Indian Mathematics

In reading about these areas of mathematics that we often take as obvious. it often was, once someone had worked it out beforehand. This series is about some of the lesser-known of those people.

The first known use of numbers in India was in the time of the Harappans, about 3000 BC. Around this time, people in India began using the counting tokens that people were already using in West Asia. Soon afterwards, people changed over to writing their numbers down, using pictographs. The Harappans also developed standard weights (like our ounces and grams), and they were the earliest people to use base 10 for their weights.

Excavations at Harappa, Mohenjo-daro and other sites of the Indus Valley Civilization have uncovered evidence of the use of "practical mathematics". The people of the Indus Valley Civilization manufactured bricks whose dimensions were in the proportion 4:2:1, considered favourable for the stability of a brick structure. They used a standardized system of weights based on the ratios: 1/20, 1/10, 1/5, 1/2, 1, 2, 5, 10, 20, 50, 100, 200, and 500, with the unit weight equalling approximately 28 grams (and approximately equal to the English ounce or Greek uncia). They mass produced weights in regular geometrical shapes, which included hexahedra, barrels, cones, and cylinders, thereby demonstrating knowledge of basic geometry.

The inhabitants of Indus civilization also tried to standardize measurement of length to a high degree of accuracy. They designed a ruler—the Mohenjo-daro ruler—whose unit of length (approximately 1.32 inches or 3.4 centimetres) was divided into ten equal parts. Bricks manufactured in ancient Mohenjo-daro often had dimensions that were integral multiples of this unit of length.

After climate change caused the Harappan civilization to collapse, about 2000 BC, some invading Indo-Europeans ruled India. This did not stop mathematical progress, and may even have encouraged it, as the Indo-Europeans may have brought Babylonian mathematical ideas to India. By 1800 BC, Indian mathematicians were discussing the idea of infinity, pointing out that "if you remove a part from infinity or add a part to infinity, the remainder is still infinity." As in Babylonia, a lot of progress was made in geometry as a result of interest in astronomy, and by 1300 BC the Indian astronomer Lagadha used geometry to write a book of rules for the apparent movement of the sun and moon. Nobody knows whether Lagadha worked these rules out on his own, or learned about them from the Babylonians.

By about 400 BC, Indian mathematicians were doing more work on the idea of infinity. The Surya Prajinapti defines five kinds of infinity: an infinite line beginning from an endpoint, an infinite line going in opposite directions, an infinite plane, an infinite universe, and the infinity of

time. This was about the same time as the Buddha.

Around 300 BC, when Chandragupta was ruling India, Indian mathematicians began working on the mathematical idea of combinations. This is the study of how many combinations you can make out of the same group of things. For example, how many different poker hands can you make out of a pack of cards? Or, what are the chances that in any class of thirty kids, some of them will share the same birthday? They were working on how you could figure that out, and published their ideas in a book called the Bhagabati Sutra. Around the same time, Indian mathematicians worked out the first beginnings of our modern number system. By 100 AD, people in India were writing the numbers as in the picture here.

1	2	3	4	5	6	7	8	9
―	=	≡	+	h	५	७	८	९

Figure 1 Indian Numerals

While the numbers 1, 2, and 3 are pretty clear, nobody knows where the other signs came from. It may be that they were taken from letters of an Indian alphabet.

Indian mathematicians' biggest invention was the use of zero as a placeholder, to make it easier to add and multiply numbers. Our word "zero" comes from the Sanskrit word meaning "nothing."

Figure 2 Aryabhata (476–550 AD) was the first in the line of great mathematician-astronomers from the classical age of Indian mathematics and Indian astronomy.

Aryabhata is the author of several treatises on mathematics and astronomy, some of which are lost. His major work, Aryabhatiya, a compendium of mathematics and astronomy, was extensively referred to in the Indian mathematical literature and has survived to modern times. The mathematical part of the Aryabhatiya covers arithmetic, algebra, plane trigonometry, and spherical trigonometry. It also contains continued fractions, quadratic equations, sums-of-power series, and a table of sines.

Next time we will look at further important developments that Aryabhata wrote about.