

Virtual Theatre: a collaborative curriculum for artists and technologists

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Abstract

Computer graphics research and applications have involved collaborations between professionals in both technical and artistic areas from the beginning. Theatre is a field where collaboration between technicians and artists has been an inherent component for centuries. Virtual Theatre merges these two collaborative arenas with the goal of providing a springboard for learning through interdisciplinary collaboration and teamwork. The project is geared toward those looking to enter the electronic entertainment industries where successful collaboration between artists and technologists is crucial to the success of a project. In the spring of 2004, students in three courses worked together to create a virtual theatre production at the Rochester Institute of Technology. In this paper we describe the collaborative learning approach taken in these courses and discuss our impressions of the results and issues that emerged.

1. Introduction

The discipline of Computer Graphics has always involved an interesting mix between art and technology. The need for expertise in both camps is especially evident in the electronic entertainment industries (e.g. computer animation, special effects, gaming, visualization, etc.) where successful collaboration between artists and technologists is crucial to successful projects. (e.g. see [Desowitz 2003])

Most academic programs in Computer Graphics focus specifically on one of the two areas: art or technology. This situation is problematic for students looking to enter the field of electronic entertainment as they must choose between the two and, more often than not, will not have the chance to collaborate with, or even meet, students on the other side.

At the Rochester Institute of Technology, we are fortunate to have programs in both the artistic and technical aspects of computer graphics, animation, and visualization. The primary goal of this work is to leverage this diversity and provide students with a collaborative experience that they may not otherwise have the opportunity to encounter before entering the workforce.

We set out to achieve this goal through a set of companion courses, two given in Imaging Arts and Sciences and another in Computer Science. In all courses, students work towards the realization of a common electronic entertainment event. Given the collaborative nature of the theatrical process, we chose a theatrical performance in a virtual space as the format.

In this paper we describe the virtual theatre project and our particular approach to interdisciplinary collaboration as a teaching methodology. We describe our specific

experiences with course offerings given in the Spring of 2004.

2. Approach

The chasm between art and technology in academic programs in Computer Graphics is being bridged via the introduction of courses that foster interdisciplinary collaboration. Most notably, courses in Animation [Ebert and Bailey 2000], Image Synthesis [Hunkins and Levine, 2003] and Virtual Reality [Zimmerman and Eber, 2001], that provide a rich and common learning experience for students from both camps, have been recently offered.

We too strive for interdisciplinary collaboration, however, our approach differs from that in the courses mentioned above. In our approach, rather than including students from both disciplines in a single course, skills for implementing the project were covered in three individual courses along with content on the collaborative process.

Towards that end, we designed our courses such that the work created in each of the courses contributed to a large scale, all encompassing project. This larger project required both technical and artistic components and the success of the project depended upon quality work from both sides. Learning was primarily hands-on; achieved through experimentation and implementation. Although formal lectures were a component of the courses, the content presented in these lectures was directly related to the tasks to be completed for the larger project. Finally, technical and artistic teams were required to interact and integrate their respective work in realizing the larger project. Our hope was that this approach would promote collaboration, empower students with an ownership stake in the project, and as a result, provide students with a richer learning experience.

3. Virtual Theatre

The collaborative nature of theater provides a natural structure that was adapted for the electronic entertainment event for this project. Inspired by the curriculum described in [Lee 2003] and [Springel 1998], we use theatre as a model for collaboration and performance, with action taking place on a virtual stage rather than a physical one. The ultimate goal of the project is to allow performers, stage crew, and audience, in physically separate places, to share in the same live, theatrical performance.

In defining our story, we were limited by the set of VR peripherals at our disposal. We wished for several full body motion capture devices in distributed locations controlling characters on the same virtual stage. Instead, we had one single node motion capture device, a data glove and a head mounted display device. This led to our choice

of a leading character as a bee. Supporting characters became flowers and a simple story line was developed around the bee gathering nectar.

The single bee, being small and rather insignificant on the stage, evolved into a swarm of bees, and a behavioral model [Reynolds 1987] was introduced to define the behavior of individual bees in the swarm. Flock motion was guided by the motion of a lead bee and the position of this lead bee was controlled by a behind-the-scenes, human actor using the motion tracker. The behavioral model also included an emotive component [Law 2004] that drove the behavior of the bees to convey one of a set of predefined emotions. The human actor, using predefined gestures recognized by the data glove, controlled the emotional behavior of the flock. Flower actions were defined via pre-scripted animations and were triggered by a second, behind-the-scenes human actor.

The story was told through a series of vignettes, each set in a different locale and containing a characteristic flower from which the flock would attempt to obtain nectar. Each scene involved an improvisational interplay between the actor controlling the flock and the actor triggering the pre-scripted flower animations.

Being critical element of theatre, the nature of the relationship between the performers and the audience was reinvented. The virtual audience was provided with the option to respond to the performance (clapping, booing, etc.). The signal from the audience response was sent back to the performers as auditory feedback in their various locations.

4. Course Details

Unlike the courses presented in [Ebert and Bailey 2000], [Hunkins and Levine, 2003] and [Zimmerman and Eber, 2001], we did not strive for a common classroom experience for both artists and technologists. Instead, students were instructed in their own discipline, however, their work was guided and shaped by constraints and requirements defined by the other half. As such, the project was implemented via a set of companion courses, two offered in Imaging Arts and Sciences and another in Computer Science, rather than a single course consisting of both sets of students.

Within each course, students were divided into a number of teams; each team was responsible for a particular artistic or technical component of the performance. The instructors served as artistic and technical directors, keeping teams on track with regard to serving the ultimate needs of the production and the production schedule. In order to assure a successful production, effective collaboration within teams, between teams, and between disciplines was required.

4.1. Imaging Arts Courses

The models, shaders, and animations were created by students in two courses in Imaging Arts and Sciences: 3D Modeling and 3D Character Design. The task for the students was to create the 3D models and textures for all of the elements present in the virtual production as well as to

define the pre-scripted animations for the flower models. Models included not only the actors in the piece but also the stage elements and virtual sets in which the actors appeared. Modeling and animation was created using Maya.

4.1.1. The Performers

The first project in the 3D Character Design course was to design, model, and rig a character that could be animated with forward kinematics. One student in the class modeled and animated the bees (Figure 1) and the remaining students modeled and animated flowers (Figure 2).

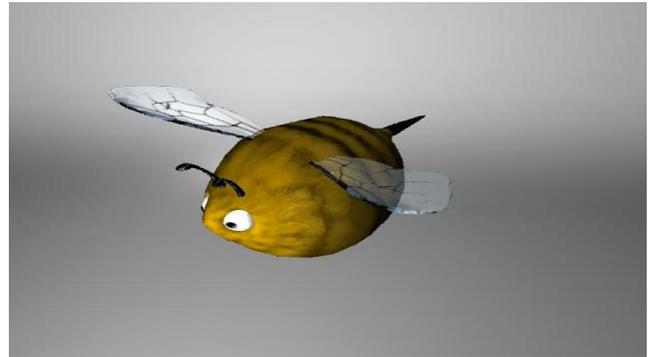


Figure 1 -- The bee model

As a group, the class discussed guidelines for the flowers. Except for the last flower, we decided to use bright primary colors and fantasy designs. The last flower was a pastel pink lily to make it appear more sweet and innocent than the other flowers. We began by deciding how the flowers were going to behave in reaction to the bees. We selected the options that seemed the most manageable to model, rig and animate for a beginning character designer in the time available. The individual flowers were designed by the students following the agreed upon guidelines. A group critique brought them closer together in style and function. Progress was shared on a regular basis to ensure that everyone was continuing to work in the same vein.

Students had strict guidelines on the poly count of each flower and the appropriate size of any texture maps they planned to use.

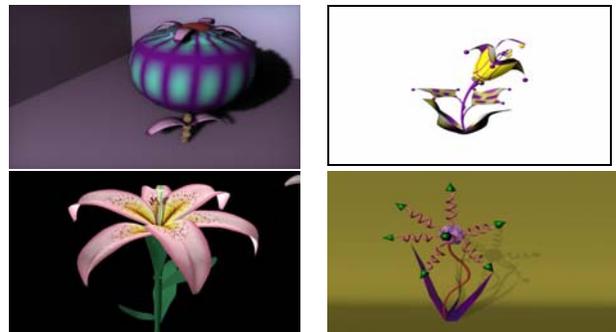


Figure 2 – Sample flower models

4.1.2 Scenery

The 3D Modeling course is a beginning course with students coming from a variety of disciplines with some variation in artistic and design experience. In this course, a group modeling project is required. The class is divided into groups and each group is assigned a large model to complete. The model has several components and part of the project is to develop a method of collecting and keeping track of all the elements of the project as well as subdividing the project so that each team member is making a contribution.

To emphasize the virtual theatre aspect of the project, a proscenium stage with curtains that would open at the beginning of the performance was developed by one of the modeling teams. The model included the house with seats and audience members. (Figure 3) Another modeling team created the stage sets for each flower. (e.g. the "swamp scene" in Figure 4)



Figure 3 -- proscenium stage with audience



Figure 4 - setting for the "swamp scene"

Since the scenery was created later in the quarter than the flowers, the background artists had pictures of the flowers

to work from in designing their environments. In most cases they had suggestions from the flower designer or artistic director as to what would be an appropriate choice for each flower. Before beginning the modeling, they submitted sketches and discussions were had regarding changes that would keep the models light (geometry wise), better integrate them into components of a single performance, and enhance their relationship to the flowers.

Like with the design of the virtual actors, the students had strict guidelines on the poly count for the models and the size of the texture maps.

4.1.3 Delivery of the Models and Assessment

Each student was responsible for making adjustments to their models as needed by the programming team. The fact that other students were relying on them to contribute their parts made almost all of the students respond well to the request for changes.

Since the projects in the character design course were individual in nature, each student was evaluated independently on their work and their ability to collaborate with others. In the modeling class, the students complete a team evaluation form listing the responsibilities and accomplishments of the teammates and evaluating their performance and the performance of each teammate.

4.2. Computer Science Course

The primary goal of the Computer Science course was to build the technical infrastructure for the virtual theatre system. The system was built on top of MUPPETS¹, a distributed, collaborative virtual environment (CVE) originally designed for enhancing student education in the areas of programming and problem solving [Phelps and Parks 2004]. A total of six teams were assembled for the class, each team consisting of 2-4 students. The teams and their responsibilities are described in Table 1:

Flock	Responsible for defining and implementing the emotive flocking model as well as integrating this model into MUPPETS.
MUPPETS	Responsible for enhancements to MUPPETS to support the virtual theatre paradigm. This included the task of importing model and animation data created by the art students into the MUPPETS platform thus making it available for the performance.
Networking	Responsible for the network communication infrastructure between distributed components, which comprised the system
Sound	Responsible for defining the infrastructure for sound effects and music presentation
Stage Manager	Responsible for building a class structure that defined a theatrical interface for lighting and staging
VR	Responsible for interfacing the VR peripherals into MUPPETS

Table 1 -- Technical teams and responsibilities

¹ <http://muppets.rit.edu>

Each team was responsible for design, implementation, and documentation of their particular component. Student assessment was based upon the code and documentation delivered by the team to which the student belonged. In addition, peer evaluations of team members and team evaluations between teams were used to assess student and team performance.

4.3 Collaboration between Classes

Much of the collaboration between the two sets of students focused on adapting the models created in Maya for use in MUPPETS. It was of utmost importance that the artistic aesthetics of the final models be preserved as the models were transferred between systems. However, because of the differences in the parameter sets and rendering methods employed by the two systems, minor adjustments to models and lighting were required after being imported into MUPPETS. To facilitate this process, a number of interactive tools were developed to allow for modification of lighting parameters, material properties, and model textures from within MUPPETS with immediate visual feedback. Interactive sessions, during which these modifications were performed, offered the richest collaborative experience. During these sessions, technologists learned the thinking process of the artists and learned how to specify and implement tools to meet the needs of these users. The artists, on the other hand, learned to adapt their work to the needs of a real time, interactive VR environment.

5. Results

Enthusiasm among the students was overwhelming, greatly exceeding our expectations. In a sense, and quite unexpectedly, the theatrical metaphor extended to the overall feeling of the project. Whereas, the Computer Science students were like the running crew on the show, making the production happen, the Imaging Art students were more like the designers in the costume and set shops, creating and shipping their elements to the theatre, with some elements returning for 'repairs'.

By the end of the quarter, technical team boundaries spontaneously evaporated with all students working together equally towards the goal of completing the system. The project became more than a course, with the drive to finish mimicking that of stage hands on opening night.

Both sets of students benefited much from the additional learning that took place as a result of the experience. For example, while the need for 'light' geometry is discussed in nearly every modeling course, it really hit home when the models created had specific face count limits that could not be exceeded. Suddenly the difference between making a simple shape like a cylinder with 3 points around rather than 8 became significant.

When importing the models, several technical issues arose which required creative problem solving. Students had to work together to create innovative solutions. Some of these solutions involved modification of the models, whereas others were technical, involving the creation of software and tools for automating the conversion.

6. Conclusions and Future Work

We feel that collaborative nature of the project enhanced the learning experience for all involved. Student work, excitement, and especially interactivity, far exceeded initial expectations. Because students were working together on one large project, more conversation occurred, with students consulting with one another about how to solve a technical problem or whether a particular look was working or not. Finally, placing the project in a theatrical paradigm, a natural structure for collaboration, further enhanced the interactive experience for both students and instructors.

Support has been secured to repeat the courses in Spring of 2005 and 2006. In these repeat course offerings the existing framework and process will be enhanced and expanded to incorporate new options, to use new VR hardware and to create a more challenging production. In addition, we plan on incorporating the same kind of collaborative approach in courses focusing on shader development in the 2005-6 school year.

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