

# **LAB 1: Mechanical Practices in Experimental Science**

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## **Purpose**

Introduce the student to mechanical practices used in the design and construction of scientific apparatus through exposure to mechanical drafting and the fundamental operations performed in a machine shop

## **Reading Assignment**

Chapter 1: *Building Scientific Apparatus*, 3rd edition, by John Moore, Christopher Davis and Michael Coplan (Perseus Books, Cambridge MA, 2003). Familiarity with the material in Chapter 2 is useful for future reference.

## **Background**

The experimental scientist must routinely design and construct scientific apparatus in order to conduct research. Typically, advanced undergraduate and graduate students in the sciences have had an introductory electronics class. Often, however, students are not introduced to the mechanical aspects of the designing and constructing scientific apparatus until after they begin their graduate research. The student's research career is greatly facilitated if they acquire the proper foundations in these mechanical practices as an undergraduate.

The mechanical aspects of building scientific apparatus involve conceptualizing the requirement, producing a mechanical drawing that defines the apparatus to fulfill that requirement, and fabricating the apparatus to the necessary specifications. As an advanced undergraduate or graduate student you will often be required to accomplish all of these tasks. As a practicing scientist, most often you will perform tasks one and two and submit task three to a professional machine shop. In either case, understanding the basic principles behind metal working, glass blowing, and materials joining will aid you in making mechanical drawings to communicate your needs and designing apparatus to fulfill these needs.

## **Mechanical Drawing**

The book, *Building Scientific Apparatus*, describes the basics of mechanical drawing. More complete treatments<sup>1</sup> can be consulted as your skill levels and needs grow. Typically, modern mechanical drawing is done with the aid of computer programs, referred to a Computer-Aided Drafting (CAD) programs, developed specifically for this task. The limited drawing required for this module will only require pencil, graph paper, a scale, a right triangle, and a compass.

Make a drawing of a 1/2-13 hex head bolt 2.5 inches long and a 1/2-13 slotted nut. Include a hole in the bolt, 0.40" from the beginning of the threads for a 5/32 cotter pin to lock the nut in place. Refer to the *Machinery's Handbook*<sup>2</sup> on reserve in the library for the necessary dimensions of the bolt, nut, and cotter pin. Complete this drawing and have your instructor check it by no later than the beginning of the 3<sup>rd</sup> class period.

## Shop Safety

The 2<sup>nd</sup> class session on will be spent will be spent in the shop actually applying some of the fabrication techniques about which you have been reading. Of utmost importance is you safety in the shop. While you are working in the shop it is REQUIRED that you:

- 1) Wear safety glasses at all times.
- 2) Wear long pants.
- 3) Do not wear sandals or jewelry.
- 4) Roll up long sleeves past the elbows and tie back long hair.
- 5) Keep you work area neat and organized.

If you have a question it is much better to ask the shop personnel for help than proceed with an operation with which you are unfamiliar. Lastly remember that SAFETY GLASSES MUST BE WORN AT ALL TIMES when you are in the shop.

## Machine Shop Practices

After having some exposure to the theory of machine tool practices, as presented in your text, it is best to continue learning by experience. For the second class period you will go to the machine shop and be introduced to the most basic equipment by one of the machinists. Under the machinist's supervision, you will then use the band saw, hand file, and drill press to make the part shown in the attached drawing.

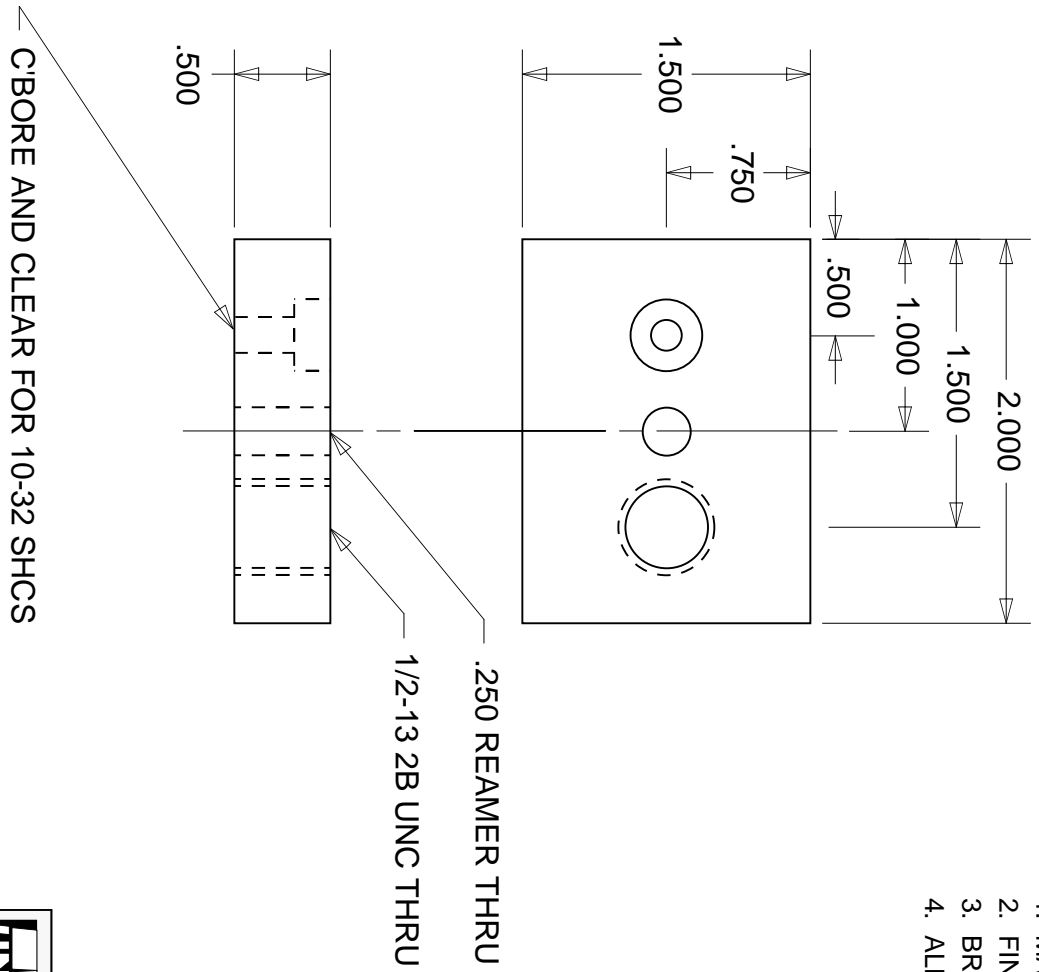
Your next machining exercise will begin in the 3<sup>rd</sup> lab period in which, again under the supervision of a machinist, you will begin to make the 1/2" slotted nut and bolt drawn for in your mechanical drafting exercise. Making these parts will require you will carry out many of the most important operations done in the machine shop using the lathe and milling machine; the machines on which the majority of the work in a machine shop is performed. Completion of the nut and bolt will require most of the remainder of this laboratory module. During this time basic joining processes such as soldering and welding will be demonstrated so that you are also familiar with these techniques.

Submit your completed nut and bolt to the course instructor for examination. If the parts are within tolerance you will have just completed your introduction to mechanical practices in experimental science.

## REFERENCES

- 1) *Technical Drawing*, by F. E. Giesecke et al., 12<sup>th</sup> edition (Prentice Hall, 2002) ISBN: 0130081833. {This is an updated version of a book that has been a classic in the area for 60 years}
- 2) *Machinery's Handbook* by Erik Oberg et al, 26<sup>th</sup> edition (Industrial Press, 2000) ISBN: 0831126663 (CD ROM and Cloth). {This book has a wealth of information and is a standard reference in the metal working industry}

- NOTES:
1. MATERIAL: AI 6061-T6.
  2. FINISH: #32 OR BETTER, ALL OVER (NO SCRATCHES).
  3. BREAK EDGES AND CORNERS .005 MIN. R (SMOOTH).
  4. ALL DIMENSIONS ±.025 UNLESS NOTED.



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TITLE: LAYOUT AND DRILL PRESS EXERCISE

Prepared By: PRS      Dwg #: SENIOR LAB 01-03

Approved By:              Size: ANSI A      Rev: A

Scale: 1/1      Date: 11/15/02      Sheet: 1 OF 1