



School of Engineering
*Information
Technology Program*

ITP 415 3D Design and Prototyping

Units: 2

Spring 2019 – Tuesdays/Thursdays 1pm-2:50pm

Location: KAP 267

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 (Prerequisite can be waived for certain CAD or 3D modeling experience at instructor's discretion based on demonstrated work. Contact Instructor at winkel@usc.edu)

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](https://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](https://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](https://blackboard.usc.edu)

Autodesk Maya Online Documentation at knowledge.autodesk.com

Lynda.com via [Blackboard.usc.edu](https://blackboard.usc.edu)

Learning Resources for other tools like V-Ray, Preform, and Houdini can be found on Lynda 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](https://blackboard.usc.edu).

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

This is the anticipated course lesson plan and will be subject to change based on capstone production needs

Week 1 – Introductions

Day 1 KAP267

Survey of students modeling, CAD, and/or 3D animation experience
Overview of course plan and objectives
Sample previous capstone work.
In class design challenge

Day 2 KAP267

Understanding 3D Geometry
Review of fundamental 3D concepts 3D vs. CAD
Object creation workflow
Defining units and scale
Planning a design process
Constructing object primitives to scale and with accuracy
Duplication and arrayed duplication
Grid control. Snapping to grids, points, curves, and constraints

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 Combined Classes

Initial Presentations by design faculty
Goal setting and scheduling

Day 2 Combined Classes

Meeting your interdisciplinary team
Identifying project problems
Needs / Wants / and Desires

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 KAP267

Understanding 3D geometry
Modeling workflows for Polygons

Additive vs. Subtractive Tools
Mesh editing
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 KAP267

Best Practices for constructing printable polygon meshes
Modeling for Form, Function, and Style
Fundamental Structure vs. Ornamentation
Making an object printable
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 KAP267

Understanding NURBS
NURBS Surfaces advantages
Similarities and differences between NURBS and CAD drawings
Curve and surface construction
Clean and uniform topology
Best Practices for NURBS
Illustrator, IGES, and other import/export pipelines

Day 2 Combined Classes

Rough Concept Pitches for faculty approval
Changes and Revisions until approval given

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 KAP267

Modeling workflows for NURBS and Polygons
Conversion techniques
NURBS to Polygons
Polygons to NURBS
Subdivision surfaces
Best practices for geometry conversion

Texturing coordinates
Preserving UV texturing coordinates throughout conversion

Day 2 KAP 267

Design only critiques
Uniform presentation material prep
Renders and breakdowns for capstone teams

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 KAP267

Modeling workflows for NURBS and Polygons
Conversion techniques
NURBS to Polygons
Polygons to NURBS
Subdivision surfaces
Best practices for geometry conversion
Texturing coordinates
Preserving UV texturing coordinates throughout conversion

Day 2 Combined Classes

Design team presentations for 2D/3D Concepts

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

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

Project production, planning, and critique
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

Project production, planning, and critique
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

Project production, planning, and critique
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

Project production, planning, and critique
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

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

Day 2

Project production, planning, and critique
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

Final Project production, planning, and critique
Print Lab setup

Loading models and arranging print stage
 Printing

Day 2

Final Project production, planning, and critique
 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

This is a reproduction of the Capstone Shared Milestones for Spring 2019 and will be subject to change.

1	1/8	Individual Classes	1/10	Individual Classes	
2	1/15	Fertitta Hall, Room 322 ITP, EE, MKT introductions. Course and MKT Intro (Therese); EE Intro and Project Specs (Allan); Design Principles (Lance)	1/17	Fertitta Hall, Room 322 Meet your interdisciplinary team! Team Building and class competition Teams: Identify project problems/needs and begin brainstorming concepts. Teams choose brand interests.	Teams Formed Initial Brand Selections Brainstorming Begins
3	1/22	Individual classes	1/24	Fertitta Hall, Room 322 Brainstorming continues. Define 3 rough concepts for approval next week.	
4	1/29	Individual classes	1/31	Fertitta Hall, Room 322 Rough Concept Approvals/Team with all Professors	Teams: 3 Verbal Rough Concept Definitions with 2D sketches; complete concept approval forms
5	2/5	Individual classes	2/7	Fertitta Hall, Room 322	Teams: Finalize 3 Concepts for Testing
6	2/12	Individual classes	2/14	Fertitta Hall, Room 322 ITP team presents initial 2D/3D concepts.	ITP: Initial 2D/3D Concepts

					EE: Identify universal requirements.
7	2/19	Individual classes	2/21	Fertitta Hall, Room 322 ITP team completes final 2D concepts for testing. TBD-Intellectual Property Guest Speaker	ITP: Final 2D/3D Concepts completed for testing EE: Identify specific requirements. MKT: Concept Testing begins
8	2/26	Individual classes	2/28	Fertitta Hall, Room 322 MKT teams present key findings from concept testing. Teams complete Scoring Model and implications for final concept definition.	MKT: Concept Testing results EE: Identify final requirements Teams: Complete Scoring Model
9	3/5	Fertitta Hall, Room 322 Final Concept Definition Sign Product Protocol document	3/7	Individual Classes	Teams: Final Concept Definition ITP: Revised 2D/#D EE: Parts List MKT: Product Protocol due Mid-term Cross Team Peer Evaluations due to your Professor
10	3/12	Spring Break!	3/14	Enjoy!	
11	3/19	Individual classes	3/21	Fertitta Hall, Room 322 Project status and brainstorm names Final Presentation Overview	EE: Final estimated product specs and non-available components ITP: Complete CAD files Developing final concept
12	3/26	Individual classes	3/28	Teams #1-#3 in OLIN 240 Teams #4-5 in KAP 267 Circuit Board Lab & 3D Printing Process At 2:40, students switch to other location	ITP: CAD /printable models due for printing
13	4/2	Individual classes	4/4	Individual Classes	ITP: Model printing renders
14	4/9	Individual classes	4/11	Fertitta Hall, Room 322 Final Team Meeting & Presentation Prep	Presentation Preparation ITP: 3D Models & Renderings

15	4/16	Fertitta Hall, Room 322 Part 1: Final Shared Team Presentations (EE, ITP, MKT) Smile; You will be recorded	4/18	Individual classes	
16	4/23	Fertitta Hall, Room 322 Part 2: Final Shared Team Presentations (EE, ITP, MKT) Smile, you will be recorded Competition Awards given	4/25	Final Individual classes. Final Cross Team Peer Evaluations due to your Professor	

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>