

LAB 1: Mechanical Practices in Experimental Science

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.

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* [1], describes the basics of mechanical drawing. More complete treatments can be consulted as your skill levels and needs grow [2-3]. Typically, modern mechanical drawing is done with the aid of computer programs, referred to as 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. Follow the instructions of your shop teacher for submission of your drawing.

Shop Safety

The 2nd class session will be spent in the shop actually applying some of the fabrication techniques about which you have been reading. Of utmost importance is your 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 your 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. During this lab rotation, 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 machine and construct a pre-determined piece. Making these parts will require that you 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 piece will require the remainder of this laboratory module. During this time basic joining processes such as soldering and welding may also be demonstrated so that you are familiar with these techniques. Submit your completed piece 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] *Building Scientific Apparatus*, 3rd edition, by John Moore, Christopher Davis and Michael Coplan (Perseus Books, Cambridge MA, 2003).

[2] *Technical Drawing*, by F. E. Giesecke et al., 12th 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}

[3] *Machinery's Handbook* by Erik Oberg et al, 26th 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}

This document is a modification of 'LAB 1: Mechanical Practices in Experimental Science' by Paul R. Schwoebel and Tony Babbaro (LASSP Shop, Cornell University)