THE EVOLUTION OF CERTAIN COMMON HAND TOOLS USED IN WOODWORK

THESIS

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CHAPTER I

INTRODUCTION

Purpose of the Study

The purpose of this study is to present in narrative form a discussion of the evolution of hand tools employed in woodwork. The purpose is to make this treatment as concise as possible, and at the same time to depict in some detail a comprehensive analysis of the topic under consideration.

Limitations

Certain limitations were recognized in developing this study, some of which were formulated by the investigator at the beginning, and others of which confronted him in the course of collecting information and materials needed for the development of the topic. In the first place, the study was limited to a treatment of the evolution of hand tools used in woodwork. Machines and machine tools are not to be dealt with in this study, although their pre-eminence in the modern woodworking shop is recognized. Secondly, those hand tools utilized in fields other than woodwork are eliminated from the ensuing discussion, although it is to be noted that certain tools, such as the hammer, the axe, and the saw,

may often be utilized in work other than that dealing with wood. In this study, however, the use of these tools with wood is to be the only phase of their utility to be treated. Thirdly, the transition of use of some of these tools from one area of work to another must be recognized; for example, the prehistoric hammer and axe made of stone were, in all probability, utilized first as weapons and as implements for the killing of animals for food. Perhaps these tools were used for thousands of years for these functions before they were ever adapted as tools for working with wood. In the fourth place, the relative scarcity of recorded information dealing with the evolution of hand tools in the field of woodwork necessarily limited the sources of information to be consulted in this study.

Definition of Terms

"Hand tools" are regarded in this study as any tools which are held in or manipulated by the human hand without the application of power from any other source. In other words, the hand is the source of power for the operation of these tools.

The term "evolution" as employed in this study refers to the development of the various hand tools from their primitive forms to their modern designs. Whenever possible, the evolution of a given tool is traced step by step through the period of its historical development.

The individual hand tools are defined in their respective chapters within this study.

Sources of Data

As mentioned above, information relative to the topic under consideration in this study was comparatively limited in quantity. Sources consulted included books and encyclopedias. Most of the books contained only limited materials relating to this study, although three books were found to deal entirely with the evolution of hand tools and to treat the subject in a rather comprehensive manner. Consequently, these three works are listed as the primary sources of information: The Carpenter's Tool Chest, by Thomas Hibben; Common Woodworking Tools—Their History, by Edwin M. Wyatt; and Ancient Carpenters' Tools, by Henry C. Mercer. A number of other sources likewise are cited and utilized here and there throughout the study, but these three works have provided a substantial proportion of the information collected for this study.

Procedure

The first step in the development of this study was to read all materials available dealing with the evolution of hand tools used in woodwork. As the reading was done, notes were taken and complete bibliographical data were assembled. When the reading was completed, the notes were organized according to subject matter and carefully

arranged in chronological sequence. With this done, the actual process of writing was undertaken. The writing was done directly from the notes, rather than from the sources.

Organization

The study has been organized into chapters in such a way as to present the subject matter in chronological sequence, as nearly as possible. The second chapter presents a brief survey of the evolution of hand tools in terms of the various eras of man's development. Succeeding chapters treat the hammer, the axe, the saw, tools for boring in wood, tools for smoothing, layout tools, and certain miscellaneous tools. The final chapter presents a brief summary of the study.

CHAPTER II

THE EVOLUTION OF HAND TOOLS USED IN WOODWORK: A BRIEF SURVEY IN TERMS OF THE VARIOUS ERAS OF MAN'S DEVELOPMENT

The development and ever-increasing use of tools tell of progress and the growth of civilization, for it appears that the first inventions of man consisted of tools for improving his living conditions and for providing new methods which would make it possible for him to do his work and to provide for himself and his family more quickly and efficiently than was possible by the use of his hands alone. Every new tool that came into permanent use proved to be an important milestone in the advance from primitive life to the cultivated farms and growing cities of civilized men.

This trend of progress was slow, sporadic, and uncertain. The story that can be told within the scope of a few pages required thousands, perhaps millions, of years for its slow evolution and completion.

In prehistoric times, man had to work with crude and cumbersome tools, for he had no other kind; but as he worked with such simple

and inefficient tools as he could devise for himself, he gave thought to these tools and to means of improving them. Consequently, men slowly but steadily learned how to fashion better and more precise implements with which to build and furnish their houses (after they had graduated from caves to crude houses made of brush or stone), to construct bridges, and to make whatever was needed to add to the comfort, security, and enrichment of life in those far-off days of the past. Thus, it becomes apparent that the woodworking tools in use today represent many ages of accumulated experience on the part of mankind, and a man who wishes to handle these tools expertly must acquire specialized knowledge and skill in their use.[1]

> Truly man's lordship over the other creatures of the earth is due not a little to his ability to take things in nature and turn them into simple tools, with which in turn he makes greater tools to be used for producing super tools.[2]

Perhaps, before proceeding any further, it would be well to define the meaning of tools. A hand tool is defined by the encyclopedia as "any tool which is held and operated by the unaided hands; e.g., a chisel, plane, or saw."[3] Understanding of this definition is enhanced by Usher's amplification, as follows:

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[1]Walter E. Durbahn, Fundamentals of Carpentry, Vol. I, Tools—Materials—Practice, p. 15.

[2]Edwin M. Wyatt, Common Woodworking Tools—Their History, p. 3.

[3]Encyclopaedia Britannica, 14th edition, XXII, 286.

> The mechanical equipment of any given society consists largely of tools and machines. In the restricted sense that is most useful for historical study or mechanical analysis, the term "tool" may best be confined to implements for the direct execution of certain kinds of work; notably cutting, striking, or rubbing. Although all tools were originally used in the hand, many have been adapted to machinery without significant change of form or purpose.[4]

The essential distinction between a machine and a tool lies in the degree of independence in operation from the skill and motive power of the operator; the tool lends itself to manual manipulation; the machine, to automatic action produced by a source of power other than the human hand. In determining the difference between a machine and a tool, the degree of complexity is not important; for the human hand and eye, through the use of the tool, can perform complicated actions which are equivalent in function to a well-developed machine. On the other hand, there are highly effective machines, like the drop hammer, which do very simple tasks, with the aid of a relatively simple mechanism. Thus, the difference between tools and machines lies primarily in the degree of automatism they have reached.[5]

In all probability, the history of hand tools began when primitive man discovered that small lumps of flint, called nodules, when struck together or with other stones, would split and produce flakes along certain planes. By proper percussion and the application of pressure to

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[4]Abbott Payson Usher, A History of Mechanical Inventions, p. 66.

[5]Lewis Mumford, Technics and Civilization, p. 10.

the edges of the flint, either flakes or cores could be shaped to suit certain purposes. The flakes were usually more suitable for knife-like tools, saws, scrapers, and the like; while the cores could be used as daggers, borers, and axes.[6]

> . . . The first tools that man invented were the hammer, the axe, the knife, the saw, and the drill, and probably in the order named. Just how and under what conditions these primitive tools were invented goes so far back into the dim ages of the past that we can at best make only a rough guess about them, but, fortunately, the tools themselves still exist as evidence of their reality, and this gives us a fairly good insight concerning their making as well as a key to the improvements that followed at a much later date.[7]

Probably the first tools to be used by our early-human or proto-human ancestors were nothing more than pieces of wood or stone picked up at random and entirely unworked and unshaped by man. Even the great apes may be said to have attained this stage of development, for they pick up and use sticks and stones as tools and implements. At a very early stage of his history, however, man began to select sticks having a convenient size and shape for the purpose for which he intended to use them, and likewise he sought for stones with sufficiently sharp edges or points. Later, when convenient shapes were not to be found readily in their natural state, man began to trim lumps of stone by striking off flakes around the edges, and to modify sticks, perhaps by

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[6]R. J. Forbes, Man the Maker, p. 16.

[7]A. Frederick Collins, A Birds' Eye View of Invention, p. 25.

sharpening or pointing their ends. At this point begins the tool-making or distinctively human stage of man's development. The earliest stone implements or eoliths which have been discovered consist of pieces of flint, chipped so crudely that it is often difficult to distinguish them from shapes that might have been produced by natural causes. In fact, there is sometimes much controversy among archeologists as to whether some of these eoliths have actually been made by prehistoric man or not.[8]

Hibben agrees with Sayce in stating that, at first, primitive man used as tools such stones as could be found in any stream-bed or on any rocky hillside. Some of these, having been worn by the water and by moving about in the current against other stones until they were flat and a little sharp, were used as knives, and others that were round and smooth fulfilled the function of hammers. Eventually, primitive peoples discovered that pieces of broken flint had sharp edges and made better tools than did other stones. Gradually, they learned to break the flint themselves and afterwards no longer had to depend upon finding suitable broken pieces in the natural state. Now, with their new technique of breaking flint, they could make different kinds of tools, and evidently did so, although most of the prehistoric tools made of stone which have been found look very much alike, regardless of the

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[8]R. U. Sayce, Primitive Arts and Crafts, pp. 56-57.

purposes for which they may have been used. Often, primitive men would leave the "crust" on one end of the flint so that it would not hurt their hands when they pounded with it. Later, they learned to wrap a little skin around the end of the flint as a handhold. Little by little, they found ways of making better tools, until they had several kinds.[9]

> By the end of the Unground Stone Age . . . , mankind had learned to make a great many kinds of tools: axes and adzes, saws, hammers, chisels, gouges, awls, and drills. And these tools were sharp and accurate so that the carpenters were able to do a great deal more work and life became easier. . . . What brought an end to the Age of Unground Stone tools was the discovery of the way to make tools of metal, and although stone tools continued to be used for hundreds of years, gradually tools made of bronze came to take their place so that stone tools were but rarely used any more. However, even as late as the battle of Hastings the Saxon troops under Harold, finding themselves short of iron, used stone weapons when they attempted to prevent William the Conqueror from landing in England.[10]

In the latter part of the Stone Age, man began to polish stone. This process enabled him to make tools from very hard stone, such as granite, by patient grinding with sand or with other stones. These ground tools were more durable than those shaped from flint, which so often shattered into fragments when it was subjected to unusually hard impacts. Particularly were such practical tools as picks, axes, hammers, and sickles shaped from hard, not-so-easily-shattered stones. But flint was by no means abandoned as a material out of which tools

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[9]Thomas Hibben, The Carpenter's Tool Chest, pp. 87-88.

[10]Ibid., pp. 102-103.

might be made. Actually, the manufacture of flint articles eventually was perfected into a real art, especially for certain tools and weapons used by primitive peoples.

Modern excavations into the remains of primitive civilizations have revealed that the cutting edges and shapes of ancient tools, as far as the intrinsic design is concemed, resembled rather closely those of modern tools. Being familiar with present-day shapes and uses of tools, the archeologist has been able to reach some rather clear-cut conclusions as to the uses to which ancient tools were put. Certain tools very obviously were employed in working with wood, and thus it becomes apparent that the origin of carpentry dates back to the Stone Age, when the first woodworking tools were devised from stone.[11]

The tools employed today for cutting, shaping, marking, smoothing, and measuring wood and for driving nails into wood are sharp and accurate and balance easily when held in the hand, but carpenters' tools have not always been so fine. It has taken thousands of years to make them what they are today. Tools have been invented and improved down through all the long span of the life of man. New tools have grown out of old ones, and new materials have been discovered out of which to make better ones; for tools, like everything else, have changed as mankind has changed from those early days when men lived in caves

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[11]Forbes, op. cit., pp. 26-27.

and wore the skins of animals for clothing and ate their flesh for food. Along with everything else in those early days, tools were crude and primitive implements.

Tools have ancestors just as people have theirs, and although it may seem impossible that a modern ratchet drill has descended from a piece of stone, yet it has done so. All of the modern tools which are in use today have come down through the ages from sticks and stones and broken bits of bone, until eventually the highly efficient tools of steel replaced, among civilized men, the earlier and cruder implements which had represented great strides toward progress in their respective ages of time, but which could not begin to compare in efficiency or durability with their modern steel counterparts.[12]

Just when people first discovered how to make tools out of metal no one knows, nor do we know who were the first people to use bronze. But the new ages of metals which began with the Bronze Age were very different from the older Stone Ages. In the Bronze Age cities began to grow up at strategic points, and governments and trade were established.

> . . . In the stone ages a man could make his tools from the stone he found almost everywhere. In time he learned to plant crops; hunted and fished and made clothes from the skins of animals that he killed or wove cloth from flax which he grew. He was dependent on no one but himself.

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[12]Hibben, op. cit., pp. 41-42.

> Even though men began to live in villages, no one village needed anything from another that they could not get at home.[13]

The coming of the Bronze Age changed all this, and made life more complex. For copper and tin are not found everywhere, and ancient peoples sometimes had to travel long distances in order to obtain them. Thus trade grew up, and those who lived in fertile valleys would take grain and livestock and other products to those who lived near the mines to trade for loads of copper and tin ores. But to carry on trade like this, far away from home, many people either had to cross large bodies of water or else travel great distances around such barriers. Consequently, the Bronze Age saw the building of the first ships with sails and banks of oars. Carrying loads of ore overland was slow and extremely hard work when it had to be done on the backs of men, so ultimately the wheel was invented and wagons made that would carry heavier loads more easily and much more quickly. At first, men pulled these wagons, but this, too, was slow and back-breaking work, so animals were trained to do this task.

The melting of copper and tin and the mixing and casting of bronze were difficult work in those early times. Not every one could do it, so the craft of the smith arose. So important was the smith to his neighbors that he was often set aside and supported by the rest of the

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[13] Ibid., p. 105.

community so that he might have nothing to do but make tools and weapons.

In the Stone Age it had not been very necessary to own anything, except possibly a stone axe or two, a bow and arrows, and a few hollowed-out stones to serve as containers for food. The people lived in caves or brush shelters and were always moving about in search of game and fruits and nuts. But in the Bronze Age the people who had copper and tin mines held power. So greatly were the new tools and weapons made of metal desired that to those who had mines power and prestige came, and they could trade the ores for whatever they wanted. Too, people who could make tools of metal could build cities and make weapons with which to defend them. The great empire of Egypt was founded upon the ownership of copper mines at Sinai, and the mining of this copper became a state enterprise safeguarded and protected by Egyptian armies.

If there is to be trade, there must be government and peace so that industries may grow and thrive. In time, governments were established and armies were organized, primarily, at first, for the purpose of protecting copper and tin deposits from theft by people who had none.

> . . . And so we see in the Bronze Age, springing up one after another, all the elements of what we call civilization —cities, governments, motive power, trade, manufacture, ships, wagons, writing, and the division of society into

those who make, those who use, those who trade, and those who rule.[14]

Man's first metal tools were made of copper. Copper tools were used by the Assyrians, Egyptians, and Babylonians. The period of human history commonly known as the Copper Age extended approximately from 4000 B. C. to 2000 B. C. It was probably a little earlier than the year 2000 B. C. when men discovered that a small amount of tin mixed with copper would produce bronze. This alloy was much harder than pure copper, and yet it was more easily melted. The so-called Bronze Age has been roughly set as dating from about 2000 B. C. to 1000 B. C.

Although iron was known to prehistoric man, it was rarely utilized until the Hittites found it in northeastern Asia Minor. The Iron Age dates from approximately 1000 B. C. to our modern Age of Steel.

The Romans probably contributed more than any other ancient people to the process of developing iron carpentry tools. Many examples of these tools have been discovered among Roman ruins. Progress in the development of tools was slow, however, before the advent of the factory era, beginning about 1800 A. D., when modern tools began to take form. Before that time, each woodworking craftsman had made his own tools, or else they were made by smiths; but the establishment of the factory system created a demand for more tools than could be made by hand, and especially trained craftsmen began to spend their

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[14] Ibid., p. 107.

whole time in the development, improvement, and standardization of various types of tools. Thus, most of the carpentry tools in use today have been developed within the past century in so far as their present forms are concerned, but they can be traced back into antiquity to their origins as stone, wood, bone, or bronze implements. In their modern appearance and design, however, they are of comparatively recent origin.[15]

After about 1500 B. C., or during the latter centuries of the Bronze Age, metal tools enabled carpenters to execute more accurate and delicate work than had been possible with tools made of stone. Now, fish-tail and other types of joints could be made for fastening planks together. But the most important consequence of the invention of the early metal woodworking tools was the development of the wheel, which has come to dominate almost all phases of human life.[16]

One of the most important of the ancient civilizations was that of Egypt. In that country, wood was scarce, as it still is today; and most of the building was done in stone or with bundles of reeds tied tightly together. Although the Egyptians did learn to become expert smiths and to make beautiful and difficult castings, yet they invented no new carpenters' tools. In reality, it is as workers in stone that the craftsmen

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[15]Durbahn, op. cit., p. 16.

[16]V. Gordon Childe, The Story of Tools, pp. 12-13.

of Egypt were most proficient. Although their carpentry work was excellent for that early day, they generally used such wood as they could get for making furniture, ships, boxes, and statues, rather than for buildings.[17]

By the end of the Bronze Age, almost every kind of carpenters' tool had been invented. However, there was no brace and bit as yet, nor any plane. Man still had to learn how to cut saw teeth regularly and to set them. And, although the Bronze Age level equipped with a plumb-bob was a good one, a different and much better level was to be developed at a later time. Nevertheless, there is little that can be done with modern tools that could not be done with the tools of the Bronze Age, although great improvements have been made and the work can now be done much more rapidly.[18]

It is not known any more definitely about when and where the use of iron began than is true of copper and bronze casting. Iron ore is fairly common in most sections of the world, and it is not difficult to extract the metal from the ore. But to work iron up into tools is harder than the casting of bronze or copper implements. In Mexico, for instance, there are whole mountains of high-grade iron ore, but the Aztecs and the Mayas never learned to make their tools from iron.

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[17]Hibben, op. cit., pp. 124-126.

[18]Ibid., p. 143.

Even when building their vast pyramids and huge temples that are almost entirely covered with beautiful sculpture, often cut in the very hardest of stone, they used tools of flint and copper.[19]

> The Chinese and the people who lived in India were among the first great workers in iron—those of India being particularly clever, making a kind of iron called wootz that was very like steel and was imported by the Romans and the smiths of Damascus for their finest tools.[20]

The earliest tools made of iron were shaped very much like those that had been made of bronze; there was no appreciable change except in the material from which they were constructed. It was not until the time of the Romans that the craft of the ironsmith became widespread and tools made of this metal came into use everywhere.

A little tin added to copper changes it from a soft metal to bronze, which is hard enough to make fine tools. The addition of very small amounts of carbon to iron produces even more startling effects. Sheets of nearly pure iron are fairly soft and can be cut with scissors. But the addition of five parts of carbon to one hundred parts of iron will make it so hard that it will scratch like a diamond. Thus, by varying the amounts of carbon and by the use of different methods in making the metal, several different kinds of iron may be made. The three most common kinds are wrought iron, cast iron, and steel.

Of the three, wrought iron has the smallest proportion of carbon in it, the amount usually being less than one part to two hundred. When

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[19] Ibid., p. 145.

[20] Ibid., p. 149.

wrought iron is heated, it becomes soft and can be worked into almost any shape; but when it is cold again, it becomes very strong and tough. Wrought iron gets its name from the fact that it is heated and then beaten into shape, the term "wrought" coming from the old English word "wright," meaning worker. Hence, wrought iron is iron that can be worked. Because of its strength and because it was not difficult to work, wrought iron was used for tools and implements from the beginning of the Iron Age up to almost the present day.

Cast iron contains the most carbon of any of the forms of iron—from two to five parts in every hundred. When it is liquefied by melting, it can be poured into moulds like bronze, but the castings made in this manner are usually brittle and may crack if they are hit hard. The Greeks and the people of India knew how to make cast iron, but they did not use it much for tools and it did not become common until a few hundred years ago.

Steel is the form of iron which comes between cast iron and wrought iron in respect to the amount of carbon contained, which is usually about one and one-half parts to every one hundred. Steel is both very strong and very tough, and it is now used for almost all tools, particularly for cutting edges and for tools that are used in hammering or beating. The people of India and the people who lived in Pontus on the Black Sea were early steel workers. But the art of making steel is a very difficult one to master, and not until the

twentieth century did steel become the most important metal in human life. In fact, the present era could well be called the Steel Age, for not only our tools, but also our ships, railroads, machines, and even buildings are made of steel.[21]

Although the Iron Age did not see the invention of very many new tools, it did produce the developments which changed those tools which the worker in wood already possessed into instruments of great accuracy, speed, and efficiency.[22]

After about 200 B. C., frame saws, cross-cut saws, claw hammers, and new varieties of axes, adzes, chisels, gouges, and borers were devised for the use of carpenters. About 50 B. C., even planes and augers were to be found. By the time the Roman armies added Britain to the far-reaching Roman Empire in 43 A. D., nearly all of the manual tools used today by smiths, carpenters, masons, bricklayers, shoemakers, barbers, tailors, millers, and so on, had been invented, though they were to experience many improvements and changes in later centuries.[23]

The use of metal for tools experienced a prolonged set-back after the fall of the Roman Empire. During the time of Grecian and Roman culture, tools and implements were made almost exclusively of bronze

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[21] Ibid., pp. 149-151.

[22] Ibid., p. 143.

[23] Childe, op. cit., pp. 16-17.

and iron, but during the Middle Ages the common tools and utensils were more often made of wood than of any other material. Even carpenters' tools were made of wood with the exception of hammers and cutting edges.[24] The reason for this extensive abandonment of metal is not known with certainty, although some authorities believe that the astounding growth of armies and the almost constant warfare that existed during the medieval period were in some measure responsible. Methods for mining and making iron and steel were slow and inefficient, and most of the metal that could be produced went into implements of warfare. It was the same situation that has come down to the present day; civilians are willing to deny themselves in order to give the best of everything to their fighting men.

Since the emphasis during the Middle Ages was placed upon warfare and not upon peacetime pursuits, few improvements were made in the tools used by workers in wood. In fact, the tools of the Middle Ages were much like those of the Roman era, except that wood was substituted for iron wherever possible. Minor improvements were made in some instances, and the sphere of usefulness for certain tools was extended and broadened. For some strange and unknown reason, however, the plane apparently was not used, however, until near the

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[24]Mumford, op. cit., p. 119.

close of the medieval era; but throughout the Middle Ages such tools as the vise, the axe, the adze, the chisel, the gouge, the gimlet, the auger, the compass, the square, the marking gauge, the saw, and the hammer were in use.[25]

During the Renaissance, the greatest genius of the age, Leonardo da Vinci, turned his attention to the carpenters' trade, along with the innumerable other interests which consumed his time. Before his time the wood lathe had been invented, but it was a crude and ineffective machine. Da Vinci made so many improvements on the wood lathe that he can almost be called its inventor. Also, da Vinci built a planing machine operated by hand that was capable of smoothing boards much more rapidly than could be done with the small hand planes that carpenters had been using. At the same time, this inventive genius perfected a machine for cutting files and for giving them their rasping edge.[26] Thus, da Vinci benefitted the carpenter, although he did not devote any attention to the improvement of hand tools.

As has already been indicated, and as will be demonstrated more vividly in succeeding chapters,

> The tools you and I use today have been developed by a long process of gradual cumulative improvement from much simpler and less efficient implements of wood, stone, bone, bronze, or iron, devised centuries, and sometimes hundreds of centuries ago, by our rude ancestors or ape-like precursors. They still bear the stamp of their remote origin

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[25]Hibben, op. cit., pp. 180-181.

[26]Ibid., p. 190.

> and of the very different social and economic organizations under which they were first made and used. In the course of the long time over which archaeologists can follow the story of tools, men have changed not only their tools but also the whole way in which they got their living (their economy), and consequently the way in which society was organized for co-operation.[27]

Concisely and eloquently, Wyatt has depicted the manner in which mankind has engaged in a long-drawn-out march down the road toward progress and personal and economic efficiency:

> . . . By conquest of the club, the stone hammer was conquered; by conquest of the hammer, the drill was conquered; by conquest of the drill, the wheel was conquered; by conquest of the wheel, the lathe was conquered; by conquest of the lathe, the steam engine was conquered; by conquest of the engine, the electrical age was achieved; all because primitive man learned that he could strike harder with a club than with his fist.[28]

Thus, progress and advancement have come about through a long series of evolutionary developments which have brought about improvements and added efficiency in the doing of work.

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[27]Childe, op. cit., p. 1.

[28]Wyatt, op. cit., p. 3.

CHAPTER III

THE HAMMER AND ITS EVOLUTION

The hammer is defined by the encyclopedia as

> . . . an implement consisting of a shaft or handle with head fixed transversely to it. The head, usually of metal, has one flat face, the other may be shaped to serve various purposes, e.g., with a claw, a pick, etc. The implement is used for breaking, beating, driving nails, rivets, etc., and the word is applied to heavy masses of metal moved by machinery, and used for similar purposes.[1]

Exactly when the hammer came into use is not told in history because the hammer—or rather, crude stone implements fulfilling the functions of a hammer—had been in existence perhaps for millenniums before the beginning of recorded history. It is certain, however, that some crude form of the hammer must have been used in the earliest days of man's handicraft.[2] The first hammers appear to have been pebbles picked up by ancient man from the hillsides or from stream beds to help break open mussels, nuts, and bones in his quest for food. Later, he learned to use them to break or flake other stones in shaping them into weapons or into other tools. Since they were selected for convenient fitting of the hand, they frequently had depressions for the

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[1] Encyclopaedia Britannica, 14th edition, XI, 132.

[2] Encyclopedia Americana, 1942 edition, XIII, 664.

thumb to facilitate gripping them securely with the hand. They varied in size and shape but always fit the hand and frequently showed wear on the striking face. Many that have been found evidently had their shape intentionally changed by striking, or pecking, and rubbing with other stones. Archeologists call these handleless pounding implements "hammer stones," reserving the name "hammer" for a later time when handles would be attached to these stones.[3]

Archeologists believe the hammer to have been the first tool developed by man. Probably a stone held in the hand, with the forearm serving as a handle, gave primitive man his idea for the first hammer. Next, he cut grooves in the stone to make it easier to grip with the fingers. Later, animal skins were wrapped tightly around the portion of the stone that was held in the hand, thus providing a rudimentary handle, or at least a "shock absorber" to render the pounding of the stone less disastrous to the hand that held it. Finally, ancient man conceived the idea of making a handle for the stone from some convenient stick, which he fastened securely to the stone with rawhide, or animal sinews, or plant fibers. Most likely, the first handles were sticks of green wood, split at one end, in which the stone was inserted, and then they were lashed tightly together.[4] Sometimes, though, a

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[3]Edwin M. Wyatt, Common Woodworking Tools—Their History, pp. 9-10.

[4]A. Frederick Collins, A Birds' Eye View of Invention, p. 25.

flexible handle was bent into a U-shape around the stone and then tied securely with thongs or fibers.

> . . . There have been found all over the world . . . many stone hammer heads which show unmistakable evidence of having been intentionally shaped by man to turn them into better tools. They have a groove about them that made possible a firmer lashing-on of the handle. These grooves were undoubtedly laboriously made by pecking and rubbing with other stones. The handle was usually a flexible withe, bent U-shape around the head and lashed with fiber or thongs. Very rarely a stone hammer has been found with a handle hole through it. Even though many primitive races could drill stone, it seems to have been considered better to put the head through the handle rather than, as we do now, to put the handle through the head.[5]

Durbahn discusses the origins of the hammer in much the same way as do the authorities cited above. He points out that the oldest pounding tools known to the archeologist were small, flat, round stones with a depression on one side designed to fit the thumb as the stone was held in the hand. The first hammer was evolved, however, when man began to fasten a stick to the stone with leather thongs, thus equipping the stone with a handle to provide leverage and to increase its pounding power. Such crude stone hammers are still in use among certain primitive tribes in various parts of the world.[6]

Van Loon, with his typical vivid, lucid, and imaginative writing, describes the origin of the hammer in the following manner:

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[5]Wyatt, op. cit., pp. 10-11.

[6]Walter E. Durbahn, Fundamentals of Carpentry, Vol. I, Tools—Materials—Practice, pp. 16-17.

> And for thousands of years man simply grabbed at his living food with his bare hands, held his prey with his bare hands, tore little beasts and birds apart with his bare hands, and never for a moment thought that it might be possible to do otherwise.
>
> Until one individual at last had the courage to say: "This can be done much better and more simply," re-enforced the striking power of his hand with a stick or stone, and gave us our first hammer.
>
> That is as far as our information goes. Whether that first hammer was of wood or of granite, we do not know and we shall never be able to find out, for wood is a very perishable commodity, while stones will last forever unless they are crushed to bits by a twenty-ton truck or a high explosive shell. . . .
>
> When man first discovered that he could multiply the strength of his hand by means of a stone, any stone would do; that is to say, any stone small enough to be grasped firmly by the five fingers of the hand, yet not too small to be effective when used as the means of crushing a nut or a skull or a bone filled with that great antediluvian delicacy, marrow.[7]

These early hammers made of stone must have been rather efficient tools, especially after the art was learned of attaching handles firmly to the stones; for long after man had learned to work with metals, he still clung to his old stone hammers. Not until just before iron came into use were bronze hammers to be found, and then in no great numbers.[8]

Many thousands of years later, when men had forgotten that they had ever used tools made of stone, the people used to believe, when these old stone tools were found, that they must have fallen from the sky—there was no other place they could have come from! In fact,

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[7]Hendrik Willem van Loon, Man the Miracle Maker, pp. 82-84.

[8]Wyatt, op. cit., p. 11.

they thought that whenever thunder roared or lightning flashed, one of these old stone hammers was falling to earth; and so the Norsemen and many other peoples wore tiny stone hammers as charms to protect themselves from being harmed by thunder and lightning.[9]

Round-shaped stones held in the bare hand, without a handle, were still in use by masons and even sculptors in Egypt and other civilizations of the Bronze Age. For the purpose of breaking up ore and forging it, Bronze-Age metal-workers cut a groove around the stone and lashed it on to the end of a wooden handle. For lighter blows, a billet of wood was used, even in Palaeolithic times, and by the time of the Bronze Age this had been improved into a handy mallet. Later in the Bronze Age the handle was made separate from the head and fitted into a hole in the latter, just as in present-day mallets. Sometimes sections of tree trunks or limbs from which a convenient branch projected, or of antlers with projecting tines would be cut so as to make wooden or horn hammers with natural attached handles. Before the end of the Bronze Age the wooden hammer-head had been copied in solid bronze for heavier work. Later, the Greeks had a variety of hammers, all made of iron.[10]

One of the strangest things about the Egyptians was the fact that they never learned to put handles on their hammers. With one of the

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[9]Thomas Hibben, The Carpenter's Tool Chest, pp. 99-100.

[10]V. Gordon Childe, The Story of Tools, p. 25.

most highly developed cultures of the ancient world and with a civilization unsurpassed at that time, they still did their pounding with hammers made of stone, which were no improvement at all over the round-shaped stones held in the bare hands which had been the characteristic implement of the Stone Age. The Egyptians did, however, make wooden mallets for driving chisels and wedges into wood and stone, constructing them by inserting a wooden handle into a cut section of a tree trunk or limb. The wooden mallet is the oldest tool that is still used in its original form.[11] It is almost unbelievable that the Egyptians could have accomplished their amazing and elaborate building programs with such crude hammers as stones held in the bare hands, but there is no evidence that they ever had anything better during the height of their ancient power and culture. For much of the work, the wooden mallets must have been made to do the work of hammers. The Egyptians, however, were not alone in their backwardness with regard to the hammer. In many parts of the world where copper and bronze were extensively used for tools, the metal hammer was never developed until long after the Bronze Age had passed away. In contrast to Childe's statement that is cited on the preceding page, to the effect that the Greeks had a variety of hammers, all made of iron, Wyatt says that the Greeks must quite generally have used the hammer made of stone,

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[11] Hibben, op. cit., p. 128.

although a few iron ones quite similar to the Italian bronze hammer have been found in Greek excavations; but they are all small—hardly more than tack hammers in size.[12]

After about 1500 B. C., heavy bronze hammer-heads with a hole for the handle like modern sledge hammers, began to replace the stone ones in use earlier.[13] In the ruins of Pompeii and Herculaneum, many "claws" for pulling nails have been found as separate and individual tools, and the specimens of hammers found in these ruins were used solely for driving nails. The claws were forked pieces of metal, very much like the claw on the modern hammer. They were curved so as to provide leverage for the pulling of nails, and had handles of metal a foot or sometimes as much as two feet in length. In other parts of the Roman state, however, the claw was sometimes combined with the hammer, just as modern claw hammers perform both functions of driving and pulling nails.[14] Crude hammers made of iron, with claws attached, have been found at the sites of ancient Roman army camps. Roman claw hammers and some plain hammers had holes in the head providing for the insertion of the handle.[15] Apparently, the Romans were the first people to develop the hammer as a specialized tool for

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[12]Wyatt, op. cit., p. 11.

[13]Childe, op. cit., p. 11.

[14]Hibben, op. cit., p. 155.

[15]Durbahn, op. cit., p. 16.

performing different functions. Earlier hammers had been blow-striking implements that could serve as weapons as readily as tools. Some of the Roman hammers were the first to combine the nail-pulling claw with the nail-driving head,[16] and thus they were the first hammers which began to take on the appearance of the modern tool.

Whereas the Roman claw hammer had a hole in the head to provide for the insertion of the handle, the claw hammer of medieval Europe lacked this hole in the head. Perhaps this was because the Roman hammers were rather thin in comparison with modern hammers, and the hole for the handle was small; consequently, the handles probably broke rather often under the impact of heavy blows. The medieval hammer, on the other hand, had been widened and thickened, and very closely resembled the present-day claw hammer except that the face or striking surface was usually square or rectangular, instead of round, which is the most common form today. These medieval claw hammers, like some of the earliest ones made in Colonial America, had no hole through the head for the insertion of the handle, but instead had thin iron plates extending upward from the head, one on each side.[17] Between these iron plates the handle was riveted securely, the end resting snugly against the solid hammer-head, between the plates.

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[16]Wyatt, op. cit., p. 11.

[17]Durbahn, op. cit., pp. 16-17.

The hammer, somewhat enlarged and equipped with a semi-circular flange instead of claws, opposite which was a heavy and massive striking surface, became popular as a hand-weapon during the Middle Ages. Fastened to a long shaft or handle, it was used by infantry in attacks and for breaking their way through fortifications. Also, it was particularly effective when employed by infantry against mounted troops. With a short handle and usually made altogether of metal, it was also used by cavalry as an implement of warfare.[18]

Although the claw hammer, ever since its invention, has been a most efficient tool, the history of its development is fragmentary, so far as the records disclose. These gaps in the history of the claw hammer are suggestive, since all carpenters would necessarily use a hammer of some description, but they would have no use for a nail-pull on their hammers unless they used nails. Hence, in China, where, until recent times, wooden pegs generally were used instead of nails, the claw hammer has only recently become established as a carpenters' tool, although it was used much earlier by shoemakers for extracting nails from shoes. Evidence further shows that the claw hammer became much more abundant in the nineteenth century, after the revolutionary multiplication of nails cut by machinery had done away with the expensive and relatively scarce hand-forged nails previously

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[18] Encyclopaedia Britannica, 14th edition, XI, 132.

used. In like manner, the use of the claw hammer appears to decline steadily the farther we go backward into the time when cheap wooden pegs were common and expensive hand-wrought nails were rare.[19]

An old claw hammer discovered in the ruins of Fort Ticonderoga, New York, was very much like the medieval hammer, indicating that early American hammers were made according to patterns developed earlier in Europe. The Ticonderoga hammer had riveted to the sides of the handle a pair of iron straps that went through the end as a part of the handle and thus strengthened it at its place of greatest strain.[20] This arrangement differed from the medieval European hammers in that the handle extended through a hole in the head, whereas the European tools did not provide for the handle to enter the head at all but to be supported entirely by the iron flanges which were riveted to it. These supplementary iron braces, whether forged onto the hammer-head as in Europe or extending through the hole in the head as in Colonial America, were hard to replace if the handle should break, and apparently they were not much used on American tools, as relatively few examples of this type of hammer have been found in the United States.[21]

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[19]Henry C. Mercer, Ancient Carpenter's Tools, p. 264.

[20]Wyatt, op. cit., p. 12.

[21]Mercer, op. cit., p. 266.

Such hammers, however, were very common in Europe during the Middle Ages, as we have noted, and continued to be popular in some countries until rather recent times. Typical of these tools was the so-called "Canterbury Hammer" which had side plates between which the handle was riveted. These plates were very much like those on the Ticonderoga hammer except that they were forged as a part of the head. An early sixteenth-century painting, "Melancholia," by the famous German artist, Albrecht Durer, has in it a carpenter's hammer of almost identical form. Museums in all parts of Europe have extensive collections of such hammers, dating back to medieval times.[22]

In addition to sledge and claw hammers, early American blacksmiths made hatchets for shingling wooden laths and for cutting the laths to be shingled. These pioneer hatchets were almost identical to those in use today for the same types of work. They even had the notch on the lower edge of the blade which is used for pulling nails. In Europe, carpenters had hatchets similar to these, but they were used primarily for lathing and only seldom for shingling, since most roofs in Europe were made of tiles, thatch, or slate instead of shingles.[23]

Apparently, no hammers made before the nineteenth century had the deep eye for holding the handle, such as has now become universal

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[22]Wyatt, op. cit., p. 12.

[23]Hibben, op. cit., p. 198.

by means of an elongated shank which serves to strengthen both the hammer and the handle and to prevent breakage at what was formerly the weakest point in the tool.[24] This so-called deep or adze-type eye that holds the handle so strongly and securely that the handle seldom breaks or comes loose from the head is the distinct difference which the modern claw hammer has in comparison with all ancient hammers. This improvement was made more than a hundred years ago by David Maydole, a blacksmith, in his shop at Lebanon, New York, back in the early thirties of the last century.[25] Becoming disgusted with the old hammers because of the frequency with which their handles would break or come loose, Maydole began to experiment with improvements on the hammer. When he made his first adze-eye hammer, he decided that he had made the best hammer that had ever been made up to that time. He used it successfully in his blacksmithing, and showed and demonstrated it to his neighbors and friends. Soon they began to want him to make hammers for them like the one he was using in his shop. He did so in his spare time, and before long hardware stores in neighboring communities were asking him to make hammers for them to sell. Within a few years the demand had become so great that Maydole quit blacksmithing entirely and devoted all his time to making adze-eye claw hammers. He employed men to help him in his little blacksmith

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[24]Mercer, op. cit., p. 267.

[25]Wyatt, op. cit., pp. 12-13.

shop, and soon built a small factory. This plant has continued to grow until it has long since been the largest hammer factory in the world. Thus the village blacksmith who made the first modern claw hammer soon was the head of a great factory which has been making, ever since, what David Maydole called to his dying day "the best hammer that's made."[26] Although other factories are now making the same type of hammer, the Maydole design is still recognized as the best hammer ever invented.

Modern hammers are made in a variety of shapes, the most common and the most in demand being the claw hammer. This and the shoemaker's hammer have not altered their shapes appreciably for hundreds of years.[27] The numberless effects which are due to its remarkable force of impact have made the hammer a necessity in all trades. Immense factories, employing thousands of men, are grinding year in and year out, making hammers, while ten times as many wholesale houses are busy putting their products on the market. The industry has advanced to such a stage that many general hardware firms in the United States have thrown out the hammer, leaving it to the business firms that deal in tools exclusively.[28] Thus, the hammer has become the recognized necessity as a valuable tool in many lines of work in addition to

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[26]James Parton, A Captain of Industry, the Story of David Maydole, pp. 3-7.

[27]Encyclopedia Americana, 1942 edition, XIII, 664. [28]Ibid.

woodwork, and the size, shape, and design of the hammers may vary according to the uses to which they are to be put. All types of hammers are made in America today. They range in size from the little tack hammer which weighs only a few ounces and is indispensable in home, store, and factory, to the twenty- or thirty-ton hammer, driven by steam or electricity, and used for making immense forgings.[29] They are all hammers, but how different they are!

> Of course, modern hammers are better than ancient ones in other ways than shape. This is especially true of the materials of which the modern tool is made. No one would consider an iron hammer, either cast or wrought, a good one now. We expect a hammer to be of steel especially selected for hammer manufacture, and this steel skillfully hardened so that it will neither yield nor break. We expect a hammer to be beautifully polished and to have that essential quality of suitability to use in the human hand that we call balance. These are the developments of many unlisted research engineers whose combined efforts give the woodworker of today, a tool for one dollar that a vast fortune could not have purchased a hundred years ago.[30]

Thus, it becomes apparent that the hammer has undergone various changes in shape and in the materials from which it has been made. The modern tool, in its various sizes and shapes, adapted to many uses, is a far cry from the ancient pounding implement which was made of a rounded or chipped stone. The hammer, like everything else, has experienced evolutionary development through centuries of time.

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[29] Ibid.

[30] Wyatt, op. cit., p. 13.

CHAPTER IV

THE AXE AND ITS EVOLUTION

The axe is probably the oldest of the cutting tools, and for thousands of years it was the one most used. But today the axe is seldom employed by the carpenter unless he has to clear trees from the site where he intends to build a house.[1]

> Like the knife, adz, chisel, and hoe, the forerunner of the ax was doubtless the humble all-purpose stone celt —a stone chipped or flaked by primitive man to a sharp-edged disk, and held in the bare or padded hand for all kinds of digging, scraping, and cutting. It became an ax when man learned to affix to it a wooden helve or handle by which he could increase its impact in cutting. We should not overlook in passing that the helve was one of man's greatest inventions. These first stone axes seem crude, rough implements to us, but the primitive men who made them probably considered them quite differently. The helve was a forked, split, or U-bent stick lashed around the stone head with fiber or thongs.[2]

In the Stone Age, wood was split by means of wedges made of ivory or antlers, which were chopped or ground off by stones to form a V-shaped wedge which was driven into the wood by the use of heavy stone hammers or wooden mauls or mallets. Later, blades of flint

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[1] Thomas Hibben, The Carpenter's Tool Chest, p. 45.

[2] Edwin M. Wyatt, Common Woodworking Tools—Their History, p. 14.

or polished stone were inserted into antlers and used as wedges. This innovation may have led to the development of the axe for chopping. The stone axe-head might be attached to a wooden shaft by the use of leather thongs bound tightly around it, or with the aid of a perforated section of antler; or it might be inserted directly into the split end of a wooden shaft and bound securely with thongs or plant fibers.[3]

When primitive man found, or made, a wedge-shaped stone with a more or less sharp edge, and when he had fitted it with a handle, he thereby invented the axe. By fastening a handle to a stone axe-head with leather thongs or tough plant fibers so that the cutting edge was at right angles to it, early man converted the implement into a new and useful tool which is now known as the adze, used for stripping bark from logs and for smoothing timber. Since the passing of the pioneer log cabin in America, however, the adze is little used in civilized countries; for the stripping of bark and the smoothing of lumber are done by machinery, for the most part. Another adaptation of the same idea was the hoe made of stone, invented by primitive man as an aid in tilling the soil.[4]

The chipped flint of the oldest Stone Age was a tool of all work, used to crush, dig, or cut, as the need arose; it was too heavy and shapeless to be used except by hand. As soon as one of these flints

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[3]V. Gordon Childe, The Story of Tools, p. 26.

[4]A. Frederick Collins, A Birds' Eye View of Invention, pp. 25-26.

was shaped and sharpened to permit the tying of a handle to it for delivering a heavier blow, the axe came into being and was probably the earliest implement to be differentiated from the all-purpose stone pounding implements. So natural a device was separately invented by each race in the early days of its history and made of the materials available: flint in England and America; whinstone or granite in Ireland and among the lake dwellers of the Continent; bone among the American Indians and Eskimos. Axes made of stone are still used by some of the South Sea Islanders who have not been much influenced by the progress of civilization. In all of these cases and virtually until the era of metals came, the handle was secured with a thong or a fiber cord, as piercing the stone to provide a means of inserting the handle was regarded as impractical,[5] although a few stone axes with holes in them have been discovered.

In time, primitive man learned that large pebbles, sharpened on one edge by grinding between pumice stones, could be fitted into a handle of wood or antler to serve as axe-heads or adze blades for chopping, or they might be used bare, without a handle, as wedges or chisels, or, if the edge had been hollow-ground, as gouges. Thus, ancient men discovered ways of doing their work, using the natural equipment which was readily accessible to them.

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[5]Encyclopedia Americana, 1942 edition, II, 681.

> With this equipment they could hollow canoes out of tree-trunks, and even cut short planks and fashion paddles and sledge-runners (some of which have been preserved in peat bogs). Stone tools are quite adequate for this sort of work and might even serve for making rough mortice and tenon joints.[6]

The first step made in improving the stone axe was to peck or grind the stone head into a smoother and sharper implement. In doing so, a shallow groove was made around it to hold the helve securely. The helve was split so as to fit into the groove and projected beyond the head, then was fastened securely by thongs or fibers. Most of these stone axe-heads were made with a flat top or hammer poll, so that one side of the blade would serve as an axe for chopping, while the other would function as a hammer for pounding or killing. Stone axes like this were made by primitive people all over the world. In the days of Homer, the Greeks were using them 900 years before Christ;[7] the American Indians were using them when the white men came to these shores; the Eskimos are using them today.[8]

One of the strangest ways of making an axe during the Stone Age was to set small pieces of flint or flakes of obsidian in a groove in a wooden stick filled with gum. When the gum hardened the splinters of stone were held tightly in place, and the axe was very sharp. Obsidian,

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[6]Childe, op. cit., p. 7.

[7]Walter E. Durbahn, Fundamentals of Carpentry, Vol. I, Tools—Materials—Practice, p. 17.

[8]Wyatt, op. cit., p. 14.

or black volcanic glass, is found in many places in the world—often in quite large pieces and sometimes as whole mountains or cliffs. Primitive man could split and shape it in much the same way as flint by pressing on the edges with a bone, wood, or stone chisel. Splinters of obsidian are very sharp, and were often used as knives by primitive peoples. Eventually men learned how to bore holes through very hard stone, and made their axes, adzes, and hammers with holes in them for handles, although the hole was seldom found in axes of the Stone Age. These were the best tools made by the people of the Stone Age. Excavators have found many such tools that are very beautiful, so perfectly are they formed and so finely is the stone polished.[9]

Excavations into the remains of primitive civilizations have revealed two or three tool forms that stand out and that occur again and again with very little variation at a vast number of sites in Western Europe, Africa, and southern Asia. Their makers, who are thought to have lived from 50,000 to 100,000 years ago, obviously were trying to copy recognized standard patterns which perhaps originated in almost identical forms in numbers of places around the world. Collective experience of the groups had demonstrated that particular tool shapes were most suitable for recurrent jobs and had evolved a regular method for reducing shapeless chunks of natural stone to these forms.

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[9]Hibben, op. cit., pp. 98-99.

Thus, the form and method of manufacture became standardized and were maintained by social tradition, being handed down from generation to generation. Consequently, the individual was saved the time and trouble on each occasion of pondering about what type of tool he wanted and how to acquire it.

Archeologists call all of these first standardized tools "hand-axes," but no one today is certain as to their exact use. They could readily have served for cutting, digging, scraping, and stabbing—very likely they were used for all of these purposes and possibly for others as well. Among the primitives, a hand-axe was a sort of universal tool of all work, an unspecialized instrument.

Ancient man learned to make standardized tools of several different shapes, each specialized to a more limited range of uses than was the hand-axe, also a standardized tool. For instance, thin triangular pieces of flint with two trimmed edges converging in a point could be used for knives, but also as spear-tips that would pierce the hides of mammoth and rhinoceros, both highly prized as food by primitive man; and D-shaped flints sharpened along the convex side only would be handy for cutting, for scraping skins, and for other similar purposes.[10]

In the latter part of the Stone Age, known as the Ground Stone Age, the people were able to make axes that would cut almost as sharply and

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[10]Childe, op. cit., pp. 3-4.

clearly as a modern axe, for they had learned how to grind and polish their stone tools, thus giving to their period of history its name of Ground Stone Age. Sometimes they used sand and water for polishing and grinding the edges of their tools, or they might use coarse sandy stones that would wear down the surface. In this way they made good stone axes, chisels, and gouges with which they hollowed out tubs and bowls and canoes, although their larger boats were still made by burning out the center of a log with fire.[11]

When the people of the Ground Stone Age learned how to put handles on their axes and adzes and hammers, their work became very much easier. Such a thing as a handle on a tool seems to be a very simple thing to us, because we have always been accustomed to having tools with handles; but to prehistoric man, who before the latter portion of the Stone Age had never known about handles, this simple supplement for his tools proved to be a highly significant invention. A handle or helve on an axe changed the whole work of cutting through a log from a long and tiresome task to a job that could be done much more quickly and effectively. The power of the stroke was multiplied many times by the leverage provided by the handle. Axe and adze heads were put on handles in different ways. One method was to bind them on securely with withes of willow or strong branches, or with leather thongs. These

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[11] Hibben, op. cit., pp. 96-97.

were wrapped around the stone, twisting the ends until the stone was held fast. Another method was to strap the handle onto a shaft of bone or wood with thongs of leather. In some places the stone was set into a wide wooden handle or even extended through it. Among other peoples, holes were bored through the wooden handle, and through these holes thongs were threaded around the stone until it was held fast.[12]

All products chipped out by the use of these early axes made of stone were, of course, crude and rough-hewn, bearing the marks of the cutting instrument and being far from uniform in thickness and degree of smoothness.[13] The important factor, however, was that man had learned to make tools that would render his labor easier, more productive, and more effective. He had started on the long journey of invention which has not yet been completed—a journey that has, through the countless centuries, brought to man greater efficiency, many types of progress, and untold comforts and conveniences.

During the Copper Age, man learned to beat native copper into much the same types of tools that his ancestors had made of stone. At first, he altered the shape of the axe hardly at all, and continued to helve it with thongs or fibers, as had been done with the earlier axes made of stone. Eventually, though, as he learned that the copper axe

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[12] Ibid., pp. 97-98.

[13] R. J. Forbes, Man the Maker, p. 34.

was a better tool than the stone implement, and as he came to depend upon copper for many uses, he slowly modified the shape of the axe-head and the method of fastening it to the helve. The T-shaped axe was developed in widely separated parts of the world—in Egypt and in Peru, for example. In Peru it was always made of copper, but the Egyptians kept the same form after they had learned to cast it of bronze and forge it of iron.[14]

Although copper and bronze axes at first closely copied those made of stone, there was the difference that the blades of the metal axes tended to be somewhat splayed, thus affording a larger cutting edge. This spread-out blade was at first the result of hammering the metal casting to produce a sharp edge while the casting was still hot and workable; but later, when the greater efficiency of the expanding cutting edge was recognized, the splay was enlarged and incorporated into the mold in which the casting was made. At first these metal axes were inserted into split wooden handles, like their stone predecessors, and bound securely to the handle with thongs; but later, after about 3000 B. C., copper and bronze axes were provided with shaft-holes in the head, into which the handle might be inserted, like modern axes. These shaft-holes were made during the process of casting the metal in the axe-molds.[15]

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[14]Wyatt, op. cit., p. 16.

[15]Childe, op. cit., p. 26.

> . . . when casting had become familiar, it was seen that there was no difficulty in casting a hole to thrust the handle in, making a much surer and heavier stroke; and with this "eye" the modern axe appeared. The bronze axe was lightened and better shaped, and in its turn displaced by iron, for which, with the progress of invention, has been substituted an iron butt inset with a steel cutting part.[16]

It is believed that the Sumerians of Mesopotamia invented the art of writing, and it is certain, in the light of present-day archeological research, that the first bronze tools appeared among these people, who perhaps developed the first great civilization of the world, which had already disappeared and was forgotten while England was still in the Stone Age.

The Sumerians experimented with making tools and weapons of either copper or tin, but those implements were usually too soft to be practical. Through a long period of experimentation they discovered that a little tin mixed with copper would produce a metal that was very hard and that would make tools strong and sharp. They even decided that the best mixture is one part of tin to nine parts of copper, which is the ordinary way that bronze is made today. So expert did the Sumerians become that their smiths produced the finest workmanship known to the ancient world.

Among the Sumerians, their most interesting tool was their axe, which had a hole for the handle through the head parallel to the blade, just as modern axes do. This pattern was unusual for that ancient

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[16]Encyclopedia Americana, 1942 edition, II, 681.

day, since most people of the Bronze Age did not use this method for inserting the handle into the axe-head. In order to make these holes through the head, the Sumerians had to learn how to do what is now called core-casting. When people of the Bronze Age first began to make castings, they could make only such simple tools as could be cast in molds cut into stone. These were necessarily very flat tools, like those previously shaped from flint. Eventually, however, some of the ancient peoples learned to cut half of the mold in one stone and the other half in another. Then, when these stones were put together so that one mold fitted exactly over the other, they could pour the metal in at the top and make much larger and better tools. Of course, they had to trim off the edges where some of the metal would run out between the stones, but it was a good method very much like that which is in use today for certain types of castings. This method did not provide for leaving any hole for the handle because, when the molten metal was poured in, it filled up the whole mold solid. To remedy this situation, Bronze-Age smiths invented cores. They would make little cylinders of clay and put these in the axe-head molds just where they wanted the hole to be. When the metal was cool, they would remove the casting from the mold and knock out the piece of clay, which left a hole for the handle.

Later, the Sumerians developed still another way of making their castings which was even better. They would make a mold of wax exactly

like the tool which they wanted to cast. Then they would cover the wax model with several coats of wet clay until they had built up thick walls all around the model, leaving one hole from the outside into the wax. Then they would heat the clay until the wax all melted and ran out, leaving a perfect hardened mold of clay ready for metal to be poured in to make a tool. Now it was easy to draw patterns and designs in the wax which would be reproduced in the clay mold and also on the surface of the metal tool. It was only natural, then, that the Sumerians began to make tools with beautiful decorations on them. Of course, they had to break the clay mold in order to get the new tool out, and they had to make a new wax model and clay mold for every tool made, but it was a very good method that they developed, nevertheless, and one still widely in use today. After the tools were cast, the rough edges were trimmed, and the cutting edge sharpened by beating while the metal was still hot. Not only axes but also many other tools were made in this manner.

As the art of casting metals developed, the Sumerians had to have more and more copper and tin. No longer was it possible to obtain enough of these minerals from the ores they could find on top of the ground, so they learned to follow the veins of ore into the earth, digging mines far below the surface. They began to go farther and farther away from home in search of copper and tin, using large cumbersome wagons for overland travel and building ships for voyages

across water. In either case they always took loads of products from their country to trade for the copper and tin which they sought elsewhere. One group of Sumerians became known as the Phoenicians, the greatest sailors of the ancient world, who sailed as far as England and Ireland in search of ores and markets for their wares.[17] This long journey represented an amazing undertaking for those prehistoric days, since it involved sailing from the eastern end of the Mediterranean Sea all the way to what are now the British Isles.

The Egyptians early made use of bronze implements for felling trees. They used both axes and pointed saws. They used bronze axes for felling trees, but these implements had no hole into which the handle could be fastened. Instead, their bronze axe-heads were bound to the handles by leather thongs or strong cords made from plant fibers in the same way that stone axes had been secured to their handles. Not only were bronze axes employed by woodsmen in cutting trees, but also the carpenters and joiners of ancient Egypt—even as long ago as 3500 B. C. —used bronze axes for woodworking activities, the heads being tied to the wooden or bronze handles by leather straps.[18]

Several kinds of axes made of bronze were known to the Egyptians of the ancient world. One type that was very common had an extremely flat head and was long and slender like a very thin celt. Others were

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[17]Hibben, op. cit., pp. 114-120.

[18]Albert Neuburger, The Technical Arts and Sciences of the Ancients, pp. 68-71.

flat and nearly square, and still others were almost semi-circular. At first, the blade was pushed into a slot in the handle, but later holes were bored along the rear edge so the blade could be lashed to the handle with leather thongs or fiber cords. Sometimes, too, lugs were left sticking out on each side of the axe-head, by means of which it could be tied to the handle. Axes of ancient Peru, halfway across the world from Egypt, were likewise made in this manner. Shaft-holes in the head like those of the Sumerians in Mesopotamia were very late in coming to Egypt. There were none at all, apparently, in the Bronze Age and very few even in the Iron Age.[19]

In addition to the simple single-bladed copper and bronze axes which were so common during the Bronze Age, after about 3000 B. C. double-bladed forms were made, especially in Greece and Crete. These more complex forms of axes provided combinations of axe and adze, axe and hammer, or axe and pick, the form of the blade opposite the cutting edge depending upon the purpose for which it was to be used. After 1000 B. C., all of these forms could be reproduced in iron, and gradually replaced the unperforated forms in which the blade was fastened to the handle with thongs or fibers. The principal subsequent development consisted of the extreme widening of the cutting blade as in the Roman woodsman's axe.[20]

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[19]Hibben, op. cit., p. 128.

[20]Childe, op. cit., p. 26.

On the island of Crete in the eastern Mediterranean, ancient civilization flourished during the Bronze Age. Large cities grew up, and the crafts became highly specialized. Smiths became so expert that their bronze tools and other products were in great demand among the people of Greece, Egypt, and Asia Minor. Enormous palaces were built, sometimes whole towns living within their walls; and many of the homes were two stories in height, made of stone and sun-dried brick, but utilizing much wood also in beams, doors, and timbers.

The Cretan carpenter was a skilled workman who had excellent tools with which to work—both long and short saws, heavy chisels, awls, nails, files, and axes—all made of bronze. A peculiar tool that the Cretan used was the double axe, so-called because it had cutting edges on each side with the handle in the middle, like the double-bladed axe most commonly in use today in the United States. Axes of this type were found in ancient Hungary and Etruria, in Nineveh, and among the Indians of the Americas. In America, some of these double axes were made of copper, but usually they were cut from soapstone, which is so soft that axes made of this material must have been used in the ceremonial rites of the Indians instead of for cutting wood.[21]

> . . . Among . . . latter Bronze Age peoples, particularly in western Europe, there developed a peculiar kind of ax which was quite different from the axes of Sumer and Egypt. It is called a palstave. At first copper and bronze celts were thrust into slits in sticks of wood, just as was

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[21] Hibben, op. cit., pp. 131-132.

> done everywhere in the beginning. Then the toolmakers found they could make a better handle by using a branch with a knot on the end. They split the knot and tied the celt in place with thongs. But in cutting hard wood the celt would be driven back into the knot and split it so that the blade would come loose. Then they tried hammering the sides of the blade until wings were made that stuck out and these were lapped around the knot and held it together better. But still it wasn't satisfactory, so they tried another way. This was to have lugs stick out from the face of the blade between the wings. Now the head of the celt could not split the knot, for the lugs held it in place. Finally, when they had learned core casting, they made their palstaves like large wide-socket chisels. A stick shaped like a cane was used for the handle, the short leg being thrust into the socket. Then to hold the head firmly in place they cast rings on the sides of the head and through these lashed it back to the handle. Adzes were made in the same way, except that the blade was turned so that it cut flat along the surface of the wood.[22]

As late as the age of Homer, about 850-800 B. C., stone axes were still in use to some extent among the Greeks for felling trees and cutting off branches, although axes made of iron or bronze seem to have been far more prevalent than those constructed of stone—a fact substantiated by the Iliad. With the use of such crude instruments the procuring of wood must have been a very laborious undertaking. The Grecian and Roman axes made of bronze and iron had their handles stuck through a hole in the axe-head. These handles usually projected an inch or two on the other side of the axe-head and appear to have been fastened securely to the head by means of wedges driven into the protruding end of the handle.[23]

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[22] Ibid., p. 141.

[23] Neuburger, op. cit., pp. 68, 73.

Although Neuburger has stated that the Greeks as well as the Romans had holes through their axe-heads for the insertion of the handle (see the above paragraph), Wyatt is certain that the Romans were the first people to "put an eye" through the axe-head.[24] When authorities fail to agree on a point, one finds it difficult to determine what is the actual truth in the matter. At any rate, it is known that the Romans did have handle-holes in their axe-heads, and, apparently, so did the Greeks! It is possible, of course, that the specimens of "eyed" axes found in Grecian excavations were relics of the Roman occupation of Greece and of Roman origin and not actually Greek axes at all.

Durbahn agrees with Wyatt that the Romans contributed the eye and the double blade to the development of the axe. The double-bladed woodcutting axe of the Romans was later developed into the English joiner's hatchet, an unbalanced and often fantastically shaped tool, always with the handle inserted in a through-eye and usually with a large, gracefully curved, semi-circular, single blade.[25]

Roman axes found in the ruins of Pompeii and Herculaneum had very wide blades curving back to a small socket for the handle.[26] So large was the blade and so small was the handle that one wonders whether the handle of these axes frequently snapped under the weight

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[24]Wyatt, op. cit., p. 16.

[25]Durbahn, op. cit., pp. 17-18.

[26]Hibben, op. cit., p. 154.

of the large and heavy blade. Apparently, the Romans felled their trees in much the same way as this work is done today, when power machinery is not utilized. They chopped notches out of the trunk with axes until the tree could be pulled down with ropes.[27]

Instead of squaring and smoothing their timbers with the plane and the adze, medieval carpenters employed the axe. For this purpose the logs were elevated on wooden horses, and the workman, standing beside them, hewed them straight and smooth with the axe. The blade of these axes—which were adaptations of the Roman axe—was very long and straight, with the head turned outward slightly from the handle so the workman would not hit his knuckles on the side of the log as he cut it into a square. In order to cut timbers in this manner, great skill must have been required. Carpenters of this period also used a long-bladed, short-handled axe as a chisel.[28]

During the Middle Ages the axe became a popular and effective implement of warfare, especially among the Franks, who often mowed down their enemies by the skillful wielding of their extremely sharp axes with great semi-circular blades, mounted upon the ends of long handles. Many beautifully forged specimens of battle axes have survived, but these hardly deserve more than mere mention in this story of axes used by the worker in wood. In medieval times, the woodcutting

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[27]Neuburger, op. cit., p. 69.

[28]Hibben, op. cit., pp. 180-183.

axe lost the double-bladed form that the Romans had developed, and became a quite unbalanced, often fantastically shaped, tool.[29]

Apparently, the first axes used in America were the long-headed, rounded-poll, straight-helve type, which were made by forging a piece of iron around an iron eye form. Many of these axes were imported into the Colonies for sale to the Indians up until about 1740, and the early settlers had brought this same type of axe to the New World on the Mayflower and used it to good advantage in clearing the land of virgin forests in preparation for growing crops.[30] It was a form of axe that had existed in most sections of Europe, with little alteration in form, for hundreds of years. Axes of almost identical pattern have been dug up in the ancient mounds of Ireland, where they must have lain buried for at least two thousand years. Some of these ancient axes varied in the flare of the blade or in other minor details, but none of them resembled to any appreciable degree the square-poll balanced tool which is universally in use today among civilized peoples.[31]

Since the axe is primarily the woodsman's tool, it was to be expected that the American frontiersman, who lived in or near the forests and cleared and cut wood nearly every day of his life, would make improvements in this tool which he used so much. Such was the case.

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[29]Wyatt, op. cit., p. 16.

[30]Henry C. Mercer, Ancient Carpenters' Tools, p. 3.

[31]Wyatt, op. cit., pp. 16-17.

Axe-heads made in America became shorter in the blade and were much better balanced tools than those used in Europe at that time. Also, American woodsmen learned to curve and shape their axe handles so that the tool was easier to swing. Many different shapes of axe-heads were made by American blacksmiths, who used steel for the cutting edge. They would take two blocks of iron and place between them an iron core for the handle hole. They then would forge them together with a strip of steel at the edge. After this was sharpened, the axe was as fine a tool as could be desired.[32]

By the middle of the eighteenth century (around 1750), the Americans had developed an axe which had a solid-iron rectangular or square, flat-surfaced maul or poll at one side of the axe-head for pounding and driving. Americans also shortened the axe blade in order to give it a better balance on the handle.[33] By the time of the Revolutionary War, the American axe-head was virtually the same in form and shape as it is today. What changes the axe has undergone since that time have been largely the result of making this tool mechanically in factories.[34] Thus, our modern axe is the product of machinery installed in axe factories, whereas the older tool was hand-forged by smiths. This new

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[32]Hibben, op. cit., pp. 197-198.

[33]Durbahn, op. cit., p. 17.

[34]Wyatt, op. cit., p. 17.

method of making axes dates from about 1840. Curved axe handles, probably suggested by the turning of gunstocks, were first made commercially in 1853 in Warren, Massachusetts, by Aaron and Obert Blanchard, who did this work on a new type of lathe that had been developed for turning gunstocks. Before this time, all commercially made axe handles had been straight, although some woodsmen who made their own handles had discovered that curved handles were much better and more easily manipulated and were, therefore, providing themselves with curved helves. Now, curved handles could be manufactured as cheaply as straight ones, and nearly all men who wielded axes preferred them to the old style.[35]

About the time of the change in the axe helve, some daring manufacturer revived the old Roman idea of a double-bladed axe. It became quite popular in America and has been on the market ever since. No other country, however, uses the double-bladed axe, which is by far the most popular style in use in America.[36]

Perhaps this discussion should contain a word about the axe's close relative, the hatchet. This tool, like the axe, came out of the Middle Ages without a poll. When the axe later was balanced by the addition of a square poll and when its blade was shortened by the Americans, the hatchet, too, changed its appearance. It no longer

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[35]Ibid.; also, Durbahn, op. cit., p. 17.

[36]Wyatt, op. cit., pp. 17-18.

looked like a meat cleaver, since now it was given a broad blade beveled on one side only, thus making it suitable for hewing out wooden pegs or "treenails" and equipped with a heavy square poll for driving them.

About 1830, when sawed lumber came into general use and metal nails began to replace wooden pegs or "treenails," the hatchet underwent another change. The blade was not so important now, and it became beveled on both sides for miscellaneous purposes. The poll was altered in such a way that it was suitable for the driving of nails, and some provision was made for pulling nails—either a claw was placed on the back side of the poll or a notch was cut in the blade.[37]

Within the past century the most important change in the axe and in the hatchet has been to make them entirely of steel. For ages, the main part of the axe-head had been made of iron, and the steel blade had been welded or forged into a split in the head. This procedure produced an axe that would not break except under extreme circumstances, but it did become deformed when it was subjected to hard usage. When the steel blade had been ground away by repeated sharpenings, the axe would no longer hold an edge sharp enough for effective cutting. The all-steel axe was first put on the market in 1911 by the firm of Fayette R. Plumb, Inc. The all-steel hatchet had made its appearance several years earlier. Now all of the better axes and

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[37] Ibid., p. 18.

hatchets are made wholly of steel, properly tempered for providing hard cutting edges and for toughness about the eye.[38]

In the United States, the manufacture of axes at the present time involves, first of all, cutting the butt from a piece of white-hot steel. Then the eye for the handle is punched, and the butt is reheated and shaped into the desired form by subjecting it to great pressure between concave dies. Then it is reheated for a third time and beaten out to a proper edge by trip-hammers. This work is done while the steel is at a white heat. The next process is that of hammering off the implement by a combination of hand and machine work and restoring the shape lost in drawing out the edge. The axe-head is then ground into symmetrical shape, hung on a revolving table in a furnace and heated over a small coal fire at a red heat and then cooled in brine and later in fresh water. Then it is removed to another furnace, where it receives the last heat treatment. It is next polished to a glossy finish that exposes every flaw that may be within it; if a flaw is found, the axe-head is discarded and melted again and carried through the same processes. If no flaws appear, the polishing technique is continued until the metal is as smooth as glass. This polishing procedure enables the axe to resist rust and to enter wood more easily. The head is next painted to prevent rust; then it is weighed, labeled, and packed for sale.[39]

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[38] Ibid., pp. 18-19.

[39] Encyclopedia Americana, 1942 edition, II, 681-682.

As has been indicated previously,

> The ax is one of man's oldest tools; it has gone through a good many steps in its evolution, but its evolution has been an evolution of refinement, not of the principle on which it works. The man who first lashed a stick to a stone celt to ease the blisters on his hands, and then discovered his celt cut faster with its new handle, was the greatest contributor in all history to the evolution of the ax. All improvements since have been but refinements of his invention.[40]

Thus, it becomes apparent that the axe, too, along with other hand tools, has undergone a long process of evolution from its earliest crude forms to its present high state of efficiency and durability.

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[40]Wyatt, op. cit., p. 19.

CHAPTER V

THE SAW AND ITS EVOLUTION

Although the hammer is an extremely useful tool, the whole modern industrial development of the present day would probably have been impossible without the augmented hand known as the saw. Van Loon has defined the saw as "a most cunningly devised implement for increasing the tearing power of the bare hand."[1] The encyclopedia is somewhat more technical in its description of the saw, but it adds little to the fundamental and vivid definition of Van Loon:

> A saw is a tool consisting usually of a thin, flat blade of highly tempered steel serrated or having a series of triangular-shaped teeth usually on one of the edges, but sometimes on both edges. It is one of the most important of the various forms of cutting tools and is extensively used for working wood, metal, stone and other substances, but principally wood.[2]

In all probability, the first saws ever used by man were scallop shells, and the second were perhaps nicked stones. Although primitive man probably used such crude tools, he may have thought of them as badly dulled knives. There is considerable evidence that the saw developed from the knife, but from a bronze one—not from a tool of

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[1]Hendrik Willem van Loon, Man the Miracle Maker, p. 85.

[2]Encyclopedia Americana, 1942 edition, XXIV, 334.

the Stone Age. As far as is known, according to Wyatt, the Egyptians were the first users of the saw. They had these bronze tools as early as 4500 B. C.[3]

There is, however, some disagreement on this point, as Collins points out that, next to the axe and the knife, the saw is the earliest and most ancient woodworking tool to have been invented. He discounts the idea that the first saws were bronze implements, and says that in all probability, the first saws were made from the jawbones of snakes or the backbones of fishes. Certain ancient Greek historians ascribed the invention of the saw to certain of their contemporaries, but there is little doubt that the saw in its primitive forms, made of bone and stone, antedated the Greeks by a hundred thousand years or so. Recognizable figures of saws have been found on some of the oldest Egyptian monuments constructed thousands of years before the rise of Greek civilization. Saws used in ancient Greek and Roman carpenter shops were very much like those in use today, as is verified by discoveries in excavations in various parts of the Greek and Roman worlds. The early Chinese also used saws.[4]

One of the world's largest manufacturers of saws, the Henry Disston and Sons Company of Philadelphia, recognizes the fact that

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[3]Edwin M. Wyatt, Common Woodworking Tools—Their History, p. 20.

[4]A. Frederick Collins, A Birds' Eye View of Invention, p. 27.

the earliest saws, like other tools, were not metal at all, but were made of bone or stone. This company's research specialists have written an interesting account of the earliest saws known to man, as follows:

> Long before the dawn of history, the saw was being used in every part of the inhabited world. It is one of man's most ancient tools, and antedates civilization by many thousands of years. Remains have been traced back to the days of the hairy mammoth, wooly rhinoceros and saber-toothed tiger, all of which have long been extinct.
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> It seems reasonable to believe that the first saws were discovered rather than invented. When ancient man wished to cut a bone or stick of wood, he probably reached for the nearest sharp-edged stone. By drawing it back and forth across the object to be severed, he discovered that its cutting action was due to this roughness. Eventually, he looked for more suitable stones, chipped the edges, made the teeth more uniform, and the first fabricated saw was born.
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> Many of these crude saws, roughly shaped from flint, have been found in England and on the European continent. They have also been found in Asia, Australia and the Americas. Regardless of their origin, all bear a close resemblance to each other, differing only in minor details. . . .
>
> Flint saws have been found among the remains of Neanderthal man, who roamed through central Europe about 130,000 years ago. They have been found in caves in France. Many have been dug out of ancient stone heaps in Denmark and Sweden and in the vicinity of the lake dwellings of Switzerland and northern Italy.
>
> America's earliest records of ancient man were found in Folsom, New Mexico. These consist of tools or weapons of flint with ragged edges made by flaking, and closely resemble the ancient saws of Europe. Before Columbus reached America, the Caribs used saws made of notched shells.
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> The oldest saw of the historical era was found in Ur of the Chaldees in Mesopotamia. . . . These blades were made from obsidian, a volcanic glass, and are two inches

> in length. They were made by the Sumerians, a race of ancient Babylon, and the age of the saws has been established at 6,000 to 7,000 years, antedating Abraham by 20 centuries.[5]

Thus, as the Encyclopaedia Britannica points out, it becomes apparent from available evidence that saws date from the Stone Age, when they were formed from flint flakes that were given finely jagged edges. In time, of course, these saws made of stone were followed by implements made of copper or bronze, and much later, by those made of iron and steel.[6]

Notched flints were used for sawing through bones by the hunters of the Stone Age, but blades long enough to serve as carpenters' saws were impossible with flint and could not be provided until the discovery of metallurgy. This fact perhaps explains Wyatt's contention, mentioned above, that the bronze saws of the Egyptians were the first ones known. Apparently, all saws of the Bronze Age were shaped something like present-day butcher knives, with small notches or teeth on one edge of the blade, which was now made of metal; namely, bronze. Frame and cross-cut saws were originated early in the Iron Age before 500 B. C., and usually had raked teeth, though they were all set in one plane.[7]

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[5]Henry Disston and Sons, Inc., Disston Saw, Tool, and File Manual, p. 2.

[6]Encyclopaedia Britannica, 14th edition, XX, 29.

[7]V. Gordon Childe, The Story of Tools, p. 27.

Saws made of metal were first used in the Bronze Age, and probably developed from the knife. The Egyptians, as previously indicated, were the first people known to have used bronze saws. The teeth of these saws were probably hacked with stones, as neither the Egyptians nor the Greeks had metallic files. Later, about 700 B. C., the Romans, who had metallic files, were to begin the use of saws made from iron and steel.[8]

> The early Egyptian saws were but crudely notched flat pieces of copper without handles, although they later learned to put on handles, at times extending the metal for a handhold and other times using wood. They made quite large saws, but it was a long time before they learned to cut regular teeth, nor did they set them out alternately from the face as we do.[9]

Saws used by the Egyptians looked very much like large modern bread knives with tapered blades, straight or slightly bent handles fastened to the blade by a tang, and teeth cut without rake or set. During the later periods of Egyptian history, the teeth may have been cut by iron chisels. As these early saws were without set, it was necessary to use wedges in the kerfs to prevent the saw from sticking to the sides while passing to and fro in the wood. On old tombs and monuments there are drawings and carvings showing Egyptian workmen using these large knife-like saws in ripping out boards from logs elevated upon their ends and held in place by ropes. The Egyptians also had

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[8]Walter E. Durbahn, Fundamentals of Carpentry, Vol. I, Tools—Materials—Practice, p. 18.

[9]Thomas Hibben, The Carpenter's Tool Chest, p. 129.

small saws designed for small work, but they were all very much alike in form. Although the teeth of these saws had no rake, the stiffness of the blade and the tang fastening of the handle indicate that the Egyptian saws probably cut mostly on the push stroke, as do the modern handsaws.[10]

The workmen of ancient Egypt utilized both axes made of bronze and pointed saws for felling and cutting up trees. In making boards from tree trunks, the saw played an important role. The trunk to be sawed was placed upright with an end on the ground and tied securely to a stake set vertically into the ground. Sawing was then commenced at the top of the trunk and proceeded downwards to the ground, the operators of the saw standing on ladders or on platforms having steps of varying height. When the trunk had been sawed a sufficient distance from the top, ropes were tied to the two halves, which were thereby held apart by men on the ground holding the ropes to prevent the sawed parts from pressing together and jamming the blade of the saw. The most commonly used Egyptian saw had straight teeth which were not bent outwards first to one side of the blade and then to the other alternately like modern saws, the purpose of which arrangement is to prevent the blade from getting stuck in the wood.[11]

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[10]Wyatt, op. cit., pp. 20-21.

[11]Albert Neuburger, The Technical Arts and Sciences of the Ancients, pp. 68-69.

Drawings on Egyptian tombs and monuments reveal some interesting saws whose teeth point backward, thus indicating that the cutting action was present in pulling instead of pushing—a method which still prevails in many parts of the Orient, even with modern steel saws. Double saws, held tense with thongs, were used by both the Egyptians and the Romans. These may well be called the ancestors of the frame saw and the farmer's wood saw or bucksaw. Saws with inserted teeth, which are generally regarded as strictly modern developments, may nevertheless be traced back for thousands of years. Researches into the ancient civilization of Egypt have revealed that saws made of bronze, equipped with jewelled teeth, were used by the Egyptians for cutting stone. In Tahiti, the islanders made saws in which sharks' teeth were mounted, and the Incas of Peru sawed granite and other stone with copper bands in which diamonds and emeralds were imbedded, to function as teeth.[12]

Next to those from Egyptian tombs, the oldest saws made of metal which have been discovered are some that were found at Bologna in a heap of old tools evidently gathered together about 900 B. C. None of these saws is complete, but the fragments are of slender blades that must have been used in a frame of some sort. The teeth are raked on one side for one-way cutting, but there is no way of knowing whether

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[12]Henry Disston and Sons, Inc., op. cit., p. 3.

they were intended to be pushed or pulled. The teeth were without set, as were virtually all saws up to that time.[13]

Although abundant evidence proves that the Egyptians were using saws made of metal long before the beginning of Greek civilization, the early Greeks claimed to have invented the metal saw. They insisted that the mythological Perdix got the idea from the jawbone of a great fish. Most saws dating from the Bronze Age have been found in Germany and Denmark, but they appear to have been only slightly better than those made of stone. Perhaps it is because of the inefficiency of bronze as saw material that relatively few bronze saws have been discovered; actually, not more than thirty have been found in all of Europe. An almost perfect saw blade made of bronze was found near the remains of an ancient lake dwelling in Switzerland, and others less perfect have been discovered in various other countries of Europe. In Sweden has been found a stone mould for casting bronze saws.[14]

The little saws made of silex and chalcedony found in the excavations of Troy and other Greek cities probably were used to cut bones and possibly to smooth the surfaces of wood, which was necessary because it was hardly possible to cleave directly through a tree with the crude stone, iron, and bronze axes then in use. As a result, shaped

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[13]Wyatt, op. cit., p. 21.

[14]Henry Disston and Sons, Inc., op. cit., p. 3.

boards were rather uneven, in spite of all the pains that may have been taken to make them as smooth and symmetrical as possible.[15]

Among the Greeks and the Romans, saws were made according to improved and more convenient designs. Some of the saws were built into a curved frame, to which the blades were attached like the string of a bow. Two operators, one grasping each side of the frame, would pull the blade back and forth between them. Other Greek and Roman saws were mounted in rectangular frames in such a way that the blade was set in the middle of the two short sides of the rectangle and parallel to the two longer arms. The blades of these saws were either perpendicular to or parallel with the plane of the frame. Most of the blades had the teeth arranged in a straight line, although some specimens have been discovered in which the teeth protrude slightly in alternate directions, as is true of modern saws to prevent the jamming of the blade in the wood.[16]

Saws discovered among the ruins of Pompeii and Herculaneum have regular teeth, and were well-made and sharp. They were of iron.[17] It is commonly believed that the Romans did not know how to set the teeth in their saws and therefore moulded or cut the teeth into the blade. However, a few examples have been found to prove that the Romans, at least in the later periods, did know how to set the teeth

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[15]Neuburger, op. cit., p. 68.

[16]Ibid., pp. 73-74.

[17]Hibben, op. cit., pp. 153-154.

into their saws. Tools for setting the teeth have been found, and a few saws with set teeth have been unearthed by excavators. For the most part, however, Roman saws had unset teeth. It is also known that the Romans had files for sharpening the iron and steel saws which came into use about 700 B. C. In later Roman times, the bow-saw gave way to the bucksaw with its blade tightened by a twisted thong, probably quite similar to the saw still in use for cabinet work in some countries of Europe and commonly utilized for sawing stove wood in the United States. The Romans also developed the rectangular frame saw, used for a thousand years later by European cabinetmakers as a rip-saw, and the frame saw of the lumber cutter.[18]

Bucksaws and framepit saws were well known in Rome, the bucksaw dating back to the Bronze Age in Italy. Cross-cut saws having long blades and worked by two men have been known since the time of the Assyrians and the Egyptians, but the Romans' cross-cut saws, made of iron, appear to have been the best in the ancient world.

The great improvement that the Romans made in saws was to set the teeth out alternately so that the blade cut a wider notch and slipped through easily without sticking or binding on the sides. The Romans also had a tool for setting saw teeth, as has been previously mentioned; and the shape of this instrument was almost exactly the

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[18]Wyatt, op. cit., p. 21.

same as that used for the same purpose until approximately one hundred years ago.[19]

The setting of saw teeth as a general practice began during Roman times but was not always done; in fact, more Roman saws without set teeth have been found than is true of those with set teeth. Many saws made as late as the seventeenth century in various countries did not have set teeth.[20] Thus the setting of the teeth in saws is a relatively recent development.

Not until the advent of the Iron Age were really efficient saws made. One of the oldest examples of saws made of iron was discovered near the ruins of Nineveh, and is thought to date from the time of the Biblical character, Job, in whose life the city of Nineveh played a prominent role. This saw represented a rare find, for, because of the rapidity with which iron oxidizes, only a few of these earlier iron saws have ever been found. Another powerful stimulus to the development of the saw was the invention, or discovery, of steel, the date of which is lost in the dimness of the past. In 850 B. C., Hesiod refers to "bright iron" and "black iron"; and Ezekiel, in 600 B. C., also refers to "bright iron," which undoubtedly was a low grade of steel. Translations of the Scriptures mention both iron and steel. The

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[19]Hibben, op. cit., pp. 160-161.

[20]Ibid., p. 202.

Egyptians were familiar with steel as far back as the time of the construction of the pyramids, for in 1874 a plate made of this material was discovered imbedded in the masonry of the Great Pyramid of Cheops, which was erected approximately 5,400 years ago.[21]

During the Middle Ages, the saw was the carpenter's tool that underwent the most improvement, as might be expected among people who used so much wood. In late Roman times a new method for sawing planks was devised. This process involved the digging of a pit in the ground, over which logs were rolled. The saw had a long flat blade held tightly in a frame. One man would go down into the pit and pull the long saw downward by means of grasping the frame, and another man above ground would pull it upward in the same manner. This alternate motion up and down was the best method yet invented for making boards from logs. This device was called the framepit saw, or simply the pit saw, and the workmen, who soon formed a guild of their own, were known as pit sawyers.

During the Middle Ages, the use of the pit saw for cutting planks greatly increased, but far more important than the pit saw was the new invention of the sawmill. There is some evidence that one or more sawmills existed in Germany in the fourth century and in France in the sixth century, but it is not known definitely that these sawmills actually existed, nor is it known what they were like if they did exist. There

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[21]Henry Disston and Sons, Inc., op. cit., pp. 3-4.

is, however, ample evidence that the Romans used waterwheels for power to grind corn and that the Persians, a little later, knew about windmills. There is even a legend that the Welsh used both water power and windmills as early as the fourth century. Whatever may be the truth in these instances, it is known that the use of waterwheels to furnish power for sawmills did not become general until the fourteenth century. Once begun, however, these power sawmills grew rapidly in number, and in time carpenters were relieved of the arduous drudgery of sawing planks by hand. Even so, pit sawing continued to exist until the nineteenth century, especially in areas where water power was not readily available. This use of machinery, once started, was later to spread to other fields of labor and in time would change the lives and work of everyone.[22]

Like the sawmills that came into being during the Middle Ages, those of the Renaissance period were operated by waterwheels or turned by oxen. Saw blades were straight and worked up and down. Sometimes several blades were fastened side by side in a frame so that more than one board could be cut at a time. Sometime between the sixteenth and seventeenth centuries, the circular saw was invented in Holland, and it eventually replaced straight blades in the sawmills. Although these mills made planks and boards much more easily

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[22]Hibben, op. cit., pp. 183-185.

obtainable and far more plentiful, thus helping the carpenters, they worked a hardship on the pit sawyers, who previously had provided the principal source of cut lumber. Since one machine could do the work of many men, and do it better and far more quickly, these men who had spent their lives at a useful craft saw their work being slowly taken from them. Thus began, in a small way, the battle between men and machines—a struggle that has increased by leaps and bounds as almost all types of manual labor have undergone extensive mechanization.[23]

It became fashionable during the Renaissance to make elaborate tables whose tops contained hundreds of small pieces of wood inlaid in intricate designs and made to fit together like the parts of a jigsaw puzzle. A new tool, the fret saw or scroll saw, made this art possible, for it could cut curved patterns. A finer and more versatile saw than any that had been known previously, the scroll saw is thought to have been invented by Boule, an Italian furniture-maker. The blade was like a wire stretched tight in a bow, and because the blade was so thin and small, it could be readily manipulated so as to cut delicate and intricate curves in wood.

European carpenters of the Renaissance period used bow-saws, also, in addition to regular saws. The bow-saw was larger than the

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[23] Ibid., p. 191.

scroll saw, the blade was wider, and it, too, could cut a curve in wood. It had two wooden handles, usually curved, held apart at their centers by a crossbar. The bottom ends of the handles were connected by the blade, while the opposite ends were held together by strong cords or twisted wire. Although the bow-saw looked very much like the bucksaw of Greece and Rome, there was a difference: the blade of the bow-saw could be turned and adjusted, while the blade of the bucksaw was fixed rigidly in place. Long boards could not be cut with a bucksaw because the bar in the middle would soon get in the saw. But the bow-saw permitted the handle to be turned to the side so that the blade could be used to rip a board as well as to cut across it. The bow-saw came into use during the sixteenth or seventeenth century, and is still used, although it ordinarily is no longer carried in the carpenter's tool chest. The bucksaw is not used at all by carpenters any more, but it is common with farmers, who use it for cutting firewood.[24]

At first, the handles on saws were merely extensions of the stone out of which the tool had been cut. Later, when saws made of metal were developed, the handle was a straight piece of wood riveted onto the copper or bronze blade. But as early as Egyptian times the handles were curved in some instances. Although straight handles were used and still are to be found on small saws, after the Renaissance period the handles on the saws were fashioned to fit the hand, and the grips were

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[24] Ibid., pp. 199-200.

gradually improved until the beautifully curved and convenient hand-hold of the modern saw was evolved.[25] The modern hollow-grasp, riveted-on saw handle did not appear until about 1750, and even then it was not extensively used until about 1840, when factories for the making of saws were established in the United States.[26]

Steel is now employed exclusively for making saws. Some saws designed for sawing wood are tempered soft enough to be sharpened with a file, while those for cutting metal can be sharpened only with a grinding wheel. The fineness or coarseness of the teeth varies greatly, according to the purpose for which the saw is intended. So do the shapes of the teeth, some pointing forward with straight or curved edges, others of equal angles, and many of special "M" shapes for heavy cross cutting of lumber. The most elaborate teeth have "cleaner" teeth interspersed so as to scrape out the sawdust and clean the cutting neatly.[27] Saws are made in a great variety of forms and sizes in order to adapt them to the varying characteristics of the materials to be worked and to suit them to the particular kinds of work for which they are used, and also to suit the circumstances involved in the manner in which they are operated or handled.[28]

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[25] Ibid., p. 202.

[26] Durbahn, op. cit., p. 18.

[27] Encyclopaedia Britannica, 14th edition, XX, 29.

[28] Encyclopedia Americana, 1942 edition, XXIV, 334.

The "pitching" of the teeth is closely related to the nature of the material to be cut and to the direction of cutting. It is much coarser for timber than for metals, coarser for ripping or sawing with the grain than for cross cutting, coarser for soft than for hard woods. The "setting" of the teeth, or the bending over to right or left, by which the clearance is provided for the blade of the saw, thus preventing binding or jamming in the wood, is subject to similar variations. It is greatest for soft woods and least for metals; in fact, the clearance is often secured without the setting of the teeth by thinning the blade backwards.[29]

In Japan today, saws are always made so that they cut on the pull rather than on the push motion of the arm. In fact, the Japanese hold and operate most of their tools in a manner exactly opposite from that followed by Americans and Europeans and most Asians. Among them, for instance, the plane is turned around and pulled toward the worker, instead of being pushed away from him.[30]

> The characteristic action of the saw being the removal successively of minute portions of the material worked by the cutting or tearing action of a series of sharp edges thrust against the material indicates that it is essentially a tool adapted for cross-cutting or cutting at right angles to the fiber of the material. Necessity and custom, however, have compelled its application for ripping or cutting with the grain also, thus adapting it to work which otherwise would

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[29] Encyclopaedia Britannica, 14th edition, XXII, 290.

[30] Hibben, op. cit., p. 202.

> be accomplished by the use of cutting tools such as axes and chisels. These conditions define two primary classes of saws—the cross-cut saws and the rip-saws, which divide all the different kinds of saws into two groups according to the general purposes for which they are used.[31]

In the present age of lumber manufactured by machinery it is difficult for us to realize that it was not so very long ago that boards had to be sawed laboriously from the log by hand- and back-operated saws. Yet the machine saw has not done away with handsawing in some parts of the world, for Henry Disston and Sons, Inc., were exporting many open pit saws at the time of the first World War, and are still manufacturing these and other types of hand-operated saws designed for the cutting of boards from logs. In most of the more highly industrialized countries, however, the production of lumber by hand is a thing of the past. But this is largely a development of the twentieth century, since prior to that time the extensive mechanization of the lumbering industry had only begun. Numbers of men are still living who, during the Klondike gold rush of 1898, carried pit saws with them beyond the Canadian frontier, to be used for cutting logs into boards for making the boats that would carry them and their belongings on their adventurous quest.[32]

In the cutting of lumber by hand, two types of saws, called pit saws, were used, the framed and the open. The framed pit saw, the

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[31] Encyclopedia Americana, 1942 edition, XXIV, 335.

[32] Wyatt, op. cit., pp. 21-22.

older form, which was widely used among the Romans and until modern times, had a slender, fast-cutting blade; but it was cumbersome because the frame had to be dismantled when the blade could not be backed out of the kerf. The open pit saw was easier to operate, but it was difficult to make the blade stiff enough without making the kerf objectionably wide. Both types had handles at each end so that two workmen were required to operate them.

The log that was to be used for making boards was rolled over a pit about six feet deep, and supported on several cross timbers. For light-weight logs, high horses were sometimes used instead of a pit, but that was not the usual procedure and was resorted to primarily as a temporary means of providing boards that were needed immediately. In more modern times, chalk lines were adjusted to the length of the log on both top and bottom. Then, with one man above and one in the pit, the laborious job of working the pit saw up and down began. As supporting cross timbers were reached in the cutting, the saw had to be withdrawn from the log, which was then shifted into new position, and the sawing continued. Pit sawing was back-breaking toil, but man did not know of any other way to make boards until the water- or steam-driven power machine was developed.[33]

The wide-blade saw was unknown until the sixteenth century, when the wide stiff-blade open pit saw, and the forerunner of the modern

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[33] Ibid., pp. 22-23.

handsaw, appeared. At first, the handsaws had tang-mounted handles very much like those on ancient Egyptian saws made of bronze. A picture dating from 1718 shows a handsaw with a handle that might well have belonged to a dueling pistol of that time. Incidentally, it had the useless little nib that ever since has been retained in most saw handles, serving only to cause little boys to ask questions as to its purpose. This same type of saw was used in America at least until the time of the Revolutionary War. The modern hollow-grasp, riveted-on handle was not made until about 1750, and probably was not universally used until saws began to be made in factories, about 1840.[34]

> When saws became a factory product, men made them no longer incidentally as an occasional blacksmith job, but as a lifework. They could take time to study the best shape for the blade, the most comfortable form and mounting of the handle, and the likes and dislikes of workmen; they could develop special machinery to roll out their metal, shear it to shape, grind a taper to the blade, file the teeth, and form the handles; and, more important still, they could employ scientifically trained men to conduct extensive research into such matters as the most suitable steel, the best means of tempering the blades, and how to give it the most attractive and sale-producing finish. Though the factory has not materially altered the form of the saw, it has undoubtedly greatly improved it in quality. There have been no great inventions to the saw since an unknown Bronze Age workman hacked teeth in his knife to make it cut wood faster. All of these later saw inventions have been little, polishing-up improvements that came gradually through the ages to produce our efficient modern sawing tool.[35]

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[34] Ibid., p. 23.

[35] Ibid., pp. 23-24.

By the time factories were established for the manufacture of saws, there were already a number of varieties of saws to be made in addition to the various forms of the common handsaw. In their modern adaptations, saws may be divided into two principal classes: (1) reciprocating saws, such as handsaws, and (2) continuous action saws, such as circular and bandsaws. Although the saws in the second class are usually regarded as being very modern in development, they are not so recent in origin as is commonly supposed. Hippocrates, about 460 B. C., is said to have invented the first cylinder or drum saw for use in the operation of trepanning the skull. However, the circular wood saw as it is known today was invented in England in 1777 by Samuel Miller,[36] although it has been claimed that circular saws were used in Holland nearly a century earlier. The first eighteen-inch circular metal cutting saw was produced in America by Disston in 1889. William Newberry of London is supposed to have patented the first endless bandsaw in 1808, but his machine and saw were never developed for use. The difficulty of making a smooth, strong joint was the stumbling block which prevented the perfection of his idea. How much credit should be given to Newberry's inventive genius is open to question, as archeologists have found instances to indicate that the bandsaw was brought very near to its present form by ancient peoples.

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[36]Henry Disston and Sons, Inc., op. cit., p. 4.

About 1846, Mlle. Crepin, a French woman of great mechanical genius, secured in France a patent on a machine and bandsaw similar to Newberry's. Another patent was later obtained by M. Perin, who greatly improved the saw by perfecting the joint. To him has gone the credit for making the general use of the bandsaw possible.[37]

Thus down through the ages the evolution of the saw moved slowly forward. People of many nations and cultures contributed to its development. But during the past one hundred years, as metallurgical knowledge increased by leaps and bounds, the saw advanced rapidly to the high degree of perfection which it now enjoys. During those hundred years, the firm of Henry Disston and Sons, Inc., of Philadelphia, the foremost manufacturer of saws in the world, has been credited with many important developments in metallurgy, in the design of saws, in bringing out new styles and forms, and in the processes of saw manufacture. Every type of saw, for the cutting of every kind of material, is manufactured in the Disston plant.[38]

The saw industry of the United States is confined principally to about eighty factories, having about 5,000 employees engaged in the manufacturing processes. In 1937, the products of these factories were valued at $19,853,034, but more than a third of this amount represented the value of the steel and other materials used in the manufacture of saws. Between 1914 and 1925, the industry more than doubled

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[37] Ibid.

[38] Ibid.

its production. Illinois is the leading state in saw manufacturing, followed by New York.[39]

> In the long history of saws the great problem has always been to get as thin a blade as possible. After all, the object of using a saw is to cut a board, and the thinner the blade the easier it will slide through the kerf. That is why the Greeks and Romans used buck saws and frame saws because, since the early blades were made of bronze, they wanted them as thin as possible. A thin piece of bronze would have broken quickly unless stretched tight in a frame. The early hand saws had no frames and they were thicker and the teeth were so faced that the saw cut only when it was pulled. A thin piece of bronze would have buckled if they had pushed on it. Probably in sawing soft wood, the saws were used to cut both ways. As iron and, later, steel blades were made, they were so much stronger that in time all blades came to have their teeth so faced that the cut was made only when the saw was pushed.[40]

Thus, from the foregoing discussion, it becomes apparent that the saw, though a common and taken-for-granted tool that is in use every day by many people, has had a long and eventful period of evolution behind it. It required centuries of time and the individual contributions of many persons and races of people to bring the wood-cutting saw to its present high state of perfection and utility.

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[39]Encyclopedia Americana, 1942 edition, XXIV, 338-339.

[40]Hibben, op. cit., pp. 200-201.

CHAPTER VI

TOOLS FOR BORING IN WOOD

> There is no more interesting chapter in the story of the evolution of hand tools than that pertaining to man's implements for making holes. This is partly because of the variety of tools man has experimented with for boring, and because the story of such tools spans the entire known history of the human race. No matter how far back we explore into the dawn of man, we find him always possessed with some tool for making holes. There exists today no known tribe of men so low in the scale of intelligence that they do not possess, and make for their own use, tools for boring or drilling holes. This primitive skill includes not only ability to bore holes in soft materials but also in hard stone. Indeed, it is the hard materials like shell, bone, and stone that have survived the many thousands of years between lower savagery and civilization.[1]

When a circular hole is cut in wood with a bit and brace or with any other similar device for cutting holes, the process is called boring; but when a similar operation is performed in metal, it is called drilling.[2] In some form or another, boring tools appear to have been in use for a long, long time. Far back in prehistoric times, flaked stones, known as "celts," were used for drilling in stone or for boring in wood. Later, these celts were fastened to sticks and rotated, thus

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[1] Edwin M. Wyatt, Common Woodworking Tools—Their History, p. 25.

[2] Encyclopedia Americana, 1942 edition, IX, 336.

increasing their speed and effectiveness. Such drilling or boring implements were in use by the American Indians before the coming of the white man to these shores.[3]

The earliest operations of boring and drilling were performed by means of a fish-bone or bone-awl set in the end of a cylindrical stick of wood. Given a rotary motion by holding it between the palms of the hands and then moving them over it in alternate directions, thus spinning the bone drill back and forth, it could be made to cut holes, though the process was extremely slow and laborious. A crude drill of this type, used without abrasives, could penetrate nothing except soft substances, and primitive man eventually improved it by fastening a bit of flint or other hard stone to the drilling end of the bone. This innovation provided a good cutter, but the speed of the rotary drill was still too slow to be effective. Eventually, an ingenious inventor appeared among the primitive peoples, who devised the plan of winding a leather cord around the shaft of the drill two or three times. By holding the ends of this thong in his hands, he was able to attain a higher speed and more effective drilling and boring by pulling the cord back and forth. With this type of flint-pointed drill the operator could make a hole into and through the hardest object, even through bones or stones. The next step was the bow-drill, in which the drilling

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[3]Walter E. Durbahn, Fundamentals of Carpentry, Vol. I, Tools—Materials—Practice, p. 18.

shaft was set into a depression in a piece of stone or bone which was held in the hand or pressed against the body. The bowstring of a bow similar to that used for shooting arrows was made to encircle the drill shaft. By moving the bow slowly back and forth with the hand, the operator could cause the drill shaft to rotate by means of the bowstring that encircled it. Pressure could be placed upon the boring tool by the body of the operator, and thus the drill could be made much more effective than had been possible with earlier forms in which little pressure could be applied. From the primitive bow-drill have evolved all other drills that work upon the bow principle, as well as the lathe.[4]

The drill or boring tool has been called the most remarkable tool of the cave-dwelling people. Eventually they learned how to bore holes through even such hard materials as bone and shell, ivory and stone. Shells and teeth with holes bored through them have been found in caves in the same layers of deposits as the bones of the mammoths and the cave hyena. The art of boring holes was known almost everywhere by the most primitive peoples, and bored shells strung on threads of bark or strings of leather came to be used as ornaments (as they still are among many native groups), perhaps as money, and possibly—as some believe—served as a means of keeping records.

At first, the drill was merely a splinter of flint held in the hands and twisted back and forth. Sometimes the end held in the hand was

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[4]A. Frederick Collins, A Birds' Eye View of Invention, pp. 27-28.

wrapped in skins to avoid cutting the hand of the operator. Then the primitives learned to bore holes with sticks of hardwood. Splinters of bone and long thorns for the awl were the most primitive of the drilling tools. Men would hold the object that was to be bored between their knees or with their toes, and by twirling the stick back and forth with the palms of their hands they would bore the hole. Sometimes they would put sand and water in the hole to speed up the drilling process, which, at best, was slow and tedious. This kind of simple instrument was called a shaft drill.

The next improvement was the strap drill. The hard stick tipped with sharp stone was still used as the drill point, but instead of turning it by hand, it was operated by a strap or leather thong. Passed once around the shaft, the strap was pulled back and forth, making the shaft spin around. In order to hold the shaft in position and to apply pressure to the drill point, the operator used mouthpieces of bone or wood which he held between his teeth. The top of the drilling stick would fit into this mouthpiece, and by pushing down with the head, the shaft point was pressed against the object that was being bored. Then, by pulling the strap back and forth, the stick was made to spin and the hole was slowly bored. This was uncomfortable work, for it hurt the teeth and mouth and jarred the head. Eventually, the primitives learned to make a strap drill to be operated by two men working together. In this case the small mouthpiece was replaced by a crossbar

that was held and pressed down by one man, while another pulled the strap back and forth, thus operating the drill that was held in position and given pressure by the one holding the crossbar. This improvement made it possible to use larger drills than those operated by one person, and thus the size of the holes bored could be increased. For all of these primitive tools, of course, a different stone boring bit had to be used for holes of varying sizes, and consequently the size of the holes bored was strictly limited by the size of the stone awls available and by the inadequacies of these primitive methods of boring and drilling.

The reason the primitive peoples became so skillful and inventive in making drills is because the drill evolved directly from the tools used for making fire. In the earliest days fire was made by rubbing sticks together, later by spinning one stick against another, and still later by friction between two flints. As fire was perhaps the most important factor in their lives, as it cooked their food and gave them warmth and protection from wild animals, the primitives quickly invented better ways of starting it, and from these early fire-making practices they learned to make the early drills and boring devices.[5]

In order to bore holes through the very hard stone that they began to use for axes, hammers, and adzes in the latter Stone Age, the

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[5]Thomas Hibben, The Carpenter's Tool Chest, pp. 89-91.

primitives had to have better drills than the shaft or strap drills, and certainly much better ones than the old stone celts which had been painstakingly rotated in the palms of the hands. In order to meet this need, ancient peoples developed several new kinds of drills, which were really machines rather than tools—among the earliest machines of mankind.

The bow-drill, already mentioned, was the first of these new drills. It was so called because it looked like a bow. At one end of the bow the leather or fiber string was tied securely; at the other end it was loose and held in the hand. When the string was looped around the shaft of the drill and the shaft and drill point held in position by a headpiece, the shaft could be spun around by sawing back and forth with the bow, very much like playing a cello. The headpieces were made of bone, stone, or wood, with a shallow hole in them in which the top end of the shaft could spin around as it was rotated by the bow-string.

Drill points were made in many ways. Some were hard wood, like the earlier strap-drill points, but later points of flint or bone were used. Sometimes a sharpened hollow reed or straight bone was used, so that the drill would cut a circle instead of a hole. Then, when the tube had gone all the way through the stone, the center section would drop out. These cylinder-cutting drills were usually employed

with sand and water as abrasives, and worked more rapidly than the solid point.

The bow-drill made a very accurate hole, but for axe and adze heads the hole was always bored from both sides by first boring approximately halfway through from one side and then turning the stone over and drilling from the other side until the holes met. Holes in such tools were very accurate, as shown by many specimens discovered in excavations, so these early peoples must have had some way of measuring to insure that the holes drilled from opposite sides of the stone would meet evenly, but we do not know what device they used for this purpose.

Another type of drill was the pump drill, which had a shaft passing through a hole in a crosspiece. A cord made of skin or fiber was tied to each end of this crosspiece and the middle part of the cord wrapped around the shaft. On the lower end of the shaft was a round ball or disc of stone which spun around with the shaft when the crosspiece was pushed downward. Because the stone ball or disc was heavy, it not only bore down on the point, making it go in deeper, but also the disc continued to turn the shaft after the crosspiece had been pushed down as far as it would go. The spinning of the disc caused the cord to wrap around the shaft again, so that by alternately pushing down and letting the cord rewrap itself around the shaft, the drill point

could be kept spinning as long as desired. And since the motion involved was very much like pumping, this tool was called the pump drill.[6]

The first really significant improvement in the oldest types of boring tools was the bow-drill, out of which the other types of drills and boring devices evolved from time to time. It has been stated that

> . . . The bow-drill consists essentially of a wooden spindle rotated by the to-and-fro movement of a bow, the string of which is looped around the spindle. . . . The point may be a flint borer or a core or tube or bone or wood that drives round an abrasive power, sand (or emery if available). Save for the substitution of a metal point, the device remained unchanged till the late Middle Ages and is still current among many tribes. It will pierce wood, stone, bone, rock, and even precious stones like cornelian and turquoise.[7]

The bow-drill of ancient Egypt was fixed in a wooden holder which ended in a block held in the left hand, thus enabling the drill to be pressed against the material to be bored. The end-block and the drill holder probably were not in one piece, but the wooden holder likely rested loosely in the block. The string of a bow was looped around the holder, so that by moving the bow back and forth, the drill was made to turn.

Also in use were borers which were pressed against the chest. They were in similar form to the bow-drill, but the holder was turned

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[6]Ibid., pp. 100-102.

[7]V. Gordon Childe, The Story of Tools, p. 10.

by hand rather than by the to-and-fro motion of a bow. The drill points for both of these types of boring tools seem usually to have been of pyramid shape with the point serving as the agent of entry into the material to be bored, while the three or four corners of the little pyramid served as cutting edges. The drilling produced no chips, but only fine drill-dust, which was expelled from the bored cavity by reversing the direction of the drilling.[8]

Needles and awls even today preserve the form of the first ones, made of bone in the Stone Age. Boring tools as they are known today began with the flint awls of the Stone Age, used for perforating bone. When attached to the stock of a bow-drill, they became bits; and when, later, they were made of metal, they usually had square butts and could be used as a hollow borer as well as a gouge.

Center bits and reamers were first used in the Iron Age, about 700 B. C. Screw threads to get rid of the borings were never cut on the point before 400 B. C. Not until the Middle Ages did the brace-and-bit replace the bow-drill. However, by 2500 B. C., Egyptian stone-cutters were using a drill-stock with a bent handle weighted with stones to produce the downward pressure which the left hand and the weight of the body would later supply in the brace. Augers with a "T" handle like those in use today were sometimes to be found in Roman times.[9]

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[8]Albert Neuburger, The Technical Arts and Sciences of the Ancients, p. 72.

[9]Childe, op. cit., p. 27.

When metal tools came into use, rounded, jagged, or pointed cutting surfaces made of metal made their appearance as drills or borers. These were shaped at the ends of metal shafts which were pointed on the other end and driven into sticks that served as handles. Like the earlier stone celts, these tools were employed to scrape materials into dust, instead of cutting the materials.

The so-called nose-bit pared the shavings from the bottom of the hole and pulled the shavings out when the bit was withdrawn. This was a gouge-like bit with a turned-in cutting lip. This probably was the forerunner of the modern bit. Nose-bits have been found in the ruins of Roman army camps, and are believed to date back to about 700 B. C.[10]

Early metal drill bits and boring tools varied in shape and size, and as a rule were made to turn either way. They simply scraped out small particles or reamed small holes larger, in no way cutting a shaving as all boring bits do today. These crude bits were generally driven into the end of wooden shafts and then rotated by the use of a bow. Thus they were mere improvements upon the older bow-drill. No one had thought of making the bits interchangeable, but each one had its own shaft. Judged by today's standards, they were indeed crude implements, but they represented vast improvements over the bits

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[10]Durbahn, op. cit., pp. 18-19.

made of stone which formerly had been utilized for piercing wood by means of the available boring tools.

No one knows with any degree of certainty which was the first boring tool that improved over the dust-making drill. Probably, though, it was the gouge bit, since the ordinary pushed or driven gouge is as old as the Stone Age, and since the boring gouge bit differs little from the paring tool. Except for the handle, the boring tool differs only in being sharpened along the sides as well as at the end. In operation, it was revolved either right or left, or first one way and then the other— either process of operation made it an ideal tool for use with a strap or a bow. It left a central core that had to be broken off and dug out. It could not be used for end grain and was not practical for deep holes. For small bits the end was quite rounded, and the tool was commonly known as a quill bit. Undoubtedly, these boring tools were in use throughout the ancient period and the Middle Ages, and so near to the present time that occasionally one can still be found in an old cabinetmaker's tool chest. They belong to the past, however; no firm makes or markets them today.[11]

In ancient Egypt, the boring tools were excellent, for that early period in the world's development. Bow-drills, pump drills, and the auger were in common use among workers in wood, and apparently

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[11] Wyatt, op. cit., pp. 26-27.

were effective tools for accomplishing their intended purposes. On the walls of ancient Egyptian tombs one may still see many pictures of carpenters at work with these tools.[12]

The earliest picture of a screw-auger appears in an ancient manuscript copy of the poems of Hesiod, which is thought to date back to the eighth or ninth century B. C. This auger has a rectangular crossbar near the end of the pointed auger-stem. Both lower edges of this crossbar are curved outward in opposite directions and sharpened to a fairly thin cutting edge. It is difficult to imagine that such a blunt-looking instrument could do an effective job of cutting when powered solely by the operator's hands. Apparently, this auger left only dust, and no chips.[13]

For boring holes, Pompeiian carpenters had bow-drills and strap drills, but neither the pump drill nor the brace-and-bit was known there.[14] At least, no examples of these latter tools have been discovered as yet in the excavations of this buried city.

Another ancient boring tool was the spoon or duckbill bit, which bored either right or left and possessed two decided advantages over the gouge bit. In the first place, it bored out the entire hole into true shavings so that it was a practical end-boring tool; and, in the second place, it pulled out its own borings when withdrawn from the

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[12]Hibben, op. cit., p. 128.

[13]Neuburger, op. cit., pp. 72-73.

[14]Hibben, op. cit., p. 155.

hole for that purpose. The spoon bit is a very old boring tool, there being some evidence that it was developed in northern Europe. However, the oldest specimens discovered are from the camps of Roman armies. It probably was used throughout the Middle Ages both as a brace bit and as a cross-handled auger. It sometimes appears in medieval pictures, and as late as 1768 it was listed and pictured among the tools of the carpenter and the wheelwright.

A tool that, at first glance, looks like a gouge bit but is soon seen to be quite an improvement over it, is the nose bit, which made its hole not by cutting a gouge end but by the paring of shavings by a turned-in cutting lip or router somewhat like the cutting edge of a modern auger. This was a one-direction boring tool, and therefore it had only one sharp edge along the reaming trough. It pulled out the shavings, bored both end and cross grain, and was a practical tool for deep boring. This bit was in common use until two or three generations ago.[15]

An ancient boring tool that was used both as an auger and as a brace bit was the pod auger or bit, which very much resembled its modern counterpart. It was possibly the first boring tool that was equipped with a spiral that served less for the removal of shavings from the hole than for feeding the tool into the wood and reaming the hole to the desired size, for the spiral was always tapered in a manner

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[15]Wyatt, op. cit., pp. 27-28.

resembling the modern wood screw. Earlier augers had little or no spiral, and had to be pressed into the wood constantly to keep them boring. The pod auger was a very efficient boring tool, particularly in end grain. The cutting end operated like a gouge bit, leaving a central core that the spiral broke off and held. The outer edges of the spiral helped to feed the tool into the wood and at the same time reamed the hole out smoothly to the required size. It had to be withdrawn frequently to pull out the shavings. Apparently, the pod auger or bit is a very old tool. At least one old Roman pod bit has been found, though it is a very crude one. A fifteenth-century painting of the Holy Family shows Joseph boring with a pod auger. The German gimlet bit is probably the nearest thing in use today to the old pod auger or bit.[16]

Seemingly, the first long, spiraled, shaving-discharging auger was invented by Phineas Cook of England in 1770. It had the long double helix or twist that is used now on the Russell Jennings bit. The lower end of the spirals ended in curved router-like lips that shaved out the bottom of the hole. It had a leading pivot point like the old centerbit or the screw on the modern bit, but there is some uncertainty as to whether this pivot center was threaded for easier penetration of the wood. If the first models were not threaded, certainly it was not long before threads appeared on the center point. This was the first auger, so far as is known, that elevated the shavings from

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[16] Ibid., pp. 28-29.

the hole as it bored; all boring tools that preceded it had to be removed from the hole periodically to get the shavings out of the way. In spite of its effectiveness, though, it still lacked some of the essentials of the modern tool; for instance, it had no spurs to score the hole to a smooth, perfect round; and it probably had to be crowded by pressure to make it cut.[17]

The really modern auger bit dates from the beginning of the nineteenth century. Being developed in the United States, it was perfected by several different inventors, whose individual contributions to the evolution of this tool are not quite clear. Knight's American Mechanical Dictionary states that Lilly and Gurley, both of Connecticut, invented the auger bit about 1800, but the first patents went to Hoxie in 1804 and to Hale in 1807. In 1809, L'Hommedieu made some improvement in the auger, so that by that time it was looking very much like the modern tool. Other patents followed, and further improvements were made, until in 1850 Russell Jennings patented the extension lip. Most persons familiar with auger bits think of Jennings as being associated with the double-twist bit in which style his bits are made, but his real invention consisted in placing the scoring spur back of and under the router or cutting lip. This device scored a perfectly round hole ahead of the cutting lip and left the lip so it could be easily sharpened. This is the most popular bit ending in use today.[18]

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[17] Ibid., p. 29.

[18] Ibid., pp. 29-30.

In bringing the story of the auger to modern times, we have stepped ahead of our story a bit. Let us now look back into the medieval period. For boring holes, the carpenters of the Middle Ages had augers and gimlets, bow-drills and strap drills, and to these they added the pump drill and the brace-and-bit. It appears strange that these two boring tools were not known earlier, for the pump drill has been found among quite primitive peoples, and the brace-and-bit certainly was not too difficult a tool for the Romans to have invented. Nevertheless, the earliest traces of the brace-and-bit that have been discovered appear in paintings produced in medieval times, and the earliest of these tools that has come down to us dates from the fifteenth century.[19]

While small boring tools are known as drills or bits, larger drill points, turned by means of a handle set crosswise to the shank, are called augers. During the Renaissance, augers were often made large enough and with a shank long enough to bore out small tree trunks to be used as pipes for pumps. The twisted points lifted the shavings out of the hole for a short distance, but in long holes the tools had to be removed from time to time to clean out the shavings. In 1770 the invention by Phineas Cooke of the spiral auger produced a tool which not only would bore a hole quite effectively, but the spiral

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[19]Hibben, op. cit., p. 183.

was so long that the shavings would climb up the spiral and come out of even the deepest holes. Among the numerous improvements which have since been made on Cooke's auger, the most significant is that of equipping the bit with spurs at the lower end which run ahead of the spiral and cut the sides of the hole. But the general form of the present-day spiral auger is the same as that invented by Cooke nearly two hundred years ago.[20]

Boring tools have always had to have some auxiliary tool or device for holding them when in use. The crude awl which primitive man made of stone had to have a wrapping of fiber or skin to protect the hand from the sharp, rough corners; the drill point made of stone by ancient man had to have a shaft of reed so that it could be twirled between the palms of the hands. Today, modern auger bits must have a brace or they are useless, as were the primitive drills made of stone without their twirling shafts. The ancestry of the present-day brace extends back into history to these primitive holding devices of the man of the Stone Age.

The reed drill, which was rotated by hand, was rather awkward to operate, and primitive man eventually learned that it could be turned more easily and rapidly by wrapping a leather cord around the shaft and pulling the cord. Cord-operated drills developed in two

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[20] Ibid., p. 205.

forms, the strap drill and the bow-drill, both of which have already been discussed, in brief.

The strap drill is still to be found among the Eskimos of Alaska and other regions of the Far North, and among other primitive peoples on isolated islands. The ancient Egyptians and Greeks knew the strap drill, too, but as a two- or three-man tool, while the smaller and simpler form found today among the Eskimos requires only one man to operate. In the carved pictures of the Egyptians, this type of drill is illustrated; and Homer, in his Iliad, tells of boring "with a drill while his fellows below spin it with a strap, which they hold at either end." In the one-man form, the upper end of the drilling shaft of the strap drill fits into a separate socket piece held in the mouth, while the two ends of the strap are held in the hands. When in operation, the strap is drawn tight and alternately right and left, causing the drill point to rotate first one way and then the other. In the two- or three-man type of the strap drill, one man pulls at each end of the strap and either one of them or a third operator holds the tool steady. Sometimes the shaft extended through a rock or other weight that acted like a flywheel and made it possible to spin the drill continuously in one direction like a top.[21]

Simultaneously with the strap drill, the bow-drill developed in most parts of the world. In the carvings of ancient Egypt, it is to be

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[21] Wyatt, op. cit., pp. 31-32.

seen along with the strap drill in many pictorial representations. In Europe, the bow-drill survived as a tool in certain trades long after the bow ceased to be a weapon of warfare. It is still to be found in use in some sections of the world, and its use is not confined to primitive peoples. The woodworker, however, discarded the bow-drill centuries ago when workers in metal learned how to make bits for him that pared out shavings instead of particles of wood dust.

> When the true boring or shaving-cutting bit came into use, woodworkers had to have a holding tool that would permit of the application of considerable turning force. It is logical to suppose that the simple cross auger handle would be the first answer to such a need. It may have been, though we have earlier historical record of the brace than of the auger handle. It is recorded that an artificer of Athens invented the gimlet, or wimble, about 1240 B. C., but whether he invented the twisted boring end, or the cross handle to a drill previously turned by other means is not clear.[22]

When one examines the handle of a present-day auger, he notices how simple a device it is, but it has not always been so. Because of the screw feed on the end of the modern auger and of the spiral design of the cutting blade, the cross handle now serves merely as a convenient means of rotating the tool, but in earlier designs of the auger, before the screw feed was developed, this handle had to serve also as a means of pressing the tool into the wood.

While augers are usually bits so large that the only feasible method of operating them by hand as boring tools is by the use of a

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[22] Ibid., p. 32.

crosspiece set at right angles to the boring shaft, smaller bits lend themselves readily to easier and more convenient means of operation. Many drills, augers, and bits have been mechanized so that they can be operated by electric, steam, or gas power; but for common usage among woodworkers the smaller bits are operated by the use of a so-called "brace," which enables the operator not only to rotate the bit but also to press it into the wood. Together, the bit and the brace constitute a carpenter's tool commonly called the brace-and-bit or the bit brace. Since bits are interchangeable in the modern tool, one brace may be used for operating many different kinds and sizes of bits. This is a simple and indispensable tool for the woodworker, but it has had a long and interesting history in its development.

The brace-and-bit is a very ancient tool, for in an early Egyptian carving a workman is clearly shown using one in building what appears to be a mummy case. A number of other Egyptian representations of the bit brace have been found, all of which are lacking in detail. Therefore, it is impossible to determine the material out of which the braces were made, or whether the bits were detachable from the brace. In the ruins of ancient Rome several bits have been found that would fit nicely into a brace, but no braces have been found among these ruins, perhaps indicating that the Romans made braces out of wood or some other equally perishable material. Apparently, it was customary to make braces out of wood throughout the Middle Ages.

The earliest braces made of wood, and even many dating from the seventeenth century, did not have the U-shaped bend in the shaft which is now the predominant characteristic of the brace, allowing continuous rotation of the bit by enabling the hand to grasp the peculiarly shaped shaft and to turn it continuously. Instead, the early wooden braces consisted of a straight shaft with the bit driven into one end and a crosspiece at the other end to permit the application of pressure to the bit. A round wooden rod was driven through the wooden shaft at right angles to it. The hand, grasping the projecting rod, could turn the shaft only a short distance before coming up against the shaft, when a momentary pause would be necessary in the boring operation to allow for a new grasp. As early as the seventeenth century, though, wooden braces very similar in design to those in use today were coming into existence. In these braces, it is interesting to note that the iron bit fit into a wooden shank, which slipped through a square hole in the brace. This intermediate wooden shank seems to have been customary on early bits intended to be used in wooden braces. Many old bits have the metal at the upper end merely flattened as though to be driven into wooden shanks which, in turn, would fit into the braces.[23]

Bits equipped with the modern square tangs were probably first used on drills developed for use in the blacksmith shop. Quite naturally,

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[23] Ibid., pp. 32-33.

the smith made his drill braces of metal and therefore had no need for the intermediate wooden shank. In all probability, the carpenter was reluctant to give up entirely his wooden brace even after he had become convinced of the superiority of the smith's metal tool.

So far, the oldest metal braces date from the seventeenth century, though it is probable that some of these tools were in use earlier and may, in time, be discovered. In principle these early metal braces were identical to those of the present day, but in design they were much more elaborate; in fact, they were things of beauty with their delicately curving lines and their geometrical symmetry. The artistry and craftsmanship of these fine old tools are to be admired, even though they are all out of harmony with modern ideas of tool design, which demand that tools shall be as simple in design and as utilitarian in purpose as possible. These old metal drills explain why the sweep handle or center of a brace is still called the ball, since they were equipped with small ornately carved metal spheres which were to be grasped by the hands in operating the brace. [24]

In 1850 or thereabouts, the first factory for the manufacture of braces was established in the United States. These braces were rather crude cast-iron devices equipped with rivets for the head to turn on. There was no free-turning handle in the sweep, and the bit was held in the square socket by a thumbscrew. An early improvement of the

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[24] Ibid., pp. 34-35.

iron brace was to lighten its weight by making the body of wrought iron and the head of wood. At the same time, it was refined and made more serviceable by giving it a free-turning center handle, usually made of wood. These braces, which were essentially similar to the modern tool, came out about 1865.

These early braces made of iron were produced before the days of standardization in manufacturing processes, and each manufacturer of bits made the tangs on his bits to conform to his own ideas of size and style. The result of this practice was that the first thing a purchaser of a bit had to do was to file his new tool to fit his brace socket. This created a demand for an adjustable socket or chuck to be installed in the brace. In 1859, Spofford met this need by patenting a brace which had a split socket that could be easily adjusted by means of a thumbscrew to grip any size and taper of bit tang. Strange to say, this improved brace did not sell very well until John S. Fray and Horace Pigg purchased the patent in 1866 and popularized it. It soon was greatly in demand.

The first true shell-type chuck was brought out by Barber in 1864, and it has been the most popular type of chuck on the market ever since. All large manufacturers of braces make it, although each has his own modifications in design and style. Nevertheless, it remains Barber's original idea in its essence. Another chuck for

grasping and securing the bits in the brace is one invented by Fray and called the Fray chuck. It was developed sometime after Barber's and has likewise survived, because no one has yet been able to design a better one for its particular purpose. The Fray chuck holds only square-tang bits, and probably does it better than any other chuck made. On the other hand, the Barber chuck holds either a square or a round tang, and does both well.[25]

During the nineteenth century a wooden ring was threaded on a spiral wooden shaft called a drill stock so that by moving the ring up and down the shaft with the hand, the drill point was made to turn. From this early device evolved later the ratchet drill and the double-spiral drill that are in use today. During the nineteenth century, also, the hand drill and the breast drill, in which the point is turned by gears, came into existence.[26]

The first American patent on a ratchet brace was granted in 1868,[27] and others followed soon thereafter. Apparently, though, the new ratchet brace was not generally accepted by the public, for no American firm claims to have manufactured such a tool before the 1880's. Probably the first reaction to the ratchet was that it was an unnecessary frill which would serve no real purpose, or that it was

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[25] Ibid., pp. 35-36.

[26] Hibben, op. cit., p. 203.

[27] Wyatt, op. cit., p. 36.

designed for use on a special-purpose tool. Many braces, like the Spofford, continued to sell long afterwards, even though they did not have this convenient means of working in tight corners.

The use of ball bearings has probably been the most recent important change in the design of the brace. The better braces now have ball races under the heads, in the center handles, and even in the chucks, thus improving the ease and smoothness of operation.[28]

Thus, like other hand tools, devices for boring holes have evolved from crude articles made of stone to their present high state of perfection and efficiency. Many peoples over long centuries of time have contributed to their development. Always the object of the improvements has been that of greater efficiency, ease, and speed in the boring of holes. An examination of modern boring devices leaves one with the impression that there is little left to be done in the further perfection of boring tools.

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[28] Ibid.

CHAPTER VII

THE CHISEL, THE GOUGE, AND THE PLANE

The chisel has been defined as "a sharp-edged tool for cutting metal, wood, or stone. . . . The carpenter's chisel is wooden-handled with a straight edge, transverse to the axis and bevelled on one side. . . . A chisel with a semi-circular blade is called a 'gouge.'"[1] Again, the chisel has been called "an edged tool for cutting wood, iron, or stone, operated by striking its upper end with a hammer or mallet, or by pressure. The form of chisel used in carpentry is the most familiar."[2]

Some of the shaped stones found in Europe as relics of prehistoric times are believed to have been used as chisels, and similar tools were known also to the ancient Egyptians. In ancient times, chisels were made first of tough, hard stone and later of various metals. The more civilized of the native tribes of North and South America were acquainted with the chisel, and, at the time when these continents were discovered, were using chisel-like tools made of stone or copper.[3]

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[1] Encyclopaedia Britannica, 14th edition, V, 601.

[2] Encyclopedia Americana, 1942 edition, VI, 569.

[3] Ibid.

Some of the unearthed implements made of stone dating from the Age of Polished Stone have been called chisels and gouges, since their shapes indicate that they could have been used for the purposes for which such tools are now utilized. However, the names given to these prehistoric tools may not be entirely accurate, for when tools were few and difficult to make, their uses were likely to be many. Some of the stone implements classified as chisels or gouges may, in reality, have been skinning knives, digging tools, axes, or adzes.

> . . . Because these stone implements, especially the gouge, seldom show much evidence of wear, the theory has been advanced that when these tools were used on wood, the material was first charred by hot stones, and the tools used only to scrape out the charcoal. Anyway, we know that the Stone Age man made stone tools that resemble and could be used as chisels and gouges.[4]

Primitive people early learned how to make a tool that was to help them make better tools. This was a small chisel-like instrument made either of bone or ivory. With it they could remove small flakes from the edges of a piece of flint. By setting the point of the chisel near the edge of the piece of flint and pressing down suddenly and very hard, they could cause a flake to split off, and so by carefully working around a rough piece of flint, they could make it into a beautifully sharp tool. Much practice was necessary to do this work well, but one who was experienced could make an arrowhead in a few

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[4]Edwin M. Wyatt, Common Woodworking Tools—Their History, p. 37.

minutes. After the invention of this early chisel, the people of the early Stone Age made very fine tools, considering that they were all made of stone and with extremely crude instruments. Saws, chisels, and gouges, as well as axes, hammers, and adzes were made in this manner.[5]

Many of these chisels made of stone were shaped just like the earlier stone and bronze axe-heads, but were considerably narrower. At first they were held in the bare hands and struck with hammers made of stone; but in the Iron Age, tongs were devised for holding the chisels, which were usually made now of iron. A little later they were often mounted in horn or wooden handles, as they still are today.[6]

Probably the first chisels made of metal were simply bars of that material flattened and sharpened at the end like the modern cold chisel. In all probability, similar ones were beaten from copper, ages before iron was forged.[7] Many metal chisels dating, it is believed, from around 1000 B. C., have been recovered from various excavations of early civilizations. These are considerably like the modern chisel in form and design, although the latter is more refined

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[5]Thomas Hibben, The Carpenter's Tool Chest, pp. 91-92.

[6]V. Gordon Childe, The Story of Tools, pp. 25-27.

[7]Wyatt, op. cit., pp. 37-38.

in shape and in the quality of the metal used. Iron chisels recovered from the ruins of Pompeii, dating back to 75 A. D., are almost identical in form with their twentieth-century counterparts.[8]

Gouges were first made of bone, then of stone in the Stone Age, and began to assume a modern form in the Bronze Age, when they were made of bronze and later of iron.[9] The Egyptians, as long ago as about 3500 B. C., used bronze or iron chisels and gouges, whose form closely resembled those in use today. Only the blades, however, were made of metal, being inserted into wooden, bone, or stone handles.[10] Egyptians of the Bronze Age had many kinds and shapes of chisels, although wide-faced chisels were not used at first. Their chisels, however, remained very simple tools, and the fine socket-and-tang chisels, developed even earlier elsewhere, did not appear in Egypt until after Roman times.[11] Much of the most beautiful of Egyptian sculpture was done with chisels made of stone. The stone used for these implements was so hard that they were quite as good as if not better than tools made of copper. Among the Egyptians, some tools were made of copper that contained impurities or that was mixed

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[8]Walter E. Durbahn, Fundamentals of Carpentry, Vol. I, Tools—Materials—Practice, p. 20.

[9]Childe, op. cit., p. 27.

[10]Albert Neuburger, The Technical Arts and Sciences of the Ancients, p. 71.

[11]Hibben, op. cit., p. 128.

with other metals, but there is no evidence that they ever learned how to make bronze tools. The comparatively few bronze implements that have been found in the ruins of the civilizations of ancient Egypt appear to have been obtained from the Sumerians.[12]

In this land of the Nile one may still see many carvings of ancient Egyptian workmen shaping coffins by the use of chisels. Indeed, the chisel appears to have been quite an important tool with these ancient artisans. They invented the wooden mallet for striking the chisel, but they never learned how to tang or socket the chisel for a handle.[13]

Most people who know anything about hand tools are of the opinion that the tang is an older means of fastening a chisel to its handle than is the socket. Perhaps this is true, but it is interesting to note that the oldest known chisels of both types were found together in a hoard of old bronze tools discovered at Bologna, Italy. Apparently, their collector got them together for remelting almost a thousand years before Christ, and then for some unknown reason never accomplished his purpose. The well-developed tangs of some of these old chisels look as if they had just slipped out of the handle of a modern paring chisel. Some of these chisels have single bevels, no chisels older than these ever having been found with but a single bevel. Others

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[12] Ibid., p. 125.

[13] Wyatt, op. cit., p. 38.

among this group of ancient tools have complete sockets for the insertion of handles. These beautifully formed old tools convince one that nearly three thousand years ago, men knew almost as much about the form of chisels as anyone does today. The changes that have been made since have occurred as adjustments to the metal that supplanted bronze.[14]

> The gouge seemed to be quite a common tool in the Stone Age, but for some unexplained reason, was less used when tools were made of metal. Only a very few ancient metal gouges have been found, and . . . those we have found vary greatly in their shape.
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> From the time iron supplanted bronze, to the beginning of the Factory Age in the last century, the making of chisels and gouges was the work of individual blacksmiths. It is interesting to see how modern these old hand-forged tools appear.[15]

In fact,

> Few implements that man uses today have changed as little in the many thousands of years that man has used it as the humble chisel. Its evolutions have been mostly one of materials, as it has been made of stone, then copper, later bronze, then iron, and finally steel. In form it has changed very little.[16]

The Romans made their chisels of both bronze and iron. Some of these tools had tangs and others, sockets, for the handles.[17] During the medieval period in Europe, regular chisels and gouges were

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[14] Ibid., pp. 38-39.

[15] Ibid., p. 39.

[16] Ibid.

[17] Hibben, op. cit., p. 154.

commonly used by carpenters, furniture makers, and other workers in wood. Thanks to the use of various sizes and styles of chisels, many medieval craftsmen were expert woodcarvers. In addition, a special long-bladed, short-handled axe was made to function as a chisel during this period.[18]

Since medieval times, no changes whatever have been made in the chisel and the gouge as to shape and form, but improved methods of forging and tempering have resulted in better steel out of which to make these blades. As has been pointed out previously, chisels and gouges made of stone by primitive man in the prehistoric era had already attained, for the most part, the shape and style which they have retained to the present day.

Such is not the case with the plane, whose story is one of evolution more truly than can be said of most hand tools. Some tools, like the chisel and the scriber, once invented, changed little from age to age, but not so with the plane; it has evolved step by step from ancient times to this very generation. It is one of the oldest tools, unless the chisel and the adze, from which it doubtless evolved, are regarded as planes.[19]

Perhaps the earliest written reference to the plane is that found in the Bible, in Isaiah 44:13: "The carpenter stretcheth out his rule;

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[18] Ibid., pp. 181, 183.

[19] Wyatt, op. cit., p. 40.

he marketh it out with a line; he fitteth it with planes, and he marketh it out with the compass . . ." One cannot be sure of the translation of the word "plane," but evidently the tool mentioned by Isaiah was some form of shaping tool. Because of this early mention of the plane in the Bible, some authorities assume that the Hebrews were the inventors of the plane. This, however, cannot be substantiated.

> Perhaps the builders of the commerce-seeking ships of ancient Phoenicia were the first users of the plane. How could they have built the ships they did without some such tool? The Phoenicians made chisel-shaped implements of stone, but how they used them we do not know: perhaps in some crude plane. . . . It is from crude beginnings . . . that our tools have evolved, and we can only speculate as to just when and where many of them originated. What we know regarding the origin of the plane is that when we first find historic proof of its existence, it is such a thoroughly developed tool that we feel that it must have gone through a long period of evolution before that time.[20]

We are convinced that the Egyptians had no knowledge of the plane. A great many of their tools have been found, but nothing has yet been discovered in Egypt which can be called a plane. The pictures they carved show Egyptian workmen shaping wood with chisels, saws, and adzes, but never with planes. In fact, these same pictures indicate that they smoothed their work by rubbing it with pieces of sandstone,[21] which, in reality, were a crude type of adze.[22]

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[20] Ibid.

[21] Ibid., p. 41.

[22] Neuburger, op. cit., p. 69.

Since primitive man, apparently, did not invent any tool that even slightly resembled the plane, the draw-knife, or the spokeshave, consequently, these tools may be thought of as modern inventions.[23] Yet they are not so modern, after all. For instance, the history of the carpenter's plane is more truly evolutionary and covers a longer period of time than is true of most other hand tools. In all probability, the first carpenter's plane dates back to the stone-cutter of a far-distant prehistoric age. On the other hand, the latest evolution, represented by the modern Stanley bedrock plane, dates back to about 1895. The beginnings of this tool can only be imagined. It is known, as already stated, that the Phoenicians had chisel-shaped stone implements, and since they were the first builders of ships, in which industry the use of such tools would be essential, it can logically be assumed that the Phoenicians were the first people to use the plane, or some crude ancestor of the plane. Probably the first planes, whether developed by the Phoenicians or by others, consisted of a sharpened stone chisel inserted into a hole cut obliquely through a half section of a tree limb so that the cutting edge of the stone extended a fraction of an inch below the flattened side of the wood. The stone chisel was probably held firmly in place by wooden wedges driven into the surplus space in the hole into which it was inserted.

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[23]A. Frederick Collins, A Birds' Eye View of Invention, p. 26.

It is known that the Romans had well-developed planes, for many of them have been preserved until the present time. These tools were made of wood banded with iron, and are actually the earliest planes to be discovered in excavations, dating back about 2000 years. The Roman plane had an iron bit held in position by a narrow wooden wedge, which was kept tightly pressed against the bit by means of a metal crossbar like that found in modern planes. This crossbar, the iron-bound construction, and a hand-grip hollowed into the wood at the back of the tool were notable features of the Roman plane.[24] Of these tools it has been said,

> . . . They were really fine tools; some that are now in museums, if in their original condition, would compare favorably with many marketed today. The very refinement of them makes us doubt if the Romans did not inherit the tool in a more primitive form from an older people. One studying the iron-shod, well-handled tool . . . can hardly believe such a plane was made nearly 2,000 years ago, or that such was the primary form of the tool. The Romans may have used wood bed planes, but, if so, none of them have been preserved.[25]

The earliest tools which can be identified as planes have been found in the ruins of Pompeii and Herculaneum. These planes had holes in the stocks back of the blades into which the hand could be placed to guide the plane when smoothing boards.[26] Well preserved

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[24]Durbahn, op. cit., pp. 20-21.

[25]Wyatt, op. cit., p. 41.

[26]Hibben, op. cit., pp. 155-156.

beneath the lava flow from Vesuvius, these planes consisted of rectangular boxes in which sharpened iron blades were mounted at an angle and permitted to protrude a fraction of an inch through a slot in the bottom of the box, thus allowing the cutting edge to come in contact with the wood over which the box was pushed back and forth. Thus, in principle, the first planes were very similar to those in use today.[27]

A long span of centuries elapsed between the days of the Roman metal-shod plane and the time when history mentions the plane again. During the period of the Renaissance, the carpenter's plane became a wooden-bed instrument with the wedge held in place by side grooves, and with a knob for the hand. Just when these changes occurred is not known, but planes dating from the sixteenth century have them. However, the knob or horn seems to have been regarded as much an ornament as a hand-hold, and not until the modern factory-made plane appeared did the knob become primarily a place for the hand to grip the plane securely in guiding it across the wood. Although the rear hand-hold, usually in the form of a hole through the back end of the plane, was used on the Roman tools, it did not appear on later planes until about the seventeenth century, when it seems to have been introduced again as a means of carrying the plane by hooking the

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[27]Childe, op. cit., pp. 27, 36.

fingers of the hand through this hole rather than as an aid in the process of planing.[28]

A marked improvement in the plane was made about 1700 by the addition of a second cap of iron which curled the shavings and made it possible to plane against the grain of the wood.[29] At first, this second iron was not fastened to the cutter by a screw, as is now done on the double-plane bit, but was held in place merely by the pressure of the wooden wedge.[30]

In medieval times, as in earlier periods, the work of the carpenter need not be smooth-finished, and today the marks of the axe and the adze may still be seen on the timbers in medieval buildings. But the people of the Renaissance wanted finished work—smooth surfaces, intricate panelings, and elaborate moldings. All this meant that carpenters must use more exact and delicate tools. So the plane came into extensive use. Old Roman styles were greatly improved, and many new kinds and shapes of planes were developed for doing special work.

Planes utilized by Renaissance carpenters for smoothing the surfaces of wood were very much like those in use today. They had "joynter" planes and jacks, the fore-plane, and the small smoother. In addition to these, they also had a number of types of planes that

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[28]Wyatt, op. cit., pp. 41-42. [29]Durbahn, op. cit., p. 21.

[30]Wyatt, op. cit., p. 43.

are no longer in use. There were molding planes and planes for making joints. The molding planes had blades cut into curves and angles so combined that the surface of a strip of wood could be shaped into various designs. The commonest of the planes for making joints was the rebate plane, so called because it cut a rebate or groove on the edge of a board similar to the shape of modern "shiplap." Sometimes a common plane was used for this work with a strip of wood fastened along the bottom of the stock which covered part of the blade. This strip was called a "fence" and served to guide the plane. It ran along the edge of the board, holding the plane blade always in the same path, so as the board was cut, a square rebate was cut along the edge. This type of joint was used so much, however, that most carpenters appear to have had rebate planes on which the fence was permanently attached. Since these planes always made the same width of cut, another plane was developed called a fillister, which had an adjustable fence to allow for widening or narrowing the rebate to be cut. A sharp little scoring point preceded the blade on the side toward the wood, and this kept the cut square and clean. Wheelwrights had a special kind of plane that would cut around a circle, and coopers who made barrels had a very long plane for cutting staves. It was set on legs with the blade projecting upward into the air. Thus, instead of pushing the plane over the wood to shape it, the wood was

moved back and forth across the blade. These special planes, developed during the Renaissance, are seldom used today, since most work of this kind is now done by machines.[31] At the time of their invention and until recent date, however, they met vital needs in the woodworking trade.

Until the early part of the nineteenth century, when factories began the manufacture of tools, master workmen usually made their own tools. This practice resulted in considerable individuality, and frequently in excessive ornamentation of a workman's tools, for his tools were largely his certificate of craftsmanship. The custom that a workman should make his own tools was largely responsible for the fact that the woodworker's tools were, whenever possible, made of wood. When the factory era began, manufacturers accepted the plane as a wooden tool and made only those adaptations that were necessary for quantity production. These planes, made for half a century or more without any variation of pattern, had the iron held in place by a wooden wedge that served in lieu of the lever cap on the modern tool. This wedge was tightened in tapered side grooves by driving with a hammer. The iron was adjusted for depth by being set light and driven to the desired depth by taps of a hammer. To lighten the cut, it was necessary to pull the wedge and cutter out and

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[31]Hibben, op. cit., pp. 192-193.

reset for depth all over again. This removal could be accomplished by pulling on the wedge and striking the top of the cylinder of end-grain wood set in the front of larger planes and in the rear end of smoothing and block planes. This resetting was time-consuming work, and the old-time workman tended to use several planes, each with a varying depth of set, instead of stopping to reset one plane as often as different depths of cut might be required.

The modern plane made of iron or steel is quite a radical change from the 2000-year-old wooden one, but it is not the invention of any single individual. Instead, it evolved through the contributions of many men over a period of approximately a century.[32]

The first so-called modern plane dates from 1827, when H. Knowles patented his cast-iron bed plane. This tool had the channel-shaped body and turned knob of the modern plane, but the cutter was still held in place by a wooden wedge. There was a "horn" at the front to be grasped by the left hand in guiding and steadying the plane in its movements.

Other craftsmen later added improvements to the Knowles plane. Many of the most important of these improvements were probably those of Leonard Bailey. Between 1858 and 1900, Bailey invented the lever cap, fastened the blade to the curling iron with a screw, and

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[32]Wyatt, op. cit., pp. 44-45.

bent the curling iron on the lower end. He also developed the adjustable "frog" to control the width of the throat, or opening, and continued to modify or improve the tool until he had made so many changes in the original tool that it is now known as the Bailey plane instead of the Knowles plane.[33]

In 1844, T. Stanford patented a screw adjustment by which the bit could be adjusted longitudinally, or up and down, without hammering. His invention consisted of a simple wing screw that directly pushed or pulled on the bit, in the same way as adjustments are still made on the modern Gage plane. This device was improved later by T. W. Worrell and by Leonard Bailey, who placed the longitudinal adjustment feature in the handy location near the forefinger where it is still located. In the 1870's, G. A. Warren made his greatest contribution to the modern plane by giving it its present graceful lines, its pleasing balance, and its convenient arrangement of parts.

The bedrock plane with its "frog" so made that the throat opening can be adjusted without removing the bit, was developed by the Stanley Rule and Level Company in 1895. Its convenient adjustment of the throat is an improvement appreciated by careful workmen who like to make little adjustments in their tools in order to improve the quality of their work.

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[33]Durbahn, op. cit., pp. 21-22.

In addition to the various types of planes designed for smoothing wooden surfaces, there are many special planes, of different styles and sizes, for making dadoes, rabbets, tongue and grooves, rounds, hollows, reeding, and complete moldings. Thus, there is no limit to the special planes a woodworker may accumulate. Now, however, in an age when standard moldings are made by machinery and when cabinetmaking, too, is largely the product of the machine rather than of manual skill, many of these special planes are still in existence but seldom used, except by those workmen who delight in producing particularly artistic work and who are able to find patrons willing to pay for the additional time and skill required for such creations. Now, the universal molding plane, with its score or more of assorted cutters, fills whatever need is left for any special hand planes.[34]

From the foregoing discussion it has become evident that

> The plane has evolved into the most intricate of the woodworking tools. In a sense, it has become more than a tool, for most woodworking machines are but super-planes and these machines have largely usurped the work of the simple tool. Probably there will always be some place for the hand plane, and it will continue to change by the gradual elimination of inferior details and the addition of improved ones. It is doubtful, however, if the changes of another century will be at all equal to the many changes which have been made since the appearance of the first cast-iron plane a little over 100 years ago. If they are, it will likely be by the elimination or alteration of the 2000-year-old basic idea of a chisel held in a depth-controlling gauge.[35]

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[34]Wyatt, op. cit., pp. 46-48.

[35]Ibid., p. 48.

Thus, the plane is a modified chisel, and both of these essential woodworker's tools have undergone few fundamental changes in recent times. Through a process of evolution, they attained, centuries ago, virtually the same designs and forms that they now assume.

CHAPTER VIII

LAYOUT AND OTHER MISCELLANEOUS WOODWORKING TOOLS

When man attained that degree of advancement that included a knowledge of some of the fundamental principles of geometry, he developed a number of tools for laying out the geometrical forms which are characteristic of the homes in which civilized man lives. These layout tools constitute a convenient group for brief consideration, since they are the devices utilized for measuring, gauging perpendicularity and horizontality, and dividing distances into minute segments. The changes that have occurred in these tools are virtually the same as those that have transpired in other tools. They include changes in materials as man developed better and better metals; improvements in form as trial found them to be desirable; changes in ways of manufacturing as man developed new tools, machines, and methods of working. In addition, a few changes have been made for the purposes of increasing the uses of the tools.[1] Among the layout tools to be considered briefly are the rule, the square, the compass, dividers, the plumb-and-level, and the marking gauge.

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[1] Edwin M. Wyatt, Common Woodworking Tools—Their History, p. 49.

> The first measuring devices were doubtless parts of the human body, as the length of a man's foot, the width of his hand, the reach of his arm, and the like. The Hebrew cubit was the length of a man's forearm; the Greek palm, the width of a hand; the English fathom, the span of a man's outstretched arms. A good many people have used the length of the human foot as a unit of measure, though the units have not been very close in agreement. Our English "foot" probably came to us through the Greeks who divided it into three "palms." The Romans rejected the palm and divided the foot into twelve inches. The Saxons gave us our present standard of length which is legally the yard.[2]

The fact that parts of the human body were at first the units of measurement is substantiated by the use, even today, of the word "foot" to designate a common unit of measurement. Also, the height of horses is commonly expressed as being so many "hands."

It is obvious that the early units of measurement based upon the parts of the human body and upon other devices were not very accurate, for the length of the foot and of the forearm would vary considerably in different individuals. In time, of course, these units of measurement became standardized as twelve inches to the foot and eighteen inches to the cubit (the length of the forearm), but not until comparatively recent times was such standardization attained. In England, King Edward II, in 1324, decreed that "three barley corns, round and dry, make 1 inch; 12 inches, 1 foot." Thus, perhaps the first official standard of measurement was decreed by a king, who failed to consider that "barley corns" would vary somewhat in size.

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[2] Ibid.

For more than five hundred years, Edward II's standard of "three barley corns, round and dry," remained the standard unit of length among the English people. Then, at last, George IV established a certain bar of brass as being the "standard yard." Later, this standard yard was destroyed by fire, but since 1834 the standard yard has been the distance between two parallel scratches on a bar of bronze and gold in Westminster Hall. This bar is officially named Bronze I, and a copy of it, called Bronze II, is in the archives of the United States Government in Washington. So carefully are these two metal bars preserved that, under no circumstances, are human hands ever permitted to touch them.

With such indefinite units of length as "three barley corns, round and dry," it may be supposed that the early carpenter's tools and rules for measuring were not very accurate, and certainly they were not standardized in length. Probably, like so many of the carpenter's tools, it was a product of his own making, and its accuracy would therefore depend upon his skill and the accuracy of the scale which he utilized in its construction. In a book published in 1678, the rule is illustrated simply as a foot-long stick, flattened on one side and naturally rounded on the other. In a book published in 1813, the rule is shown as a narrow flat device with two six-inch hinged arms.[3] Evidence indicates that the present-day jointed rule made

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[3] Ibid., pp. 49-50.

of boxwood or hardwood, twenty-four inches in length, and constructed in four folding, brass-tipped arms, each six inches long, appeared in England about 1840. Soon it was being imported into the United States, and before long it was being manufactured in this country.[4] In addition to this tool, which was factory-made, the carpenter continually made for himself, as he did in Colonial times, a thin wooden strip for long measurements, notched or marked into ten-foot-long divisions. This was called the ten-foot rule.[5]

Who manufactured the first rules in the United States has not yet been determined. The present Stanley Rule and Level Company had its beginning in 1850, when it began manufacturing boxwood and ivory rules, but other firms had manufactured rules in this country before that date.

The zigzag rule was first made in the United States by the Stanley Company in 1899. At first it was thought of as a novelty, but it steadily grew in popularity until it has practically rendered obsolete the older three- and four-foot folding rules. The zigzag rule, when elongated, will measure several feet in length, but when folded up it makes a very compact article six inches in length which can readily be carried in the pocket.

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[4]Henry C. Mercer, Ancient Carpenter's Tools, p. 63.

[5]Ibid.

Several years ago, the flexible-rigid steel tapelike rule that is now threatening the popularity of the zigzag rule was developed by Hiram A. Feirand of Berlin, New Hampshire, who sold it under the name of "rapid rule." Recently the Stanley Company bought Feirand's patent and is now putting out the new rule in a somewhat modified form under the name of "push-pull rule." This rule, possessing the combined advantages of the rule and the tapeline, promises to become a permanent addition to the woodworker's tool kit. [6]

One of the greatest and most significant advances made in mechanical engineering is that of measurement. Since the beginning of the nineteenth century steady movement has been going on in this direction. Methods of measurement applied in woodworking have but little bearing upon the work of high-class engineers, although they do function in such metal trades as sheet-metal working, girder work, and so on. When a carpenter or a joiner begins to construct a door, a window sash, a roof, or a box, he utilizes a rule, a marker, and possibly compasses. His marker is usually the square, which combines the rule and two or more straight edges for marking. [7]

Undoubtedly, the square is a tool developed by civilized man, unlike many of the other hand tools which had their origins in prehistoric antiquity. One cannot conceive of a savage, having no knowledge

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[6] Wyatt, op. cit., p. 50.

[7] Encyclopaedia Britannica, 14th edition, XXII, 292.

of mathematics, making any intelligent use of such a tool. Therefore, it is not surprising to find that the builders of the ancient pyramids were, in all probability, the first users of the square. In fact, the square may even have been devised for the express purpose of aiding in the construction of the pyramids, since some such tool was obviously essential in such astounding engineering feats. The builders of Jerusalem and those of Grecian and Roman civilizations also obviously employed the square, or a tool which resembled it in form and function.[8] Thus, the square or its ancestor is an ancient tool, but less ancient than other hand tools which originated with primitive peoples. Durbahn has pointed out that the pyramids, erected probably about 3000 B. C., are indisputable proof that the early Egyptians were familiar with some type of instrument similar to the modern square.[9]

Throughout the Middle Ages, the square was a tool employed in several building crafts and varied in form, size, and material with the requirements of the trade and the intended use. The smith, and sometimes the mason, used metal squares, while the joiner and the carpenter used wooden squares, but of different sizes and forms. Workers in wood made their own squares out of wood until the

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[8]Wyatt, op. cit., pp. 50-51.

[9]Walter E. Durbahn, Fundamentals of Carpentry, Vol. I, Tools—Materials—Practice, p. 22.

beginning of the factory era in the nineteenth century. The now familiar and indispensable practice of marking the square with scales is apparently a recent improvement, since no such markings are to be found on old squares or on pictures of them.

The first squares made of metal in the United States for the use of carpenters were probably made by Silas Hawes, a blacksmith of South Shaftsbury, Vermont, about the time that the War of 1812 closed. One day he welded some old pit-saw blades together to form squares, stamped scales on them and sold them to a peddler. This vender found such a ready market for the newfangled iron squares that he kept reordering, until within a year Hawes had established a factory for the making of squares with several assistants employed. Hawes patented his metal squares, developed machinery for making them, and organized several new factories. In 1828 he was able to retire from business as a man of considerable wealth.

Until about the close of the Civil War, all metal squares were graduated by hand tools. In 1865, the still existing Eagle Square Manufacturing Company, located where Hawes had started making his first squares, developed a mechanical graduator that stamped the scales into the metal far more rapidly, accurately, and neatly than had been possible by hand. About a decade later, machine stamping

was extended to applying some of the special markings now found on the carpenter's framing square.[10]

> The square had originally been simply a tool for testing and laying out right angles. The addition of scales to the square greatly increased the possibilities of the tool. These made it possible to use the tool to lay out miters, special angles, ends of braces, figure rafter lengths, and gave many other uses to the square. Knowledge of how to use the square came to be looked upon as a measure of a builder's craftsmanship. Many pretentious books were written explaining how to use this tool. This accentuation of importance of the tool caused ingenious minds to devise many new markings to go on it. Even before the day of machine graduation, a Mr. Essex, then a foreman of the Eagle Square Manufacturing Company, had developed the Essex board-measure table. It is still one of the most valued markings on the framing square. The octagon scale, hundredth scale, and brace table were early and permanent developments. The rafter-framing table was the latest of the special markings. It appeared in 1907.[11]

Recent improvements in the square have been the development of the take-down square, making one-piece squares without a weld at the angle, making more legible markings on the square, and the development of rust-resisting finishes. The light-weight aluminum square is one of the most promising new developments, but it is one of material rather than of design or function.

Compasses and dividers apparently were unknown to the ancient Egyptian builders, as no indication of them is to be found in their

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[10] Wyatt, op. cit., pp. 51-52.

[11] Ibid., p. 52.

writings, or in their picture carvings, or in their construction work until those later days when it can be assumed that they had obtained such implements from their European contemporaries. Although the Greeks knew these tools, they apparently made little use of them. Since they were well aware of the superior beauty of freehand curves, they preferred to use such lines rather than those resulting from the use of compasses and dividers. The Romans, however, made extensive use of the circle and arc and made wide use of dividers and compasses. Constructing these instruments in both bronze and iron, they provided them with both straight and curved legs. Although the Romans knew how to make and use screws with nuts for fastening parts together, they did not use such modern devices for their compass joints. Instead, they employed the very ingenious and effective mortised pin-and-key, which was simple in construction and yet allowed easy adjustment of pressure between the two legs.

Not until recent times has any means been devised for marking arcs and circles other than by scratching with a sharp point. Only in comparatively recent years have compasses been provided with holders for pencil, chalk, or graphite. Older compasses had clamps for holding pieces of lead, charcoal, soapstone, or other substances which could be used for marking.[12]

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[12] Ibid., pp. 53-54.

Work exemplified in the pyramids and in ruins of temples and tombs dating back as far as 4500 B. C. indicates that the Egyptians probably were the first people to use a tool or device for plumbing and leveling their structural work, just as they likely were the first to employ the principle of the square. One type of early Egyptian plummet or plumb-bob was a grooved stone suspended from the end of a string tied securely around the stone in a notch or groove. Later, the Greeks made their plummets of a symmetrical piece of lead with a hole through it, near the top, for tying it to a string or line.[13] At other times, the Egyptians made their plumb-bobs of copper, bronze, or iron, cutting them uniformly into spherical or conical shapes and attaching them to the ends of cords made of soft leather or fiber. The Egyptian type of level, which was used for thousands of years afterward, all over the world, was made like the letter A. A plumb-bob hung from the apex of the A. On the crossbar, exactly in the center, was a mark. When the two legs of the A were set flat on a surface, that surface was level if the plumb-bob came exactly over the mark in the crossbar.[14]

Plummet-type levels were widely used before the spirit level was developed. These consisted of a bar of wood with smooth surfaces

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[13] Ibid.

[14] Thomas Hibben, The Carpenter's Tool Chest, p. 130.

into which a wooden archway was imbedded. From the center of the arch a plummet was suspended on a string. The plumb-bob was a small symmetrical cone of lead, fastened to the string so that the tip of the lead swung back and forth in a V-shaped depression cut through the entire width of the wooden bar which was the base of the instrument. When the point of the plumb-bob coincided with the V-point of the depression in the wooden bar, the surface being tested was level.[15]

Although the Greeks accepted the Egyptian level in its essential form, they did modify it so that it became a splendid tool. The Greek level was made like a lop-sided A with one leg straight up, the other projecting downward from the apex at an angle. At right angles to the vertical leg, extending backward over the inclined leg, a horizontal bar projected for a short distance. Through a hole near the end of this bar a plumb-bob was suspended downward. The relationship of the plumb-bob string to a mark on the crossbar of the A determined whether a surface was level. At the same time, the straight vertical leg of the A could be used for determining whether a wall was straight.[16] Thus, so far as is known, the Greek level was the first tool to be devised which combined the functions of the plumbline, the level, and the square.

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[15]Durbahn, op. cit., p. 23.

[16]Hibben, op. cit., pp. 133, 138.

Although the level and the plumb-bob of the Egyptians and the Greeks were adopted by the Romans and widely used by them, they devised still another type of level which was approaching in principle the modern spirit level.

> Although the plumb-bob and triangle were still used for finding levels, the Romans came very close to the bubble level, for a writer of that time describes a way to find the level by using water. He said that sometimes when the wind was blowing it was difficult to use the plumb-bob, which is true. So he suggested that the workman cut a long groove about an inch wide and a half inch deep in a very straight board. Then this groove was filled with water. When the top surface of the water exactly touched all the sides of the groove evenly, then the board was level. It was a good scheme and useful, but the bubble level that we use was not to be invented until sixteen hundred years later.[17]

As the Roman writer cited in the above quotation said, a plumb-line cannot be used accurately in a wind. If it were not for this fault, the plummet type of level might still be widely used; but the influence of the wind upon the swinging plumb-bob was recognized even by the ancients, who understood that the plummet was not accurate except when no wind was blowing.

In 1666, a Frenchman named Thevenove invented the modern spirit or bubble level, but it was a hundred years later before the little tube of alcohol was to present a serious challenge to the more than 2000-year-old plummet on the level used by the ancients. Some

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[17] Ibid., p. 161.

writers assert that the spirit level could not be made accurately at first, but a more important reason was that the day when each carpenter made his own tools had not yet passed.[18] The fashioning of the curved-glass tube to be filled with alcohol was too difficult a job for the craftsman who made his own tools, so ordinarily he continued to use the plummet.[19] A carpenter could easily make and install a plummet for his level, but he could not make a spirit-filled glass tube. For this reason the spirit level was not widely used or made until the coming of the factory era made it possible to produce such instruments in quantity and according to accurate and standardized patterns.[20]

Since the first one in 1666, the spirit level has undergone little change except for alterations that have occurred in the types of holders in which the all-important little bubble is encased. Thevenove, when he perfected his idea for the first bubble level, made a small glass tube which was slightly bent upward in the middle, and in it he put some wine, leaving enough space for a bubble. The reason he used wine for the liquid was that it would not freeze as easily as water, and it is from the use of wine that the tool takes its name, spirit level. "But this new tool which is so necessary a part of every

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[18]Wyatt, op. cit., pp. 55-56.

[19]Durbahn, op. cit., p. 23.

[20]Wyatt, op. cit., p. 56.

carpenter's kit today did not come into general use by carpenters until two hundred years later—so slow, sometimes, are the really fine inventions in getting to the people who need to use them most."[21]

In its present form, the marking gauge is so simple that it is difficult to believe that it could ever have existed in a form much simpler than the one in common use today. However, it is only recently that it has had the thumbscrew that is now used to tighten the head in place on the beam. In a book published in 1693 the marking gauge was illustrated without any tightening device at all, accompanied with the explanation that, if the beam should become too loose in the mortise to remain in proper position, the tool could still be used by crowding a feather wedge in beside the beam. Later, wooden or metal wedges were used for tightening purposes, until the thumbscrew was installed in recent times.[22]

Among the more common miscellaneous hand tools used by the worker in wood are the knife, the mallet, the wedge, tools for holding the work, and the awl. These will be discussed briefly at this point.

Next to an axe, primitive man's greatest need was for a knife. The first knives utilized were simply flat stones with sharp edges, with the opposite and more or less parallel edges covered with strips

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[21]Hibben, op. cit., pp. 205-206.

[22]Wyatt, op. cit., p. 56.

of rawhide for a handle. When clam shells or sharks' teeth were available, primitive man used these as knives instead of sharp-edged stones.[23]

In working flint, a new technique, that of pressure, was discovered for thinning down flakes by removing shallow scales from both faces. The operator, instead of hitting the flake with another stone, pressed firmly on the edge with a bone or a wooden instrument like a blunt chisel. New processes, grinding and polishing, were devised for sharpening bone and ivory and were applied not only to the manufacture of weapon-points and needles, but also to wedges and chisels that would split wood. Some of these primitive knives were given wooden handles, and sometimes several flakes of flint were mounted end to end in the same grooved piece of wood to form the first composite tools known to man.[24]

In other instances, primitive man gradually learned that by chipping and flattening little bits off the sides, the hammer made of stone could be transformed into an implement that would cut as well as crush. Flint became widely used, for it usually would chip without breaking. Then someone discovered that by rubbing the sides of his hammer against harder pieces of stone, the edges could be

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[23]A. Frederick Collins, A Birds' Eye View of Invention, p. 26.

[24]V. Gordon Childe, The Story of Tools, p. 5.

polished and made sharper, and the stone hammer thus became a stone knife. These smaller bits of stone with sharpened edges were the direct ancestors of our modern knives, our pocket knives, and our saws.[25]

These early knives made of stone were utilized for many purposes by primitive man. In all probability, they were used for "cutting up his food, skinning animals, scraping hides, digging roots, opening mollusks, shaping wood, and, in fact, for all cutting and scraping purposes."[26] In fact, if the ancient stone celts or shaped stones are accepted as knives, then the knife is probably the oldest tool of man surviving to the present day, superseding even the hammer and the axe. The celts, of course, were used for many purposes, too; and it is impossible to determine now whether they were actually knives, hammers, axes, or saws—they may well have been utilized for all of the purposes usually intended for all of these tools named. Beyond question, the stone celt of the ancients can be accepted as the ancestor of many of the hand tools which are now so highly specialized in both form and function, while the celts were used universally for many different purposes. There is evidence in the Bible (Exodus 4:25) that the Jews during the Bronze Age used stone knives

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[25]Hendrik Willem van Loon, Man the Miracle Maker, pp. 84-85.

[26]Wyatt, op. cit., pp. 57-58.

for the rite of circumcision, and it is known that Egyptian embalmers employed stone knives in their work long after metal implements were used for other purposes.[27]

When man learned to beat native copper into tools, he made knives from it, often making them in forms different in design from the implements made of stone. During the Bronze Age the knife began to attain the long blade which we think of as characteristic of that tool. It varied considerably in form, as it does now, depending upon the purpose for which it was intended, and also upon the artistic or utilitarian concepts of the maker. These bronze tools were made by casting, the blades being forged to some extent to harden and sharpen the cutting edges. Frequently, the handles were cast as a unit with the blade, although some bronze knives were equipped with wooden handles into which the blades were driven.

When processes for working iron had been mastered, the knife became a forged tool, and it then became less practical to use the handle as an elongated portion of the blade. Now the knife became less and less an all-purpose cutting tool and was shaped to perform special functions.

The clasp or spring pocketknife apparently originated in Flanders. At any rate, the first ones to appear in England were

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[27] Ibid., p. 58.

imported from that country in the early part of the seventeenth century. On the other hand, the woodworker's special knife, called the drawknife, dates back to the time of the ancient Romans, who probably made it first without wooden handles, as evidenced by specimens discovered in the ruins of Pompeii which had metal handles, one for each hand, curving back from the blade. However, some of the drawknives found in the ruins of ancient Roman civilizations appear to have been equipped with wooden handles, judging from the appearance of the iron shanks which obviously were made for inserting into wooden hand-holds.[28]

> There is little significance in the changes in the form of the knife. It is, and always has been, simply a sharp cutting edge. The form of the blade has been controlled by, first, the material from which it has been made and, second, by the material it was designed to cut. The uses for which knives have been made have varied or changed but little, hence the evolution of the knife has been mainly one of the materials from which they have been made—stone, copper, bronze, iron, and now steel.[29]

Although the mallet has virtually disappeared from common usage among civilized peoples, it once played a significant role as a necessary tool for workers in wood. Excavations in Egyptian tombs have frequently brought to light discarded or forgotten wooden mallets, some of which have been crumbling into dust with age and decay,

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[28] Ibid., pp. 58-59.

[29] Ibid., p. 59.

and all of which have been cracked and marred by the passage of centuries of time. Since the Egyptians never learned to make hammers—not even stone ones—these wooden mallets were probably the impact tools used in carving the stone for the pyramids, the tombs, and the temples of this ancient civilized race. Probably these billet-like mallets were the forerunners of our modern two-piece form, and certainly they were ancestors of the modern sledge hammer.[30]

While the Egyptians may have used their wooden mallets for cutting and carving stone with chisels, there have been other uses for mallets, too, from ancient times down to the present time. For instance, the woodworker, especially the forester and the lumberman, has used them for driving wedges for splitting logs. For this reason, the mallet and the wedge are closely related among the woodworker's tools, though neither is much used any more. Ancient man, however, was accustomed to split wood by the use of wedges made of mammoth ivory or deer and elk antlers driven into the wood with a stone held in the bare hand, or with a hammer or mallet made of antlers or wood in which a tine or branch served as a handle. Later, pebbles of tough stone were reduced to the shape of the old antler wedges and given a sharp edge by grinding with pumice stones, as had been done with the antler wedges.[31] Even the wedge itself might be

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[30] Ibid., pp. 59-60.

[31] Childe, op. cit., p. 7.

formed on an antler tine, cut off obliquely near the tip but not detached from the antler, thus leaving a part of the projecting tine that could be used as a lever handle after the wedge had been hammered into the wood. Or, again, the bevelled edge of the tine might be replaced by a blade of flint or polished stone inserted into the root of the tine.[32] Into comparatively recent times, when a tree was cut down, V-shaped pieces of iron, stone, or hardwood, called wedges, were driven into the trunk along the grain until the tree was split apart. For driving these wedges a heavy, long-handled mallet, called a beetle, was used. Boards made by this splitting process are very wasteful of the wood, since only a few boards can be cut from any one log. Because of this loss of wood, Peter the Great of Russia promulgated a decree prohibiting the use of wedges because of the waste of wood that resulted.[33]

Logically, one may assume that the first tools for holding things were man's own hands and feet. Doubtless, man's first pincers were his fingers, and his first vise was his foot holding an object to the ground, or his clasped hands. But when the primitive hammer, knife, and saw came into use, the need arose for a better scheme for holding things while man was working on them. The earliest vise devised by man was, in all probability, a stick of green

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[32]Ibid., pp. 25-26.

[33]Hibben, op. cit., pp. 45-46.

wood split at one end to hold the object to be worked. Later, this simple device was improved by slipping a bone ring over the stick so that the pressure on the object could be increased and the holding power strengthened, by pressing the ring down tightly over the split stick. In semi-civilized tribes of the present day, smiths use this kind of a vise, but an iron ring is used instead of the bone ring of their ancestors.[34]

Although the cabinetmaker's vise is an old tool, dating back as far as the days of the ancient Romans, it was quite a luxury in the days when screws had to be laboriously carved by hand. Many workers with wood had no vise at all, and equipped their benches with other holding devices. The holdfast was a simple blacksmith-made tool that served the workman in a number of ways: driven into an auger hole in the side of the bench, it held a board for the planing of the edges; on top of the bench, it could hold work for mortising, carving, shaving, and planing; and when used with the catch, it was efficient for broad-surface planing. It was made so as to fit loosely in auger holes conveniently located about the carpenter's bench, and could be tightened or loosened by a blow from a hammer or a mallet. It was quite an effective auxiliary to the bench but is used very little now, primarily because the vise, with which every modern woodworker's bench is equipped, makes it unnecessary and renders it obsolete.

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[34]Gollins, op. cit., p. 28.

The humble bench clamp, consisting usually of a block of wood in which a V-shaped notch has been cut for holding boards, is evidently quite an old aid to the woodworker, for there are extant illustrations of it dating back 250 years. Although these old specimens were single pieces of wood, cut in much the same manner as those in use today, they were hung over the side of the bench to support boards for edge planing.

The wooden miter box, still used today when a better one is not available, is pictured in books published in the seventeenth century, and apparently was made then in the same way as present-day models.

When screws were expensive, cabinetmaker's clamps were made without clamps. The movable jaw gripped when set by the backward turn it received from the pressure on what it clamped. It could be tightened or loosened by blows from a hammer or by springing the bar. Though it was a simple tool, it was an effective one when properly made. Probably the screw-type clamp is quite an ancient tool, but the plain screwless type must have been the popular form in olden times, for a seventeenth-century French encyclopedia pictures it among the typical tools of the cabinetmaker of that era.[35]

Very likely, the awl is one of the oldest of man's tools. The first awls may have been thorns broken from trees, or slivers of

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[35]Wyatt, op. cit., pp. 60-61.

wood or bone. But we know that during the Stone Age awls made of stone were in use by primitive man. They consisted mainly of elongated pieces of stone, usually flint, which were shaped in such a manner that one end extended into a long needle-like projection. It must have required much time and patience to chip the stone in such a way as to preserve such a point without its being broken off in the process of chipping. Many such crude awls must have been ruined for each one that was successfully completed. In view of the difficulty of making such tools, they must have been regarded as very valuable implements, judging from the relatively large number that have been discovered among relics of primitive man.

During the Copper Age, ancient man forged out of native copper many needle-like bits of metal that must have been handled and used as awls. Many of these awl points have been found in the mound builders' mounds in the Mississippi Valley and in virtually every copper-producing region of the world. During historic times, iron replaced the older copper, bronze, and stone points, and in modern times the iron has given way to steel.

The primitive awl was probably quite an all-purpose tool. The same implement may have served to pierce, to enlarge holes, to skewer food in cooking, to scribe and mark, and even for sewing garments. In contrast, the modern awl is quite a specialized tool, many crafts using it in different forms and modifying it to meet their

particular needs. The woodworker has two quite distinct awls, the bradawl and the scratch awl, used, respectively, for bradding and marking.

As a woodworking tool, the awl is very noticeably being displaced by other tools, and the next generation will likely know as little about the awl as this one knows about the ox goad and the broadaxe. The spiral and wheel drills have displaced the bradawl, and the carpenter's pencil and layout knife have made the scratch awl obsolete. The relatively few awls now in use are used more to hold chalk lines than to serve the purposes for which they were originally designed. Within the span of the memory of persons still living, the awl, older than civilization itself, is being evicted from the place in the woodworker's tool chest that it occupied for ages of time.[36]

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[36]Ibid., pp. 61-62.

CHAPTER IX

SUMMARY

Within the preceding pages a story of evolution has been recounted—the evolution of certain common hand tools used in woodwork. In the main, these tools have had a long and varied history as they have developed from the simplest and crudest implements to their present high state of perfection and efficiency. Like almost everything that is now used and enjoyed by mankind, the hand tools originated as very simple and crude attempts to improve ways of doing things and, through untold centuries of time, have gradually evolved into their modern forms and functions.

Virtually all of the more frequently used tools have developed from a common origin—the shaped stone of ancient man, known as the celt. These celts in their simple form in antiquity might perform the functions of the hammer, the axe, the hatchet, the saw, the auger, the awl, the knife, and the chisel and gouge. As primitive man began to understand that variations might be made in these celts to serve different purposes more effectively, they were chipped in a different manner, thus giving them different shapes, sizes, and forms out of

which grew the hammer, the axe, the hatchet, the saw, the auger, the chisel, and the knife.

When the Stone Age passed, the discovery of copper and of ways of combining copper with tin to form bronze brought about the first great revolution in the history of hand tools. Now the implements which formerly had been made of stone could be formed of copper and bronze, and the process of forging came into existence. Most of the tools made of native copper were not sufficiently durable to be very effective, but the bronze implements must have been quite satisfactory, many of them surviving to the present time. With this new and easier material out of which to make tools, it became inevitable that the forms of some of the implements should change, but basically the copper and bronze articles were very similar to those that previously had been made of stone.

When the Bronze Age was displaced by the Iron Age, still another and better material came into being for the making of hand tools, and further improvements were made. Designs experienced alterations, and tools that formerly had been crude and ineffective now became articles of great utility and durability. Strange to say, iron did not for a long time completely replace bronze and copper as a means of making tools, and during the Iron Age bronze, copper, and stone were still in use for these purposes, although to a gradually

decreasing degree. With the coming of steel, the modern age was ushered in, and tools rapidly began to assume their modern forms and degree of efficiency.

Most of the vitally significant changes in hand tools were brought about by unknown innovators in the prehistoric past whose names are not recorded. Like the discoverer of fire and the inventor of the wheel, these benefactors remain anonymous, despite the fact that they laid the foundations upon which the highly effective tools of the modern age have been constructed. Within modern times the names of the inventors and contributors to more effective tools are known, and they are duly credited by historians for their role in the drama of improving the tools that go into the woodworker's tool kit.

It is interesting to note that, although most of the common hand tools now used by the worker in wood had their origins far back in the prehistoric past, the essential features and the original forms of these first tools have not undergone as much change as might be expected. In principle and in form, most of the tools remain virtually the same today as they were when they were first brought into existence by men of the Stone Age. In most instances, only the materials out of which they are made have undergone change, and with the new materials have come modified designs which have contributed to efficiency and convenience in use. Modern scientific knowledge and practice

have brought about many improvements in tools, but they have been altered scarcely at all in form and design.

Thus, the hand tools which the modern woodworker employs are virtually the same as those used by his skin-clad ancestors of the Stone Age whose ingenuity gave birth to tools as a means of strengthening the power of the human hand.

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