



The Workshop

Tools and techniques for small workshops are the subjects of this chapter. The use of tools, and the ability to make them using local resources and equipment, are certainly very important in any appropriate technology effort. In some areas where small blacksmith shops, foundries, woodworking or machine tool workshops exist, many of the tools and processes covered in these books may have been in use for many years. In other areas, most of these crafts and skills are unknown. Therefore, the tools found in this section are of many different types, from simple hand tools to wood-turning lathes to metalworking equipment. Some may be made at the village level, others may require metalworking shop facilities.

The first several books offer illustrated inventories of a great variety of tools. Other books describe the proper uses of a wide range of hand tools and machine tools for both wood and metal work. The crafts and skills covered include woodworking, blacksmithing, general metalworking, forging and casting, sharpening, sheet metal working, designing bearings and springs, working with metal tubing and copper piping, and others. There are also plans for workshop equipment: lightweight power tools, sheet metal bending tools, and more.

*These reference books, containing thousands of ideas, should be valuable to an appropriate technology group in its own workshop. They are also a source of learning materials for improving skills, increasing versatility, and expanding available tools and equipment among local craftspeople. It should be remembered that many workshop crafts, such as blacksmithing, cannot be easily learned from a book; these reference materials can only supplement skilled instructors. However, even the most experienced blacksmith will find many unusual and valuable ideas in a reference such as **Practical Blacksmithing**.*

Tools and How to Use Them: An Illustrated Encyclopedia, MF 04-122, paperback book, 352 pages, by Albert Jackson and David Day, 1978, \$13.95 from Alfred A. Knopf, Inc., 400 Hahn Road, Westminster, Maryland 21157, USA.

This beautifully illustrated book is the best one available for descriptions of the wide range of useful hand woodworking tools. It also covers a few gardening tools, power tools, plumbing tools, and includes more than 1500 excellent drawings. For each tool the authors list other commonly used names, size, the material it is made from, and its purpose; this is followed by a short but valuable description of how it is used. Most of these tools originated in Europe or North America, but many are in common use all over the world. A good source of ideas for local adaptation. Highly recommended.

Tools and Their Uses, MF 04-123, book, 186 pages, by the U.S. Navy Bureau of Naval Personnel, 1973, \$4.50 from Dover Publications, Inc., 31 East 2nd Street Mineola, New York 11501, USA.

This book covers a very wide selection of common hand and power tools. The purpose is to "identify tools and fastening devices by their correct names; cite the specific purposes and uses of each tool; describe the correct operation, care and maintenance required to keep the tools in proper operating condition, and finally perform accurate measurements." This book will not substitute for books covering in detail the techniques and equipment used in woodworking and soldering, for example. It is just a general introduction, but one that would be useful to any workshop education program using common tools. Safety information is included throughout.

Basic Machines and How They Work, MF 04-81, book, 161 pages, prepared by the U.S. Navy Bureau of Naval Personnel, 1971, \$4.50 from Dover Publications 31 East 2nd Street, Mineola, New York 11501, USA.

Written as a reference manual for sailors in the U.S. Navy, this book explains basic mechanical principles and their applications in simple and complex machines. Illustrated examples are used to show how these principles work in common devices. For example, oars, wheelbarrows, handpump handles, and the block and tackle are forms of the lever; the brace and bit, wrench, and winch are forms of the wheel and axle. Many of the examples include explanations of how mechanical advantage is obtained, and how to calculate that advantage using simple arithmetic. Later chapters explain the uses and combinations of basic machine elements (like bearings, linkages, cams) in machines such as the typewriter and automobile engine.

Useful as a reference and as a practical way to study the physics of mechanical devices. Slang and sailing terminology may sometimes be difficult for the non-native speaker of English.

Equipment for Rural Workshops, MF 04-92, book, 94 pages, by John Boyd, 1978, £5.95 from ITDG; also available from TOOL.

This book "is intended to help people choose appropriate tools and equipment. It is not an instructional textbook on workshop technology."

Shows workshop building layout and basic sets of tools (primarily hand tools) for 1-6 person workshops, with and without power supply, for woodworking or

metalworking. The simplest level of powered equipment requires an electric drill with attachments to convert it into a circular saw, grinding wheel, jig saw, and power hacksaw. Machine tools are shown for the larger, powered, 4-6 person workshops.

The author notes that "the hand tools in the lists of basic equipment can be used to do the same work as the much more costly power tools Power tools only speed up the work and are not economic unless there is enough work to keep them in use for a substantial part of each day."

Includes mid-1977 prices of tools. Lists suppliers in Asia/Africa/Latin America. Many illustrations and photos.

Shop Tactics, MF 04-118, book, 114 pages, by B. Abler, 1973, Running Press, out of print.

"**Shop Tactics** is a guide to tools, materials, and procedures that are within the reach of a small basement shop. The beginner and amateur (and low-budget) tinkerer, artist or scientist will find here plenty of information to see him through almost any project he can undertake, whether simple or complex. Because **Shop Tactics** begins with simple tools and materials (hammer, nails, wood, file, drill, saw, and wrench) the beginner can use it as an introduction to manual techniques. He will find step-by-step instruction leading him through the motions for using these and other basic tools and materials."

"After familiarizing you with basics, this book describes the use of abrasives, adhesives (solder, glues), plastics (plexiglass, epoxy), and finally molds and casting. The last chapter concerns efficiency and effectiveness in the use of manual techniques. An appendix of basic devices, a bibliography and an index are included.

"The description for each tool and material is presented with concrete examples (the section on sheet metal describes how to make a ring) so that when you work through the example to learn the procedures you will have a completed piece of work. But this is not a how-to book presenting instructions for the completion of a few projects; instead it gives you skill and insight into tools and materials so that you can plan and complete your own projects. The home tinkerer who wants to build a mold, or the scientist who wants to build a specialized gas burner will all find here not specific instructions, but plenty of information to guide the project to completion."

This book is "directed at your imagination in the hope that, when you know what is already known, you will be able to think of new things (that you would never have been able to think of otherwise) by recombining processes and extending materials to satisfy each new demand you make of them."

Illustrations (literally hundreds of them) are included to accompany each step in the text and ensure that the text will be understood by any reader. Each presentation is very clear and easily understandable. In particular, there is a valuable discussion of a variety of casting methods. The "Devices" section gives illustrations and simple explanations of 12 simple devices (solar still, bicycle sprocket drive, set screw).

This is an excellent book, both because of the clarity of presentation of the material, and the regular use of illustrations. Perhaps of greatest value is that the author seeks to develop basic skills and an experimental approach that is fundamental to future development of appropriate technology devices.

The Use of Hand Woodworking Tools, MF 04-125, book, 273 pages, by Leo McDonnell and Alson Kaumeheiwa, 1978, Delmar Publishers, New York, out of print.

This introductory book presents only the basic hand tools used in carpentry, and most of the book is devoted to explaining how to properly use them. No previous knowledge is assumed. Designed for use in teaching, the book contains questions at the end of each section.

The author begins with measuring tools (from the T-square to the builder's transit level—the only rather complicated tool presented), and continues with saws, planes, edge cutting tools, and boring tools. Sharpening is discussed in detail for each of the cutting tools. Also covered are nails, screws, and dowels. Well-illustrated.

Handtool Handbook for Woodworking, MF 04-97, book, 184 pages, by R.J. DeCristoforo, 1977, out of print in 1985.

This book shows how to use woodworking tools commonly found around the world. These include measuring devices, saws, hammers, drills, screwdrivers, chisels and planes. The author also discusses safety, sharpening, shop math and how to choose good tools.

"You won't find this (a crown) on all saws, but many experts look for it as an indication of careful designing and superior quality. A crowned saw is one where the silhouette of the toothed edge shows a gentle arc rather than a straight line from the heel to the toe. The reason for the shape is to obtain maximum cutting effect with minimum drag. The arc brings fewer teeth into contact with the wood fibers. While you don't have as many teeth in full contact, those that are cut deeper, faster, and easier."

This book is full of tricks and tips for woodworkers, and the 400 illustrations make it easy to understand. Safety measures are very well-covered.

Woodwork Joints, book, 176 pages, by Charles Hayward, 1974, \$8.95 from WEA.

"The craft of woodwork consists largely of joining pieces of wood together. In this book we have taken the basic joints, given their chief variations, and shown how to cut them. It is not suggested that the methods of cutting described are the only ones possible ... but it can be taken that the way described is useful and has been proven by experience to be reliable."

This book is suitable for anyone experienced in working with wood who wants to learn different methods of making joints.

The Making of Tools, MF 04-103, book, 93 pages, by Alexander Weygers, 1973, Van Nostrand, out of print, but still available for \$11.95 from WEA.

"This book teaches the artist and craftsman how to make his own handtools: how to design, sharpen, and temper them, using only basic shop equipment and scrap steel." There are many illustrative drawings on each page that show the "step-by-step progression from the raw material to the finished product—the handmade tool."

Raw material is usually high-carbon steel—from steel scrapyards and auto junkyards (U.S.). Hardwood is used for the handles.

Contents include: tempering steel, sharpening tools; making a screwdriver,

cold chisel and other simple tools; stonecarving tools; cutting tools; eyebolts and hooks, tool handles, hammers, gouges, seating cutter and hinge joints, tinsnips, wire and nail cutters, large shears, and pliers; applying color patina to steel surfaces. There is also a glossary of tool-making terms (useful to non-native English speakers).

The author was born in Java, educated in Holland as an engineer, and has worked in Java and the U.S. before concentrating on art. This book, based on his teaching experiences is designed for the artist and craftsman who is interested in making (or forced to make) his or her own tools.

The Modern Blacksmith, MF 04-108, book, 96 pages, by Alexander Weygers, 1974, Van Nostrand, out of print, but available for Dfl. 29.90 from TOOL.

This book is very similar to Weygers' previous book **The Making of Tools**, but the focus is on things that can be made with hammer, anvil and forge. The basic skills of blacksmithing are covered in detail.

There is an initial chapter on elementary blacksmithing exercises: squaring and straightening a round bar and shaping the end of a square rod. Further chapters include: tempering and hardening high-carbon steel, making a small anvil from a railroad rail (see drawing), and upsetting steel (making a bolt head). There is a glossary of blacksmithing terms.

This is a very good introduction to the skills of blacksmithing, with many drawings and examples.

The Recycling, Use and Repair of Tools, MF 04-116, book, 112 pages, by Alexander Weygers, 1979, Van Nostrand Reinhold, out of print.

"The scrap steel yards across the country are full of every conceivable metal object discarded for reasons of wear, obsolescence, or damage. Much of this material can become useful stock for the beginner, as well as the skilled metal craftsman, who intends to 'make do' with what can be gleaned from this so-called junk."

In this book the author uses more than 600 drawings to show how to make useful woodworking and metalworking tools and other implements from steel scrap and discarded machine parts. Punches, chisels and gouges can be shaped and forged from steel tubing, automotive shafts, and spring steel. Files, rasps, fireplace tools, candlesticks, and other decorative implements can be made from mild and high-carbon steel scrap. Detailed perspective drawings show how to make a wood-turning lathe from salvaged materials, and adjustable bearings from fruitwood. The final third of the book discusses rehabilitating and operating metal-turning lathes, and how to use and make inserts for a trip-hammer. A short section on how to temper high-carbon steel is included, but in general it is assumed that the reader has basic blacksmithing skills. The author's previous book **The Modern Blacksmith** (see review) provides a good introduction to the use of the hammer, anvil, and forge.

"It is through actual demonstration, seeing how to manipulate tools to make tools, that I believe the student benefits most. But short of that one can learn from books in which the illustrations come as near as possible to live demonstrations. I have tried to present the information in such a way that the reader can imagine he is watching me making things in the shop."

A practical book illustrating a creative craftsman's approach to repair and reuse.

The Blacksmith's Craft: An Introduction to Smithing for Apprentices and Craftsmen, book, 116 pages, by CoSIRA/Rural Development Commission, 1955, £11.50 surface mail from Rural Development Commission, 141 Castle Street, Salisbury, Wiltshire SP1 3TP, England.

This well-written book is divided into 37 lessons to teach people the basic skills of blacksmithing. These sections cover the tools and techniques very thoroughly, and the many photos show each step in making chain links, u-bolts, harrow bars, and many other things. There is a list of books recommended for further reading.

This is possibly the best introduction to blacksmithing available.

Practical Blacksmithing, MF 04-114, book, 1089 pages, compiled and edited by M.T. Richardson, originally published 1889, reprinted 1978, Outlet Book Company, Crown Publishers, out of print.

Originally published in 1889, **Practical Blacksmithing** is a compilation of a great variety of articles on different aspects of the craft. These articles, originally printed in the 19th century journal **The Blacksmith and Wheelwright**, were submitted by hundreds of blacksmiths from all over the United States. This book thus represents an extraordinary attempt to collect, preserve, and make available common "hands-on" wisdom about a critically important craft. Hundreds of drawings show tools, layout of blacksmiths' shops, and methods of working steel and iron which had previously been passed from individual smiths to a few apprentices.

This is an outstanding reference book, to go with the teaching books **The Modern Blacksmith** and **The Blacksmith's Craft** (see reviews).

Blacksmithing, MF 04-85, book, 109 pages, by James Drew, 1943, out of print in 1985.

This book covers most simple blacksmithing skills for forging metal parts—especially useful in making and repairing agricultural implements. The chapters include: forging iron and steel, simple exercises in blacksmithing, forging and tempering steel tools, plow work, soldering and brazing. The chapter on forging steel tools covers chisels, drills, and knives. The explanations are clear, although there are only a few drawings.

This book would be a useful introductory book in an area where blacksmith facilities are desired. Experienced blacksmiths, however, will probably find the information too elementary.

Hardening and Tempering Engineers' Tools, MF 04-98, 89 pages, by G. Gentry 1950, revised by E. Westbury and reprinted 1985, Argus Books Ltd., United Kingdom, out of print.

"The efficiency of cutting tools employed in engineering and other crafts depends very largely on their correct heat treatment. In the past, the methods employed in these processes have often evolved individual methods which have been in some cases closely guarded as trade secrets. There is, however, no reason why even the novice should not be able to harden and temper tools quite successfully by adopting simple methods which can be applied without the need for

elaborate equipment."

This book contains all the relevant information on simplified processes available to craftspeople with small workshops to maintain their tools in proper working strength for a long lifetime. Detailed descriptions of case hardening and the latest processes, materials and equipment are included, plus valuable information on gas hardening, nitriding, and flame hardening. Although emphasizing modern appliances and conveniences such as welding torches and gas and electric furnaces, a very helpful chapter on forging reminds toolmakers of the importance of shaping steel by hot working under the hammer. This is precisely the state of the art for most traditional blacksmiths in developing countries, for whom the tempering suggestions should prove valuable.

Good illustrations with clear text.

Oil Drum Forges, MF 04-110, dimensional drawings, 40 pages, ITDG, out of print.

Making these forges requires no welding or brazing. One forge is bellows-operated; the other is fan-operated. Both are made from old oil drums. The plans are very simple—numbered drawings (with separate text, to simplify translation) with English and metric measurements.

These can be used by one person for any kind of blacksmith work. The author notes that these devices are also "suitable as engineering exercises, as rural craftsmen must be able to make their own tools."

A Blacksmith's Bellows, MF 04-84, plans, 23 pages, by Allen R. Inversin and D. Sanguine, 1977, South Pacific Appropriate Technology Foundation, Boroko, Papua New Guinea, out of print.

The South Pacific Appropriate Technology Foundation (SPATF) has been organized by the government of Papua New Guinea to develop and promote the use of technologies encouraging individual and village self-help and self-reliance. This booklet, one of SPATF's "how-to-do-it" publications, shows how to construct a hand-operated double-action bellows. Rubber from old inner tubes is used for the flap-valves as well as for the bellows themselves. The simple step-by-step instructions are accompanied by large, clear drawings and an explanation of how the finished mechanism works.

The design in this booklet could be built or adapted at very low cost for any kind of blacksmithing.

Metals for Engineering Craftsmen, book, 69 pages, CoSIRA/RDC, 1964, £8.00 by international money order from Rural Development Commission, 141 Castle Street, Salisbury, Wiltshire SP1 3TP, England; also available from ITDG.

This book is designed to be a simple guide to the properties of a wide range of metals and to be a useful alternative to very large technical books on metallurgy. The characteristics of most useful metals are all included along with information such as the welding and casting properties of each.

This is not a how-to book, but it is very informative.

Metallurgy, MF 04-106, book, 472 pages, by C.G. Johnson and W.R. Weeks, 1977, \$20.76 (\$15.72 for schools ordering two or more) from American Technical Publishers Inc., 1155 West 175th Street, Homewood, Illinois 60430, USA; limited supply.

Intended for those who require cast metals of high strength and durability, this book is biased towards the high-technology metals industries. There is, however, plenty of background information that could be useful to small-scale operations. A general introduction to the science of metals, the book covers the properties and testing of materials and the treatment and production of a variety of ferrous and nonferrous metals and alloys. There is a glossary of terms used in the metals sciences.

This book could be useful as a reference in a large blacksmithing, casting, or smelting operation. Some basic knowledge of chemistry is required.

Lost-Wax Casting: A Practitioner's Manual, MF 04-130, book, 73 pages, by Wilburt Feinberg, 1983, £6.95 from ITDG.

"The successful endurance of any technology over thousands of years is an impressive feat; for such a technology to find applications in our modern industrial world is a phenomenon." Metal casting of objects is practiced throughout the world, often using techniques that are centuries old. Despite the rudimentary and unlikely nature of the technology often employed, village craftspeople regularly achieve good results. This book aims to inspire simple, basic improvements and encourage further resourcefulness among practitioners in Africa, Asia, and Latin America, and anyone working with limited resources. Following a discussion of basic techniques, the author presents a number of practical, low-cost suggestions to enhance quality and productivity. The emphasis is on attainable improvements based on the realities of village foundries.

These improvements include mold and pattern-making for low-cost duplication, use of scrap material, formulas for compounds used in modeling, mold-making, kiln construction, and even the production of crucibles in which the metal is melted. Metal casting (for machine parts, tools, hardware, and so on) is a technology with great potential for local employment generation and enhanced self-reliance. Though somewhat brief, this book could contribute greatly to the quality of production and economic viability of village-level foundries. Includes case studies and technical appendices.

Foundrywork for the Amateur, MF 04-94, book, 108 pages, by B. Aspin, 1954 (revised 1986), Model and Allied Publications, £5.95 plus £0.75 shipping from Argus Books, Argus House, Boundary Road, Hemel Hempstead, Hertfordshire HP2 7ST, England.

A basic skills book for making metal castings, describing the tools and techniques needed. The requirements are simple, although some of the tools described may not be locally available (such as a ceramic crucible). A foundry can be very useful for producing metal tools and replacement parts. Scrap metal can often be used, and the tools can often be made.

The book covers subjects such as furnaces, sand, molding boxes, how to make and ram a mold, and melting iron and aluminum. Illustrations of the tools used and the steps in the casting process are included. Useful examples are given, such as the casting design for an engine crankcase. Some of the English is a little complex.

Although this book was written for use in Britain, it should be valuable in rural areas where foundry skills are needed to produce things locally.

Small-Scale Foundries for Developing Countries: A Guide to Process Selection, MF 04-127, book, 66 pages, by J.D. Harper, 1981, £6.50 from ITDG; also available from TOOL.

"This book is not intended as a textbook of foundry practice. The purpose is rather to assist anyone about to start or to expand a small-scale foundry to consider the various available processes, and to select the most appropriate for the circumstances. An indication is given of the type of raw materials and equipment which will be needed, and the degree of training or skill which is likely to be required."

Smelting Furnace, Popular Mechanics Plan X297, MF 04-113, 5 pages, by E.R. Haan, 1964, \$3.75 from Popular Mechanics.

"With this small furnace you can smelt aluminum, brass and copper; preheat small, thick pieces of iron and steel for brazing or forging; caseharden soft steel; make up alloys You can use either LP or city gas. The cost is about \$25 (1964 prices)." The furnace is about 17 inches high and 12 inches in diameter; it holds a 3-inch diameter crucible. Clear photos and drawings with the text show how to make and operate the smelting furnace. A vacuum cleaner is needed to supply forced air.

This might be of use in a small workshop where casting work is occasionally done.

Fabricating Simple Structures in Agricultural Engineering, MF 04131, book, 68 pages, 1955, Council for Small Industries in Rural Areas/Rural Development Commission, out of print.

"This volume has been prepared by the Rural Industries Bureau as a guide to blacksmiths and agricultural engineers. It deals with the application of oxygen cutting and arc welding fabrications and therefore assumes knowledge of these two processes."

The structures described are all metal and are generally used in farm applications: linkage mechanisms, wheels, rollers and brackets, bearing mountings, trusses, gates and a trailer chassis design. All pieces are made out of angle, channel and plate iron.

"The fabricated parts used to illustrate this book are intended to teach principles; they are not primarily intended to represent actual parts of machines. The object is not to show the precise way in which an exact number of fabrications can best be made, but rather to help the reader to become 'fabrication minded.' " The emphasis is on helping the reader fabricate parts of his own design.

The Procedure Handbook of Arc Welding, MF 04-115, book, 630 pages, 1973, \$6.00 plus \$2.00 surface mail postage (10% discount on orders over \$10) from The Lincoln Electric Company, P.O. Box 17035, Cleveland, Ohio 44117, USA.

This remarkably thorough and detailed book tells you probably everything you would ever want to know about small and large-scale electric arc welding. It "is directed toward those people who have day-by-day working interest in arc

welding— to the supervisory and management personnel of fabrication shops and steel erection firms; to welders and welding operators; to engineers and designers; and to owners of welding shops. The editorial aim has been to be practical—to present information that is usable to those on the job." The authors have also attempted to make the text as understandable as possible to the beginner.

Following an introduction to the fundamental principles of electric arc welding, the topics covered include preheating, relieving stress, welding different types of metals, safety, and welding underwater, in addition to power sources, equipment and supplies for arc welding.

There is an extensive reference section containing data on weights, hardness of different materials, and etching methods. There are many illustrations and a good index. Readers should have some understanding of basic welding methods.

Welding Craft Practices, Volumes 1 and 2, MF 04-126, books, 159 pages (Volume 1) and 182 pages (Volume 2), by N. Parkin and C. Flood, 1969, paper editions out of print, microform editions available from O.P. Books Department, Pergamon Press, Maxwell House, Fairview Park, Elmsford, New York 10523, USA.

"The two volumes of this book cover the ground necessary for the acquisition of the essential basic skills and safe working methods in welding, sufficient technology and related studies being included to provide a suitable background to the practical work and form a basis for further, more advanced studies. It is intended for all who wish to learn to weld, and the ground covered will enable the beginner to obtain a sound knowledge of the equipment, an appreciation of safety and, by means of a graduated series of practical exercises, a good standard of skill.

"Volume 1 deals with Oxygen-Acetylene Processes and Weld Defects, Testing of Welds, and Welding Science; Volume 2 with Electric Arc Processes and Elementary Electricity, Classification of Electrodes, Welding Symbols, Engineering Drawing, Metal Plate Surface Development and Workshop Calculations." These latter sections on drawing and welding symbols could be useful references for those who work with dimensional/mechanical drawings.

The two volumes can be bought separately; both have drawings and a few photographs. While welding is a skill that must be learned by practice, usually with the help of an experienced welder, these two books are well-suited to library or textbook use.

3 Welding Jigs, ITDG Complete Technical Drawings No. 19, MF 04-121, ,3 large sheets, by R. Mann, ITDG, out of print.

Welding jigs are used to hold parts in place and facilitate the repetition of a welding task during the fabrication of identical steel items. These drawings provide details on three jigs: a "plow share" jig for repair or fabrication of irregular sections, a shift and stock jig, and a universal jig. Exploded views are included along with materials lists. Although measurements are given, it is noted that the dimensions are approximate and can be varied to suit the local availability of materials and particular jig requirements.

Farm Shop and Equipment, MF 04-93, booklet, 16 pages, 1953 (reprinted 1975), Cumberland General Store, out of print.

"Farm machinery is important to self-sufficiency. Effective care and repair of

farm machinery requires an organized farm shop, as well-equipped as possible."

This booklet was originally written for small American farmers. It discusses the kind of work that can be done, desirable building features, and a simple equipment list for making repairs in a farm shop. It shows how to sharpen and grind drill bits and how to make a chisel. One of the unique features of this booklet is a full-page table in which the following are listed: major kinds of metals used in farm machinery, how to identify them, why the manufacturer used the particular metal, common causes of failures, and recommended method of repair. There are numerous diagrams and photos, including a farm-made substitute for a drill press that uses a hand electric drill and simple plumbing parts, and dimensional drawings for a medium-sized brick forge.

Sheet Metal Former, Plan No. X609, MF 04-112, 7 pages, 1966, \$5.25 from Popular Mechanics.

This hand-operated tool allows you to make perfect cylinders in any diameter from 1 5/8" up. It will handle 20-gauge sheet iron up to 12" wide and thicker pieces of softer metals.

Two important pieces are cut from aluminum alloy plate; production will be more difficult if steel is used. This tool will require a lot of precision metal work to make.

How to Work Sheet Metal, MF 04-100, book, 142 pages, by Herbert J. Dyer 1963, Model and Allied Publications, U.K., out of print in 1986.

This book outlines methods of sheet metal working using techniques and equipment that stress low-cost efficiency. Riveting, soldering, brazing, and other metal joining techniques are discussed as well as sheet edging and shaping methods. Includes sections on equipment, materials, and metalworking machines. Also included are dimensional drawings of a few basic sheet metal tools and equipment.

A beginner may at times have difficulty following the text; but, on the whole, an excellent book.

How to Make a Folding Machine for Sheet Metal Work, MF 04-99, booklet, 32 pages, by Rob Hitchings, 1985, £3.95 from ITDG; also available from TOOL.

Clear text and drawings distinguish this guide to building a simple yet effective and versatile tool for sheet metal work. The required materials and equipment should be available in most rural or semi-rural locations and the resulting machine will produce superior quality work with a great savings in time when compared with hand materials.

Sheet Metal Brake, Plan No. X606, MF 04-112, 8 pages, by Manly Banister, 1964, \$6.00 from Popular Mechanics.

This is a valuable, versatile, simple workshop tool for quickly and accurately bending sheet metal. For use in workshops where a lot of sheet metal bending is done or where precision is important. Hand-operated. The tool is 18 inches wide and can bend up to 20-gauge sheet metal the full width, or thicker narrower pieces.

"By using the proper forming block or mold, you can bend sheet metal to any angle, make radius bends, reverse bends, and seams." Part II describes techniques for

the effective use of the tool.

Metal Bending Machine, MF 04-105, dimensional drawings and photos, 24 pages, ITDG, out of print in 1985.

This remarkably simple machine can be used to bend thin strips of metal (the width can be varied), from right angle bends to circular rims for cart wheels. It is hand-operated by two people, and has very few parts.

The booklet has very detailed drawings with English and metric measurements. It also includes instructions and photos on how to make cart wheels with an axle jig assembly. Several ITDG designs use wheels fabricated with this machine (see the agricultural leaflet entitled **Carts**). An ingenious piece of intermediate technology.

Try Your Hand at Metal Spinning, Popular Mechanics Plan X420A, MF 04111, 5 pages, by Sam Brown, 1954, \$3.75 from Popular Mechanics.

This is a set of directions for making bowls out of aluminum by bending it into the proper shape on a lathe. No cutting is involved. "If you begin with soft aluminum and work it over a simple form you can spin a bowl in less than five minutes after the job is set up. Aluminum spins very easily and does not tend to score or buckle under the forming tools " Drawings and photos illustrate the techniques and special tools needed (simple to make). Requires 16- to 22-gauge aluminum. The lathe has to operate at about 900 rpm.

General Metal Work, Sheet Metal Work and Hand Pump Maintenance, Rural Mechanics Course 1, MF 04-134, book, 189 pages, by John van Winden, 1990, Dfl. 19.00 from TOOL.

This is the first in a series of books intended for use in a four-year course for rural mechanics, who are expected to have only a very limited toolkit without power tools.

Most of this book is on the elementary use of basic hand tools. Since a rural mechanic is a likely candidate for handpump repair, a short section is devoted to maintenance of several common handpump designs. Another short section introduces pipes and pipefitting. The last section contains 35 pages on various sheet metal forming techniques.

Blacksmithing, Welding and Soldering, Rural Mechanics Course 2, MF 04-133, book, 142 pages, by John van Winden, 1989, Dfl. 17.50 from TOOL.

Part of a four-book series for a four-year rural mechanics training course, this volume covers the basic heavy metalworking tasks that a rural blacksmith/mechanic with limited tools might expect to encounter. A broad range of blacksmithing techniques are presented, and these are exceptionally well-illustrated. Also included are exercises that require the use of most of these techniques in the production of commonly needed tools.

A more limited set of techniques for electric arc welding and gas welding are covered. Unusual items here include instructions on how to weld joints without a welding rod, and drawings with a description of the proper use of an acetylene gas generator to make acetylene on the spot.

The coverage of soldering is limited to sweating a lap joint. There is no coverage of soldering copper pipe.

Metalworking Handbook: Principles and Procedures, MF 04107, book, 480 pages, by Jeannette T. Adams, 1976, ARCO Publishing Company, New York, out of print.

This book is both a manual for the beginner and a reference book for the skilled craftsman. For example, you'll find an introduction to working with sheet metal, soldering, riveting and metal spinning. A variety of machine tools are discussed: drilling machines, milling machines, shapers, planers, lathes, and grinding machines.

The appendix offers many useful tables.

Workshop Exercises Metal, Part A, Fundamental Skills, MF 04-129, book, 90 pages, and **Technology Metal 1, Part A, Fundamental Skills**, MF 04-128, book, 90 pages; 1982, edited by H.N.C. Stam, Dfl. 25.00 each from TOOL.

Technical and vocational education in developing countries can benefit from clear and easy-to-understand texts on workshop skills. The pictorial system and straightforward language of this pair of workbooks make them appropriate for beginning shop classes anywhere metalworking tools are available. The exercises require the production of practical objects that develop skills in layout, measurement, metal-cutting, forming and fastening. The tools required may be somewhat sophisticated for typical rural workshops and schools. But where the resources are available, and a curriculum for enhanced industrial capability is desired, these books will be useful.

The Beginner's Workshop, MF 04-83, book, 244 pages, by Ian Bradley, 1975, Model and Allied Publications, U.K., out of print in 1986.

This book will introduce you to the basic tools and machines in a metalworking workshop. The author provides suggestions on buying tools and building some small items. The basic uses of the tools and machines are very well-described.

Recommended for the reader wishing to develop basic workshop skills. Readers who already have such skills may find some new information here too.

Amateur's Workshop, MF 04-80, book, 256 pages, by Ian Bradley, Model and Allied Publications, 1976, revised edition 1986, £8.50 plus £0.85 shipping from Argus Books Ltd., Argus House, Boundary Way, Hemel Hempstead, Hertfordshire HP2 7ST, England.

This book is intended for people who already possess at least the basic skills of metalworking using hand and power tools. Despite the use of the term "amateur" in the title, this book contains an enormous amount of useful information. The text is clear and well-illustrated. Workshop skills are thoroughly covered. There are many detailed plans for tools and attachments to tools; many of these are complex devices.

Amateur's Workshop will help someone with basic skills become a skilled craftsman, after lots of practice. The book would be especially useful in programs for training metal workers. There is no glossary.

This is a step beyond **The Beginner's Workshop**, by the same author. An excellent book.

Heavy Duty Drill Press, Plan No. X245, MF 04-111, 4 pages, by Arthur B. Farwell, \$3.00 from Popular Mechanics.

This appears to be a very sturdy, powerful drill press for heavy drilling in wood and metals. An imaginative design, yet reasonably simple to make. A small amount of machine shop work would be needed on a few minor parts. A small electric motor is used, but a geared-up pedal-power unit would work also. The drawings are quite clear and sufficiently detailed. This is a possible substitute for expensive heavy duty imported drill presses for many circumstances.

How to Mill on a Drill Press, Plan No. X422A, MF 04-111, 5 pages, by Kenneth B. Littlefield, 1969, \$3.75 from Popular Mechanics.

This article includes plans for cutting attachments that can be added to a metalworking drill press to enable you to do milling work. It also describes the techniques to use.

Gear Wheels and Gear Cutting, MF 04-95, book, 92 pages, by A.W. Marshall, 1984, out of print; replaced by **Gears and Gear Cutting**, by Ivan Law, 1987, £6.95 plus £0.70 shipping from Argus Books Ltd., Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST, England.

"An elementary handbook on the principles and methods of production of toothed gearing." The author tells why and how to design and make gears. He discusses gear principles and tooth shapes, a wide variety of gears (including bevel and chain gears), and cutting gears on standard metalworking machine-tools. A knowledge of basic geometry is necessary in order to use this book.

Making gears is a complex task that requires a workshop with at least a metalworking lathe and drill press. This is a good guide to the process.

10-inch Table Saw, Plan No. X585, MF 04-111, 10 pages, by Elman Wood, \$7.50 from Popular Mechanics.

This unit would involve quite a bit of machine shop metal work, but the plans are quite clear, and the final product would be a solid, versatile table saw. The 10-inch circular blade can be raised, lowered, or tilted. The electric motor would be difficult to replace with another power source.

4-Wheel Band Saw, Plan No. X36, MF 04-111, 4 pages, by H. Tuttle and R.E. Knull, \$3.00 from Popular Mechanics.

"Except for ball bearings and retainers, metal yokes, sheet-metal cover, and such shafts and bolts as are necessary in the assembly, the machine is entirely made out of wood. Most of the parts are cut from a single piece of 5/8" plywood." The four wheels are made of plywood, and covered with pieces of inner tube to provide a surface against which the blade rubs as it rotates. A pulley can be changed to allow a second speed. Uses blades 10 feet long and up to 1/2-inch wide. The small electric motor could be replaced by a 1-2 person pedal-power unit with a flywheel. Will cut

wood and light metals (this requires changing to a metal-cutting blade and operating at a lower speed). Clear drawings, sufficient for construction.

Two-Speed Bandsaw Cuts Wood and Metal, Popular Mechanics Plan No. X37, MF 04-112, 7 pages, by A.L. Mills, 1951, \$5.25 from Popular Mechanics.

This machine can be used to cut wood or metal, by shifting v belts between pulleys to change the speed of the blade. "It has every essential feature of the average dual purpose type machine." The frame is made of water pipe and fittings, while the band wheels are made of hardwood.

DeCristoforo's Book of Power Tools, Both Stationary and Portable, MF 04-88, book, 434 pages, by R. DeCristoforo, 1972, Times Mirror Magazines, New York, out of print.

A clearly written, extensively illustrated guide to the use of power woodworking tools, both stationary and hand-held. Includes table saws, drill presses, lathes, band saws, belt sanders and more. Each chapter describes the safe operation of a tool, and standard techniques, as well as many innovative applications of that particular machine. Most useful are photos and plans for simple jigs and accessories which increase the versatility of the power tools and allow the production of many identical pieces. For example, there are plans for an adjustable wooden frame for cutting large panels easily with a power hand saw.

This book only provides instruction in the proper use of commercially available machines. No design and construction details for such machines are provided. The greatest weakness of this book is that it includes almost no information about repair or even routine maintenance of the power tools. May be useful to those wishing to teach themselves wood shop techniques, especially for small-industry furniture production.

Motorize Your Hacksaw, Plan No. X334, MF 04-112, 2 pages, by Carl S. Bates 1952, \$1.50 from Popular Mechanics.

"If you have a small metal working shop or use steel bar or shafting to some extent in your home workshop, motorizing a hand hacksaw will save hours of work and can be done at a fraction of the cost of a commercial power hacksaw. The inexpensive drive unit consists of an 8- or 10-inch v-pulley and shaft, a connecting rod and a guide rod, a vise or clamping arrangement to hold the work and a suitable wooden base. When needed for handwork, the saw can be removed from the unit in a few minutes." Uses a 1/4 hp electric motor.

Scroll Saw, Plan No. X594, MF 04-112, 5 pages, by Will Hooper, 1945, \$3.75 from Popular Mechanics.

This saw is similar to a jig saw, with a narrow, reciprocating blade. The plans have to be studied carefully to be fully understood. This design is made of hardwood and a variety of small metal parts from old automobiles. Some cutting, drilling and tapping steel is required. Uses a 1/4 hp electric motor. Appears to be a sturdy machine.

Metal Turning Lathe Built from Stock Parts, Plan No X387, MF 04-113, 4 pages, by Frank Beatty, 1959, \$3.00 from Popular Mechanics.

This metalworking lathe is not a precision tool. It can accept work up to 4 1/2" in diameter and 10" long. Standard pipe and fittings are used to form a frame on which the rest of the lathe is fitted. Precision metal work is required to make this lathe.

Lathe Sanders, Plan No. X388, MF 04-112, 2 pages, by Dick Hutchinson, 1949, \$1.50 from Popular Mechanics.

This article provides ideas for making simple disc and drum sanding attachments for use with a woodshop lathe. Also shows another drum sander powered by an electric drill.

Wood Planer for \$100, Popular Mechanics Plan No. 802B, MF 04-112, 9 pages, by Ronald Guy, 1970, \$6.75 from Popular Mechanics.

This is a workshop machine for planing wood to a specified thickness. Metalworking tools are needed to do a lot of precision work to make this machine. Cost \$100 for materials in 1970. Useful in converting scrap, low-grade, or recycled lumber into more valuable boards.

A Manual on Sharpening Hand Woodworking Tools, MF 04-104, large booklet, 48 pages, by J.K. Coggin, L.O. Armstrong, and G.W. Giles, 1943, \$4.00 from Interstate Publishers, 19-27 North Jackson Street, Danville, Illinois 61832, USA.

Written and published as a shop manual for students in woodworking and industrial arts classes in rural schools. Drawings and simple instructions show how to grind and sharpen chisels, plane irons, saws, augers, knives, axes, and screwdrivers. Many of the illustrations are clear and complete enough to be used without the text. Includes simple explanations of types of steel used in hand tools, and an illustrated glossary of sharpening terms.

An excellent low-cost teaching tool and reference.

Sharpening Small Tools, MF 04-117, book, 128 pages, by Ian Bradley, 1980, MAP Publications (U.K.), \$7.95 from Sterling, 2 Park Avenue, New York, New York 10016, USA.

"In this book the sharpening of tools in general use is dealt with, and, whenever possible, simple and well-tried methods have been adopted, bearing in mind that usually the aim when sharpening a tool should be to restore, as accurately and as consistently as possible, the original form of the cutting edge."

Bradley begins with an introduction to the materials and equipment used in sharpening. Then he explains (with illustrations) the proper sharpening techniques to use with metalworking tools lathe cutting tools, shears, drill bits, and other tools used in boring. This is followed by sharpening techniques for woodworking tools—planes, saws, chisels, and drill bits—and some common household tools such as knives and scissors.

When a sharpening "stone is used dry, it will soon become filled with metal particles and ... have little abrasive action Water or oil is applied to the stone to

enable the metal dust to be carried away"

"The four common forms of cold chisels ... are generally sharpened on the grinding wheel, [although] when the edge is but little blunted it can readily be restored on a coarse emery bench stone."

Bearing Design & Fitting, MF 04-82, paperback book, 80 pages, by Ian Bradley, 1979, Model and Allied Publications, U.K., out of print in 1986.

"Although the subject of this book is complex and covers a very wide field, an attempt has, nevertheless, been made to deal with the main principles involved and, at the same time, to furnish examples of bearing design and application that may be found of use particularly in the small workshop."

Bearings are used whenever something rotates or slides against something else and it is desirable to reduce friction and wear. This book is good on the design and production of metal bearings. Many of the ideas could be applied to other materials, such as wood, of which bearings are often made in developing countries. The book covers casting of bearings from metals and plastics, machining bearings, design, lubrication, different types, and maintenance and repair. See also **Oil Soaked Wood Bearings**, reviewed on page 221.

Spring Design and Calculation, MF 04-119, book, 37 pages, by R.H. Warring, 1973, Argus Books, out of print.

This book tells you how to make metal springs. Topics covered include spring materials and the following kinds of springs: flat, helical, tapered helical, torsion, clock, constant force, and multiple leaf. Wire sizes and other details of spring construction are also discussed. Simple algebra is needed to design springs using this book.

"Spring design proportions are not something that can be 'guesstimated' with any degree of accuracy—and trial-and-error design can produce a succession of failures. Thus this book on spring design is full of formulas, as the only accurate method of predicting spring performance. However, all are practical working formulas; and all are quite straightforward to use."

This is not a book that shows specific spring making procedures—it just covers the designing of springs. Once you master the simple math, you should have no problem using this book to design springs of good quality. There are numerous illustrations and charts that will help the reader more fully understand the methods and principles described.

How to Work with Copper Piping, Plan No. X198C, MF 04-111, 4 pages, 1974, \$3.00 from Popular Mechanics.

Good illustrations and text for "sweat" soldering copper pipe joints. Notes on tools and techniques for cutting copper pipe.

How to Use Metal Tubing, Plan No. X422, MF 04-111, 4 pages, by E.R. Haan, 1956, \$3.00 from Popular Mechanics.

This article contains lots of valuable hints with drawings, on how to bend, cut, connect, solder, enlarge and generally handle metal tubing. There is a good description of soldering copper tubing joints. Relevant for plumbing, solar water

heaters, steam engines, and other uses.

Electroplating for the Amateur, MF 04-91, book, 106 pages, by L. Warburton, 1963, out of print; replaced by **Electroplating**, by J. Poyner, 1987, from Argus Books, Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST, England.

Electroplating is a process in which electricity is used to produce a protective coating on metal parts. The author attempts "to provide the amateur engineer with what is hoped will be sufficient data, not only to carry out successful electroplating in the small workshop, but also to provide himself with the essential tools of the trade, i.e., the electrical equipment and plating tanks ... reduced to their simplest forms without serious loss of efficiency The only plating plant obtainable is on a far bigger scale than anything required by even the most enthusiastic amateur." Thus, there is "a detailed discussion of a suitable size of plant, together with details as to how such a plant can be assembled in the small workshop."

The book covers electrical principles and procedures; the plating tank; chemicals; preparation of surfaces to be plated; electrolytes; chromium, copper, nickel and silver plating; anodizing aluminum; and some other techniques.

Electric Motor Test and Repair, MF 04-90, book, 168 pages, by R. Piekil, 1966, TAB Books, out of print.

This is a guide to rewinding and testing single and poly-phase, plain and split-loop small-horsepower electric motors. Winding diagrams show the sequence and number of coils to be wound into armature and stator slots, and simple schematics show electrical connections to commutator and field windings. Accompanying text gives full instructions: "... any armature with an even number of slots can be wound in the same general manner. The first coil is started in the slot selected as number 1 and comes back in slot 7, then back through slot 1 and so on around until the correct number of turns have been placed. The wire is now cut at the commutator end, leaving ample length to reach the proper commutator bar with an inch or two left over"

Testing and winding equipment, expensive or unavailable in many areas, can be made by the person doing repairs. The author explains how to build a motortest panel, simple hand-operated armature and stator coil winding machines, devices for taping and packing coils, and gear and pulley puller plates. He also discusses the use of small lamps, hand compasses, and homemade induction devices to test armatures and stators. Other useful ideas and information: reversing motor rotation direction; rewinding automobile generator armatures; building a dipping tank and baking hood for application of coil insulating varnish.

This book requires a basic understanding of electric motors. Bound with a durable cover and packed with ideas for improvising equipment, it could be used wherever motors are being repaired.

LeJay Manual, MF 04-102, booklet, 44 pages, 1945 (reprinted many times since), LeJay Manufacturing Company, Minnesota, out of print.

This is an illustrated manual on how to rewind automobile generators for all kinds of uses: from direct drive windgenerators and waterwheels to arc welders and soldering irons. For windgenerators, rewinding is done so that the generator will begin charging at a lower rpm, thus avoiding the need for gearing. This allows the

propeller to directly drive the generator shaft. The specific generators referred to have mostly disappeared; however, the principles remain the same.

A Museum of Early American Tools, MF 04-109, book, 108 pages, by E. Sloane, 1964 (fourth edition 1974), \$6.95 from Ballantine Cash Sales, Box 505, Westminster, Maryland 21157, USA.

"Covers building tools and methods, farm and kitchen implements, and the tools of curriers, farriers, wheelwrights, coopers, blacksmiths, coachmakers, sawyers, loggers, tanners," and others. The tools were generally made from wood and iron.

This book was written by a collector of early tools, with the philosophy that tools represent extensions of the human hand. The book includes drawings of the tools, descriptions of their uses, and some production sketches. These are tools that were produced by blacksmiths and farmers—from an era when most rural Americans made many of their own tools out of local materials.

Interesting items include: making barrel staves, reaming, nail-making; and complete drawings of a boring machine, wooden jacks and lifts, and smithy tools.

Stocking Spare Parts for a Small Repair Shop, VITA Technical Bulletin No. 2, MF 04-120, 4 pages, by Phil Cady, P.E., out of print in 1985.

Basic good advice for systematic stocking and record-keeping for parts.

Hard-to Find Tools and Other Fine Things, catalog, 70 pages average length, published quarterly, free (overseas shipping postage charge only) from Brookstone Company, 127 Vose Farm Road, Peterborough, New Hampshire 03458, USA.

A commercial catalog, with photos, offering a wide variety of unusual tools. Although some of the listings are expensive gimmicks, most of the tools are of high quality.

Technical Drawing, Rural Mechanics Course 4, MF 04-135, book, 100 pages, by John van Winden, 1990, Dfl. 10.00 from TOOL.

Anyone involved in building things from plans provided by other people needs to be able to "read" technical drawings. Similarly, anyone who wants to be able to provide clear instructions on how to make something will find technical drawing to be a very important "language" for those instructions. This is a good introductory book to the skill of technical drawing with exercises for the student. The emphasis is on drawing small objects for metalworking shops. This volume is part of a four volume set intended to be used in a four-year course for rural mechanics.

How to Make Planes, Cramps and Vices: Seven Woodworking Tools, Workshop Equipment Manual No. 11, MF 04-136, book, 112 pages, by Aaron Moore. 1987, £5.95 from ITDG.

This well-illustrated manual shows the reader how to make seven different woodworking tools that are quite valuable to a rural workshop lacking electricity. Tools included are jack planes, rebate planes, plough planes, spokeshaves, sash cramps, bench cramps, and beam and leg vices. The tools must be carefully made; if

not, they will be difficult and frustrating to use. Assumes the reader is already familiar with standard woodworking techniques.

How to Make Twelve Woodworking Tools, Workshop Equipment Manual No. 9, MF 04-137, book, 108 pages, by Aaron Moore, 1986, £5.95 from ITDG.

A good illustrated guide to the careful production of some useful carpentry tools, including a try square, bevel square, marking gauge, cutting gauge, mortise gauge, panel gauge, mallet, bow drill, bow saw, coping saw, fret saw and hack saw. Much of the effectiveness and satisfaction that comes from using these tools will depend upon how carefully they are made. The metal-framed saws depend upon tension to hold the blades in place; this may prove to be problematical.

"The bow saw is made to cut curves in timber up to about 50mm in thickness, giving a carpenter the ability to make fancy and decorative shapes, improving the style and range of his products. It is not a common tool, but anyone who takes the time to construct one will be surprised at the advantages it gives."

ADDITIONAL REFERENCES ON THE WORKSHOP

Simple Working Models of Historic Machines includes drawings of two different lathes, screw cutters for wooden screws, a variety of pulleys and other lifting devices, the Chinese spoon tilt hammer (which can be used by a blacksmith), and two kinds of bellows; see GENERAL REFERENCE.

Construction Manual for a Cretan Windmill contains plans for a pedal-powered turning lathe; see ENERGY: WIND.