MASONRY AND THE ANCIENT SCIENCES

This Short Talk Bulletin is the work of Brother Robert N. Crawford, Clearwater Lodge No. 127, Clearwater, Florida, who has given it as a lecture to enthusiastic groups of Masons in his vicinity.

Masonry and the physical sciences, especially astronomy and geometry, are so closely allied that to speak of one is to imply the other. One marvels at the scientific knowledge the ancient builders displayed in their designs of structures, in handling and shaping materials, and in construction.

Astronomy is probably the most ancient of the physical sciences, for primitive man paid attention to the sky and stars while tending his flocks by night. Josephus, the famous Jewish historian, followed closely the Bible story of creation. Speaking of the fourth descendant of Noah and his son Terah, Abraham's father, he wrote, "God afforded them a longer life on account of their virtues and the good use they made of it in astronomical and geometrical discoveries." In writing of Abraham's sojourn in Egypt, he also noted, "Abraham communicated to them arithmetic and delivered to them the science of astronomy. They were unacquainted with these parts of learning, for these sciences came from the Chaldeans to Egypt and from there to the Greeks."

Astronomers today can accurately predict an eclipse of the sun or moon within two or three seconds; astronomers four thousand years ago could and did predict with an accuracy of one day. Thales of Miletus, probably the greatest of all Ionian Greeks, calculated and predicted the eclipse of the sun on May 28, 585 B.C. It was Thales who saw the moon not as a rabbit, a piece of cheese, or other childish fancy, but as a dark spherical object circling the earth at a fixed distance, visible because the sun shone upon it, and eclipsing the sun at regular intervals. Thales was the first astronomer to show that the phases of the moon were due to natural causes because of the relative positions of the sun, moon, and earth. Thales taught his pupils how to determine the height of a mountain by measuring the length of its shadow when the length of their own shadows equalled their height.

Democritus in 430 B.C. taught that the Milky Way was not the product of the cow, but a vast number of stars too feeble to be seen individually. Two thousand years later it was conceded that Democritus was not a romancer telling stories to amuse his children. Two Greeks in Alexandria, Eratosthenes and Apollonius, calculated the mean diameter of the earth to an accuracy of ten per cent. Hipparchus not only calculated the precession of the equinoxes with remarkable accuracy, but also discovered that the old Chaldean calendar of 365 - 1/5 days was eleven minutes too long. Hipparchus was also the first astronomer to record the observation of a new star. The ancient Chaldeans, Babylonians, Egyptians, Hindus, and Mayas were all excellent astronomers.

Geometry is one of the most ancient of the physical sciences, long called the Queen of Mathematics. Geometry is the basis on which the superstructure of Freemasonry is erected. The word is derived from two Greek words meaning "to measure the earth" and was so named because it was first used by the Egyptians as early as 5,000 B.C. for establishing boundaries which were obliterated annually by the Nile floods.

The University of Alexandria was the first great seat of learning in the ancient world. Euclid, the father of geometry, founded a school of mathematics there in 300 B.C. Euclid was said to be a mild-mannered man who was kind to all sincere students of mathematics. It is related that one student complained that geometry brought no money, whereupon Euclid gave the student three coins from his own purse. When Ptolemy, Pharaoh of Egypt, risked if there was not an easier way to learn geometry than to study Euclid's methods, Euclid gave the response for which he is famous, "There is no royal road to geometry". The Elements of Euclid is a book on geometry written in Greek, later translated into Arabic, and then into Latin. No book, except perhaps the Bible, has had more editions printed than this mathematical treatise. The logic of presentation is perfect. It could be used today because it is much better than some and equally as good as most books on geometry.

Perhaps the most important proposition in his book is the Forty-seventh Problem with which all Masons are familiar: "The square on the hypothenuse of any right-angled triangle is equal to the sum of the squares on the other two sides." This fundamental truth was known to the early Hindus and Egyptians; Pythagoras in 550 B.C. gave the proof which associates his name with the theorem. Freemasons regard it as a symbol of the truths that the arts and sciences reveal to the intelligent man.

There are many right-angled triangles having sides expressed by integral numbers, the simplest having sides of 3, 4, and 5. The Egyptians were quite familiar with this triangle and used it for the design of the pyramid of Khefren at Gizeh, built about 2,500 B.C. By doubling the sides of this triangle we get a triangle having sides of 6, 8, and 10, which constituted the earliest surveyor's chain. It was used for centuries for laying out a line at right angles to any other line.

The pyramids of Egypt illustrate the fundamental principles of geometry. It is truly remarkable that these ancient structures, like almost all ancient buildings having religious significance, are oriented exactly on the cardinal points of the compass. The accuracy of orientation, east and west, of the larger pyramids is represented by an error of less than six minutes of one degree as determined by the use of our most modern instruments. The methods used by the ancients for achieving such accuracy have long been studied by archaeologists and mathematicians, with only general agreement as to the probable method used. It is now believed such accuracy could have been attained only with the aid of one or more of the fixed stars, since the compass was unknown to the ancients. Which of the fixed stars cannot be determined with certainty, but obviously it was necessary to fix only one cardinal point exactly, and the remaining three could easily have been determined by the use of the simple instruments available to the builders.

True north was probably determined by sighting on a star in the northern heavens and bisecting the angle formed by its rising and setting positions. To achieve accuracy it would have been necessary either to observe the true horizon at the points where the star rose and set, or to create an artificial horizon at a uniform height above these two points. This would have been fairly simple for the ancient Egyptians to do, by constructing a level wall to represent the horizon.

Neither astronomy, geometry, nor mathematics could have been developed without a system of numbers. Thus the early origin of numbers could be assumed if no evidence of their antiquity were available. Signs or symbols of numbers have existed ever since two primitive men described how many fish they caught, how many animals they killed, how many days until the next hunt, or how many wives and children each had.

Primitive man used his ten fingers for counting, so we call this method of counting "digital" because "digit" means finger. To denote 1, primitive man held up one finger; for 2, he held up two fingers; for 3, he held up three fingers, and so on; but when he got to 10, he was at a loss to denote a higher number. He probably waved his arms sidewise in sweeping fashion meaning "very many" as being more than 10. For "none" or "nothing" he probably shook his head from side to side or held out his hands palms up and shrugged his shoulders. We often see this gesture today to express the same idea.

In, addition to digitals for visual indication of numerals, primitive man could record numbers by scratching in sand with a stick, or on stone with another stone, by making one vertical stroke for 1, two vertical strokes for 2, three strokes for 3, and so on. Now he could count beyond 10 by simply adding strokes in a line. Soon, however, he discovered he could lessen his effort in writing large numbers by making a diagonal line across four vertical strokes, the group denoting 5. Then he could write large numbers and count them in groups of 5's, a method still in use today.

The Egyptians adopted a somewhat similar system of writing numbers by using vertical strokes up to 10 which they represented by an inverted letter U, thus simplifying the writing of large numbers. 11 was written U1, 12 was U11, 13 was U111, and so on up to 20, which was two inverted U's. 21 was UU1, 22 was UU11, and so on. 30 UUU; 40 was UUUU and so on up to 100, which was denoted by another sign. It is believed that the early Hindus actually invented and used such symbols for numbers, taught them to the Arabs, who passed them to the Egyptians, who in turn gave them to the Greeks and thus to Europe.

The early Greeks used an awkward system of numbers. The first nine letters of their alphabet denoted the numerals 1 to 9. Alpha was 1, Beta was 2, Gamma was 3, and so on up to 9. The next nine letters of their alphabet were used to denote 10, 20, 30, and so on up to 90. Then the remaining letters of their alphabet denoted 100, 200, 300, and so on; but since the Greek alphabet contained only twenty-four letters, they had to invent other signs for 600 and higher. Obviously, such a system was very cumbersome and complicated for use in solving even the most simple problems in arithmetic. Note that so far no sign or symbol for zero, or 0, has been mentioned.

The Romans also developed an extremely cumbersome system of numerals with which we are familiar. Imagine a Roman banker writing the figure denoting the annual budget. He would require the side of a house.

During the twelfth century the Arabs perfected the old Hindu numeral system and for the first time there appeared a sign for zero. By 1400 A.D. the Arabian numeral system was widely used and generally understood except in Italy, where the Roman system persisted until the middle of the sixteenth century. The zero was in general use. However, Victor von Hagen, an authority on the Mayas who settled thousands of years ago in Yucatan, Mexico, believes that the Mayas had invented and used the zero many centuries before the Hindus and employed it extensively in remarkable astronomical calculations in developing their calendar.

Numbers are far older than arithmetic. In fact, arithmetic is a comparatively modern science. "Arithmos" means "number" in Greek. Pythagoras and other ancient Greeks contributed greatly to the evaluation of number concepts, but Pythagoras was more of a numerologist than a mathematician. In fact, he was "crazy about numbers". He made them the basis of an esoteric cult which practiced secret rites and ceremonies. For instance, 4 was the perfect number because there are four sides to a square, four seasons in the year, four elements (fire, water, cold, and heat), and four letters in God's name (DEUS).

In Hebrew mysticism, 40 was another "loaded" number: forty days' and nights' rain to make the Deluge, forty days and nights for Moses' visit with Jehovah on Mount Sinai, forty years' wandering in the wilderness, and forty stripes, kine, cubits, or sockets of silver.

The number 3 was particularly sacred to the ancients: 3 symbolized the three sides of an equilateral triangle, man's earliest sign for God, because the triangle is the first possible closed and endless figure. The ancient Egyptians venerated most highly the trinity of Osiris, Isis, and Horus. Masons also regard three as a special symbol; three degrees, three principal officers, three Great Lights, etc.

In many respects the number 7 was a most excellent number: the walls of Jericho fell because of seven priests blasting on seven trumpets for seven days and encompassing the city seven times. There are seven deadly sins, seven virtues, seven spirits of God, seven liberal arts and sciences, seven colors in the rainbow, seven golden candlesticks, seven years to build King Solomon's Temple, and seven edges on our Masonic apron (four on. the square and three on the triangle). Seven, of course, wins on the first pass with dice.

Some ancient structures and the origin of units of measurements are also very interesting to the speculative Builder. The Ark of the Covenant built by the Israelites in the wilderness under the direction of Moses, who received his instructions from Jehovah, measured five feet long, three feet wide, and three feet high. While this may not be considered a large wooden box today to serve as a base for an overlay of pure gold, inside and out, we must consider the fact that it was made from shittim wood, now known as acacia, which grows with a very gnarled structure similar to the apple tree, seldom produces a trunk greater than seven inches in diameter, and with a woody part having such a high density that it will barely float on water. It is similar to lignum vitae, or ironwood. This wood is so hard that ordinary woodworking tools dull rapidly in shaping it and steel working tools are required to shape it easily. Judging from these properties, we can realize that the Israelites were required to build the Ark from innumerable small pieces of shittim wood and to dowel or mortice the individual pieces together.

Consider also the Tabernacle of Moses, a "knock-down" structure of shittim boards twenty feet long by three feet wide, which had to be fabricated from many small pieces. Similar problems had to be solved for the Altar of Incense, four feet square and two feet high, and for the Table of Shew-bread, four by three by two feet. These furnishings for the Holy of Holies were made from shittim wood and overlaid with pure gold.

King Solomon's Temple and Citadel were other ancient structures built with extreme precision. All Masons are familiar with the Temple. Some of the measurements given in the description of that edifice and its furnishings must be approximate, however. For example, the Molten Sea's dimensions are given in the Bible as ten cubits in diameter and thirty cubits in circumference. We know that the relationship between the diameter and circumference is not 1 to 3, but 1 to 3.1416 (or pi).

In those early days the lack of a "yardstick" was not as serious a drawback as might be imagined. While far removed from the rules and tapes we are familiar with, their methods of measurement were good enough for their purposes. So long as only one man did the measuring, it didn't make any difference how accurate their "yardstick" was, or even how long it was. In fact even now it doesn't make any difference how long an inch, a foot, or a yard is; what really is important is that everyone means the same thing when an inch, a foot, or a yard is used. In other words, any unit of measurement must be standardized so that it means the same thing to everyone. The cubit of ancient times was the length of a man's forearm from his elbow to the tip of his middle finger. In many respects this was a handy measuring stick. It was always available; it couldn't be mislaid, so nobody wasted time trying to find it. It was convenient because everybody had one. However, the cubit was not a fixed dimension because it was not standardized; its length varied according to the size of the man doing the measuring. If Noah had been a small man, his ark might have been only 400 feet long. If Noah had been a very large man, his ark might have been 500 feet long!

We no longer use the cubit as a unit of length, but we have other units of measure which originated in much the same way. A foot started out as the length of a man's foot; in early times the foot varied from eleven to fifteen inches. When early man began to use his arms and feet for measuring lengths, it was only natural that he thought of using legs, hands, and fingers. Horses' heights are still measured by "hands", the breadth of a man's hand, or approximately four inches.

What we call an inch originally was the width of a man's thumb and also the length of his forefinger from the first joint. In 1324 King Edward of England standardized the inch as "three barley-corns, round and dry, laid end to end". Twelve times this inch became the foot. Three times the length of a foot was the distance from the average man's nose to the tip of his outstretched arm, which distance became the yard. Two yards became the fathom, which several centuries ago was the distance across a man's outstretched arms. One half a yard became a cubit and half a cubit became the span, which was also the distance between a man's little finger and his thumb when his hand was stretched as far as possible. A hand was half a span and was also the width across a man's hand at the base of the fingers.

For many centuries mankind used these convenient units for measuring short distances. Today the international base standard is the wave length of light, because it is the only known invariable unit of length.

One is forced to conclude that the ancients were not stupid or lacking in knowledge and resourcefulness. In fact, the ancient scientists and builders were excellent engineers, astronomers, geometers, and mathematicians. They would "stack up" with the best of ours today. They were the original founders and patrons of the philosophic and speculative orders which represented the Freemasonry of a bygone era.