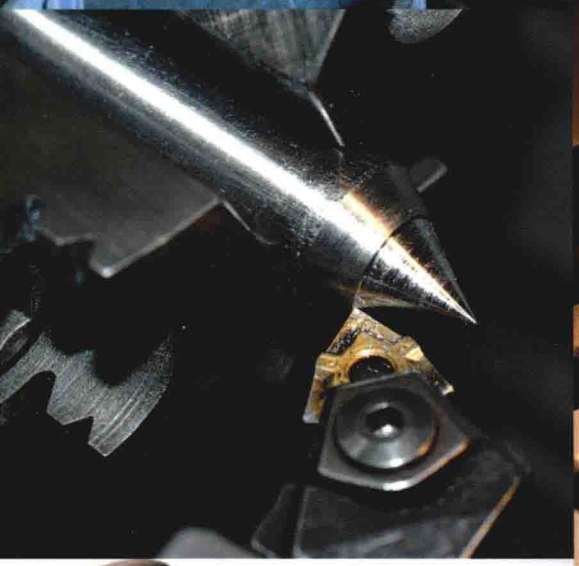
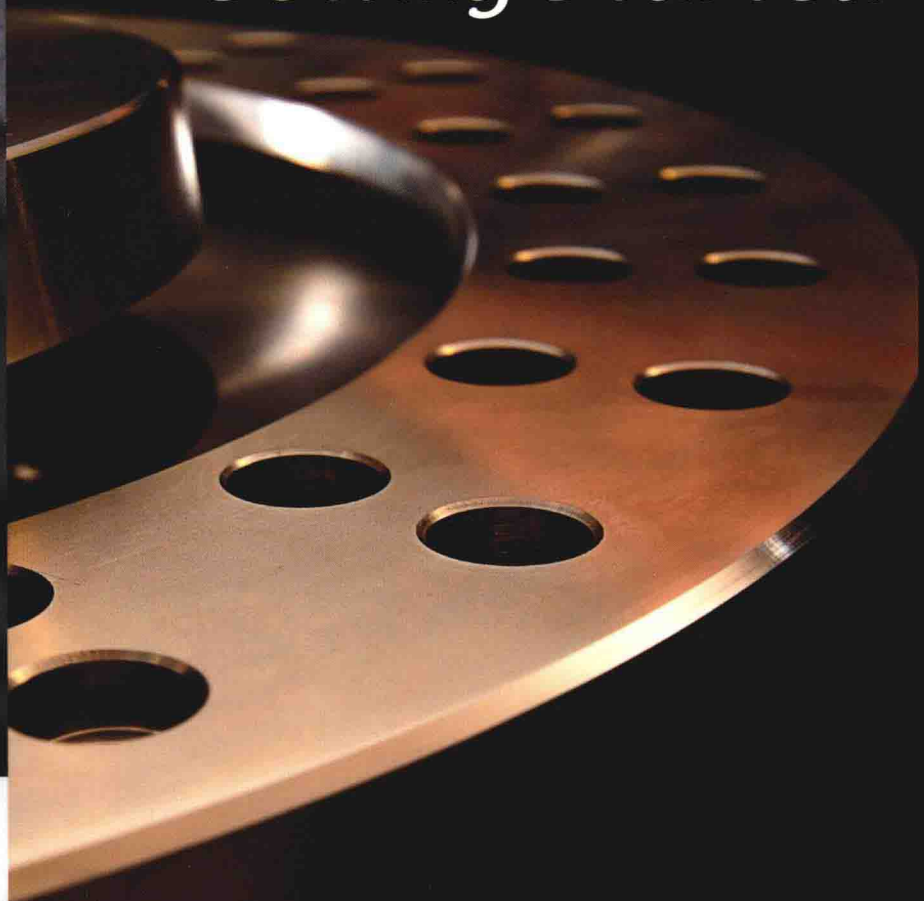


MACHINING for HOBBYISTS

Getting Started



KARL H. MOLTRECHT

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with
Fran J. Donegan, *Developmental Editor*

Foreword by
George Bulliss, *Editor, The Home Shop Machinist*

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FOREWORD

By George Bulliss, Editor
The Home Shop Machinist

My day job allows me the opportunity to talk with newcomers to the machining hobby on a regular basis, many with questions about how to get started. Unlike most other hobbies, in metalworking, and in machining in particular, it can be tough to find fellow hobbyists. For those living beyond large urban areas the learning process is typically a solitary journey.

This lonely path often starts on the Internet, where the sheer bulk of information can overwhelm and confuse. Not to mention, the Internet comes with no guarantee of accuracy; so-called old wives' tales abound, and the beginner, unable to sort fact from myth, can easily head down the wrong, frustrating path.

Fortunately for those jumping into this hobby, there is a long list of quality books that can help. However, this is not without its pitfalls. For a hobby that dates back to the beginnings of the Industrial Revolution, numerous titles have been published, making the choice extremely tough.

So what does the beginner need? First, you must get a handle on the basics and make sense of common terms and techniques. Without knowing the lingo and the various tools and equipment used in machining, learning the ropes will be difficult at best.

Mastering terms and techniques is only part of the story; sooner or later one must turn on a machine and cut some metal. It's at this point that beginners discover machining metal requires knowledge of cutting parameters if they hope to avoid damaging tools and destroying workpieces.

For anyone with woodworking experience, the fussy nature of cutting metal may come as a bit of a surprise. Drilling a hole in wood is straightforward: select the drill, turn the drill press on, and run the drill through the board on your mark, with acceptable results pretty much certain.

For the machinist it's not that easy, even for something as simple as making a hole. Marking your location accurately enough for most machined components will take more than just a tape measure and a pencil. Picking the right sized drill is easy enough, but will it actually drill the correct size hole – or even make a hole? With the right cutter geometry and drill speed, making a hole in metal is an easy task, but it quickly gets expensive when you try to guess!

When I first heard of this book I was excited by its mix of material. Finding basic machining information to answer the beginner's questions and the technical information needed to actually cut metal in one book is something of a rarity. With this book's publication I finally have an answer for that oft-asked question, "What book do I need to get started?"

Thinking about taking the plunge into machining? You'll find this book makes the perfect foundation for your shop library, and the mix of information and reference material will keep it relevant and useful for years to come.

INTRODUCTION

The heart of any machine shop is the relationship the machinist has with the tools and equipment that keep the shop humming along. That's true whether it's an industrial shop turning out parts for jet engines, or a basement or garage setup for home hobbyists.

Machining for Hobbyists: Getting Started is intended for the latter group. It examines the tools and materials home machinists use to create their own projects, reinforcing the relationship between the person and the machine. It lays the groundwork for novices and even some experienced machinists to grow in their craft. Add practice and dedication, and the inexperienced user becomes an expert.

Machining metal requires specialized tools, to which this book devotes several chapters. Chapter 2, "Measuring Tools", deals with the array of tools used by home machinists to take measurements and lay out their projects. This includes everything from plain steel rulers to the various types of calipers and micrometers. There are also tips on how to use these measuring devices.

Chapters devoted to lathes, mills, and drill presses will help the novice get started in assembling the necessary tools and equipment for their projects. These tools were chosen for this book because they come in smaller bench-top sizes that make the most sense for the home machinist. You will find descriptions of the tools and their components and tips on using the equipment.

To complement the material in this book, the editors have added six articles reprinted from *The Home Shop Machinist*, a bimonthly publication geared to machinists of all levels of experience. The articles were written and photographed by two of the magazine's regular contributors and provide expert additional information on some of the tools and processes covered in the book.

Machining for Hobbyists covers manual lathes, mills, and other equipment; it does not discuss CNC machines, which are computer controlled. CNC tools have largely taken over the industrial machining industry, but for the hobbyist, learning how to measure the work, operate the tools, and solve problems by hand is still the best way to learn the craft.

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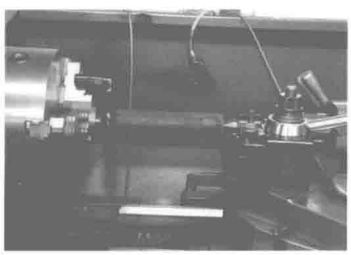

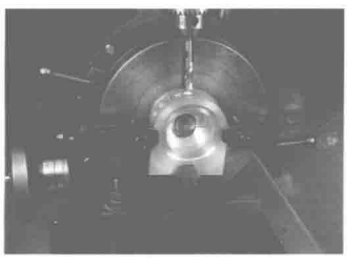

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1 Machine Shop Overview

The ability to machine metal to produce precisely engineered parts is the driving force behind large-scale manufacturing. Fortunately, the knowledge that went into producing large industrial machines is available to home hobbyists who want to build scale models of full-size items or create their own products made from metal. This book covers the selection and use of home shop-size equipment. While there are a variety of tools and equipment to choose from, *Machining for the Hobbyist* will cover the most popular, which are the tools and machines available in benchtop or home-shop size.

Machine Tools

The general term "machine tool," includes various classes of power driven metal cutting machines. Most machine tools change the shape of a material by producing chips. Machine tools serve four main purposes:

1. They hold the work or the part to be cut.
2. They hold the tools that do the cutting.
3. They provide movement of either the work or the cutting tool.
4. They are designed to regulate the cutting speed and also the feeding movement between the tool and the work.

In the production of machine parts of various shapes and sizes, the type of machine and cutting tool used will depend upon the nature of the metal-cutting operation, the character of the work, and, possibly, other factors such as the number of parts required and the degree of accuracy to which the part must he made. The development of machine tools has been largely an evolutionary process, as they have been designed to produce parts meeting increasingly stringent mechanical standards. Developments in power transmission, accuracy, and control of the movements and functions of the machine are constantly being incorporated into the design of new machine tools.

Machine tools turn metal into a variety of shapes, including cylindrical and conical surfaces, holes, plane surfaces, irregular contours, gear teeth, etc., as shown in Figure 1-1. Many machines, however, can produce a variety of surfaces. Thus, machine tools are built as general purpose machines, high production machines, and as special purpose machines. As the name implies, general

purpose machine tools are designed to be quickly and easily adapted to a large variety of operations on many different kinds of parts, such as the type of projects a home hobbyist might tackle. Production machine tools are designed to perform an operation, or a sequence of operations, in a repetitive manner in order to achieve a rapid output of machined parts at minimum cost. Special purpose machine tools are designed to perform one operation, or a sequence of operations, repetitively, on a specific part. These machines are usually automatic and are unattended except when it is necessary to change and to adjust the cutting tools. They are used in mass-production shops such as are found in the automotive industry. CNC, or computer numerical controlled machines, are computer-aided machines. They are mainly used in high-production processes, but small machines used by the home hobbyist can also be CNC machines. See Figure 1-2.

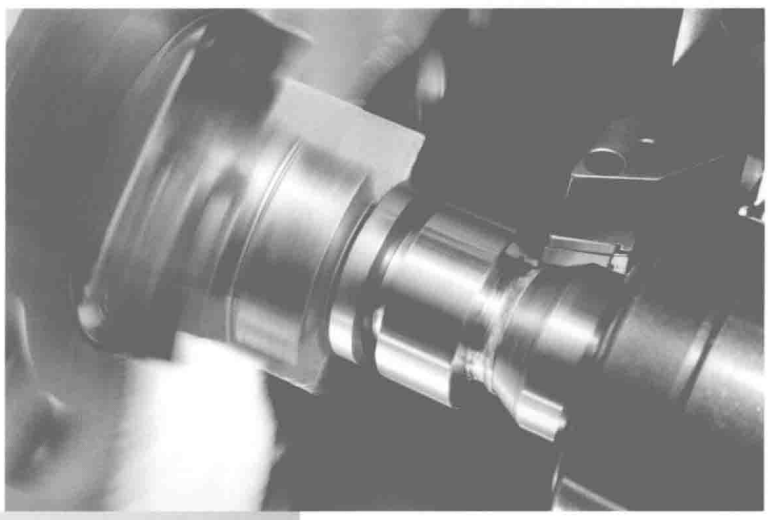

Figure 1-1
An example of a machine tool creating a cylindrical shape from a metal bar.

Figure 1-2
A CNC benchtop mill.
Photo courtesy of Sherline.

Metal Cutting Tools

The heart of a shop machine is its metal cutting component—the metal cutting tool. Metal cutting tools separate chips from the workpiece in order to cut the part to the desired shape and size. There are a variety of metal cutting tools, each of which is designed to perform a particular job or a group of metal cutting operations in an efficient manner. For example, a twist drill is designed to drill a hole having a particular size, while a turning tool might be used to turn a variety of cylindrical shapes. In order to sever a chip from the workpiece the following conditions must be present:

1. The tool is harder than the metal to be cut.
2. The tool is shaped so that its cutting edge can penetrate the work.
3. The tool is strong and rigid enough to resist the cutting forces.
4. There must be movement of either the work or the cutting tool to make the cutting action possible.

Modern metal cutting tools are made from tool steels, powdered metals, ceramics, and industrial diamonds. These materials can be made to be very hard, and they can retain their hardness at the high temperatures resulting from the metal cutting action. All metal cutting tools wear as the result of stresses and temperatures encountered in separating the chips. The rate-of-wear must be controlled by the application of the correct cutting speed and feed. After wear has progressed to certain limits, the cutting edge may be resharpened by grinding. Ultimately, further sharpening is not practical and the tool must be discarded.

Figure 1-3 A drill boring into a metal surface.

Figure 1-4
An abrasive wheel used for tool sharpening.

There are three basic types of metal cutting tools: single-point tools, multiple-point tools, and abrasives. These names are quite descriptive. A single-point metal cutting tool has a single cutting edge and is used for turning, boring, and shaping. Multiple-point tools have two or more cutting edges such as drills, reamers, and milling cutters. See Figure 1-3. Grinding wheels are an example of abrasive cutting tools, shown in Figure 1-4. Each grinding wheel has thousands of embedded abrasive particles which are capable of penetrating the workpiece and removing a tiny chip. The combined total of the tiny grinding chips can result in a substantial amount of metal being removed from the workpiece.

Planning the Home Workshop

There are many elements that determine the makeup of a home machine shop. They include the available space, budget, and the types of projects that will be completed in the shop. Because machines are the heart of any machine shop, *Machining for the Hobbyist* will examine the principal pieces of equipment that the home hobbyist may use—brief descriptions appear below with more detailed information about each piece appearing later in the book. Use this information as starting points to design and assemble your home shop.

Lathes

Lathes are machines that turn a workpiece while a stationary cutting tool removes metal from the work. See Figure 1-5. The action of the lathe allows the hobbyist to shape metal into

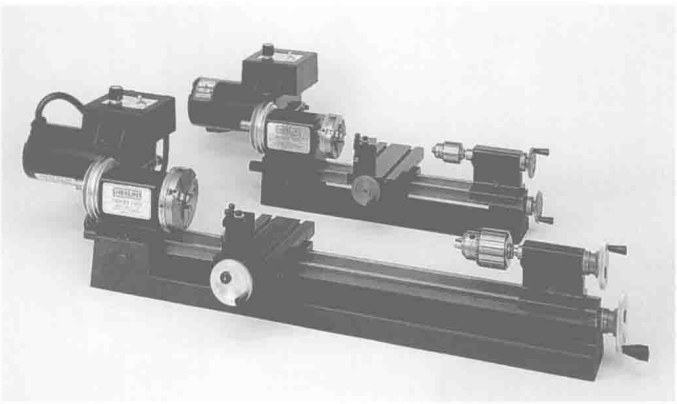

Figure 1-5 Benchtop lathes of different sizes.
Photo courtesy of Sherline

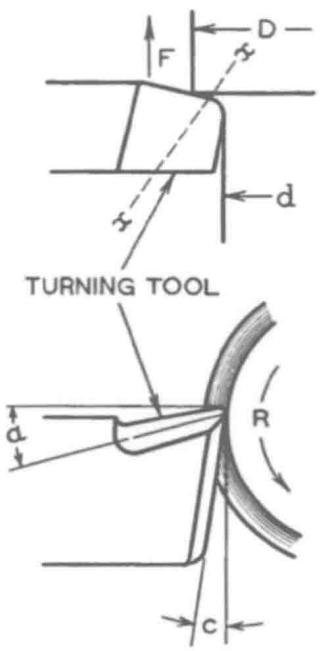

Fig. 1-6 Principles of turning and planing.