

## **Des 326 – Digital Fabrication**

Spring '19

University of Washington

(5 credits)

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### **Time / Location:**

Tues / Thur. 8:30-11:20am, Art 215 - 3D computer lab

### **Instructor:**

Jason O. Germany, Asst. Professor - ID

jgermany@uw.edu

Art Rm 134

Office hours: "by appointment"

### **Overview / Objectives:**

This course will cover topics pertaining to the use of digital tools as they relate to modern industrial design methods. Digital tools (2D raster – vector / CAD / CNC / Rapid prototyping / Laser cutting) provide one more avenue for product designers to ideate, evaluate, and communicate their ideas. In the course of design and development these pieces of software as well as prototyping machines add a level of accuracy and refinement that can have the ability to take rough concepts to final working pieces. This course is meant to bridge the gap between hand generated methods and the virtual world of CAD modeling and digital fabrication. It should be noted that this course will cover a significant amount of software ranging from 2D to 3D systems and will function as intensive overview. Although this course may not directly utilize all forms of digital prototyping during the various course projects, there will be several discussions related to digital fabrication methods as they pertain to larger topic of product design and visualization.

### **Structure:**

The class will primarily meeting in the computer lab (3D Computer lab) but there may be periodic points throughout the quarter when physical work will require the class to meet in the woodshop. The computer lab setting will provide the class with an opportunity to learn and explore the uses and applications of several different software packages. If it is required that the class meet in the woodshop then notice will be given prior to that date. In general, the class time will be split between instruction and action so students should be prepared to learn as well as create during each meeting.

### **Graded course work:**

Grades are based on the quality of work, the ability to meet deadlines, your process throughout all aspects of the assigned projects, and in-class participation in exercises, discussions, and critiques. The deliverables for this course will be composed of projects that incorporate 2D / 3D modeling and digital prototyping as well as the iterative design steps in-between (sketching, hand prototyping, etc). The grading / course projects / homework will be as follows (additional project details will be provided):

Project #1 – Laser cutting project = 15%

Project #2 – 3D print project = 25%

Project #3 – CNC project = 25%

Project #4 – Final Project = 25%

Activities and participation = 10%

**Homework / projects and late turn-in policy:**

Deadlines are an important part of the design process so please be present on the day that material is due and deliver what you have completed. Homework is due on the assignment date at the beginning of the course meeting time (9am). I will accept late homework assignment deliverables for up to 48hrs. after the initial due date / time but deliverables turned in during the first 24hr time period (late day 1) will be graded 25% off and deliverables turned in during the following 24hr time period (late day 2) will be graded 50% off. I do not accept late homework submitted more than 2 days (48hrs) after the initial due date / time. With that in mind, if you are not able to attend class on the day that homework is due because of illness, emergency, academic related absence, or disability then have a classmate bring it in for you or contact me via email / phone before the end of the deadline time (class date / meeting time). Additionally, many of the deliverables in this course will be digital uploads to Canvas – please keep in mind that the cut off for the deadlines still applies.

**Participation:**

As this is a studio based course, attendance to each meeting of the prescribed course times will be recorded and contribute to the participation portion of students final grade. Much of the material required to fully participate in this course will only be presented and discussed during scheduled class time. Additionally, various activities (critiques, reviews, presentations, demos, exercises, etc) will only take place during course scheduled times and it is your participation in the overall course exercises and tutorials not just the completed assignments that will also be graded. It is for that reason that attendance to all class meetings is highly recommended.

**Individual Assignments:**

Individual assignment handouts will be distributed separately from this syllabus. These handouts will have specific deliverables and dates for each phase of the project and should be used to determine the individual details of each assignment.

**Communication:****- Student to Instructor**

Aside from in-class course meeting times, I am accessible during my office hours by appointment. Additionally, I can be reached by my office number or by email. There is often limited time before and directly after the scheduled course times so please take advantage of these other methods of contact. When utilizing email as a form of communications, allow 1 school day for response during regular business hours – don't expect this form of communication (email) to be affective during evenings, weekends, or holidays.

**- Instructor to Students**

The three primary methods of communication during the term are in-class meeting times, online via Canvas and email. Make sure to check for online announcements as well as posted course materials each week as Canvas will be the central depository for much of the assignments, additional readings, etc. Periodically, I will send out emails with additional announcements related to the course and homework assignments. It is the responsibility of the student to check his / her *University of Washington email* in a regular manner so as to stay informed to changes in scheduling or assignments.

**Evaluation scale:**

Evaluation and distribution of grades will be as follows:

A 3.8–4.0 is given to a student who has exhibited the highest possible performance in all aspects of the course—final projects, the design process and participation are excellent. This student independently seeks out additional information on design and is highly committed/passionate about their work.

A 3.4–3.7 is given to a student who exhibits superior performance in all aspects of the course—the final projects, design process, and participation are uniformly of high quality. This student has a thorough understanding of all concepts presented, and is motivated to improve and succeed.

A 2.9–3.3 is given to a student who has good performance in most aspects of the course. This student follows a thorough design process, has good design work, and consistent participation that reflects a clear understanding of almost all concepts being presented.

A 2.5–2.8 is given to a student who has fair performance in the course. The final work is adequate, with a design process that reflects the minimum needed to complete assignments. Participation and motivation are moderate.

A 0.0–2.4 is given to a student with poor performance in the course. Projects are incorrectly prepared, incomplete or missing. This student does not understand the majority of concepts presented and rarely participates in class. This student is not prepared for subsequent courses in design.

### **Text / Reading:**

All reading or text related to this course will be provided in electronic or print form by the instructor

### **Required Tools:**

1. Caliper (6in, digital, SAE / Metric readout), \$10-20

- Affordable options (Neiko, SE, Pittsburgh)

[http://www.amazon.com/Neiko-Stainless-Digital-Caliper-Extra-Large/dp/B000GSLKIW/ref=sr\\_1\\_1?s=industrial&ie=UTF8&qid=1313112085&sr=1-1](http://www.amazon.com/Neiko-Stainless-Digital-Caliper-Extra-Large/dp/B000GSLKIW/ref=sr_1_1?s=industrial&ie=UTF8&qid=1313112085&sr=1-1)

[http://www.amazon.com/Caliper-Electronic-Stainless-Steel-Body/dp/B0019O6OCO/ref=sr\\_1\\_4?s=industrial&ie=UTF8&qid=1313112085&sr=1-4](http://www.amazon.com/Caliper-Electronic-Stainless-Steel-Body/dp/B0019O6OCO/ref=sr_1_4?s=industrial&ie=UTF8&qid=1313112085&sr=1-4)

<http://www.homedepot.com/p/Husky-6-in-3-Mode-Digital-Fractional-Caliper-1467H/206007130>

- Home Depot on Aurora will also have 6 in digital calipers

2. Calculator (basic type, no special functions required, cell phone is fine)

3. USB flash drive OR save to cloud storage (1GB minimum, 4GB recommended)

\* Note: Always backup your files from this USB flash drive or online storage system as they are often corrupted or are lost.

### **Resources (not required):**

Online Tutorials: SolidProfessor

There are various online tutorial videos and programs, one such tutorial service is called SolidProfessor (\$50 or more). This services allows for a 1 year membership and can be used to support SolidWorks as well as other CAD and CAM related software.

<https://www.solidprofessor.com/>

### **Software –**

SolidWorks Student License (1yr) - \$99.99

<http://www.creationengine.com/html/pl.lasso?s=solidworks>

<http://www.novedge.com/products/2928>

SolidWorks online tutorials (separate from SolidProfessor)

<http://www.solidworks.com/sw/resources/solidworks-tutorials.htm>

[http://help.solidworks.com/2012/English/SolidWorks/sldworks/r\\_welcome\\_sw\\_online\\_help.htm](http://help.solidworks.com/2012/English/SolidWorks/sldworks/r_welcome_sw_online_help.htm)

<http://www.solidworkstutorials.com/>

<http://www.youtube.com/> (search for solidworks and your issue)

KeyShot 15-day free trial download

<http://www.keyshot.com/downloads/>

KeyShot Educational License (1yr) - \$95.00  
<https://buy.keyshot.com/collections/keyshot-education>

KeyShot online tutorials, webinars, forum, free .hdz file downloads  
<http://www.keyshot.com/keyshot/training.html>  
<http://www.keyshot.com/keyshot/webinars/index.html>  
<http://www.keyshot.com/keyshotforum/>  
<http://www.keyshot.com/downloads/environments.html>

Rhino CAD (short term trial or purchase version)  
<http://mac.rhino3d.com/>

Rhino CAM (free demo – no saves)  
<http://www.mecsoft.com/DownloadRhinoCAM.shtml>

### **Material suppliers -**

UW Bookstore  
<http://www.bookstore.washington.edu/home/home.taf?>  
206-634-3400

Hardwick & Sons, Inc.  
<http://www.ehardwicks.com/>  
206-632-1203

University True Value  
<http://ww3.truevalue.com/universitytruevalue/Home.aspx>  
206-523-5353

Tap Plastics  
<https://tapplastics.com/>  
206-389-5900

Laird Plastics  
<https://www.lairdplastics.com/>  
206-623-4900

## **Policies (SoA and UW):**

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### **Class Participation, Engagement, and Learning Policies**

Classes offered in art, art history and design require students to be engaged as active and verbal learners in order to successfully complete the course. In addition to completing assignments and exams our expectation is that you will consistently participate in the classroom and studio during class time. It is this consistent participation and contribution to discussions, critique, gallery exhibition activities, team projects, and presentations of your research with faculty and peers that guarantees your learning, contributes to your academic accomplishments, and supports your professional goals after graduation.

Failure to comply with any of the following will undermine your learning and negatively affect your grade.

#### **1. Absences from class**

- Absences from class prevent participation and UW guidelines suggest that participation may account for at least 15% of your grade. Check your syllabus, in some cases participation may account for as much as 30% of your grade.
- If you miss class due to illness or emergency, notify your instructor immediately, provide documentation, and set-up a timeline to complete missed assignments and exams.

#### **2. Safety**

- It is your responsibility to abide by any safety policies outlined in class.

- Taking responsibility for cleaning up is required of all students enrolled in art and design studios. It promotes safety, builds community and demonstrates a sense of responsibility to your learning.
  - Spray booths are provided for use of aerosols and their use is mandatory.
- 3. Academic standards**
- Plagiarism is using the creations, ideas, words, inventions, or images of someone else in your own work without formally acknowledging them. This applies to written papers and research as well as to art, design and architectural images. All plagiarized assignments or tests will receive a grade of 0.
  - Copy-right Student work plus photos and videos of students may be used by the SoAAHD to illustrate our programs. We assume that by participating in SoAAHD classes and activities you have no objection. If you do have concerns please talk with the Academic Advisers in 104 Art.
- 4. Assignments, examinations and critiques**
- It is your responsibility to complete all assignments, take all exams, and participate in all class critiques and discussions as scheduled by your instructor.
  - Students are required to take final exams as scheduled by the University of Washington.
  - Exceptions to the above may be granted in cases of documented emergencies but must be approved by the instructor.
- 5. Grading**
- Grades in Art, Art History and Design courses are based on:
    - participation and engagement in the classrooms and studios
    - meeting deadlines for the completion of all assignments, exams and critiques
    - the quality of the work you submit during the quarter
  - Incomplete grades are only an option if:
    - you have been in attendance and done satisfactory work through the eighth week of the quarter.
    - you have furnished satisfactory proof to the instructor that the work cannot be completed because of illness or other circumstances beyond your control
  - Grade Appeal Procedure if you think the grade you received is incorrect:
    - Contact the instructor to discuss your concern.
    - If not resolved, make an appointment with the Director of Academic Advising, 104 Art, 543-0646.
- 6. Building use and policy**
- Art Building Hours
 

Mon – Thu	7:00 am – 7:00 pm
Fri	7:00 am – 5:00 pm
Sat	1:00 pm – 5:00 pm
Sun	9:00 am – 5:00 pm

    - To work after hours, have your Husky Card programmed for After Hours Access.
    - For the Art Building and Sandpoint, go to Art 104, M-F, 8am-4pm. CMA access can be programmed at the CMA.
    - Anyone in the building after hours is responsible for the safety and security of the building. Anyone who allows someone into the building or a workspace, or who props open a door for any reason risks losing after hours access to the building.
    - Students who are not enrolled in classes for the quarter may not use the facilities.
    - The campus police frequently monitor the building to insure your safety and security.
  - Lockers
    - Available to rent annually or quarterly in Art 104, M-F 8-4.
    - Quarterly rentals must be cleaned out at the end of each quarter.
    - No flammable or combustible items may be stored in lockers.
  - Exhibitions in the buildings
    - *Instructors and students must get approval from the Administrator of the School of Art + Art History + Design to install work outside the classroom. (Use of hallway bulletin boards and glass cases do not require approval.)*
    - Submit a written description of the proposal two weeks prior to installation to the SoA Administrator, 102 Art. Forms are available in 104 Art.
    - The approval process considers issues of location, health and safety, fire code, environmental factors and potential building damage prior to approval.
    - Applicants will be notified of a decision within a week of the application

## 7. Equal Opportunity

- The School of Art reaffirms its policy of equal opportunity regardless of race, color, creed, religion, national origin, gender, sexual orientation, age, marital status, disability, or status as a disabled veteran or Vietnam-era veteran in accordance with UW policy and applicable federal and state statutes and regulations.

## 8. Violence Awareness and Prevention

- Preventing violence, discrimination, harassment, and retaliation is everyone's responsibility.
- Call 911 for emergency help. Call 206-685-SAFE to report non-urgent threats or concerns.
- SafeCampus: [www.washington.edu/safecampus](http://www.washington.edu/safecampus).
- Concerns about sexual harassment: <http://studentlife.washington.edu/?s=title+ix>  
<http://depts.washington.edu/livewell/saris/sexual-harassment/>
- Don't walk alone. Campus safety guards can walk with you on campus after dark. Call Husky NightWalk 206-685-WALK (9255).
- Connect to UW Alert. Register your mobile number to receive instant notification of campus emergencies via text and voice messaging. Sign up online: [www.washington.edu/alert](http://www.washington.edu/alert)

## 9. Disability Accommodation

- To request academic accommodations due to a disability, please contact Student Disability Services, 448 Schmitz, (206) 543-8924 (V/TTY) or [uwdss@u.washington.edu](mailto:uwdss@u.washington.edu).
  - If you have a letter from Student Disability Services requesting academic accommodations, please present this to your instructor on the first day of class.
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**Weekly Outline:** *(Subject to change)*

### Week 1: Introduction / 2D CAD - Solidworks

#### Day 1: Introduction / 2D CAD – Tues 4.2

- Review syllabus, quick introduction and overview, SolidWorks overview
- 2D CAD – sketch format / planes, line types, editing, patterns, smart dimensions, sketch relations / constraints
- Exercise 1: In-class survey, Sketch image import / trace (product)
- + *Assignment - Out: Project #1 - Laser cut project*
- + *Assignment – Out: Order calipers, buy flash drive, locate calculator (due Tues 4.9)*

#### Day 2: Digital tools overview / 2D CAD expanded / 3D basic – Thur 4.4

- Expand on 2D CAD functions, sketch constraints, dimensioning & export for laser cutter, start 3D CAD basic – extrude (and drafted), extrude cut, shell, edit feature (feature tree), additive / subtractive features, approaches / strategies, work flow
- Exercise 2: Box bracket, Ortho view sketch import / trace, basic drawing export for Illustrator
- In-class work session
- + *Assignment - Out: Project #2 – 3D print project*

### Week 2: 3D CAD (basic part / multi-body part) - SolidWorks

#### Day 3: 3D CAD (single part construction & basic drawing) – Tues 4.9

- 3D CAD (continued) – extrude, cut, solid edits (fillets / chamfer), revolve, modify feature (feature tree), basic drawing creation (Legos), basic evaluate (measure), revolve cut
- Exercise 3: Legos reverse engineer , Flash light (model / drawing), vase / planter pot

#### Day 4: 3D CAD (multi-body part construction) – Thur 4.11

- 3D CAD (continued) – combine solids (add / subtract), revolve continued, sweep, dome, move, copy, scale, patterns, mirror, shell, multi-body parts
- Exercise 4: Flashlight (model & drawings), Paper clip, Planter pot w/ handle and base

### **Week 3: 3D CAD (multi-body parts & assemblies) - SolidWorks**

#### **Day 5: 3D CAD (multi-body parts & assemblies) – Tues 4.16**

- 3D CAD (continued) – sweep continued, loft basics, revolve / sweep cuts, assemblies, grip cuts
- Exercise 5: Vase handle continued (sweep), Flashlight continued, (patterns & grip parts), Basic loft part

#### **Day 6: 3D CAD (assemblies & drawings) – Thur 4.18**

- 3D CAD (continued) – revolve review, grip cuts, loft continued, split parts (shelled), assemblies, exploded views, assembly drawing layout, BOM's, part properties
- Exercise 6: Basic loft parts, Coffee cup handle (loft), Cork screw, USB (split & assembly)

### **Week 4: 3D CAD (drawings, analysis, & renderings) – SolidWorks / KeyShot**

#### **Day 7: 3D CAD (drawings & analysis) / Digital Output for .stl – Tues 4.23**

- 3D CAD (continued) – basics of rapid prototyping / applications, preparation and export of CAD files (STL), analysis of parts (surfacing & loft)
- Exercise 7: Loft to point, knife handle
- + *Assignment - Out: Project #3 – CNC cut project*

#### **Day 8: KeyShot (rendering) – Thur 4.25**

- Introduction to KeyShot, interface, import / export, materials, lighting, environments, cameras
- Creating silhouettes in Illustrator / Photoshop, contextual / hero / detail renderings
- Exercise 8: STL – USB export, Cork screw, USB stick continued (door stop, ear buds), Silhouettes

### **Week 5: Physical Output / Intro to CNC / Rhino CAD**

#### **Day 9: CNC Intro / Hand form studies– Tues 4.30**

- Overview of CAM / CNC basics – relationship to design process (lecture)
- Exercise 9: 3 axis demo, form study demo

#### **Day 10: Loft construction / Rhino CAD basics – Thur 5.2**

- Extracting data points from handle grip prototypes & loft construction, rubber grip cuts
- Basic interface, navigation, import, and edit functions in Rhino
- Exercise 10: Handle grip loft layout, Rubber grip cut-out, Object (stack, move, copy, rotate) – Rhino CAD

### **Week 6: Rhino CAM / Digital Output - CNC**

#### **Day 11: Rhino CAM 2.5 & 3 axis – Tues 5.7**

- Introduction to preparing files for Rhino CAM, Rhino CAM functionality and tool paths for 2.5 and 3 axis milling
- Exercise 11: Donut gasket (2.5 axis), Mouse (3 axis)

#### **Day 12: CAD / CAM Catch up – Thur 5.9**

- In-class work session and continued CAM preparation
- Exercise 12: Layout and approach for handle grip Rhino CAM
- + *Assignment - Out: Project Final*

## **Week 7: 3D CAD – Advanced Surfacing (SolidWorks) / 2D Tools – Adobe (Photoshop)**

### **Day 13: Advanced Modeling in SolidWorks – Tues 5.14**

- Surface modeling (extrude revolve, loft, knit), replace face, surface cuts, freeform, projected / intersecting paths, 3D sketches,
- Exercise 13: Eye glasses (3D sketch), Spoon, brush grip, Soap bottle, Cork screw (assembly mates)

### **Day 14: Advanced Modeling in Solidworks– Thur 5.16**

- Surface modeling approaches to solids modeling integration techniques
- Exercise 14: helix, text in SolidWorks, assembly mates, adv. fillet types

## **Week 8: 2D Tools in Rendering + Layout – Adobe (Photoshop, Illustrator, InDesign)**

### **Day 15: Photoshop + KeyShot – Tues 5.21**

- SolidWorks rendering (.tiffs), line work export to Illustrator, Basic overview / functionality / application for CAD renderings
- Exercise 15: Enhancing CAD renderings (shadows, textures, materials, graphics, contextual layouts)
- In-class work session (renderings & final project)

### **Day 16: Illustrator + Photoshop (continued) – Thur 5.23**

- Basic overview / functionality / application
- Exercise 16: Image trace, CAD wireframes, logo, scanned drawing clean-up (Photoshop)
- In-class work session (final project)

## **Week 9: 2D rendering and visual communications**

### **Day 17: InDesign – Tues 5.28**

- Fundamentals of graphics, layout for ID presentation
- Basic overview / functionality / application – poster, presentation, book
- Exercise 15: Poster layout (OLPC laptop),
- In-class work session (final project)

### **Day 18: Final project work day – Thur 5.30**

- In-class work session (final project)

## **Week 10: Final Project Work Week**

### **Day 19: Final project work day – Tues 6.4**

- In-class work session (final project)

### **Day 20: Final project work day – Thur 6.6**

- In-class work session (final project)

## **Week 11: Finals Week**

### **Day 21: Final Project Presentation – Thur 6.11, 10:30-12:20pm**

- Final project presentation, last day of class
- + *Assignment - In: Final projects due (all required final deliverables)*