SSG 511 Computer Aided Design

INSTRUCTOR: OA Fakinlede

webpage: oafak.com

oafak@unilag.edu.ng oafak@Hotmail.com

Department of Systems Engineering,
University of Lagos

Introduction

The syllabus for this course covers the following:

* Graphics process, projective geometry; homogenous coordinates; projective transformation, line drawing; surface modeling and object modeling; reflectance models and rendering, texture mapping; polyhedral representations. Procedural modeling.
* 3D Solid Modeling and Design
* Numerical simulation in Engineering Design, visualization and simulation of engineering systems.
* Packages: AutoDesk Fusion 360, NASTRAN, Comsol Multiphysics, Wolfram Mathematica.

What is Technology?

* Technology is the distinctive mark of the human species.
  * I propose to define technology as *the means by which we have successfully dominated our environment*. Our common experience shows that humanity, no matter how "primitive" or remote, is always at the top of the food chain.
  * It is not a surprise that our summary of the entire history of the world is a tribute to technology:
  * Ice Age, Stone Age, Iron Age, Industrial Revolution, Jet Age, Information Age
  * Our naming scheme of the epochs and times is itself usually a fitting tribute to the technology prevalent in the era.

Epochs & Eras

Technology Products

Stone Age

* The technological essentially based on the implements or instruments made using stone or the ability to use stone to make implements.
* These were for the existential purposes of protection from the elements, from cantankerous neighbors or, offensively, for domination of weaker neighbours.
* This same is largely true for the other epochs;

Bronze, Iron and even the Industrial Revolution to the present time.

Technoloy Instinct

Who Gets the Mango?

* Humans are "*technological*" by instinct and also by natural endowment:
  * The mango up in the tree may be desirable to us and several of our other neighbors.
  * Of course, the birds will get there first because they can fly.
  * The monkeys may follow, because they can climb.
  * The giraffe and elephants may reach it because of the advantage in height or a "fifth" powerful "limb",
  * The bear, though it can climb, may find the tree branch will not support its weight.
* Human Solution:
  * It is the human that will most likely proffer a technological solution of "extending" the limbs by means of a tree branch to make the mango come to meet us without depending too much on innate resources.
  * Such "technological" instinct is in man, every man, no matter how primitive – and that is closely related to his ability to dominate the others.
  * Of course, we follow that action by eventually planting the orchards (agrarian revolution, etc) we can get as many fruits as we want in season and out of season.

Technology; Existential

Technology makes a people dominate other peoples. Kings pay tribute and homage to superior kings.

* This "superiority" is usually in the level of technological superiority that can be brought to bear if a fight were to break out – as it often does, over scarce resources.

The initial drive in each man is to survive. The technological instinct in man created implements that are used for:

* Survival, and then,
* Imposing their will on others (War Making), and then,
* Gaining Trade Superiority in Peace times, and then, where there are no imminent threats or dangers,
* Doing better in Sports and cultural advancement

* History teaches us that each age creates Winners and Losers. The winners are those (Men, Nations and Peoples) who understand the metaphor of the age, apply it to advantage Reap great benefits. The losers are the bystanders who look on while these technological advances and changes are taking place!

Winners & Losers

No Surprise that:

- surprise that the Europeans ruled the world in the 18th to 20th Centuries. In earlier centuries there had been greater civilizations from the Mongols of eastern Asia to the Ming Chinese or the Arabian Moors. The Europeans dominated the world by the mastery over the oceans, use of gunpowder, well established governmental systems, etc.
- Africans were (are?) their slaves. Our most important contact with the foreign cultures of Europe took place in the context of at the end of the Iron Age. The bitter truth to face is that our forebears were the losers in that technological Time Zone. Consequently, when they could not coax us with "gifts" such as gin or looking glass to capture and sell our brothers, they coerced us with their gunpowder to give up sovereignty over our land by signing one sided "protection" treaties, and then went on looting binges.

The world map as we have it today is the result of the military victories and losses of recent centuries.

* Chinese and Indians with their massive populations restricted to their homelands while the smaller European tribes alone rule over continents of America, Australia
* in addition to substantial influence elsewhere?
* In this world, *you don't get what you deserve, but what you negotiate!* Based on population

Technology:

Engineering or Science?

* Webster defines science as "*the state or fact of knowledge*" and "*systematised knowledge derived from observation, study, and experimentation carried on in order to determine the nature or principles of what is being studied*"
* Engineering, as we know it today, is a child of the Industrial Revolution. "*Before that time, the economy was primarily agricultural, transportation was poor, and manufacturing was carried on in the labourers' homes. The invention of the spinning jenny (1763), the water-powered spinning machine (1771), and other mechanical devices gave rise to the factory system and created a need for mechanical power. … The new devices, in turn, required more efficient use of fuels, and more emphasis on factory planning; thus, mechanical engineering was established. Those civil engineers concerned with machines were called mechanical engineers, and as new sciences and skills developed, they became specialists in the new art*" [2]

Technology

* Technology is only known by the products and services it provides for the well-being and advancement of man; or of a people at the expense of other people.
  * It is wrong to think that our people did not have technology. Every people in each epoch, era, time and space had technology.
  * Technology can be primitive, it can be advanced.
  * The British probably did not know about the distillation of alcohol before our forbears. However, their products today benefits from what human beings know about chemistry and they can sell a bottle of theirs for 20,000 Naira while our own is 200 Naira –essentially containing the same chemical products!
* The main vehicle for advancing technology is science.
  * When science is deployed to the advancement of technology, it is called engineering.

Design & Engineering

* Let us first agree that once there are no products of technology, we deceive ourselves by calling ourselves engineers. Nigeria of today, is a land marked by the deficit of technology, of products and of services. Hence we might as well have no engineering.

Can you be sufficiently ambitious to change that?

* What will you tell your children? That you are Engineer Ogunsode and that you have no electricity, You mother had no water supply and you purchased all your gadgets from Germany and you are sending him to England because Nigeria does not have the capacity of educating him?
* You are admitting that there is no technology, no products, no services and that you are a fake engineer!

Fake Products

* To design is to properly specify the way a product should be.
* Engineering training equips you with the theoretical knowledge and the knowhow to design products that will serve their intended purpose.
* What we call fake products are actually products that were not properly designed to provide the services demanded of them; they fail in service and we call them “fake”
* Once again, this is Engineering failure. It is also political failure. A product that has not met requirements ought not to be sold to the public!
* Where are the people (ir)responsible for ensuring public safety? How did those products get through their oversight systems?

How is design taught?

When a course is called "Mechanics of …" you are being given, in that course, the theoretical background to make design decisions.

* The courses that are named "Design" are expected to harvest that knowledge and show you how you make products with them.
* If you have zero theoretical knowledge and get "A" in a design course, you have been trained to be a good welder – not an engineer. The products you will make (if you ever do) are fake products because the theoretical bases of product design was not learned by you!
* Background of Vector Analysis, Mathematics, programming, etc are also part of the panoply of a modern engineer.

Background Needed

To get maximum benefit from this course, You must take the following seriously:

1. Vector & Tensor Analysis.
   * If your Vector Analysis is strong, I can help you with Tensor Analysis. If you are weak, better go to look into the 2-300 level notes or books and bring yourself to currency.
2. Finite Element Analysis
   * We will use packages in this course that are built on Finite Element Numerical computations. Read all you can on this; I will fill in the gaps for the serious student.
3. Strength of Materials, Elasticity, Plasticity
   * I am teaching the course on Mathematical Theory of Elasticity this term; Theory of Plasticity next term. They are optional courses. If you really want to design, they are not so optional. They are compulsory for those who will take projects with me.
4. Two-D technical Drawing.
   * Our Parametric 3-D modeling will assume you understand 2-D sketching and the usual three views of an object.

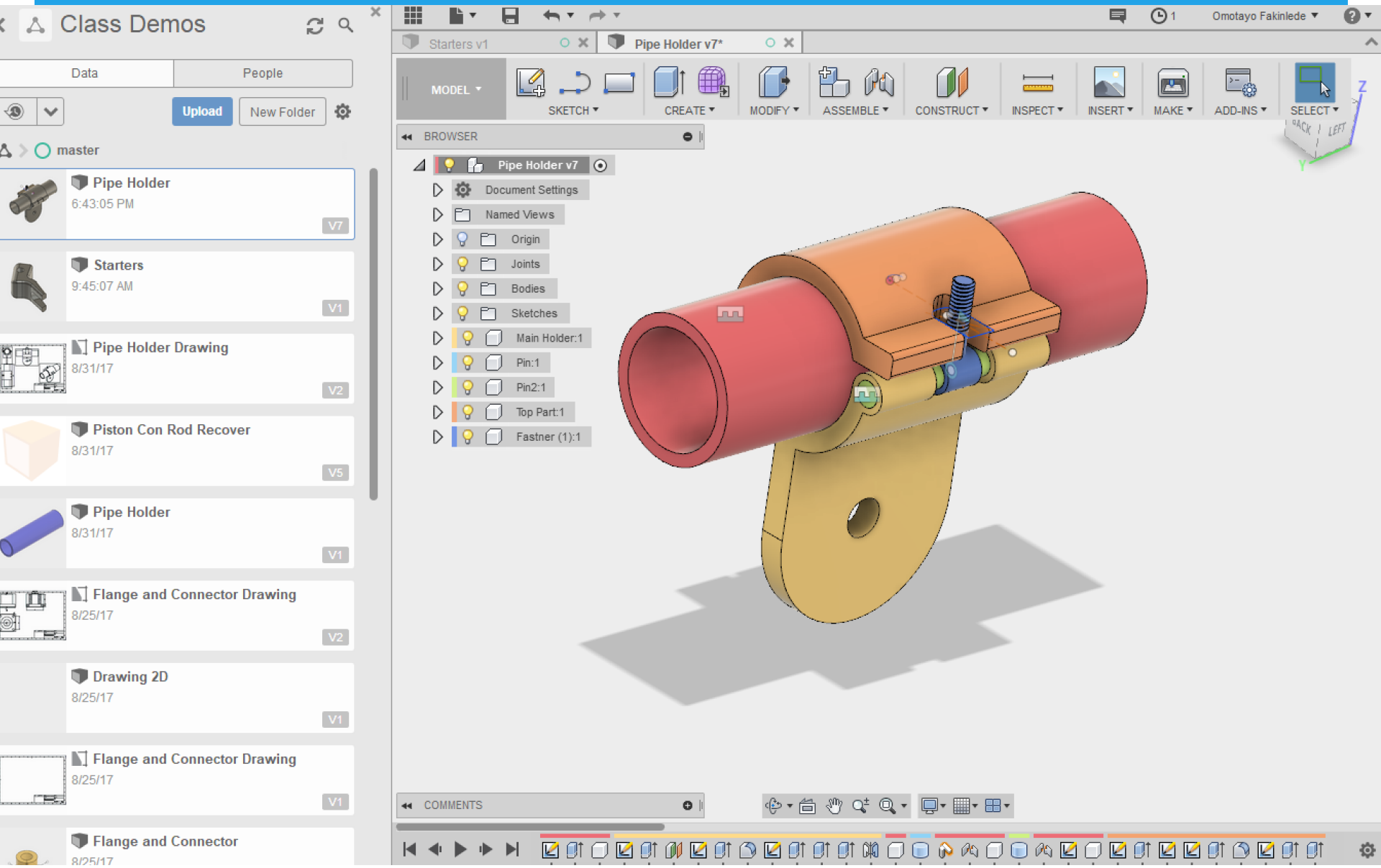
Equipping for MCE 511

* I have arranged that AutoDesk **Fusion 360** with its embedded Finite Element Processor called **NASTRAN** be made available to you. A lot of time will be spent at the beginning to get you up to steam with tgis software.
* It is good to have your own installation of this software and obtain your Three-year license while you are a student. You are also empowered by cloud credits that may be worth more than a thousand dollars free so you can run your models remotely on supercomputers that are capable of handling real-life engineering designs.

Fusion 360 Introduction

* The FIRST thing is to have a clear mind of what you want to design. This can be in the form of a rough sketch on a piece of paper; A set of unambiguous specifications; etc. Don't come empty-handed!
* Fusion 360 presents itself as your geometrical modeling platform in which you create the physical shape of the objects of interest.
* This creation will necessary have to be well orchestrated.

Let us assume that you are interested in creating the pipe holder depicted here:


Class Demos
Data
People
Upload
New Folder
master
Pipe Holder
6:43:05 PM
V7
Starters
9:45:07 AM
V1
Pipe Holder Drawing
8/31/17
V2
Piston Con Rod Recover
8/31/17
V5
Pipe Holder
8/31/17
V1
Flange and Connector Drawing
8/25/17
V2
Drawing 2D
8/25/17
V1
Flange and Connector Drawing
8/25/17
V1
Flange and Connector
Starters v1
Pipe Holder v7*
Omotayo Fakinlede
MODEL
SKETCH
CREATE
MODIFY
ASSEMBLE
CONSTRUCT
INSPECT
INSERT
MAKE
ADD-INS
SELECT
BROWSER
Pipe Holder v7
Document Settings
Named Views
Origin
Joints
Bodies
Sketches
Main Holder:1
Pin:1
Pin2:1
Top Part:1
Fastner (1):1
COMMENTS

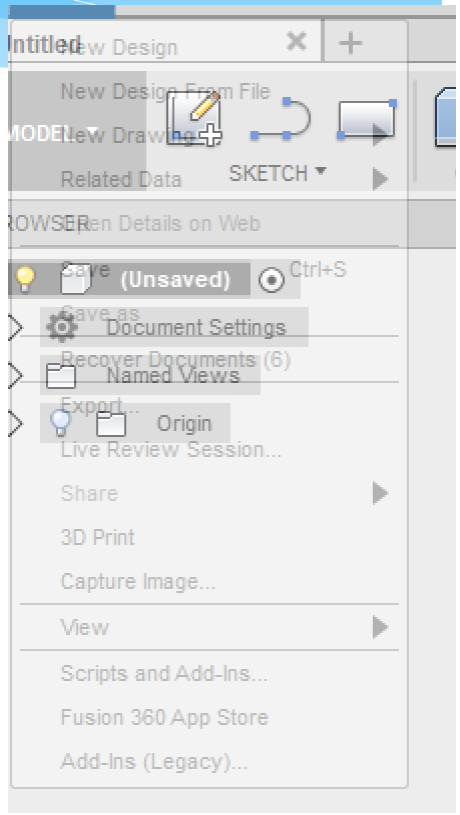
Model Environment

* You will do this in the model environment shown. There are several web videos that introduce this space. Note the different parts.
* We will talk about the following:
  * Data Panel, Menu Bar, Tool Bar
  * Browser Bar, Time Line
* IN the Data Panel, you gain access to all your files and previous work. You also gain access to files that are made available to you by Fusion 360.
* The latter could be in terms of demo projects to help you understand features and how to use them.
* It is easy to minimize the Data Panel as we show:

Menu Bar

* There are 8 items on the Menu Bar: Five to your left, three to your right.
  1. The Data Button (Hide/Reveal the Data Panel)
  2. File Menu: New Design, New Drawing, …, Save Makes the next button redundant – slower
  3. Save Menu: Could have been reached from File
  4. Undo
  5. Redo

  The last two buttons may well be the most important as you will be needing them often as edit your work.



Right Side

* To your right, you will see the following:
  1. Job Status: Are you working online? Simulating in the cloud?
  2. Identification, and
  3. Help System.

  The help system expects you to be online; when you are, you are talking to the help facility where most of your questions can be answered. It appears to be a work-in-progress to me.

Handles

* The next bar contains handles to the projects that are currently opened.
* You can select anyone just the way you would make selections on a regular Windows browser to the webpage you want to focus on.
* For example, if you move to the drawing feature while modeling, you are taken to a new window. You can return to your model window by simply clicking on it.

Tool Bar

* Fusion 360 is full of optional setting that can change the look and feel of the package. While it is tempting to delve into this immediately, it may be prudent to initially let the default settings stand while you examine what it can do. There will be ample time to see the other things you can reset.
* The button showing "Model" is actually your window to the other environments which include:

Patch, Sheet Metal, Render, Animation, Simulation, CAM and Drawing. The other environment, Sculpt, is reachable by the Create Tool.

Design Area

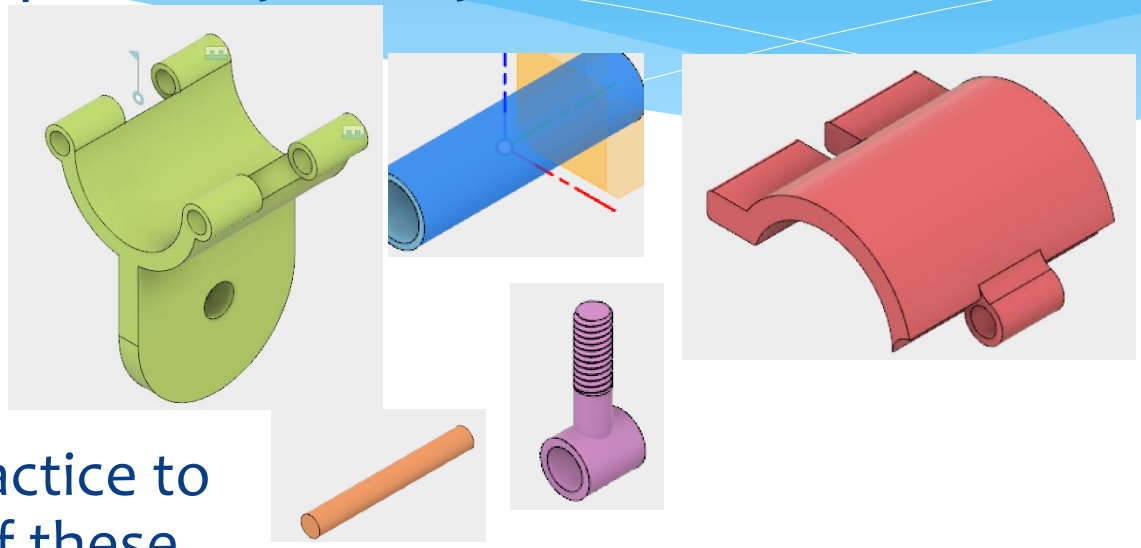
* Inside the Design Area, you have the Browser on your left; and the Home with indicator on the present coordinate view to your right.
* Bottom is your time line – a record of the progress of your work that allows you to:
  * See the individual actions that led to your current state;
  * Move back in time and even rewrite history!

First Things First

* You need to set some basic environmental conditions as they will have immediate effect on all you do. While I am teaching you, here are my preferences:
* Units: mm
  Orientation: Ground is the x-y plane while up is the z-axis. If we all set it this way, it makes instructing you easy. You can change it all when you are on your own.
* Component Oriented Design: You need to identify components in the design you are working on. Let us suppose you want to create the holder earlier shown.

Holder Components

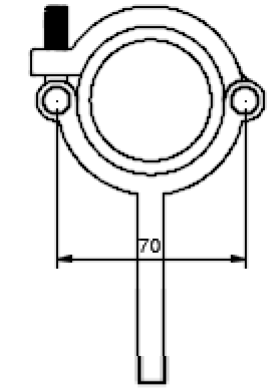
* Here are components you may consider:
* Main Holder
* Pipe
* Top Part
* Pins
* Fastner
* It is good practice to allow each of these to live in their own spaces. In fact, it is good design practice to plan NOT to create EVERYTHING. Fusion 360 actually allows you to visit shops and purchase parts. For our practice, we will simply copy the parts!



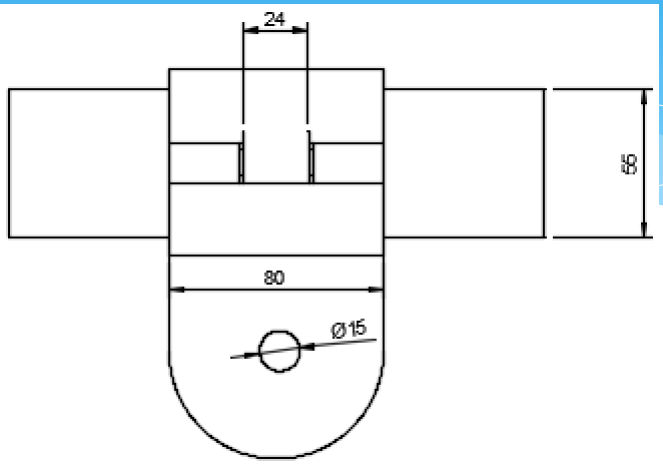
Orientation & View-Point Awareness

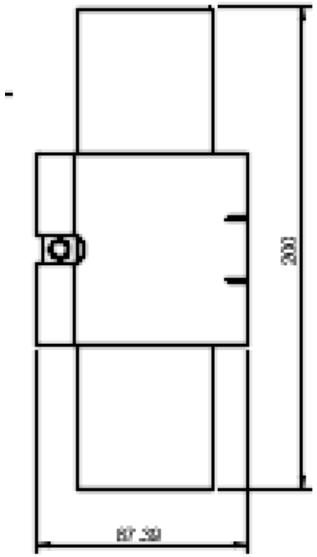
* Each component has its own coordinate system with origins, planes and axes. It is a good practice to capitalize on symmetry whenever they exist. For that reason, it is good, when it is reasonable to do so to begin your drawings around the origin of coordinates.
* Draw things in the actual dimensions. You do not need any scaling.
* Do not compute unless you have to. Use existing parts when possible to select lengths, angles and other constraining relationships. They are good for parametrization.

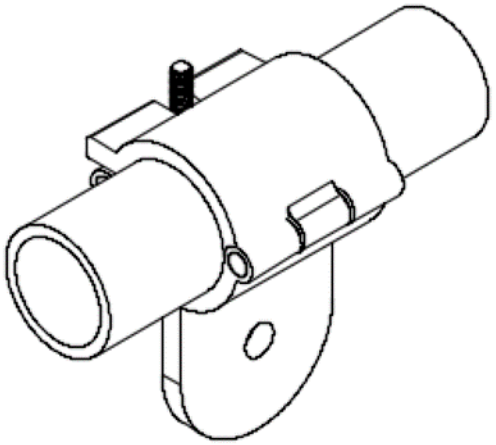
Shop Drawings



Me







2-D Sketching

* Fusion 360 allows you, among other things, to do three dimensional parametric modeling.
* Despite this facility, your 2-D autoCAD experience is NOT wasted at all! In fact, double down on it as you will find that often times, 2-D sketching may in fact have advantages in controlling outcomes when they are available as alternatives. Of course you can do a cylinder or a hole. But note that extruding a circle will achieve the same end.
* In the end, there can be ten different ways of doing the same thing. You will develop your own style by practice. Don't be intimidated by anyone's experience. This software is less than two years old! Nobody has more experience than that. Your leveraging your previous experience in AutoCAD is your secret weapon. Use it!

Get Your Hands Wet!

1. Sketch out in 2-D a tuning fork in plan. Select the x-y plane as your sketch plane;
2. Extrude the fork to the z plane in a symmetrical manner.
3. Must be completed before the next class.