

**Master of Fine Arts in Computing (MFAC)  
Program Handbook  
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## **1 Introduction**

At its meeting on November 5, 1998, the South Carolina Commission on Higher Education approved the Clemson University proposal for the Master of Fine Arts in Computing (MFAC) degree. This advanced degree program is aimed at producing graduates who intend to seek employment in the technology-based, electronic arts industry, in particular, in the special effects productions for the entertainment and commercial video and film industries.

The Program was begun, on a resource-limited basis, in the Fall of 1999. Increased resources have allowed an expanded operation to begin in the Fall of 2000, and it is anticipated that full operation will begin in 2001.

This document is intended to serve as a guide to those students and faculty at Clemson University who are participating in the Program.

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## 2 Program Administration

The MFAC Program is truly inter-disciplinary in design, and, as such, it is not housed within any academic department in the University. Rather, it is housed directly in the Graduate School and administered by the MFAC Board. The Board is composed of five Clemson University faculty members. Two of these must be from the Department of Art, two must be from the Department of Computer Science, and one must be from the Department of Performing Arts. Faculty are elected to these positions by their departments. Terms are two years and renewable. The Board elects its own Chair. As of this writing, the Board members are: Sydney Cross (Art), Robert Geist (Computer Science), David Hartmann (Performing Arts), Samuel Wang (Art), and James Westall (Computer Science). Robert Geist currently serves as Chair.

The Program Director is a twelve-month employee of the Graduate School. The Director is responsible for the daily operation of the Program and serves as the instructor for the Visual Arts Studio course (see ART/CPSC 860 under Curriculum). The Director is a member of the Graduate Committee for every MFAC student and may serve as Chair of those Committees. The Director is evaluated by the MFAC Board; the Board makes recommendations to the Dean of the Graduate School. As of this writing, a national search is underway to fill this position.

As specified in the approved CHE proposal, the MFAC Board may, by majority vote, change any components of the Program at any time. Changes to the curriculum requirements follow standard University procedure; in particular, enrolled students have the option of completing the new requirements or the requirements in place at the time of their enrollment.

## 3 Curriculum

As already noted, the curriculum for the Program may change, and it is likely to do so as the Program matures. As of this writing, the degree requires 60 credit hours, 18 - 24 of which are devoted to Visual Arts Studio (ART/CPSC 860), wherein the student produces a professional quality demonstration reel. Of the remaining 36 - 42 hours, 18 must come from the Core Courses (listed below), 6 from the Master's Thesis (ART/CPSC 891), and the remainder from Electives (listed below) or Foundation Courses (listed below).

### 3.1 Foundation Courses

- **ART 803** Fundamentals of Visual Arts
- **CPSC 801** Fundamentals of Computing

The Foundation Courses are intended for those entering students who, due to insufficient background, are not prepared to begin graduate level work in either Art or Computing. One of the courses, but not both, may be taken for credit towards the degree.

### 3.2 Core Courses

- **ART 613** Photography
- **ART 821** Art with the Computer
- **CPSC 605** Introduction to Graphical System Design

- **CPSC 611** Virtual Reality Systems
- **CPSC 815** Special Effects Production
- **PSY 823** Perception, Cognition, and Technology

The Core Courses are required courses for all students in the Program. If a student has had a course of comparable content at Clemson University or elsewhere, an Elective Course (listed below) may be substituted. Decisions on comparable content will be made by the MFAC Board.

### 3.3 Electives

- **AAH 630** Twentieth Century Art I
- **AAH 632** Twentieth Century Art II
- **ART 605** Advanced Drawing
- **ART 607** Advanced Painting
- **ART 609** Advanced Sculpture
- **ART 611** Advanced Printing
- **CPSC 805** Advanced Modeling Techniques in Computer Graphics
- **CPSC 808** Computer Animation
- **ECE 847** Digital Image Processing
- **ENGL 650** Film Genres
- **ENGL 651** Film Theory and Criticism
- **ENGL 853** Visual Communication
- **GC 801** Process Control in Color Reproduction
- **MUSIC 604** MIDI Applications
- **PHIL 845** Aesthetics
- **THEA 687** Stage Lighting
- **THEA 697** Scene Painting

Alternative electives may be approved by the MFAC Board on an individual basis. Not all sequences of electives will necessarily be approved. The program of study for each student must be specified on the Form GS-2 and must be approved by the student's Advisory Committee, as detailed in the section of this handbook titled GS-2.

### 3.4 Required Individual Study

- **ART/CPSC 860** Visual Arts Studio
- **ART/CPSC 891** Master's Thesis

As of this writing, Visual Arts Studio appears only under ART. It will be cross-listed, and it will be repeatable so that students may enroll each semester. For at least the Fall semester of 2000, CPSC 888 section 15 will be used for this purpose. The goals of the course are two-fold, to assist students in the development of

components for an individual demo reel and to provide a group project experience through a Program-sponsored annual submission to the SIGGRAPH electronic theatre. Up to 6-hrs of credit for the course may also be obtained through a Board-approved summer internship at a production studio (see section on Internships).

### **3.5 Sample Course Sequences**

Each student will bring a different collection of strengths and weaknesses to the Program, and an appropriate course sequence must be tailored to both the individual's needs and the course availability. Nevertheless, we can suggest some typical course sequences that would be appropriate for differing backgrounds.

#### **3.5.1 Strong Art/Weak Computing Background**

Semester 1.

CPSC 801 (5 hrs.)

ART 613 (3 hrs.)

PSY 823 (3 hrs.)

ART/CPSC 860 (3 hrs.)

Semester 2.

CPSC 605 (3 hrs.)

ART 605 (3 hrs.)

THEA 687 (3 hrs.)

ART/CPSC 860 (3 hrs.)

Summer

ART/CPSC 860 (6 hrs.)

Semester 3.

CPSC 611 (3 hrs.)

CPSC 815 (3 hrs.)

ART 821 (3 hrs.)

ART/CPSC 860 (6 hrs.)

Semester 4.

CPSC 808 (3 hrs.)

ART/CPSC 860 (6 hrs.)

ART/CPSC 891 (6 hrs.)

#### **3.5.2 Strong Computing/Weak Art Background**

Semester 1.

ART 803 (3 hrs.)

CPSC 611 (3 hrs.)

PSY 823 (3 hrs.)

ART/CPSC 860 (3 hrs.)

Semester 2.  
CPSC 605 (3 hrs.)  
CPSC 808 (3 hrs.)  
THEA 687 (3 hrs.)  
ART/CPSC 860 (3 hrs.)

Summer  
ART/CPSC 860 (6 hrs.)

Semester 3.  
ART 821 (3 hrs.)  
ART 613 (3 hrs.)  
CPSC 815 (3 hrs.)  
ART/CPSC 860 (6 hrs.)

Semester 4.  
CPSC 805 (3 hrs.)  
ART/CPSC 860 (6 hrs.)  
ART/CPSC 891 (6 hrs.)

### **3.5.3 Balanced Background**

Semester 1.  
ART 613 (3 hrs.)  
ART 821 (3 hrs.)  
PSY 823 (3 hrs.)  
ART/CPSC 860 (3 hrs.)

Semester 2.  
CPSC 605 (3 hrs.)  
CPSC 808 (3 hrs.)  
THEA 687 (3 hrs.)  
ART/CPSC 860 (3 hrs.)

Summer  
ART/CPSC 860 (6 hrs.)

Semester 3.  
CPSC 815 (3 hrs.)  
CPSC 611 (3 hrs.)  
ART 605 (3 hrs.)  
ART/CPSC 860 (6 hrs.)

Semester 4.  
CPSC 805 (3 hrs.)  
ART/CPSC 860 (6 hrs.)  
ART/CPSC 891 (6 hrs.)

## 4 Program Equipment

At the time of this writing, the special effects industry is making a rapid transition to extensive use of Alias|Wavefront's Maya software system. Due to Maya's extensive capabilities, its growing use in the industry, and its reasonable educational pricing, the Program is currently committed to the Maya platform as an instructional basis.

As of Fall, 2000, the University will have 5 floating licenses for Maya 2.5 Unlimited, 5 floating licenses for Maya Composer 5.5, and 20 floating licenses for Maya 3.0 Complete. Maya Unlimited is a superset of Maya Complete that includes special packages, such as fur and cloth modeling, that are unlikely to be of widespread use in the Program, and Maya Unlimited 3.0 pricing is outside the Program budget.

Maya was developed for SGI platforms running IRIX, but it now runs at comparable speeds on other systems including Intel PCs running Windows 2000 and (soon) Apple MacIntoshes running OSX. Systems on the University net that have Maya installed may check out a license from the MFAC server (jabba.vr.clemson.edu) and return it at the end of the session.

The MFAC Lab is located in E-303 Martin Hall. It has 8 SGI O2s, each with 384Mb of main memory and a 8Gb local disk. Additional O2s on which Maya is installed may be found in G-20 Jordan Hall. These also have 384Mb of main memory. Maya will also run on the University's dual-rack, dual-pipe, Onyx2 InfiniteReality2 graphics supercomputer, but that is probably not the best use of that resource.

The MFAC Lab also contains a high-resolution Tektronix color printer, a Sony digital video recorder, and a conventional TV/VCR. Students also have access (through faculty associated with the Program) to digital cameras, digital camcorders, blue and green chroma-key screens, and a dye-sublimation printer.

## 5 Movie Making: the Logical Pipeline

The production process will differ from one studio to another, but all have certain essential tasks in common. We offer here an outline of a generic production pipeline so that the student may focus on the tasks therein and begin to organize for demo reel production. Nevertheless, successful demo reels can differ substantially in content, and some contain neither animation or sound.

1. Scripting

A written description of the ideas behind the production is essential. It should include character descriptions, staging, dialogue, and desired visual effects and sound effects.

2. Storyboarding

From the written script, visual sketches of key moments in the story (shots) should be developed and displayed in time sequence, preferably on a single surface (the storyboard).

3. Virtual/Real Component Identification and Camera Capture

Decisions must be made early in the production about which components in the final product will be virtual (generated by computer graphics) and which will be real (captured by camera). Capture the camera images first, so that those producing the virtual components can use them as references.

4. Modeling

Build the computer graphics surfaces for the virtual components. Maya provides an elaborate set of tools for generating both NURBS (non-uniform rational B-spline) surfaces and polygon-mesh surfaces. Caution: animating some surfaces (next step) will require special construction steps, e.g., including inverse-kinematic (IK) skeletons.

5. Animation  
Define motion and deformation of virtual components through time. Motion and deformation of one component is often keyed to that of another. Maya provides an elaborate set of tools for motion and deformation interpolation and keying. Motion is not restricted by the laws of physics. To do so would preclude many fantastic effects, but, the flip side of that coin is that obtaining believable physical effects (e.g. gravity) can be difficult.
6. Particle Systems  
As part of the animation, some special effects, e.g., smoke, fire, tornados, crashing waves, are best achieved with *particle systems*. Particle count, particle design, and motion/collision rules all affect rendering time.
7. Lighting  
Virtual lights and light effects (glows, halos, fog, lens flares) must be defined to illuminate all virtual surfaces. Although Maya tools, such as the ability to view a virtual scene through a selected virtual spotlight, can be extremely useful, there is no substitute for a solid knowledge of lighting design (see ART 613, THEA 687). Stepping beyond a simulation of physically realizable lights is an important artistic talent. Special effects designers are sometimes asked, in a production, “Where is that light coming from?” They respond, “the same place as the music.”
8. Shading  
Building photo-realistic virtual surfaces requires detailed specification of surface material properties. This may involve texture mapping, bump mapping, displacement mapping, and environment mapping as well as attaching, to each surface, a basic model for surface interaction with ambient, diffuse, and specular illumination. Surface specification includes that of shadow surfaces and reflection surfaces, special surfaces that capture only shadows or reflections that may be later composited with camera images. Effective use of layered shaders to create effects is important.
9. View Specification  
A movie shot from a single, stationary camera can be boring. Specification of multiple virtual cameras, transitions among them, and their motion requires careful planning. Especially difficult is matching virtual camera motion to real camera motion (matchmoving) for later compositing virtual animation with live action video. The Maya Live component of the Maya Unlimited package can be helpful here.
10. Rendering  
Rendering the individual frames of a movie is completely under system control, but it can be extraordinarily time-consuming. Careful choices for rendering technique are essential to timely completion of any project. Do the math. A standard, NTSC video requires 640x480 pixels per frame and 30 frames per second. Thus a 10-minute demo reel requires specification of color values for more than 5 billion pixels. If we can render at the speedy rate of 10,000 pixels per second, it will take more than 6 days to finish. Choices such as depth-map shadows versus ray-traced shadows can have drastic effects on rendering time.
11. Compositing  
Virtual components, real components, and sound effects are often layered together in the final steps of production. Multiple virtual layers are quite common. The most common pixel format today is the true color RGBA format, where R, G, B, and A stand for red, green, blue, and alpha. Compositing is controlled by effective use of the alpha channel. Maya Composer provides many options for this effective use.

## 6 Movie Making: the Physical Pipeline

The physical pipeline is much more easily mastered than the logical one. Scripts should be written on-line, so that they may be easily viewed by multiple participants at multiple locations. Storyboards should

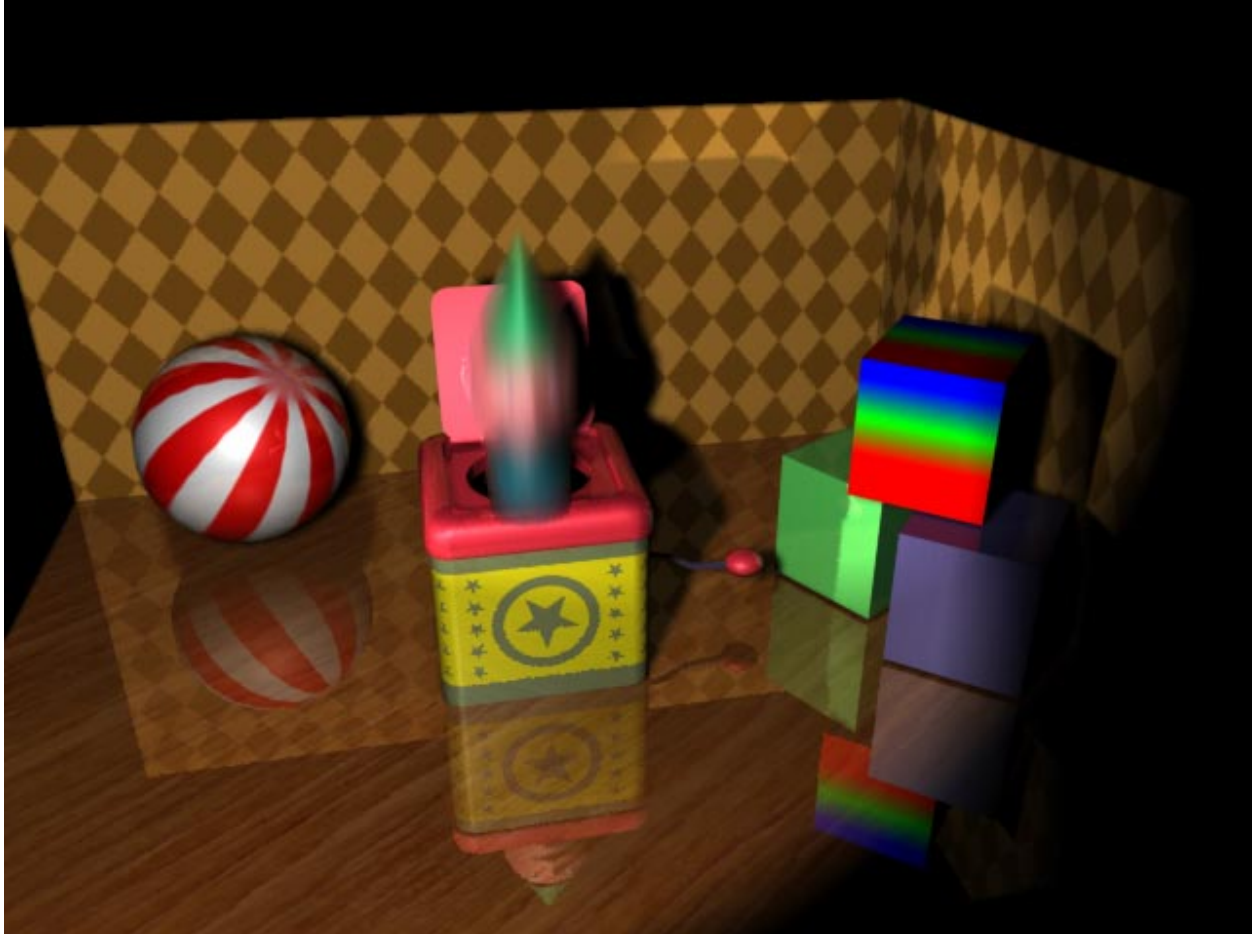


Figure 1: Jack, frame 62

be scanned into computer storage for the same reason. Production houses, such as ILM, frequently scan storyboards. A scanner is available on the 4th floor of Edwards Hall.

Camera still images or live action can be captured with a digital camcorder that belongs to the Program. See Professor Andrew Duchowski to check it out. Digital footage can be uploaded from the camcorder directly to the O2s via an IEEE 1394 (firewire) link that is installed in one of the O2s in the MFAC lab ([oola.vr.clemson.edu](http://oola.vr.clemson.edu)). Use the “dvlink” utility. Digital footage can be uploaded or downloaded using the Sony digital recorder in the MFAC lab. As of this writing, downloading digital footage directly to the digital camcorder from the O2 IEEE 1394 link does not produce good results. SGI is aware of this problem, and they have promised to fix it soon. Until then, if you must download directly to the camcorder, use the IEEE 1394 link in the Linux PC, [glint.cs.clemson.edu](http://glint.cs.clemson.edu), that is located on the 4th floor of Edwards Hall. This will require faculty supervision; see Professor Tim Davis or Professor Robert Geist. Both blue and green chroma-key screens can be checked out; see Professor Tim Davis.

Virtual components are built using Maya and custom rendering software. Compositing can be carried out using Maya Composer. Students are **STRONGLY** encouraged to proceed through the “Learning Maya” tutorial as soon as possible. Several hardcopies are available, and it can be found online. Point your web browser at [/usr/aw/tutorials/starthere.html](http://usr/aw/tutorials/starthere.html)

In figures 1 and 2 , we show single frames from an example rendering of the “Jack-in-Box” movie described in the tutorial. Simple renderings, such as these, are valuable aids to understanding lighting, shading, ray-

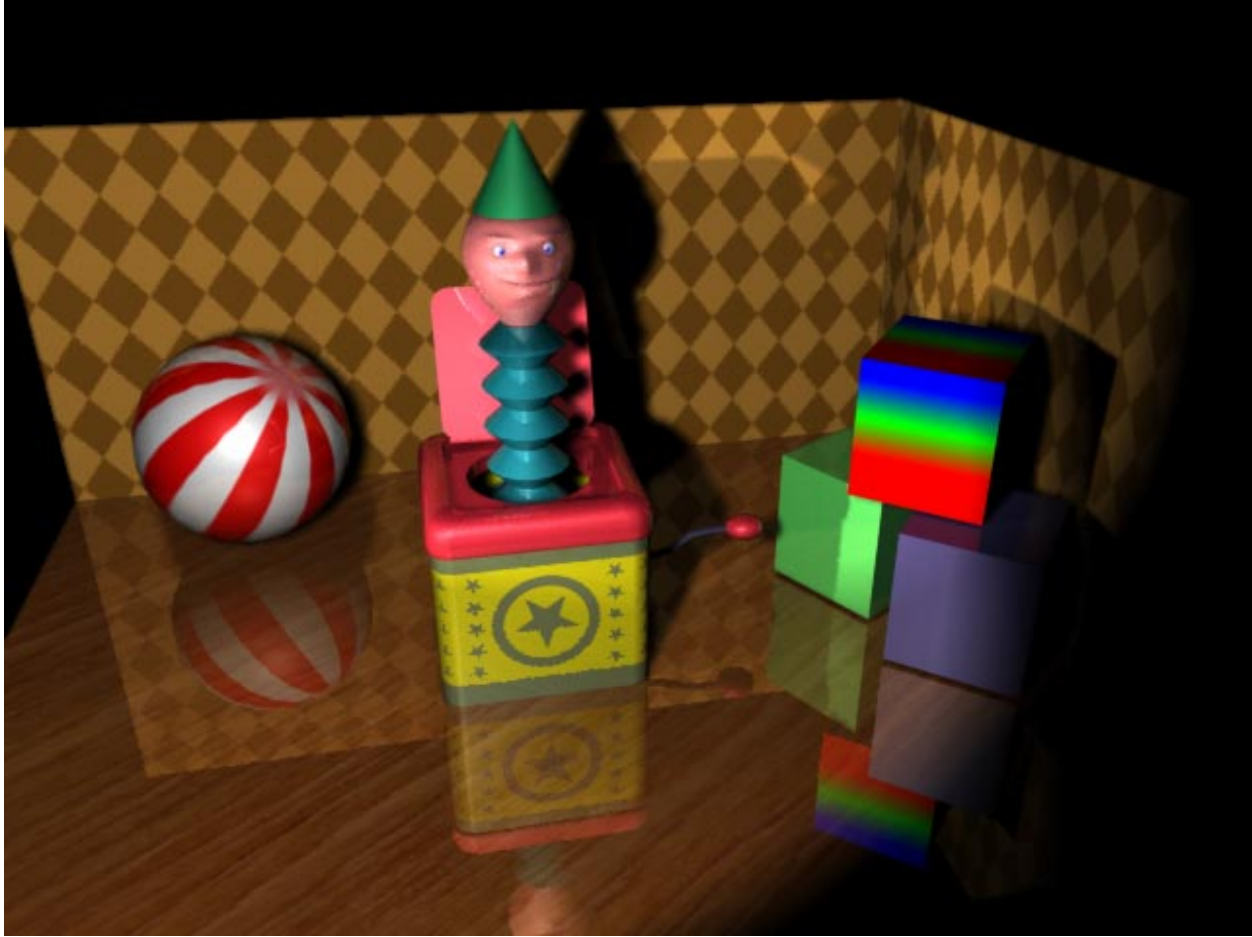


Figure 2: Jack, frame 85

tracing, inverse kinematics, motion blur, and key animation.

Other software packages, such as Adobe Photoshop and Adobe Premier, are available on some of the SGI stations to which students have access. Nevertheless, the capabilities of Maya supersede those of most other packages, and so use of the other packages is not encouraged.

## 7 Tips on Rendering

Rendering time is, as mentioned earlier, a huge obstacle to project completion. Although human intervention is seldom required, rendering usually requires substantial hardware resources for substantial periods of time. Processor speeds are now measured in nanoseconds, but rendering times can still be measured with a calendar. Rendering time estimates should be an integral part of project design.

The choice of rendering technique and rendering parameters can have a dramatic effect on rendering time. In particular, ray-tracing is an expensive choice. Although certain effects are difficult to achieve without it, e.g., texture-mapped transparency, the cost dictates that it be used sparingly. In figure 3 we show a frame from a simple movie in which a partially transparent ball rotates under harsh lighting. This movie is structurally simple compared to the “Jack-in-Box” movie, but 120 frames of “Jack” required 45 minutes to render and

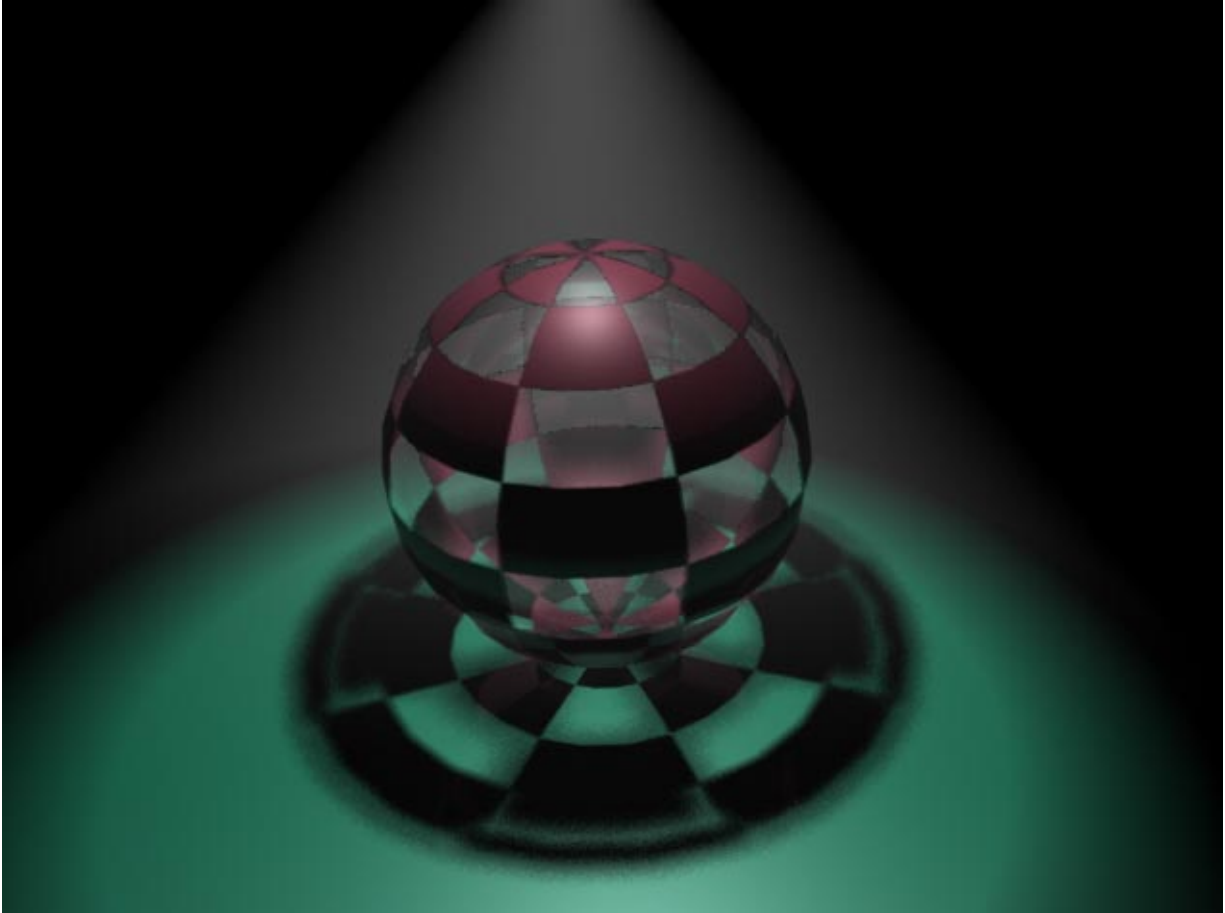


Figure 3: Fogball, frame 1

60 frames of “Fogball” required 2 days to render.

Another important step for local rendering, particularly in the MFAC lab, is directory selection. Maya users may select the directories in which to store the various files, including images, that they generate during a session. Under the *File* menu, select *Project*→*Edit Current*. If local disks are not explicitly chosen, all rendering takes place over the net to files on the server in Rhodes. Net connections from the MFAC lab are among the slowest on campus, and so rendering over the net should be avoided until the final production run. Local disk storage is always located at /pub/<machinename>, e.g., /pub/oola, /pub/nikto, /pub/hansolo, etc.

## 8 Assistantships

A small number of assistantships are available within the Program. Assistants should report to the Program Director to receive assigned duties. (Until that position is filled, see the MFAC Board Chair.) Assistantships are generally 9-months, but they can be extended through summer if an internship cannot be secured. Assistantships are renewable for a second year, but such depends upon student progress.

Other assistantships are available in many Departments throughout the University. Those students with strong computing background should see the Director of Graduate Studies in the Department of Computer Science to check availability. Those students with strong art background should see the Chair of the Art

Department.

## **9 Internships**

Summer internships at production studios are highly desirable, and it is a goal of the Program to assist all qualified students in securing such positions. Internships are competitive; successfully competing requires exactly two things: a strong demo reel and a strong recommendation from someone whom the studio knows and trusts.

Building a strong demo reel in the first year is a difficult challenge. Those students interested in internships should select an advisor (see GS-2 section) who can assist with this task as early as possible, but in no case later than the end of the first semester.

Strong recommendations are not given lightly, in that they reflect on the strength of the Program and affect future relationships with the studio in question. The studios want to see two-pairs of antithetical characteristics in every person: they want an artist and a scientist, and they want a creative, original thinker and a cooperative, team player. Accordingly, all four factors are weighted equally in making recommendations. The bottom line: both attitude and work quality count.

## **10 GS-2**

All students must complete the Graduate Degree Curriculum form GS-2. It should be completed no later than the beginning of the second academic year. This form lists both the student's planned curriculum and the student's Advisory Committee.

The Advisory Committee is selected by the student with consent of the faculty selected. The Committee must include the MFAC Program Director (when the position is filled), at least 3 MFAC Board members, and (optionally) one additional Clemson University faculty member. Any Committee member may serve as the Committee Chairperson. The Chairperson is the student's principal advisor. The MFAC Board Chair signs as Department Head and the Dean of the Graduate School signs as College Dean.

The Advisory Committee will read the Master's Thesis, hear the Thesis defense, and decide, by majority vote, on a pass/fail for the Thesis.