ITP 305 Advanced 3D Modeling, Animation, and Special Effects

Units: 3

Spring 2019 – Tuesdays/Thursdays 12noon-1:50pm

Location: KAP 107

Course notes and resources on Blackboard.usc.edu.

Instructor: Lance Winkel

Office: OHE 530 H

Office Hours: Tuesdays / Thursdays 8am-10am, 2-3pm

Contact Info: winkel@usc.edu, 213.740.9959.

I check email daily and will reply within 24 hours.

Teaching Assistant:

Office: Physical or virtual address

Office Hours:

Contact Info: Email, phone number (office, cell), Skype, etc.

IT Help: Group to contact for technological services, if applicable.

Hours of Service:

Contact Info: Email, phone number (office, cell), Skype, etc.

Course Description

Explore advanced modeling techniques and the benefits of procedural asset creation workflows for cinematics, games, animation, design, modeling, texturing, visualization, as well as AR/VR.

Learning Objectives

In this course, students develop a hands-on understanding of how to apply procedural workflows into their expanding body of computer graphics tools. Utilize scripting, live data, node-based architectures, dynamically and procedurally generated content, and custom interfaces to create highly complex, efficient, and look specific behaviors tailored to their application and content delivery platform. Learn how to apply procedural creation concepts to the asset creation process for controlled iteration, customizability, and variability. Apply these concepts to modeling, layout, animation, choreography, lighting, shading, materials, effects, look development, and rending phases, as well as methods for migrating these assets to other applications.

Prerequisite(s): ITP 215.
Co-Requisite(s): None.
Concurrent Enrollment: None.
Recommended Preparation: None.

Course Notes

Lecture slides, notes, and course resources, will be posted on Blackboard.usc.edu.

Technological Proficiency and Hardware/Software Required

Understanding of either Mac or Windows operating systems and general software use.
Autodesk provides free academic licenses of the Maya software that we will be using for this course. Notes on how to set up a license will be provided on Blackboard.usc.edu
SideFX provides free academic licenses of the Houdini software that we will be using for this course. Notes on how to set up a license will be provided on Blackboard.usc.edu
Adobe Cloud provides discounted academic accounts but is not required if using lab computers.
VRay, Renderman, Nuke, and other software packages may be useful, but are not required.
ITP offers Open Labs which are posted at itp.usc.edu. ITP also offers remote desktop access for students enrolled in ITP courses. Instructions will be posted on Blackboard.usc.edu.

Required Readings and Supplementary Materials

Recommended:

Houdini Foundations Book
Robert Magee (ISBN: 978-1775333814)
Digital Lighting and Rendering (3rd Edition)
by Jeremy Birn, (ISBN: 978-0321928986)

Recommended if available:

Texturing and Modeling, Third Edition: A Procedural Approach (The Morgan Kaufmann Series in Computer Graphics) (ISBN: 978-1558608481)

Course slides are available on Blackboard.usc.edu

Autodesk Maya Online Documentation at knowledge.autodesk.com
Lynda.com via Blackboard.usc.edu
Learning Resources for other tools like V-Ray, Preform, and Houdini can be found on Linda or at their specific sites:
V-Ray https://www.lynda.com/V-Ray-training-tutorials/1173-0.html
Houdini https://www.sidefx.com/learn/collections/quickstart-houdinis-interface/

Description and Assessment of Assignments

Consult the Assignment posting on Blackboard.

Grading Breakdown

Rigid body collision = 15 points)
Particle impact = 15 points)
Advanced Hard Surface Model progress checks (3) = 10 points each (30 total)
Advanced Hard Surface Model Complete = 20 points
Advanced Hard Surface Rigging progress checks (2) = 10 points (20 total)
Advanced Hard Surface Rigging Complete = 20 points
Final project (See detailed instructions below) = 60 points
Midterm Exam = 20 points
Final Exam = 50 points
Attendance and Participation = 30 points
Total = 280 points

Grading Scale (Example)

Course final grades will be determined using the following scale

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Rubrics

Assignment details and grading rubric will be posted along with the assignment as it is posted. Students with questions are encouraged to attend office hours for critique and to make sure they are understanding the scope of the assignments as detailed.

Assignment Submission Policy

All homework will be submitted on Blackboard. Detailed instructions and resources for each assignment will be posted on Blackboard along. http://blackboard.usc.edu

Grading Timeline

Grades will be posted within a calendar week after the submission due date.

Additional Policies

- Make-up policy for exams: To make up for a missed exam, the student must provide a satisfactory reason (as determined by the instructor) along with proper documentation. Make-up exams are generally only offered in emergency situations.
- Before logging off a computer, students must ensure that they have saved any work to either a USB drive or a service such as Dropbox. Any work saved to the computer will be erased after restarting the computer. ITP is not responsible for any work lost.
- ITP offers Open Lab use for all students enrolled in ITP classes. These open labs are held beginning the second week of classes through the last week of classes. Hours are listed at: http://itp.usc.edu/labs/.

Course Schedule: A Weekly Breakdown

Week 1 – Introduction to dynamic geometry

Day 1

Rigid Bodies Overview
Fields and dynamic movement
Workflow, baking animation, and processing efficiency

Day 2

Modeling fractured surfaces
Best practices for render quality (Hero) vs. dynamic stand-in (Stunt) geometry
Visual sleight of hand

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 1

Assignment/Project

Rigid Body Collision: Create a Rigid Body simulation of collapsing, destructing, or fracturing geometry. Model and dynamically process the sequence. Use at least 50 rigid solved objects. Bake the sequence out as keyframed animation.

Week 2 – Particle dynamics

Day 1

Understanding particle simulation and workflow
Particle tools and concepts: emitters, unique attributes, lifespan, and shaders
Defining look and behavior for particles

Day 2

Smoke, fire, rain, dust, sorcery, sparks, lasers, swarms, and other applications
Particle disk cache
Per particle attributes

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 2

Assignment/Project

Particle Impact: Use particles to enhance and add impact to an animation scene. Examples will vary based on scene concept. You may use previous models and animation. Fire and smoke for rockets. Smoke or dust trails at an impact or following the pressure wave of a speeding vehicle. Venting from a reactor. Lasers and awesome stuff. Demonstrate lifespan, per particle attributes, particle shaders, and disk cache.

Week 3 – Advanced modeling theory

Day 1

Forms that work well with Polygons
Forms that work well with NURBS
Setting up a scene for modeling
Image planes

Day 2

Mesh topology
Quad's (4-sided) vs. Tri's (3-sided) vs. multi-sided faces
2-manifold vs. non-manifold polygon geometry

Complicated meshes and Boolean modeling operations

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 3

Assignment

Giant Robot (Progress 1 of 4) – Design and prepare a character design for the Giant Robot. Create a project folder, set up the scene and scale, and begin modeling the Giant Robot. Main shapes of entire character should be blocked in. Due week 4.

Week 4 – Modeling with NURBS

Day 1

NURBS (Non-Uniform Rational B-Splines)
NURBS components (Control Vertices, Hulls, Spans/Sections, Curve Degree, Edit Points, U and V coordinates)
Curve-based modeling concepts and techniques

Day 2

Complex extrusions and lofts
Bi-Rails

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 4

Assignment

Giant Robot (Progress 2 of 4) – Add details to the Giant Robot using multiple techniques including NURBS. At least five (5) detail structures should use NURBS geometry. Due week 5.

Week 5 – Modeling cleanup and texture implications

Day 1

Modeling workflows for NURBS and Polygons
Conversion techniques
NURBS to Polygons
Polygons to NURBS

Day 2

Subdivision surfaces
Best practices
Preserving UV texturing coordinates throughout conversion

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 5

Assignment

Giant Robot (Progress 3 of 4) – Finish and clean up the geometry of the Giant Robot character for group critique in class. Objects should be named cleanly in preparation for the next phases of the project. Due week 6.

Week 6 – UV unwrapping and texturing

Day 1

In class critique of the Giant Robot models
UV Coordinates

UV Projections and unwrapping
NURBS vs. polygon UV coordinate space
Exporting UV snapshots to Photoshop
Materials Fundamentals

Day 2

Midterm Exam

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 6

Assignment

Giant Robot (Complete 4 of 4) – Unwrap the UV's of the Giant Robot, and assigning custom materials to each object. Create UV snapshots of each unwrapped object. Due week 7.

Week 7 – Automation and Movement

Day 1

Skeletons and hierarchies
Rigging for hard surfaces and multi-object models
Binding
Preparing geometry for rigging and animation
Review fundamental animation and performance principles

Day 2

Forward vs. Inverse Kinematics
Hierarchies: Parent -> Child Relationships
Skeletons and Joint Hierarchies
Organizing a complex character (defining what and how things move)
Creating a simple rig
Range of motion and types of motion

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 7

Assignment

Giant Robot Rig (Progress 1 of 3) – Cleanup models for rigging. Build a skeleton hierarchy to support the automation of the model. Bind the geometry. Due week 8.

Week 8 – Controlling Animation

Day 1

Float, Vector, Integer, and Boolean data types
Controllers
Driven Keys
Direct Connections

Day 2

Expressions, functions, and MEL
MEL format
Python/MEL format
Time, attribute, and mathematic operators
String, and Enum data types
Custom variables

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 8

Assignment

Giant Robot Rig (Progress 2 of 3) – Build all necessary controllers and secondary motion controls. Use expressions, set driven keys, and direct connections to manage these functions. Due week 9.

Week 9 – Constraints and Deformation

Day 1

Understanding animation constraints
Tranformations
Deformations
Blending between multiple constraints

Day 2

Planning advanced multi-nodal mechanical constraints
Turrets, treads, and synchronized mechanical structures
Avoiding breakage

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 9

Assignment

Giant Robot Rig (Complete 3 of 3) – Finish the rig. Refine any remaining control problems. Due week 10.

Week 10 – Visual Effects and Animation

Day 1

In class critique of the Giant Robot rigs
Adding visual effects to animated scenes
Shatters, explosions, and other types of effects

Day 2

Previs for VFX
View previous successful projects

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 10

Assignment

Begin the Final Project. Details on Blackboard. Progress checks due each week. Due during final exam session.

Week 11 – Render Layers and Render Passes

Day 1

Rendering engines (Mental Ray, Renderman, VRay)
Render Layers
Render Passes

Day 2

Overview of file formats and their application
R, G, B, A, Z, and other channels
Bit depth (8, 16, 32), integer vs. floating point, compression, and color

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 11

Assignment

Final Project progress check due week 12.
Break a lit scene down into its constituent render contribution passes. Separate render passes for each major scene element (minimum: environment, subject object, and background). Each pass should also contain diffuse, specular, reflection, lighting, shadow, and GI passes.

Week 12 – Compositing

Day 1

Introducing the Nuke interface
Node based compositing

Day 2

Read, merge, and write nodes
Merge arithmetic operators
Nuke script planning and layout strategies

Reading

Reference Slides
Digital Lighting & Rendering – Chapter 12

Assignment

Final Project progress check due week 13.
Using Nuke and the render passes from the previous assignment; reassemble the sequence to achieve the closest matching composite result. Once this is complete, use color correction and other layers to sweeten the sequence.

Week 13 – Compositing for dynamics

Day 1

Zdepth
Particle render passes and special topics
Black hole matte

Day 2

ID channels
Particle layers for special effects (heat blurs, atmospheric distortions, etc.)
Reasons to break out certain passes into a unique scene

Reading

Reference Slides

Assignment

Final Project progress check due week 14.

Week 14 – Advanced dynamics

Day 1

Fluid dynamics
nDynamics (nParticles, nCloth)

Day 2

Mapping fluids to particles
The overburn technique

Reading

Reference Slides

Assignment

Final Project progress check due week 15.

Week 15 – Final Rendering and Advanced Topics

Day 1

Final class critique
Putting the finishing touches on a completed scene
Rendering and post processing of a finished scene
Review of dynamics tools based on needs of projects

Day 2

Final Exam Review

Reading

Reference Slides

Assignment

Pull out all the stops to finish this Final project! The final should be at least 15 seconds long and be composed of at least three shots. This is a chance for you to use camera, shot selection, character performance, lighting, and effects to create a finished portfolio quality piece. Final output should be QuickTime format, Sorensen 3 or H.264 codec. I would like to collect project folders as well. Final Project due for viewing and in-class critique at start of our arranged Final Exam session.

Final Exam – Wednesday, May 9, 2-4 p.m.

Multiple choice
Bring a pencil
Arrive early

Final Project

Due

Due at start of our Final Exam session according to the Final Exam Schedule
Wednesday, May 9, 2-4 p.m.

Details

The final should be at least 15 seconds long and be composed of at least three shots. This is a chance for you to use camera, shot selection, character performance, lighting, and effects to create a finished portfolio quality piece.

Final output should be QuickTime format, Sorensen 3 or H.264 codec. I would like to collect project folders as well. Final Project due for viewing and in-class critique at start of our arranged Final Exam session.

The scene must include dynamic simulation and include at least two of the following techniques:

- Rigid bodies
- Particles
- Fluids
- Overburn

- nCloth

The scene should be rendered in multiple passes with particles rendered separately from the geometry and composited using After Effects or Nuke.

- Diffuse (normal)
- Reflection (add)
- Specular (add)
- Shadow (subtract)
- Hardware effects (if necessary)
- Software effects (if necessary)

Due at start of our Final Exam session according to the Final Exam Schedule

Assessment:

The Final project is worth 60 points. The Final project will be graded based on:

- Fifteen seconds long, three shots = 10 points
- Demonstrated effort = 10 points
- Complexity, range, and effective use of tools = 10 points
- Quality of the finished product
    - Performance = 20 points
    - Visual quality = 10 points