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| Catalogue Description | Explore the range of 3D printing and Prototyping technologies, and their application in modern industrial, design, and creative fields. |
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| Objective | Explore the range of 3D printing and Prototyping technologies, and their application in modern industrial, design, and creative fields. Overview of 3D design and modeling techniques for modern Rapid Prototyping and Additive Manufacturing applications. Prototyping technologies, base materials, and their applications. 3D modeling and design techniques for manufacturing and product development. Successful modeling methodologies, topologies for exporting to printing, measurement techniques, and manufacturing tolerances. Overview of modeling software and modeling techniques, including procedural modeling. |
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| Prerequisites | ITP 215 or experience with 3D modeling or CAD software package re |
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| Instructor | Lance S. Winkel E-mail: winkel@usc.edu Tel: 213/740.9959 Office: OHE 530 H Office Hours: Tue/Thur 8-10am, 2-3pm by appointment |
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| Hours | 4 hours |
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| Course Structure | <ul style="list-style-type: none">• Details for projects, labs, and due dates are detailed in the syllabus below and also on Blackboard.• The Midterm Exam will be Week 9.• The Final Exam will be conducted at the time dictated in the Schedule of Classes. Tuesday, May 8, 2-4 p.m.• There will be a capstone Final Project due for viewing during the first half of the Final Exam Session.• Details and instructions for all projects will be available on Blackboard.• For grading criteria of each assignment, project, and exam, see the Grading section below• Final Exam: Tuesday, May 9, 204pm OHE 540 (See Schedule of Classes) |
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| Textbook(s) | Recommended: Manufacturing Processes for Design Professionals by Rob Thompson, Hardcover: 528 pages, (ISBN-13: 978-0500513750) Linda.com tutorials for software packages used throughout production Learning Maya, Learning Solidworks, Learning Fusion 360, or an account with Solidprofessor.com or other introductory book or resources as necessary. |
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|----------------------|--|------|---|--------|----|--------|----|--------|---|--------|----|--------|----|--------|---|--------|----|----|----|-------|---|----|----|--------------|---|
| Grading | <p>W_1 – Custom Lego (10 points)</p> <p>W2_3 – Team Designs Rough (15 points)</p> <p>W3_4 – Team Designs Unbiased (30 points)</p> <p>W5 – CAD Enclosure (15 points)</p> <p>W6 – Embedded Detail (10 points)</p> <p>W7_12 – Team Design Finished Printable (50 points)</p> <p>W8 – Precision Measurement and Part Negatives (10 points)</p> <p>W9 – Buses and Connections (10 points)</p> <p>W12_W14 – Print Finish and Cleanup (20 points)</p> <p>Midterm Exam: (20 points)</p> <p>Final Exam: (30 points)</p> <p>Total = 200 points</p> | | | | | | | | | | | | | | | | | | | | | | | | |
| Grading Scale | <p>Letter grades will be assigned according to the following scale:</p> <table> <tr><td>93%+</td><td>A</td></tr> <tr><td>90-92%</td><td>A-</td></tr> <tr><td>87-89%</td><td>B+</td></tr> <tr><td>83-86%</td><td>B</td></tr> <tr><td>80-82%</td><td>B-</td></tr> <tr><td>77-79%</td><td>C+</td></tr> <tr><td>73-76%</td><td>C</td></tr> <tr><td>70-72%</td><td>C-</td></tr> <tr><td>69</td><td>D+</td></tr> <tr><td>67-68</td><td>D</td></tr> <tr><td>66</td><td>D-</td></tr> <tr><td>65 and below</td><td>F</td></tr> </table> <p>Half percentage points will be rounded up to the next whole percentage. So for instance, 89.5% is an A-, but 89.4% is a B+.</p> | 93%+ | A | 90-92% | A- | 87-89% | B+ | 83-86% | B | 80-82% | B- | 77-79% | C+ | 73-76% | C | 70-72% | C- | 69 | D+ | 67-68 | D | 66 | D- | 65 and below | F |
| 93%+ | A | | | | | | | | | | | | | | | | | | | | | | | | |
| 90-92% | A- | | | | | | | | | | | | | | | | | | | | | | | | |
| 87-89% | B+ | | | | | | | | | | | | | | | | | | | | | | | | |
| 83-86% | B | | | | | | | | | | | | | | | | | | | | | | | | |
| 80-82% | B- | | | | | | | | | | | | | | | | | | | | | | | | |
| 77-79% | C+ | | | | | | | | | | | | | | | | | | | | | | | | |
| 73-76% | C | | | | | | | | | | | | | | | | | | | | | | | | |
| 70-72% | C- | | | | | | | | | | | | | | | | | | | | | | | | |
| 69 | D+ | | | | | | | | | | | | | | | | | | | | | | | | |
| 67-68 | D | | | | | | | | | | | | | | | | | | | | | | | | |
| 66 | D- | | | | | | | | | | | | | | | | | | | | | | | | |
| 65 and below | F | | | | | | | | | | | | | | | | | | | | | | | | |
| Homework | <p>All homework will be submitted on Blackboard. Detailed instructions and resources for each assignment will be posted on Blackboard along. http://blackboard.usc.edu</p> | | | | | | | | | | | | | | | | | | | | | | | | |
| Policies | <p><i>Make-up policy for exams:</i> 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.</p> <p>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.</p> <p>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/.</p> | | | | | | | | | | | | | | | | | | | | | | | | |

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct/>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu/> or to the *Department of Public Safety* <http://capsnet.usc.edu/departement/departement-public-safety/online-forms/contact-us>. This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage sarc.usc.edu describes reporting options and other resources.

Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu/> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

A Further Note on Plagiarism

In this class, all homework submissions will be compared with current, previous, and future students’ submissions using MOSS, which is a code plagiarism identification program. If your code significantly matches another student’s submission, you will be reported to SJACS with the recommended penalty of an F in the course.

It is okay to discuss solutions to specific problems with other students, but it is not okay to look through another student’s code or source material. It does not matter if this code is online or from a student you know, it is cheating. Do not share your code with anyone else in this or a future section of the course, as allowing someone else to copy your code carries the same penalty as you copying the work yourself.

Week 1 – Introductions

Day 1

Survey of students and 3D animation experience
Overview of course plan and objectives
Sample work
In class Lego design challenge

Day 2

Introduction to Maya GUI
Object creation workflow
Constructing object primitives to scale and with accuracy
Duplication and arrayed duplication
Grid and point/vertex snapping

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment/Project

W_1 – Custom Lego (10 points): Lego Design Challenge. Design and build a custom Lego piece of your own design that conforms to the Lego design specification. It must interface with other Lego pieces and according to the Lego design specification in at least three locations or dimensions. Curvilinear surfaces should be built using NURBS curves and converted to polygons or be tessellated to a proper level of subdivisions so that printable models do not show facets.

Week 2 – Basic Polygon Modeling

Day 1

Understanding 3D geometry
Modeling workflows for Polygons
Additive vs. Subtractive Tools
Mesh editing

Day 2

Best Practices for constructing printable polygon meshes
Fundamental Structure vs. Ornamentation

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment/Project

W2_3 – Team Designs Rough (15 points): Based on initial team meetings design three (3) rough concepts for production team brainstorming. These can be in drawn form or 3D Visual development reference for similar products.

Week 3 – Intermediate Polygon Modeling and Clean up

Day 1

Combining, merging, and sewing up polygon meshes
Understanding two-manifold vs. non-manifold geometry
Identifying, predicting, and fixing non-manifold geometry
Freezing transforms and deleting history
Exporting geometry

Day 2

Laying out a simple model on a stage for print.
Hollow forms and the importance of reducing volume
Cost of size, cost of volume, cost of detail, cost of time

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment/Project

W3_4 – Team Designs Unbiased (30 points): Refine the three rough concepts so they are ready to present for marketing analysis. Each concept should be at an equal qualitative level to provide unbiased evaluation and input to the production team.

Week 4 – Intermediate Modeling with NURBS

Day 1

Understanding NURBS
NURBS Surfaces advantages
Similarities and differences between NURBS and CAD drawings
Curve and surface construction
Clean and uniform topology

Day 2

Best Practices for NURBS
Illustrator, IGES, and other import/export pipelines

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

W5 – CAD Enclosure (15 points): Using a CAD program, either Solidworks or Fusion 360, build an enclosure made out of two parts that close around a defined space. A box, a two part iPhone case, or other device.

Week 5 – Advanced Surfacing with NURBS

Day 1

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

Day 2

Best practices for geometry conversion
Texturing coordinates
Preserving UV texturing coordinates throughout conversion

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

W6 – Embedded Detail (10 points): Using a combination or multiple combinations of the tools and techniques presented in class, create a ring, small bracelet, or other jewelry sized object with embedded or complex relief detail. NURBS text, ZBrush or Mudbox

driven mesh data, or other processes can be used to create the detail. Clean and export it for printing.

Week 6 – Accurate Measurement and Part Negatives

Day 1

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

Day 2

Best practices for geometry conversion
Texturing coordinates
Preserving UV texturing coordinates throughout conversion

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

Complete CAD Enclosure and Embedded Detail projects.

Week 7 – Modeling for design and production

Day 1

Moving Parts and Articulation
Hinges
Ball and sockets
Flexibility and elasticity
Locks, bolts, and fasteners
Threading (taps and dies)
Interfacing, support, and reinforcement

Day 2

Form and function
Visualizing the assembly process
Complex interactions and motorizations
Creating a part negative

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

W7_12 – Team Design Finished Printable (50 points): Based on feedback and group analysis, begin developing final concept into a workable / printable 3D product. Any and all necessary tools should be utilized. Work with product marketing and engineering teams to evolve the design into a completed product prototype for printing. Finished Printable files due Week 12.

Week 8 – Embedding detail

Day 1

Creating Text in Maya the proper way (NURBS Curves, surface lofts, conversion to polygon)
Painterly tools (Sculpt Geometry Tool, etc.)
Workflows with other programs (ZBrush, Mudbox, etc.)

Day 2

Non-linear animation tools
How rigging, shading, dynamics, fluids, and other Maya 3D toolsets can be applied to creating manufacturable and printable objects.

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

Work with team on Finished Printable.
W8 – Precision Measurement and Part Negatives (10 points): Based on team product feedback, determine engineering parts needs and specifications of those parts. Measure and model negatives for each part in preparation for full production model.

Week 9 – 3D Modeling software vs. CAD

Day 1

How are modeling software packages different from CAD packages
Sketch/drawing based workflows
Similarities and differences between CAD and NURBS
Broad overview of manufacturing techniques
Molding, sculpting, lathing, lofting, welding, cutting, drilling, gluing, etc.

Day 2

An overview of CAD software packages
Introduction to Fusion 360
Drawing based workflow
Drawing constraints
Surfacing operations

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

Work with team on Finished Printable.
W9 – Buses and Connections (10 points): Based on team product feedback, determine assembly and interconnectivity of the parts. Busses for interlocking parts. Range of motion for interlocking or moving features.

Week 10 – 3D Design Fundamentals and Starting a Project

Day 1

The good, the bad, and the ugly of design
Prominent Designers
Franchises
Success stories
Pop culture

Day 2

Early decision making criteria
Knowing the product
Vision vs. Reality
Brainstorming and critique in the early design phase
Group critiques of in-progress projects

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

Work with team on Finished Printable. Based on team product feedback, make changes and necessary adjustments.

Week 11 – Starting a Production

Day 1

Early decision making criteria
Knowing the product
Vision vs. Reality
Scale and cost
Calculating the total cost
Tolerances
Initial scene set-up
Roughing in the model

Day 2

Structural integrity
Range of motion
Progress checks and group critiques of in-progress projects

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

Work with team on Finished Printable. Based on team product feedback, make changes and necessary adjustments. Fully cleanup and refine the model and arrive at model consensus and sign off by the team and faculty for final printing.

Week 12 – Prototyping and Printing Technologies

Day 1

History of 3D Printing
Overview of 3D Printing technologies
Selective Laser Sintering (SLS)
Direct Metal Laser Sintering (DMLS)
Fused Deposition Modeling (FDM)
Stereolithography (SLA)
Laminated Object Manufacturing (LOM)
Electron Beam Melting (EBM)

3D Printing (3DP)

Day 2

Final cleanup and processing of files for printing. This is the due date for files that are of a printable scale to be considered for printing!

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

W12_W14 - Print Finish and Cleanup (20 points): Cleanup and prepare print files for Team Presentation Week 15.

Week 13 – Manufacturing and Molding

Day 1

Vacuum forming
Resin casting
Injection Molding
Terms and standards for injection molding systems
Printing Resolutions and Tolerances
Materials Properties (Temperature, Flexibility, Strength, Brittleness)

Day 2

Planning for injection molding
3D Printing for injection molding

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

Continue cleaning up and preparing print files for Team Presentation Week 15.

Week 14 – Product Visualization

Day 1

Workflows for printing
Software and Drivers
Formats for Printing (SLA, OBJ, CAD, etc.)

Day 2

Cleanup and airtight modeling
Post and Export

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project
Linda.com tutorials as necessary to assist the project

Assignment

Continue cleaning up and preparing print files for Team Presentation Week 15.

Week 15 – Print Cleaning and Final Presentations

Day 1

Print Lab setup
Loading models and arranging print stage

Printing

Day 2

Removing support material

Special topics

Remaining time will be Final Exam Study Session

Begin Final Presentations if already complete

Reading

Autodesk Maya Help, Online Resources, and tutorials as necessary to assist the project

Linda.com tutorials as necessary to assist the project

Assignment

Critiques and Presentations in class. Printing and other special topics.

See Blackboard for details and notes for Final Exam

Final Exam – Tuesday, May 8, 2-4 p.m.

Multiple choice

Bring a pencil

Arrive early