California State University, Chico
Department of Mechanical and Mechatronic Engineering and Sustainable Manufacturing

SMFG 468 – MANUFACTURING TOOLING (4 Units)
COURSE SYLLABUS – Spring 2018

Lecture: Tuesday 2-4:50pm (LANG 104)
Lab: Thursday 2-4:50pm (PLMS 121)

Instructor: Scott Brogden
Office: PLMS 114B (Office hours M 4-5pm, T 9-10am, W & Th 5-6pm or by appointment)
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Prerequisites: SMFG 218, SMFG 360; SMFG 458 or MGMT 444

Course Objective
Students design, fabricate, test, and evaluate production tooling used in the manufacture or assembly of metal or plastic parts in their capstone projects.

Course Usage of Blackboard Learn
Copies of the course syllabus and major assignments may be found on Blackboard Learn. You are responsible for regularly checking the online resources, which is accessed through the Chico State Portal at http://portal.csuchico.edu. Support materials for the course may be provided via the portal and it is expected that you will either have hardcopies or electronic access to the materials during in-class activities.

Student Learning Objectives
Provide students an overview of the tool and die industry by investigating materials, manufacturing techniques, design, and business practices. Provide students an environment to gain practical experience in equipment operation for tool manufacturing, material selection, and cost justification.

Course Content Learning Outcomes
Upon successful completion of this course, students will be able to:

A. Understand and design various types of production tools designed to increase productivity in a manufacturing environment.
B. Apply and understand material selection and cost justification skills to produce tangible production tooling.
C. Functionally communicate technical information through the use of CAD/CAM.

Required Texts and Materials

Textbook (required)

We will be following the text closely for the entirety of the course so it is imperative that you get a copy as soon as possible. Readings can be found on the Course Schedule in Blackboard Learn. Quiz/exam questions can and will be pulled from the text; it is in your best interest to keep pace with readings.

Highly Recommended:
Machinery’s Handbook 25th edition or newer

Previous course texts for reference

Materials (required)
Calipers (6” or larger)
Safety glasses
Flash drive (backup your data)
Calculator (one that you know how to use, no cell phones)
Laptop Computer with Solidworks Student edition installed

Highly Recommended:
0-1” micrometer

Classroom Protocol
It is expected that students are in-class on time, as the class will start promptly at the scheduled time. Any homework class assignments are due at the start of the class and must be submitted in person at the turn in file that will be located at the front of the classroom.

The use of technology is encouraged for in-class coursework and activities, however extra-curricular activities (phone calls, email, web surfing, etc.,) are not allowed during class. Students violating this policy will be asked to leave, as they are potentially distracting to their colleagues who are engaged in learning.

Safety
A brief training session on lab safety in the Material Removal Laboratory (LANG 120) will be conducted during the first lab meeting. Students are required to read the Department’s Lab Safety Policies and Procedures document and sign an acknowledgment form before conducting laboratory experiments. Safety glasses are required and to be worn at all times in the lab. Failure to do so will result in the student being removed from the lab and being dropped from the class. The student must read,
understand, and follow all safety procedures. If there are any questions about safe
operation the student must talk to the instructor before operating any of the equipment.

Communication
If you need to meet or contact me outside of class hours please attend office hours or
email me.

In the event that I need to contact the class members for matters between class meetings
(schedule, assignment, or class changes, etc.,) it will be done via your university email
account linked to the Portal. University policy requires students to monitor campus email
accounts and it is suggested that you set up email forwarding if you have another
preferred email account.

Dropping and Adding
You are responsible for understanding the policies and procedures about add/drops,
academic renewal, etc. found http://www.csuchico.edu/catalog/. You should be aware of
the new deadlines and penalties for adding and dropping classes.

Assignments and Grading Policy
Assignments are due according to the class schedule and are subject to change depending
on course progress through the semester. Changes to the schedule will be announced
during class or via the communication protocol described above.

Any homework class assignments are due at the start of the class and must be submitted
in person. Late work is not accepted.

Students will be assigned groups for in-class or lab activities. It is critical that all group
members attend class and work on the group or lab work together.

Course Grade Breakdown:

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm Exam</td>
<td>100</td>
</tr>
<tr>
<td>Final Exam</td>
<td>100</td>
</tr>
<tr>
<td>Quizzes, Gear Checks, Lab Activities</td>
<td>200</td>
</tr>
<tr>
<td>Prototype Project</td>
<td>250</td>
</tr>
<tr>
<td>Mfg Process Project (including presentation)</td>
<td>350</td>
</tr>
<tr>
<td>Total</td>
<td>1000</td>
</tr>
</tbody>
</table>

Students are allowed to have 1 page (8.5”x11” Front and Back) of notes for use on any
quiz or exam. Make up quizzes or exams are not allowed unless there was a documented
emergency and a doctor’s note.

Project Descriptions:

1. Prototype Tooling project (individual)

   Each student will complete one prototype project. This project will be an
   individual activity that demonstrates knowledge of some aspect of tooling. The
The goal for this project is to produce a tool (or other device) that would increase productivity and decrease costs when used in a manufacturing environment. This deliverable is simply a prototype, so it should not be overly complex; it is a proof of concept. Example: if you want to make a nested milling fixture, instead of making a 4-sided, 16-cavity tombstone, make a single cavity (and all the hardware that goes with it). It should be noted that this is a capstone course and students will think of and execute their own projects. To save you the cost of printing, you will submit this project electronically (except drawings).

Choosing a Project:

Remember that this is a prototype exercise. Choose a project that meets all of the requirements below, but take care to make sure that you have not signed up for too great a task. I am in no way suggesting that you suppress your creativity, just keep in mind that you will be responsible for completing your project on time.

Deliverables:

Note: For the items below, please report your findings in paragraph form.

1.) Project description:
   A detailed account of the project and all of its features.
   What is the problem?
   What are the project’s requirements? (what does it need to accomplish)

2.) Project Sketches: Visual representation of initial ideas
   What is this thing going to look like?
   Give me some rough dimensions
   Designate the key features (where might datums be? Where are the tight tolerances?)
   Either scan your sketches or take a good picture of them

3.) Solidworks CAD Model
   A complete 3D model of every part of your project (apply a material)
   A complete 3D assembly model of your project with exploded view
   Design for manufacturability built into your model (if it is a milled part, did you radius the internal corners?)
   Did you use mechanical fasteners? They should appear in the assembly.

4.) Technical Drawings:
   Always be as clear as possible
   Use ANSI standards (third-angle projection)
I want a drawing for every part except toolbox items

**Specify material on All part drawings**
Use GD&T and be able to justify it
An assembly drawing (collapsed and exploded views) with completed bill of materials

*Note: your individual project may vary. I give you license to make your drawings as clear as possible. If you need multiple drawings for the same part in different views to preserve clarity, that works*

5.) Material Selection:
   What material or materials are you using?
   Why? Give some justification.
   What were other material choices you considered?
   Where are you sourcing your material?
   What is the cost? (if it is shop material find the lowest price online)

*Note: It is in your best interest to be thinking of material selection from day one. We do have access to some funds for material acquisition, but it will be easier and quicker if you are using common materials that we already have. Some projects will require material to be ordered, but if there is something we already have that does the job just as well, ask to use that material.*

6.) Process Selection:
   What manufacturing processes will you use to produce your project?
   Justify your choice. (Casting may be a good choice. Pieces of your project may need to be ground.)
   Could any other processes be used to make your part? Which ones?

7.) Tool Selection:
   What tools are required to make your project? (be specific)
   Endmills? Drills? HSS or Carbide? Specifications of tools?
   What machines will you use?
   How many operations are required?
   What manual operations will you do? (de-burring? Sanding?)
   If money was no object, what tools would you use?

8.) Purchased Parts Required:
   Did you use any?
   Which ones?
   How many?
   What was the cost? (if they were shop parts find an online price)

9.) What you learned:
   Did you meet your tolerances?
   If not, suggest why
   Conclude your paper with a brief summary
   Tell me what you learned
   What was difficult?
What was easy?

Ideas:

Drill fixtures/jigs
Milling fixtures
Welding fixtures
Assembly fixtures
Soft tooling for thermoforming
Soft tooling for injection/blow molding
Soft tooling for polymer casting
Simple matched plate pattern for sand casting
Soft tooling for composite layup

Turning it in:

As previously mentioned, we are going to do this whole thing digitally (except drawings).
After you have answered all of the questions above, in paragraph form, you will have what is essentially an essay.
You will also have hand sketches (in digital form) and CAD files.
i.) Create a new folder on your flash drive titled your last name.
ii.) Put your essay inside the folder.
iii.) Put all of your solidworks files in this folder as well. (A simple copy and paste should work.)
iv.) Put all of your drawings in the folder in the same manner.
v.) Open your drawings in Solidworks. Save as: PDF and add to folder
vi.) Also include either the scans or photographs of your hand sketches.
vii.) Bring your flash drive, with everything on it, to class on the due date.
viii.) Turn your folder in to me by copying it to the classroom computer desktop.
ix.) Bring your physical prototype project to class and turn it in.
x.) Bring printouts of your drawings to class.

2. Production Tooling Project (collaborative groups 2 or 4 members)

Each team will produce the tooling required for the mass production of a part or parts. This project differs from that of the prototype in that it is a more in-depth exercise designed for students to apply many different skills. It is expected that projects will be more complex, creative, and have larger assemblies than the prototype project. Students will have the entire semester to complete this project with deliverables due along the way. This is the time to apply the skills that you have learned throughout the major. I do not expect you to know how to do
everything yourself on day one. Remember that we are after problem solving skills; if you do not know how to do something, find out where to look for the answer. The nature of our equipment dictates that you will be machining regardless of the end use of your project. I highly recommend that you go back and study your SMFG 360 and SMFG 260 information; it will help. Also keep in mind that your lab time is precious.

Deliverables:

Anytime the project is being worked on, keep track of your hours (excell recommended)

1.) Project description:
   A detailed account of the project and all of its features.
   What is the problem?
   What are the project’s requirements? (what does it need to accomplish)
   Who would the customer be?
   How does your project increase productivity?
   What machine (if any) is your tool designed for?

2.) Project Sketches: Visual representation of initial ideas
   What is this thing going to look like?
   Give me some rough dimensions
   Designate the key features (where might datums be? Where are the tight tolerances?)
   Either scan your sketches or take a good picture of them
   How many parts are there going to be?

3.) Solidworks CAD Model:
   A complete 3D model of every part of your project (apply a material)
   A complete 3D assembly model of your project with exploded view
   Design for manufacturability built into your model (if it is a milled part did you fillet internal corners?)
   Did you use mechanical fasteners? They should appear in the assembly
   Tell me about how the tool functions
   How competent does the operator need to be?
   What kind of ergonomics did you build in?
   Hours spent on CAD

4.) Technical Drawings:
   Always be as clear as possible
   Use ANSI standards (third-angle projection type stuff)
   Develop your own naming standards (you can modify the department nomenclature)
   I want a drawing for every part except toolbox items
   Specify material on All part drawings:
Fully defined part geometry with proper GD&T is critical
An assembly drawing (collapsed and exploded views) with completed bill of materials
Hours spent on drawings
Note: your individual project may vary. I give you license to make your drawings as clear as possible. If you need multiple drawings for the same part in different views to preserve clarity, that works

5.) Material Selection:
What material or materials are you using?
Why? Give some justification.
What were other material choices you considered?
Where are you sourcing your material?
Did you have to condition the material (ex heat treat) tell me about it
What was the cost? (if it is shop material find the lowest price online)
How much does your project weigh in Solidworks?
How much does it weigh in real life?
Hours spent deciding
Note: it is in your best interest to be thinking of material selection from day one. We do have access to some funds for material acquisition, but it will be easier and quicker if you are using common materials that we already have. Some projects will require material to be ordered, but if there is something we already have that does the job just as well, ask to use that material.

6.) Process Selection:
What mfg processes will you use to produce your project?
Justify your choice. (if casting has too poor a surface finish say so, if pieces of your project need to be lapped tell me that)
Could any other mfg process be used to make your part? Which ones?
Hours

7.) Tool Selection:
What tools were required to make your project? (be specific)
Endmills? HSS or Carbide? How many flutes?
Drills?
What machines did you use?
How many operations were required?
What manual operations did you do? (de-burring? Sanding?)
What was cycle time for each CNC part?

8.) Purchased Parts Required:
Did you use any?
Which ones?
How many?
What was the cost? (if they were shop parts find an online price)

9.) What you learned:
Conclude your paper with a brief summary
Tell me what you learned
What was difficult?
What was easy?
Add anything else that sounds cool
How many man-hours total did the project take?

10.) Analysis:
   i.) Assuming that each team member makes $25/1 hour of work, what was the Total labor cost?
   ii.) Assuming that CNC equipment costs are $30/1hour, what was the total machining cost?
   iii.) Your material cost was?
   iv.) Your tool cost was? (use online sources for pricing)
   v.) Calculate Total cost by adding all of the above
   vi.) You will be assigned a sale price for each part your tool would hypothetically produce
   vii.) Break even analysis:
      Assume you as the toolmaker charge 15% markup for the tool you produced. What is the sale price of the tool?
      How many parts does the customer need to produce to break even with the sale price of the tool?

11.) Oral Presentation:
   Your team is required to present its findings to the class
   Length of presentation will be determined by number of teams
   Include a powerpoint with visuals

Ideas:
Complete polymer injection mold (if funding is approved)
Extrusion blow mold
Match plate for sand casting (meeting complexity standards)
Tombstone for machining
Multi-part fixture plate for milling
Composite compression mold
Composite vacuum mold (meeting complexity standards)
Grinding jigs
Modular fixtures
4th axis-rotary fixtures
Welding fixtures

3. Lab Policies

This is a capstone course and as such, lab time is extremely important. Students are expected to be in lab on time and with all required materials. Safety glasses
must be worn at all times in the lab. Random gear checks will take place in lab to ensure that students are prepared to work. There are only 7 desktop computers in Langdon 120 because its primary function is material removal. Students will need their own computers with Solidworks installed to ensure that they have a machine to work on. Also note that lab time is the time for making things. I will have in-lab activities for you to do, but when those are done it is your world. Make sure that you are working on your CAD files and other project materials in your spare time; it is your homework. You will not make it if you only work on your projects during lab time.

University Policies and Campus Resources

Academic integrity
Students are expected to be familiar with the University’s Academic Integrity Policy. Your own commitment to learning, as evidenced by your enrollment at California State University, Chico, and the University’s Academic Integrity Policy requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the Office of Student Judicial Affairs. The policy on academic integrity and other resources related to student conduct can be found at: http://www.csuchico.edu/sjd/integrity.shtml.

Campus Policy in Compliance with the American Disabilities Act
If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Students with disabilities requesting accommodations must register with the DSS Office (Disability Support Services) to establish a record of their disability. Special accommodations for exams require ample notice to the testing office and must be submitted to the instructor well in advance of the exam date.

IT Support Services
Computer labs for student use are located on the first and fourth floor of the Meriam Library, Room 116 and 450, Tehama Hall Room 131, and the Bell Memorial Union (BMU) basement. You can get help using your computer from IT Support Services; contact them through their website, http://www.csuchico.edu/itss. Additional labs may be available to students in your department or college.

Student Services
Student services are designed to assist students in the development of their full academic potential and to motivate them to become self-directed learners. Students can find support for services such as skills assessment, individual or group tutorials, subject advising, learning assistance, summer academic preparation and basic skills development. Student services information can be found at: http://www.csuchico.edu/current-students.
**Americans with Disabilities Act**
If you need course adaptations or accommodations because of a disability or chronic illness, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Please also contact Accessibility Resource Center (ARC) as they are the designated department responsible for approving and coordinating reasonable accommodations and services for students with disabilities. ARC will help you understand your rights and responsibilities under the Americans with Disabilities Act and provide you further assistance with requesting and arranging accommodations.

**Accessibility Resource Center**
http://www.csuchico.edu/arc
530-898-5959
Student Services Center 170
arcdept@csuchico.edu

**Student Learning Center**
The mission of the Student Learning Center (SLC) is to provide services that will assist CSU, Chico students to become independent learners. The SLC prepares and supports students in their college course work by offering a variety of programs and resources to meet student needs. The SLC facilitates the academic transition and retention of students from high schools and community colleges by providing study strategy information, content subject tutoring, and supplemental instruction. The SLC is online at http://www.csuchico.edu/slc. The University Writing Center has been combined with the Student Learning Center.