

**Mechanics Segment Handout**  
**AST 351** **Spring 2004**

**1. Background**

You (may or) may not spend much time in a machine shop building parts for an instrument, but the best way to know what can be built and how to tell someone how to build it is to do some machining yourself. In addition, there might not be a machinist available Sunday afternoon, when you have to ship your equipment to Chile the next morning, or when something breaks in the middle of the night at the telescope. Drafting ability is useful not only as a part of making things yourself or getting things made but also because it teaches you how to read mechanical drawings. This is an invaluable skill if you need to estimate costs and schedules or evaluate other people's designs. As someone who "grew up" drafting with pencil and paper it is hard to say this, but AutoCAD is not simply a way to make neater looking drawings and be able to edit them quickly. Using AutoCAD gives you a way to make assembly drawings and to transmit drawings to colleagues and distant shops. In some cases, CNC mills and lathes can work on parts from interpreted AutoCAD files.

**2. Goals**

In this section, you should learn...

- (1) The principles of drafting and of tolerancing parts.
- (2) How to use the basic features of AutoCAD 2000 or AutoCAD LT
- (3) The terms, tools, techniques, and machines used in metalworking
- (4) The essentials of material properties and of fasteners
- (5) Basic machining skills
- (6) Elementary principles of mechanical design

**3. Segment Organization, What to do**

There are three parts to this unit: reading, drafting using AutoCAD, and machining. You will have to do the reading, and preferably the drafting, before doing the shop course, but schedule the shop course right away. You must hand in a hard copy of your drawings, and you must show me what you made in the shop. Your first job is to set up your shop course with Jimmy Welborn. Figure out what blocks of available time your group has in common (Jimmy is most likely to require an 8-hour stint on a Saturday). Go up to see Jimmy in the Astronomy shop, RLM 17.330.

Please be aware that he not only has to deal with his personal constraints but also with the demands of his day job, working on instruments for the McDonald Observatory telescopes.

#### 4. Reading

Books which you may wish to consult include:

Moore, et al., *Building Scientific Apparatus*

Yoder, *Opto-Mechanical Systems Design*

Parts catalogs from Allied Devices, PIC, and Berg. We have a few copies of these catalogs in the classroom. Look them over. They contain some very useful information like tables showing all the different dimensions of different screws. They will probably send you a copy if you ask them nicely. Please don't remove the class copies from the room.

Your specific reading assignment is:

Chapter 1 of Moore, et al.

#### 5. Drawing

AutoCAD is a software package for drafting (mechanical drawing). We have two versions: AutoCAD LT and AutoCAD 2000 (on two of our computers). LT is easier to learn, but if you've seen it before or plan on doing much CADing, 2000 is more capable. AutoCAD is useful mostly for making drawings like you could do more tediously with pencil and paper. There are a lot of options and tools in AutoCAD, and it would take quite a while to learn to use all of them, but you can learn enough to make simple drawings pretty quickly. I recommend the follow sequence (after reading ch. 1 of Moore et al.):

1. Read chapter 1 of the AutoCAD LT User's Guide. Note that we also have a copy of the *AutoCAD LT Quick Reference Guide for Windows*.
2. Go through the online tutorials. You may find that they lead you along a bit too much, so that you don't remember all of it, but you'll see some of the tools.
3. Read chapter 3 of the User's Guide. It is another tutorial, but it puts more emphasis on the kind of drawing we need to do, and you will probably find that it encourages you to think more about what you are doing than the on-line tutorial did. Do the tutorial on the computer as you read.
4. Glance at the rest of the book, so you'll have some idea where to find more information if you need it, play around with the online help, and try out the various icons and menus, to find out what you can do.
5. Make a drawing of one of the items we'll have for the purpose. Check with us first about which item to draw. Draw it using the standard three projections, with dimensions (for which you'll have to measure it with calipers).

6. Print out your drawings and hand them in. Note in the shop course section below that you will also need in to hand in the drawings of the pieces you make in the shop.

If you want to do much drawing you'll have to read all of Parts 1 and 2 (chapters 1-17) of the User's Guide, but you don't need to know everything to make a few simple drawings.

## 6. Shop course

Get together as a group with Jimmy Welborn (RLM 17.330) to pick a schedule to do the shop course. You must do it as a group; we can't ask him to give personalized courses, since his primary job is machining, not teaching. It will take about 8 hours. Depending upon what works best for your group and for Jimmy, this can be in one go or in chunks as small as two hours. Jimmy will tell you what you need to have prepared for the first class. One reminder: Your group should bring the tool chest up to the shop when you go to work with Jimmy and bring it back when you are done. Please remember the bringing back part. Some of the tools will be needed by people in other segment groups.

### 6.1. Drawing Assignment

In the shop course, you will make something on the lathe and something on the milling machine. Before you make the parts, you need to draw them. If you aren't up to speed on AutoCAD by the time the work starts, you can draw them on paper. Be sure to show Jimmy your drawing on the first day you begin to cut metal on each of these parts. He will tell you what day you need to have the drawing ready. Below you will find verbal descriptions of what you must draw. I would like you hand in two drafts of the drawing: The one you make before you learn anything about machining and a corrected version based on what you learn you should have indicated in the drawing but didn't.

/subsectionLathe Part: Cylindrical Aluminum Ziggurat

The part is a cylinder whose diameter stair-steps inward along its length. Viewed end-on from the small diameter end, then, one sees a series of equally spaced concentric circles. The piece is 4 inches long and has a diameter of 1 inch at its widest. This section is one inch long. The next section has a diameter of 0.75 inches and a length of 1 inch as well. The third section has a diameter of 0.5 inches and a length of one inch. The final section has a diameter of 0.25 in. The transitions between the sections are perpendicular to the long axis of the piece. Present two views of the piece in your drawing.

**Mill Part: Drilled block**

The piece is a one inch thick rectangular aluminum block with dimensions 2 inches by 2.5

inches. Along the centerline of the piece going along the 2.5 inch direction, are 4 holes drilled through the thickness of the block. The first hole is 0.25 inches from the edge and is drilled with a #27 drill. The second hole is 0.75 from the same edge and is drilled through with an 11/64 diameter drill. The third hole is 1.25 inches from the original edge and is a #9 hole. The final hole is 1.75 inches from the starting edge and is drilled through with a 1/4 inch drill. Show three views of this piece. Be sure to include the drilled holes in the side view.

## 7. Deliverables

### **Each Student:**

1. Drawing of part we give you.
2. Preliminary drawing of parts to be machined.
3. Final drawing of parts to be machined.
4. Machined parts.

### **Group:**

None.