A Collaborative and Interdisciplinary Computer Animation Course

David S. Ebert
University of Maryland
Baltimore County
ebert@umbc.edu

Dan Bailey
University of Maryland
Baltimore County

This paper presents the pedagogical approach, curriculum, and results we used to develop an interdisciplinary course in computer animation for artists and computer scientists.

Introduction

Computer animation has always required a close collaboration between artists and computer scientists. However, traditional educational approaches to computer animation isolate artists and computer scientists from each other. Traditional courses fail to teach students the important interdisciplinary nature of computer animation and fail to provide practical interdisciplinary collaborative work experience to students. We have developed an interdisciplinary computer animation course that focuses on contemporary issues in computer animation and requires the skills of animators and programmers working in teams. The goals of this course are to:

- Develop students'teamwork and effective group dynamic skills.
- Increase the technical graphics and animation knowledge of computer science students.
- Increase the animation skills and knowledge of advanced computer animation techniques of art students.
- Introduce art students to the technical aspects of rendering and animation, and expose them to research issues in computer animation.
- Introduce computer science students to traditional and computer animation techniques.
- Introduce art students to the creative potential of writing procedural shaders, models, and animation expressions.
- Provide practical animation production experience, using and extending commercial animation software.
- Provide a collaborative learning environment where students will learn from each other, as well as the course instructors.

A key aspect of this course is that students gain experience in participating in interdisciplinary teams. Teams of four-five visual arts and computer science students work together to produce animations that utilize each member's skills and interests, in a manner similar to commercial animation environments. The computer animation industry requires employees to work in teams on large projects, where the teams are composed of members from quite disjoint backgrounds. We have structured this course to help students learn how to communicate, work, and even thrive in this environment.

Background and Motivation

Animation's history, from its origins in the 1880s to contemporary time, is a continuous line of technological inventions that have allowed animators the ability to achieve higher-quality effects with greater ease.[1] At the heart of each of these developments has been the successful synthesis of artistic and scientific talents, usually resulting from creative collaborations. Equally as important, large-scale animation production has always required large teams of variously talented individuals. The Warner Bros. animators of the 1930s through the 1950s produced some of the most successful cartoons of this century, resulting from effective collaboration among its directors, animators, writers, technicians, artists, and musicians.[1]

Both of these issues point to the fact that a successful and contemporary animation curriculum should not only be interdisciplinary, but it should also encourage students to develop effective team skills. However, crossing the boundaries between areas and departments within universities has always been difficult. Therefore, many schools are slow to address the industry trend to teach and encourage effective teamwork and collaboration between animators and computer scientists. Currently, many animation, special effects, and computer graphics houses are creating their own in-house workshops and programs to address these issues.

Pedagogical Approach

Our pedagogical approach to this course has two key themes: interdisciplinary work and collaborative education. This is true even in the instruction and design of the course, which is team taught by a visual arts faculty member and a computer science faculty member. Most of our lectures are designed to have sections that both faculty members present, highlighting the technical computer graphics aspects and the art and animation aspects of the material. In every aspect of the course, we encourage students to collaborate and help each other. Initial assignments, described below, are designed to provide easy and difficult segments for both types of students, thus encouraging students to begin interacting with their counterparts.

Curriculum

The curriculum for the course was developed with three concerns in mind:

1. How to introduce mathematical expressions and scripting to the art and animation students and, at the same time, introduce the computer science students to basic animation concepts and the animation software. This was accomplished through individual projects and tutorials that students completed within the first two weeks of class.
2. How to present the basic aspects of effective collaboration among individuals and create an environment that encourages strong teamwork. This was accomplished through presentations, discussions, examples, and two initial assignments that "broke the ice" and encouraged the teams to utilize the skills of individual team members.
3. How to present both the computer science and art concepts of 3D computer animation. The course was always taught collaboratively by the two instructors. Topics were presented as lectures and demonstrations with each instructor presenting material.

We structured the course to include the following material:

- Group dynamics and collaborative teams.
- Basic mathematics for computer graphics and animation.
- Computer science basics of rendering, shading, anti-aliasing, and procedural techniques.
- Photorealistic rendering techniques and tricks using a commercial animation package.
- Scene composition, camera angles, basics of set lighting, and cinematography.
- Animation basics: timing, keyframing, hierarchical animation, interpolation, and motion paths.
- Kinematics and inverse kinematics.
- Object deformation, soft objects, and blending.
- Dynamics, physics-based animation, and inverse dynamics.
- Behavioral animation: particle systems, crowds, flocks, and emergent behavior.
- Procedural animation and intelligent characters.
- Animating natural phenomena.

We have chosen to use a text for the class[3] that is intended to teach computer animation to artists and recommend several computer-science-oriented animation books as supplemental material.[4]

Group Dynamics and Collaborative Work

Traditionally, students are not given the skills to work effectively in collaborative teams. To address this, we present the basic concepts of effective collaborative work and emphasize this concept by leading a class discussion that relates individual experiences in group work. Students are given background material on teamwork, "groups versus true teams," and a worksheet to help evaluate the effectiveness of each of their team meetings and identify problems as early as possible. Another important aspect of effective student teamwork is close interaction of the teams and the instructors, which allows instructors to serve as observers, help identify team problems early, and then work with teams to correct these problems. Our experience shows that meeting every 10-14 days with individual teams is effective in improving the performance of the teams. Another technique that aids the creation of effective teams is to allow the teams to change after an initial assignment, providing students with more control over the team composition. In our experience, we have not had any teams change during this "free-agency" period, but this opportunity has encouraged teams to evaluate their effectiveness and discuss and resolve problems early in the class.

Structure and Implementation

The 15-week course utilizes the Maya software package from Alias|Wavefront. The students start working in teams of four to five students during the second week of the class. Students may propose the composition of their team, but each team must consist of at least two art and two computer science students. The students have an icebreaker team project to perform in Weeks 3-5. We also have some initial assignments that expose artists to working with vectors, angles, and simple illumination, expose computer scientists to key-frame animation, and both to the procedural, extensible aspects of the Maya modeling, animation, and rendering package.

To expose students to the power of procedural shading techniques,[2] the flexibility of the Maya Embedded Language (MEL) scripting language, and the challenge of photorealistic image generation, the students'second major project is to generate a photorealistic image or animation that must contain a specific type of light and a specific object element chosen randomly. We also require students to create a GUI for the artists to use in creating the final image or animation. Students are given three weeks to complete this assignment.

The main component of the course is a 12-week team project to produce an interesting, professional animation that includes extending the Maya package to implement a new animation capability. Students must also consider the subject matter of the project and choose an

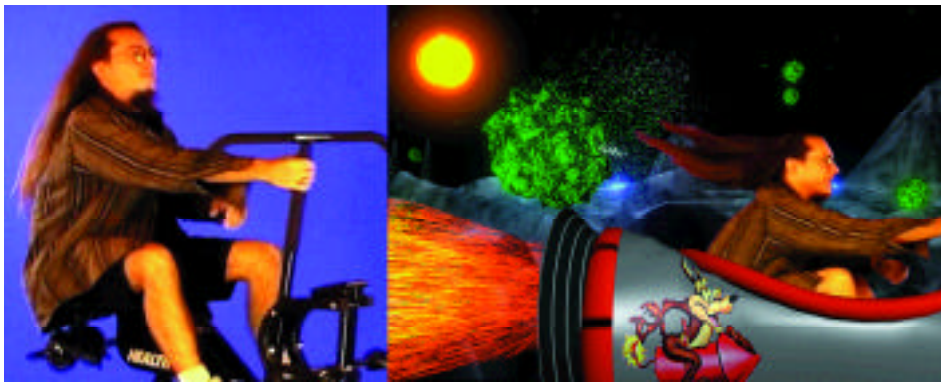

Figure 1: (a) Sample bluescreen image. (b) Example final animation still by CSmART Allstars.

appropriate structure and format, since a successful animation is only as good as its story, premise, or content. Early in the semester, each team is required to "pitch" its animation in a professional presentation with storyboards, charts, and slides. This project also requires a presentation of progress to the class after five weeks of work and a final presentation of results to the class. These are graded on presentation, artistic merit, and technical merit.

Initial Results

We have successfully offered this course twice. The students enjoyed the class and gained valuable experience in computer animation and working in teams. Most of the teams worked successfully together, and team dynamics varied widely. In fact, one of the most successful teams started out with very poor group dynamics. By the end of the semester, they learned how to communicate effectively, appreciate each other's skills, and work as a team. Only one team suffered significantly from group dynamics (one team member dropped the class).

Blue-Screen Project

Our ice-breaker team project required each team to composite live-action video with computer-generated effects for a 10-second animation. Teams were required to generate both CG foreground and background elements. This assignment proved to be successful in providing the teams with an initial low-risk and fun project that encouraged creative collaboration. An example still of the blue-screen video is shown in Figure 1a. An example still from a completed project is shown in Figure 1b.

Script and Rendering Assignment

This assignment was presented in two parts. The first part emphasized the computer science students'skills by requiring each team to create a MEL script and GUI that allowed an animator to create pizzas with different types of crust and different amounts of toppings. An example GUI can be seen in Figure 2a. The second part of the assignment emphasized the artists'skills in creating a photorealistic image and/or animation of the pizza in a given setting with a specific type of light source. These settings and light sources were chosen randomly and included romantic dinner by candle light and late night TV dinner by television set. An image showing a photorealistic rendering of a pizza illuminated by a television can be see in Figure 2b.

Semester Animation Projects

The semester animation projects included a wide variety of technical and artistic styles. Below are summaries of a few team projects:

- *The Autonomous Chicken Farm* by The A-Team. This team explored behavioral animation by developing procedurally animated "creatures." The example creatures (chickens) had controllable personality attributes (hunger, beauty, and aggression) based on the seven deadly sins. The final product of this project was a MEL script for creating autonomous "smart" creatures and controlling their movement, generating input for the inverse-kinematic controls and expressions that the animators used for controlling the motion of the creatures. A short demonstration of the Maya extension was also produced. Results can be seen in Figure 3a.
- *Expressive Avatar: An Expression-Driven Emotive Artificial Intelligence* by Digital Macabre. This project created a plug-in that uses facial morph targets and an IK skeleton to enable a character to react to a random environment based on programmable personality. The team also produced a computer-animated short film that demonstrated the expressive facial animation of their character reacting to typical events in a hospital waiting room (Figure 3b). The character's head was modeled from scanned photographs of a student, which were also used to generate the texture maps for the head.
- *Midnight Music* by the Primary Elephants. This project created a plug-in that enables artists to use music to drive their characters' animations. For the demonstration of this plug-in, several toys were animated to different musical segments. The animation of each toy automatically adapted to different musical segments based on the dance style created for their toy type.

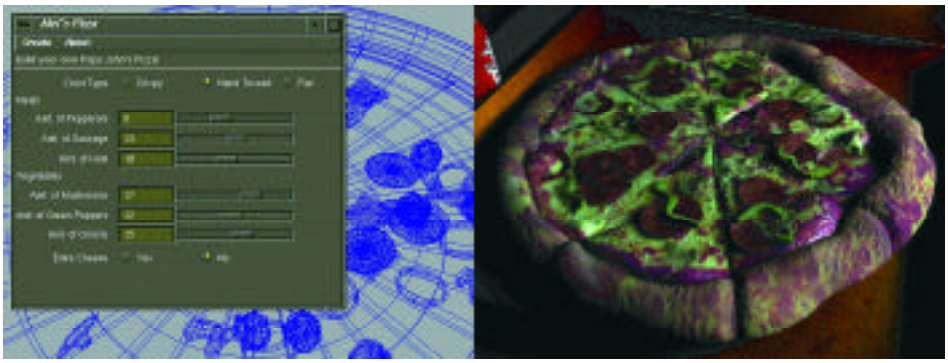

Figure 2: (a) Example pizza creation G UI.

(b) Example final rendered pizza illuminated with TV light by the Digital Macabre.

Many teams completed their projects, but a few did not. Two teams continued their projects the following semester by working independently with the instructors.

Evaluation of Collaborative Teams

To evaluate the effectiveness of the teams, each student filled out a questionnaire at the end of the class. Students were asked to evaluate the amount of work they contributed to each project, which aspects of the team worked well, which aspects of the team didn't work well, and what would have helped the team work better. Comparing these evaluation forms showed that the teams worked very well together. Even the team with the worst performance agreed as to the cause of their team's weak performance. All team members realized that more frequent team meetings and better communication among team members would have made their team stronger.

Conclusions

We have developed a successful interdisciplinary course to teach computer animation to computer scientists and artists based on interdisciplinary collaborative work. This approach for education is very powerful and rewarding, but it does require a significant amount of effort in teaching not only computer animation but also successful teamwork and group-dynamic techniques. From our experience, the most important aspect of teaching a team-based course is helping students work effectively in teams. Interactive class discussions, frequent meetings with individual teams, and effective role models are very beneficial.

We believe that our collaborative teaching approach provided a good example to the class of the strength and effectiveness of interdisciplinary collaborative work. Our experience has also shown that both the artistic and computer science aspects of computer animation can be effectively taught in a semester course. Finally, our experience has shown that this collaborative, interdisciplinary approach to teaching computer animation provides more benefit to students than a traditional computer animation course. Students not only learn from the instructors, they also learn even more from their team members, especially from those who are on the "other side" of computer animation.

We would like to thank the student teams who helped us develop and improve this course:

The A-Team: Tracy Corder, Will Gee, Mike Keesey, Joe Romano

Analog Blacksmiths: Chris Esposito, Mary Levy, Phadke Pratik, Evan Williamson, Damion Wilson

Beasts: Kim Harrington, Mike Madison, Chris Morris, Brian Resurreccion, Shawn Wood

CSmART Allstars: Ava Collins, Alex Eller, Jason Lubawski, Marlin Rowley, Christian Valiente

Day 8: Drew Cobleigh, Kris Kuhn, J McBride, Divyesh Shukla

Digital Macabre: Jeremy Dobrzanski, Dennis Moellers, Dov Horowitz, Mike Sharp, Stephan Sherman

Primary Elephants: Andy Cedilnik, Jodi Kravetzker, Sushama Prasad, Aaron Weidele

Screaming Nixons: Eun Baek, Jon Feibelman, Costas Kleopa, Vlad Korolev, Steve Matuszek

Wookie Pimps: Michelle Hunt, Steve Jacobs, Chris Slingluff, Joy Saunders

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Figure 3: (a) A still from "Expressive Avatar" by Digital Macabre showing responsive facial animation to a character's environment.

(b) A still from the "Autonomous Chicken Farm" by the A-Team showing behavioral procedural animation of articulated skeletons.