicated to computer graphics. In the past seven years, I have built a rich computer graphics program at Harvard University, one that includes a full curriculum, as well as one-on-one undergraduate and graduate advising.

Three dimensional computer graphics is the study of techniques to both represent and simulate shape, light, material and motion. The synthesis of these techniques is used to create images and movies of virtual 3D objects.

Computer graphics has made a large impact on a number of application areas. Perhaps the most well known application of computer graphics is in the entertainment field, specifically special effects in movies, computer generated animation, and computer games. These same techniques are also at the core of many more sober applications. In the area of computer aided design, computer graphics tools are routinely used in the design of automobile bodies and architectural environments. In the area of computer aided training, computer graphics is used to simulate surgeries on humans and simulate combatants on a battlefield, allowing individuals to learn difficult skills without endangering themselves or others. In the area of computer human interaction, computer graphics is used as the core tools to allow computers and humans to more expressively interact. In the area of data visualization, computer graphics tools are used to display 3D MRI data, to visualize weather patterns, as well as visualizing abstract scientific and mathematical data. Recently, computer graphics tools have even been used to accurately record the geometry of some of Michelangelo's sculptures. These data will be used to study the artwork, as well as plan for its care and restoration.

Computer graphics is a unique part of a computer science education in that it bridges many large gaps between various related fields. Thus, it, in my opinion, can play a pivotal role in a computer science education. Computer graphics deals with continuous quantities but necessarily in a discrete domain, thus it bridges classical continuous mathematics with the kinds of discrete mathematics found in computer science. Computer graphics requires precise mathematical modeling, but it must be implemented in an efficient and usable computer system, thus bridging the more theoretical and system oriented aspects of computer science. A computer graphics education also routinely covers material on signal/image processing, computer vision, information theory as well as numerical analysis and scientific computing.

I am proud of the success of the educational program I have built at Harvard University. Many computer science concentrators graduate having taken three computer graphics courses from me (greater than 10/year). Undergraduate students who come through this program are in great demand in both industry and graduate programs. To name a few recent examples, Ashley Eden has gone on to UC Berkeley and Benedict Brown to Princeton to pursue PhDs. David Ryu was recruited to Pixar Animation Studios, and Allie Pritkin to Xbox at Microsoft. Scott Asher, Forrester Cole, Hamilton Chong and Sanjay Mavinkurve have all been summer interns at Nvidia (the largest maker of consumer 3D graphics chips).

Courses

At Harvard University, I have developed three courses in Computer Graphics, cs175: Introduction to Computer Graphics (Fall terms), cs277: Geometric Modeling (every other Spring term), and cs278 Rendering and Image processing (every other Spring term)[1].

These computer graphics courses have been very well attended, and are rated quite highly in the student CUE guides. The introductory computer graphics course has grown from a size of around 20 in 1996 to a peak of 73 in 2001. (Note that there are only about 70 students entering the computer science concentration

[1]Note that cs175 was formally also listed as cs275. Also note that cs277 and cs278 were previously taught under one repeated number cs276r.

year	Fall class size	Fall cue ratings (course/prof) out of 5	Spring class size	Spring cue ratings
1	24	4.2/4.1	11	na
2	54	3.9/3.4	14	na
3	39	4.3/4.2	18	4.5/4.6
4	54	4.5/4.6	34	4.6/4.6
5	68	4.6/4.6	37	4.1/4.3
6	73	3.9/4.0	25	na
7	40	4.6/4.8	24	4.3/4.8
8	38	3.9/4.3	13	4.5/4.9

Table 1: Enrollment and student ratings for graphics courses. Note that in the sixth Spring, we began limiting enrollment to 25 in order to maintain class participation. Also note that beginning in the seventh Fall, the introductory course was no longer offered for graduate credit.

each year). The advanced courses' enrollments have grown from a size of 10 in 1996 to a peak of 37 in 2001. Enrollment and CUE ratings data are shown in the included table. Because of its broad technical coverage, as well as exciting applications, the computer graphics courses routinely draw students from other concentrations such as Mathematics and Physics.

cs175 (see http://www.fas.harvard.edu/∼lib175/). This is a first semester course introducing students to three dimensional computer graphics. As part of our this undertaking we have written our own text material that we use instead of any available textbooks. (sample chapters are available from the course website). This text aims to consistently explore linear affine and projective spaces. It also has strong sections on color, photometry and quaternions. We plan to continue this text and eventually publish it as a textbook.

cs277 : In this course we cover differential geometry, blossoming and polar forms, implicit surfaces, direct manipulation for modeling, subdivision surfaces, model simplification, surface parameterization and signal processing, Delauney tetrahedralization, as well as a section on motion capture processing.

cs278 : This course covers basic signal processing, wavelets, image compression, texture filtering, image processing applications such as blue screening and image restoration, image based rendering, light transport simulation, and occlusion culling.

In the future, the program could be expanded by including courses in human perception, human computer interaction, animation techniques, computer graphics hardware and systems. To achieve this would require the expansion of our program by at least one more faculty member.

Computer graphics brings together many interesting ideas from computation, mathematics and physics. In the future, I would be interested in teaching a Core course that would use computer graphics to show how mathematical modeling is used to describe many aspects of the physical world.

Advising

Advising students has been an experience I have greatly enjoyed, and I hope the students have gained from the experience as well. Through this kind of advising, I have gained insight into many technical areas that I could never have accomplished on my own. Hopefully I have also helped these young students better understand the research process. I will briefly outline a number of advising relationships I have had recently.

Chris Buehler (PhD, May 2002). I co-advised Chris on his MIT PhD thesis ”Rendering from Unstructured Collections of Images” along with Leonard McMillan of MIT. This was a study into the process of creating novel output images from an unstructured collection of input images. In my opinion, Chris was among the best graduates in the Computer Graphics field in 2002. He is currently working for a local startup company.

Xianfeng Gu (PhD, January 2003). I have advised Gu on a series of projects related to processing meshes of arbitrary topology. This work has lead to the developement of the “Geometry Image” representation, as well as recent work on discrete holomorphic forms.

Pedro Sander (PhD, May 2003). I have advised Pedro on mesh processing and parameterization projects. This work has lead to a parameterization method specialized to the application of sampling and texture mapping. Work with Pedro has lead to four (two SIGGRAPH) papers.

Danil Kirsanov (planned completion PhD, Ocotober 2004). I have advised Danil on projects related to globally minimal surface computation and their application to continuous variational problems and medical volume segmentation.

Douglas Nachand and Geteeka Tewari are second year PhD students

Hamilton Chong is a first year PhD students whom I am just beginning to advise.

David Ryu (undergraduate thesis April 2001). I advised David on his thesis ”Visibility Layer Decomposition”. This paper won a Hoopes Prize. David is currently working at Pixar.

Ashley Eden (undergraduate thesis April 2002). I advised Ashley on her thesis ”Directable Motion Texture Synthesis”. She is currently beginning a PhD program in Computer Graphics at UC Berkeley.

Forrester Cole (undergraduate thesis April 2002). I advised Forrester on his thesis ”Automatic BRDF Factorization”. This work was presented as a poster at EGRW 2002, and has been submitted for patent.

Hamilton Chong (undergraduate thesis April 2003). I advised Hamilton on his thesis ”Optimal Shadow Maps”. This work has let to a paper presented at EGSR 2004.

Director of Undergraduate Studies

Over the past 5 years, I have held the position of Director of Undergraduate Studies of Computer Science at Harvard University. In this job, I have take the lead role in updating and reorganizing the concentration requirements, as well as being the first point of advising for all CS concentrators, and the first point of communication with outside agencies and the press.