

MACHINE TOOL WORK

FUNDAMENTAL PRINCIPLES

BY

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MACHINE TOOL WORK

PREFACE

The course of instruction in machine tool work given at Purdue University has been administered in a series of lectures, interspersed with laboratory demonstrations. Brief outlines of the lectures, together with detailed instructions for solving or making the different problems, have been printed and made available for student use. With the development and growth of the course came the necessity for a complete revision of the printed instructions. This revision has been made and is here presented.

The purpose of this work is to offer a systematic course of instruction in the fundamental principles of machine tool work—a course that may be followed by students or by individuals and one that will help them to discover and understand some of those basic principles upon which the present highly specialized art of machine tool work is founded.

One of the great problems in machine tool work is how to machine successfully any one piece of work. The solution of this problem involves a very careful study and analysis of each of the following detailed problems: (1) how to *hold the work* securely in the machine; (2) how to *set* and to *hold the cutting tools* in correct relation to the work; (3) how to give *correct shape* to the cutting tools; and (4) how to determine the *cutting speed* and *feed* to use for the cutting tool. These are fundamental problems that are common to all kinds of machine tool work. This book has been prepared for the purpose of helping to analyze and to solve some of these detailed problems.

In the study of these problems, standard types of machines are used, such as the lathe, planer, shaper, milling machine, drilling machine, and grinding machine. No attempt has been made to describe the design or the method of operating the more complicated and intricate automatic or single-purpose machines, since the successful performance of any one of these highly developed machines depends very largely upon the observance of the fundamental principles that are taught by the use of the simpler types.

The methods for making any one of the many problems may not always appear to the expert to be the quickest or even the best method, it being quite obvious that there are many other methods that might be used to accomplish the same end; however, the methods described illustrate correct principles, and they have been proved, after many years of trial, to be the safest and the best for the beginner to use.

Acknowledgment is here made of the kindness of the following manufacturers who have furnished illustrations and information that have been helpful in preparing this work: Brown & Sharpe Manufacturing Company, Pratt and Whitney Company, The Warner and Swasey Company, South Bend Lathe Works, The Cincinnati Milling Machine Company, Lucas Machine Tool Company, The American Tool Works Company, The Cincinnati Bickford Tool Company, Abrasive Machine Tool Company, Gardner Machine Company, The G. A. Gray Company, Kearney and Trecker Corporation, and others.

WILLIAM P. TURNER.

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TO THE STUDENT

This book has been written for the purpose of helping you to catch a vision of shop methods, to help you to understand better some of the principles of machine tool work, thereby enabling you to do your work more quickly and accurately, and to help you to experience that thrill of joy that comes to one who does his work well.

Before you begin any new job, there are certain things that you should know. It is much like starting on an automobile tour through a strange land. You first decide *where* you are going; then *how* you will go; *which* roads are the safest and best; what *preparation* is necessary for the trip; and many minor details. In a similar way should you plan for your new work. *What* are you making? *What* are the requirements for a perfect job? *How* may it be made? *Which* way do you choose for making it? In other words, plan your trip carefully; analyze your job carefully.

Job Analysis.—When making an analysis of any job, one should carefully consider the following points: (1) the specifications or requirements for the finished piece; (2) the machine available and suitable for doing the work; (3) the tools to be used; (4) the method of holding the work on the machine; (5) the proper speeds and feeds to use; and (6) the sequence of operations in their logical order.

The specifications tell you the things that are *required* in the finished piece. The discussion will bring to your attention some *new* and *fundamental principle* that you will discover and remember, as you might remember places of interest on a touring trip. The analysis is made to determine the *best* way to do the job. There may be a number of ways, as there might be a number of roads leading to the end of your automobile journey, but some one way may be found to be better than any of the other ways.

With your first job, do as you would do on your first trip over a strange road: *follow* the *directions* given.

In the following problems, the analysis and the directions are given by one who has been over the road many times. He has seen many failures and many wrecks caused by carelessness and by failure to heed warnings or by not following the directions. Follow the directions carefully, and you will surely attain success.

CONTENTS

	PAGE
PREFACE.	v
TO THE STUDENT.	xiii
CHAPTER I	
GENERAL SHOP INSTRUCTIONS	1
Safety in the Shop—Shop Organization and Regulations: Tool-room Service—Job Cards—Student's Work Record Card—Care of Machine Tools—Neatness and Orderliness—Oily Waste—Inspection of Machines and Reports: Inspection—The Speed of a Machine—The Feed of a Machine—Inspection Report.	
CHAPTER II	
TOOL SHAPES FOR CUTTING METAL	9
Standard Shapes—The Name of a Lathe Tool—The Shape of the Cutting Part—Clearance—Effective Top Rake—Effective Cutting Angle—Keenness—Planer and Shaper Tools—Boring Tools—Reamers—Milling Cutters—Best Shape of Tool—General Statement—Stellite Tools—Tungsten Carbide Tools.	
CHAPTER III	
CUTTING SPEEDS AND FEEDS	18
Speed—Cutting Speed—To Find the Cutting Speed—Limit for Cutting Speed—Feed—Estimating Time—Use of Lubricants and Coolants.	
CHAPTER IV	
METALS COMMONLY USED IN MACHINE TOOL WORK.	24
Cast Iron—Malleable Iron—Steel Casting—Wrought Iron—Steel—Alloy Steel—S.A.E. Steel—Tool Steel—High-speed or Tungsten Steel—Cold-rolled Steel—Screw Stock—Drill Rods—Brass—Bronze—Temper of Brass—Annealing Brass—Aluminum—Duralumin—Stellite—Tungsten Carbide—Babbitt Metal—Marking Steel Bars—Questions on Chapters I to IV.	
CHAPTER V	
THE LATHE AND LATHE WORK	35
Cylindrical Turning: The Lathe—Types of Lathe—Principal Parts of a Lathe—Tool Rests—The Size of a Lathe—Lathe Centers	

—Truing Lathe Centers—When Lathe Cuts Do Not Meet Concentrically—When the Work Is Tapered—Turning a Cylinder—Cleaning and Inspecting Stock—Measuring—Centering—Locating Position for Center Holes—Drilling Center Holes—Centering Machines—Mounting the Work on a Lathe—Squaring the Ends—Tool for Cutting on Ends—Setting the Tool—Speed of the Lathe—First Roughing Cuts—Finishing Cuts—Measuring the Length—Inspecting the Center Holes—Turning Diameters—The Tool—Setting the Tool—Starting the Cut—How to Adjust a Tool to Turn a Desired Diameter—Finishing Cuts—Measuring the Diameter—Setting Calipers—Final Inspection—Time—Turning Steel: Shape of Tools—Tool-holder Bits—Cutting Speed for Steel—Use of Coolants or Lubricants—Caution—Turning Two Steel Shafts—Center Drilling—Squaring the Ends—Side Tool—Step Method of Squaring Ends—Rough Turning the Diameters—Good Practice—Finish Turning Diameters—Measuring—Using Micrometer Calipers—Reading Micrometers—Finishing Corners—Square or Rounded Corners?—Turning a Steel Shaft: Centering—Squaring the Ends—Turning to Diameters—Cutting the Notch—Measuring—Questions.

CHAPTER VI

TAPERS AND TAPER TURNING 66

Uses for Tapers—External and Internal Tapers—Expressing Taper—Standard Tapers—Methods of Turning Tapers—The Set-over Method—The Taper Attachment—The Compound Rest—Special Taper-turning Lathes—Making Internal Tapers—Turning a Taper: The Gauge—Preparing the Stock—Cutting the "Spots"—To "Set over" the Dead Center—The Caliper Tool—The Tool—Setting the Tool—Roughing Cuts—Testing the Taper—Finishing the Taper—Finishing the Corner—Questions.

CHAPTER VII

BORING AND FACING 78

Boring on the Lathe: Holding the Work to Be Bored—Lathe Chucks—Face Plate and Clamps—Accuracy in Setting Work—Test Indicators for Setting Work—Tapered Holes—Using a Boring Bar—Types of Boring Machines—Tools for Boring—Chucking Reamers—Rose Reamers—Fluted Reamers—Adjustable Reamers—Boring a Collar for a Shaft—Putting a Chuck on the Lathe—To Remove a Chuck—Chucking the Work—Facing—Boring—Setting the Tool—First Roughing Cuts—Finishing Cuts—Measuring—Final Testing—Putting the Work on a Mandrel—Turning the Diameter—Facing the Side of the Collar—Rounding the Corner—Use an Old Mandrel—Filing—Polishing—Drilling and Tapping—Boring a Sleeve Bushing: Chucking and Facing—Boring—Spot Boring—Holding the Reamers—Using the Rose

Reamer—Using the Fluted Reamer—Finishing the Outside—
Questions.

CHAPTER VIII

KINDS OF FITS AND FITTING 104

Interchangeability—Allowance—The Amount of Allowance—
Names of Fits—Working or Running Fit—Snug or Wringing
Fit—Driving Fit—Forced or Pressed Fit—Shrinking Fit—Allow-
ance and Tolerance—Preparing Fitted Surfaces—Cylindrical
Fitting: Inspecting and Measuring the Bore—Turning to Diame-
ter—To Square the Shoulder—Filing—Marking for Fitting—
Questions.

CHAPTER IX

SCREWS AND SCREW THREADS. 115

Uses for Screw Threads—Standard Screw Threads—The National
Standard (American) Screw Thread—Names of Parts of a Screw
Thread—Forms of Screw Thread—A Single-threaded Screw—A
Multiple-threaded Screw—Right-hand or Left-hand Threads—Pipe
Threads—Screw Threads for Fire Hose—Measuring Screw
Threads—Screw-thread Gauges—Three-wire Method of Measuring
Screw Threads—Pitch and Lead—Accuracy of Shape of Threads—
Cutting Threads with a Die—Milling Screw Threads—Rolling
Screw Threads—Cutting Screw Threads on a Lathe—Gearing the
Lathe—Simple Gearing—Gearing a Quick-change-gear Lathe—
Threading Tools—Setting the Threading Tool—Setting the Tool
Stop—Cutting the Left-hand Thread—Using the Thread Dial—
Computing the Size of the Gears to Cut a Desired Lead—Simple
Gearing—To Cut a Fractional Thread—Compound Gearing—To
Cut a Metric Thread—To Cut a Multiple Thread—Cutting a
Square Thread—Thread Tools for Cutting Square Threads—Find-
ing the Helix Angle—Cutting an Internal Thread—Problems in
Cutting External Threads—Internal Threads—Left-hand Threads
—Square Threads—Turning Long Shafts—Steady Rests—
Questions.

CHAPTER X

THE SHAPER AND THE PLANER. THEIR WORK 186

The Shaper—The Planer—The Vertical Shaper—Size of Planers
and Shapers—Use of Vises—Use of Plain Clamps—Use of Finger
Clamps—Use of Screw Pins—Use of Angle Plates—Springing or
Bending the Work—Planer Jacks—Planer Parallels—Setting
Work—Planer and Shaper Tools—Rake and Clearance of Tools—
Laying Out Work—Problems in: Planing Flat Surfaces—Bevels
—Dovetails—Key Ways—Making “Down Cuts”—Questions.

CHAPTER XI

THE MILLING MACHINE AND ITS USES. 217

Types of Milling Machines: Universal—Plain—Verticle-spindle

—Planer. Spindles—Arbors—Collets—Types of Milling Cutters—Gang Mills—Forming Cutters—Direction of Feed—Holding the Work—Index Centers—The Universal Dividing Head—Plain Indexing—Compound Indexing—Cutting a Helix—Classes of Work for Which the Milling Machine Is Adapted—Speeds and Feeds—Milling Flat Surfaces—Milling Squares and Flutes—Milling the Hexagon on the Hexagon Nut—Milling the Gear-model Frame—Milling Helical Flutes in a Hand Reamer—Right-hand or Left-hand Helix—Questions.

CHAPTER XII

GEARS AND GEAR CUTTING	258
Spur Gears—Definitions of Tooth Parts—Circular Pitch—The Diametral Pitch—The Pitch Diameter—Full Diameter—Computing the Number of Teeth—Shape of Gear Teeth—Stub-tooth Gears—Computing Gears—Helical Gears—Normal Pitch—Normal Diametral Pitch—The Angle of the Helix—The Lead of the Helix—To Find the Angle of a Helix—To Find the Lead of a Helix—Right-hand and Left-hand Gears—Herringbone Gears—Speed Ratio of Spur Gears—Bevel Gears—Forming Method—Generating Method—Cutting a Spur Gear—Selecting the Cutter—Holding the Work—Setting for Correct Depth of Cut—Testing—Cutting Helical Gears—To Find the Angle of the Helix—Lead of the Helix—Selecting the Cutter for a Helical Gear—Milling the Teeth in a Bevel Gear—Questions.	

CHAPTER XIII

THE TURRET LATHE AND TURRET-LATHE WORK	287
The Hand Turret Lathe—The Automatic Screw Machine—Semi-automatic Machines—Operating Turret Lathes—The Spring Chuck—Turret-lathe Tools—The Box Tool—Hollow Mills—Cutting Screw Threads—The Cutting-off Tool—The Back Forming Tool—Circular Forming Tools—Problems in Making a Shaft-coupling Bolt—Shaft-coupling Flange—Steel Collar—Gear-model Handle—Questions.	

CHAPTER XIV

DRILLING MACHINES AND DRILLING	310
Types of Drilling Machines—Twist Drills—Sharpening Drills—Hand Drill Grinding—Machine Drill Grinding—Ways of Holding Drills—Ways of Holding the Work While Drilling—Breaking Drills—Laying Out Drill Holes—Drill Jigs—Drilling on a Lathe—Questions.	

CHAPTER XV

KEYS AND KEYWAYS	320
Uses for Keys—Kinds of Keys—Splines and Feathers—Tapered	

Keys—Woodruff Keys—Round Keys—Cutting Keyways in Shafts by Planing or Milling—Cutting Keyways in Hubs by Planing or Milling or Key Seating Machines—Broaching—Problems in Cutting Keyways—Questions.	PAGE
--	------

CHAPTER XVI

THE GRINDING MACHINE AND GRINDING METHODS	334
Grinding Wheels—Natural and Artificial Abrasives—Bonding—Vitrified Wheels—Silicate Wheels—Selecting Wheels—Cutting Speed of Wheels—Dressing Wheels—Grinding Machines—Cylindrical Grinding Machines—Use of Coolants—Distortion of Work from Heat of Grinding—Steady Rests—Formed Grinding—Set Wheel Grinding—Surface-grinding Machines—The Disk Grinder—Internal Grinding—Problems in Grinding—Questions.	

CHAPTER XVII

MISCELLANEOUS PROBLEMS IN MACHINE TOOL WORK	352
Gear Model Assembly—Gear-Model Frame—Gear-Model Stud Bolts—Flanged Shaft Coupling—Square-head Bolt—Lathe Centers—Boring a Propeller Hub and Fitting the Propeller Shaft—Standard Mandrels—Face-plate Arbor—Hexagon-nut Arbor—Chucking Reamers—Floating Reamer Socket—Toolmaker's Buttons—Making a Drill Jig—Miscellaneous Tables.	

INDEX	413
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MACHINE TOOL WORK

CHAPTER I

GENERAL SHOP INSTRUCTIONS

SAFETY IN THE SHOP

1. **"Stop, look, listen"** is a slogan applicable in all industries where power and machinery are used. Persons working in shops or factories are constantly exposed to the danger of injury from accident. Accidents come quickly and as a surprise to the individual. "I didn't think" and "I was not looking" are common excuses. Almost all accidents may be avoided by *paying strict attention to one's own business*.

The chief sources of personal danger in the machine shop are found in moving belts, gears, shafts, grinding wheels, and milling cutters.

In all well-regulated shops these danger points are recognized, and safety devices for the protection of the workman are used. Belts are guarded with heavy wire guards, gears are covered, grinding wheels are covered with heavy protecting hoods, and goggles are provided for wear when using grinding wheels. But with all of this mechanical protection should be mixed a reasonable amount of care and caution on the part of the individual.

2. **Overhead belts** cannot well be covered or protected. When one of these belts slips from a pulley, it may be put back by the use of a long pole or belt shifter. Under no conditions should a student be allowed to ascend a ladder to put belts on pulleys by hand.

3. **When working on dry grinding machines**, one should protect his eyes from dust, dirt, or injury by wearing goggles designed and made for such work. The work rests should be adjusted close to the wheel. The wheels should be kept true by dressing. Wheels may burst from too high a speed of revolution, 5,500 ft. per minute being average safe peripheral speed.

4. When working on milling machines, keep hands and fingers away from moving cutters. Do not try to brush shavings or oil from the work with the fingers while the cutter is in motion.

In case of an accident, report at once for first aid.

SHOP ORGANIZATION AND REGULATIONS

In most shops there will be found certain rules and regulations the purpose of which is to keep the organization in the best working condition and also to safeguard the workman. One who is perfectly familiar with all of the shop regulations and follows them faithfully usually gets along faster and better than the person who is indifferent to them.

5. Tool-room Service.—A tool room is usually connected with the machine shop. In the tool room are kept the special tools, jigs, and fixtures not in actual use. In this room is usually also a variety of small general tools, such as drills, reamers, milling cutters, rules, files, and calipers. Stock supplies, such as castings, bar steel, brass, bolts, and screws, are also kept in the tool room of most school shops, although in the industries such supplies are kept in a stock room.

The tool room is in charge of a tool keeper whose duty is to attend to the needs of the workman in supplying stock or loaning tools and also to keep track and take care of the tools.

When beginning work in the machine shop, the student is usually assigned a shop number and given six brass checks on which the number is stamped. These checks constitute his "capital" to do business with the tool room. When he draws a tool for use, he deposits his check with the tool keeper as a receipt. The student will be held responsible for the tool that he has borrowed to the extent of paying for it if it is lost or for paying for repairs if it is damaged. He should take good care not to lose a check, for if a check should be found by a dishonest person and cashed in at the tool room for an expensive tool, the owner of the check would be held responsible for the loss. Should a check be lost, that fact should be reported at once to the tool keeper.

6. Job Cards.—Job cards are used in shops for the purpose of recording the time spent on a job and also for other kinds of information. A form of job card that has been used in a school shop with success is shown in Fig. 1. This one card serves

[illegible]

Front

[illegible]

[Back](#)

FIG. 1.—Machine shop job card, for recording time, order of operations, stock, etc.

many purposes, such as an assignment to a job; an order on the stock room for stock; making an analysis, of the job; showing time spent on the job; recording the grade given.

When a job is assigned to a student, the instructor will give him a job card on which is written the name of the job assigned. The student should print his name and the date on the card. He then ascertains the size and kind of material required for making the job and writes in the blank space under the heading "stock order" an accurate list of the materials needed. This information regarding the material needed may be found by consulting the drawing of the job and by reading the instructions accompanying the drawing.

On the back of the job card under the heading "operations," the student should write his analysis of the job and list the various steps or operations that he proposes to follow when making the job. The card should then be taken to an instructor, who examines it, and if he finds it correct he will sign his name and punch the card under the heading "stock order approved." The card may then be taken to the stock room as an order for the necessary material. The tool keeper will deliver the material and make a record of so doing by punching the job card under the heading "stock order filled."

This job card also serves as a time card. A daily record of time spent on the job should be recorded.

Record the time in hours and tenths of hours, for example: 2.4 hr. The time used while listening to instructions or demonstrations should be recorded as part of the time spent on the job.

The student should take care of his job card until his job is finished, at which time he presents it with his work for a grade. The instructor will record the grade on the card.

7. Student's Work Record Card.—A form of record card used by the student for keeping a record of every job of work that he does in the machine shop is shown in Fig. 2. On this card are printed the names of some of the regular machine-shop jobs. Under the heading "value" is indicated the value of each job in "points." A definite number of points must be earned by the student to obtain a passing grade, while additional points earned will improve the grade. A student will receive full point value for his work if, in the judgment of the instructor, the work is perfect, and the grade given is 100 per cent. If, however, the