ITP 415 3D Design and Prototyping
Units: 2
Spring 2019 – Tuesdays/Thursdays 2pm-3:50pm

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

Collaboratively explore advanced modeling and CAD toolsets along with 3D printing and prototyping technologies working alongside engineers and marketing experts to create market-ready functional prototypes.

Learning Objectives

Explore the range of 3D printing and prototyping technologies, and their application in modern industrial, design, and creative fields. Apply iterative design principles, CAD, and modeling tools for visualization, ideation, and prototyping via additive manufacturing platforms. Explore printing technologies, base materials, and their applications. Understand how 3D modeling and design techniques are applied for manufacturing and product development. Successful modeling methodologies, topologies for exporting to printing, measurement techniques, and manufacturing tolerances. Simulate a complete product development cycle in a team-based capstone collaboration between marketing and electrical engineering students to design a functional prototype product.

Prerequisite(s): ITP 215
Co-Requisite(s): None.
Concurrent Enrollment: None.
Recommended Preparation: Understanding of any 3D Modeling or CAD software package

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 and Fusion 360 software that we will be using for this course.
Adobe Cloud provides discounted academic accounts but is not required if using lab computers.
Formlabs offers their PreForm 3D staging software free from their website.
SolidWorks 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:

Manufacturing Processes for Design Professionals by Rob Thompson, Hardcover: 528 pages, (ISBN-13: 978-0500513750)

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

Assignment/Grade Item	Assignment Name/Description	Points
W1	Custom Lego	10
W2_3	Team Designs Rough	15
W3_4	Team Designs Unbiased	30
W5	CAD Enclosure	15
W6	Embedded Detail	10
W7_12	Team Design Finished Printable	50
W8	Precision Measurement	10
W9	Buses and Connections	10
W12_14	Print Finish and Cleanup	20
Midterm Exam	Thursday of Week 8	20
Final Exam	As per Schedule of Classes	30
Peer Review Assessment		10
Participation		20
Total		**250**

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 – 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

Manufacturing Processes for Design Professionals – Part 1
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

Manufacturing Processes for Design Professionals – Part 1
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

Manufacturing Processes for Design Professionals – Part 2
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

Manufacturing Processes for Design Professionals – Part 2
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

Manufacturing Processes for Design Professionals – Part 3
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

Manufacturing Processes for Design Professionals – Part 3
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

Manufacturing Processes for Design Professionals – Part 4
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.)
Non-linear animation tools
How rigging, shading, dynamics, fluids, and other Maya 3D toolsets can be applied to
creating manufacturable and printable objects.

Day 2

Midterm Exam

Reading

Manufacturing Processes for Design Professionals – Part 4

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

Manufacturing Processes for Design Professionals – Part 5

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

Manufacturing Processes for Design Professionals – Part 5

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

    <u>**Day 1**</u>

        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

    <u>**Day 2**</u>

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

    <u>**Reading**</u>

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

    <u>**Assignment**</u>

        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

    <u>**Day 1**</u>

        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)

    <u>**Day 2**</u>

        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!

    <u>**Reading**</u>

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

    <u>**Assignment**</u>

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

Week 13 – Manufacturing and Molding

    <u>**Day 1**</u>

        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 – (See Schedule of Classes)

Multiple choice

Bring a pencil

Arrive early

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 Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/scampus-part-b/. 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.

Support Systems

Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. https://engemannshc.usc.edu/counseling/

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.
https://engemannshc.usc.edu/rsvp/

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class.
https://equity.usc.edu/

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessment-response-support/

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. http://dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. https://diversity.usc.edu/

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, http://emergency.usc.edu

USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.
Provides overall safety to USC community. http://dps.usc.edu