Quarrying Limestone Blocks in the Yucatán

Many of the large buildings in the ancient Maya cities in Central America were constructed from limestone blocks. It was estimated (Adams 1991) that some 70 million cubic feet of cut blocks and fill were needed to construct the Danta Complex, a group of buildings and a platform at the Preclassic Maya city of El Mirador, Guatemala. It was previously not known how these blocks and fill were quarried, with what tools, how they were transported and placed in the buildings, how the mortar and stucco (made from the same limestone) were made, or how much time and effort it all involved. It was important to know how much labor and time were needed so as to be able to estimate the labor force, the overall population of the area, the resources Maya society committed to the project, and how the project may have impacted the environment.

James C. Woods and Gene L. Titmus of the Herrett Museum in Idaho undertook to investigate these issues (Woods and Titmus 1996). Working with the RAINPEG (Regional Archaeological Investigations in the Northern Petén, Guatemala) Project, they traveled to Nakbe, a Maya city located a few miles from El Mirador, to locate and excavate quarries where the limestone blocks had been cut and to examine the quarry debris. They found a variety of broken flaked stone bifaces associated with the ancient quarries, and they concluded that those bifaces may have been used to cut and shape the limestone blocks. Woods and Titmus replicated numerous bifaces, and then hafted them in different ways to see what would work. They began to cut limestone blocks themselves. They found that bifaces hafted on wooden shafts, like a spear, could be used to cut through the limestone rather easily. They also found that the resulting toolmarks in their experimental limestone quarry matched those in the ancient quarries. The replica bifaces that were broken during the experiment had the same breakage patterns as the prehistoric examples, suggesting that they had been used in a similar manner.

An experimentally quarried limestone block is removed from the quarry at the Maya site of Nakbe, Guatemala.

Woods and Titmus found that a team of eight men could cut, remove, and shape four large limestone blocks in a day, and this information was used to calculate the time needed to provide materials for the large Maya buildings like those at El Mirador and Nakbe. Woods and Titmus calculated that a force of less than a thousand workers working half of each year over a period of four centuries could have been sufficient to provide the building materials for the Danta Complex. Some of the general quarry debris was used as fill; the rest was processed into mortar and stucco.

Woods and Titmus also noted that some of the quarries were located very near causeways (roads) that led to the city, making transport of the blocks easier than had been first thought. The experimental work at Nakbe provides valuable information regarding the time and effort required to build ancient Maya cities and gives us a glimpse at the ancient Maya themselves.

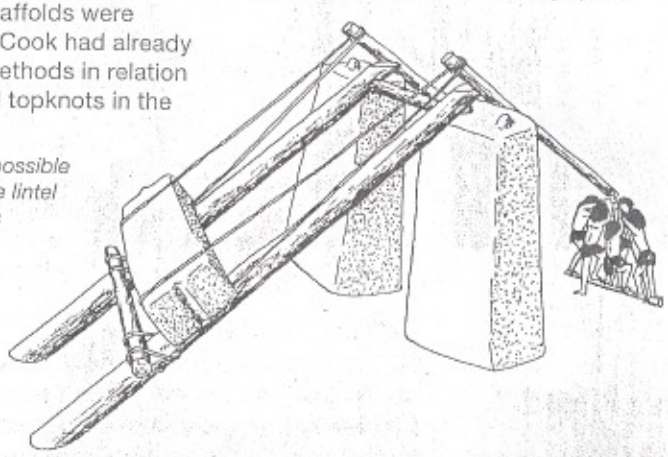
RAISING LARGE STONES

For centuries, scholars have puzzled over the problem of how Stone Age people managed to raise tremendously heavy stones onto the top of high uprights: most famously at Stonehenge, where horizontal lintel stones are accurately fitted on to the top of pairs of uprights to form "trilithons," but also on Easter Island, where many of the statues had *pukao* or topknots (cylinders of red volcanic stone, weighing 8 tons or more) placed on their heads.

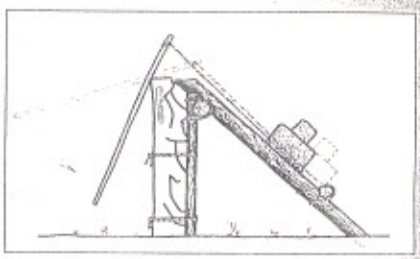
It has traditionally been assumed that enormous ramps of earth or imposing timber scaffolds were required – Captain Cook had already suggested these methods in relation to the Easter Island topknots in the late 18th century. Others have suggested – for both Stonehenge and Easter Island – that the lintels/topknots were lashed to the uprights or statues and the whole unit raised together. However, this is not only very difficult but archaeologically unlikely – the Easter Island topknots were clearly a later addition to the statues. The few that have been placed on to restored statues in modern times have had to be raised by cranes.

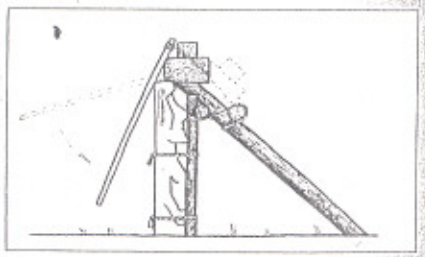
Czech engineer Pavel Pavel has found that the feat is actually quite straightforward, requiring just a people, ropes, and some length timber. He began by working with a clay model of Stonehenge, and, when the method appeared to work, he built a full-size concrete replica of two upright stones and a lintel. Two oak beams were leaned up against the top of the uprights, and two other beams were installed as levers at the other side. The lintel – attached by ropes to the levers – was gradually raised up the sloping beams, which were lubricated with fat. The whole operation was achieved by 10 people in only 3 days.

Pavel has subsequently carried out a similar experiment with a replica Easter Island statue and *pukao*, again finding that the method worked perfectly and with little effort. As with all such experiments, one cannot prove that the Stone Age people used this technique, but the probability is high that something of the kind was employed. The work shows that modern people, so accustomed to using machinery, tend to overestimate the difficulties invol in stone monuments, and underestimate what can be achieved with a little ingenuity, a few people, and simple technology.



Reconstruction of a possible method used to lift the lintel stones of the trilithons at Stonehenge.





Two stages in the possible method of raising the topknot on the Easter Island statues. Modern experiments have shown that this method works perfectly.

Ethnoarchaeology: the work of Lewis Binford. (Right) From observations among living Nunamiut Eskimo in Alaska, Binford derived this model of bone processing around an outside hearth. Small bone fragments fall in a "drop zone" around the men, while larger pieces are thrown both in front and behind them in two "toss zones." (Below center) At the Paleolithic site of Pincevent, France, dating from about 15,000 years ago, the excavator Leroi-Gourhan interpreted three hearths as being evidence for a complex skin tent (reconstruction, center right). (Below) Binford applied his "outside hearth model" to the three Pincevent hearths, and deduced from the distribution of bones that his model fitted the evidence better than that of Leroi-Gourhan: i.e. that the hearths lay outside, and not within a tent. (Below right) Classic semicircular arrangement around an outside hearth as demonstrated by Nharo Bushmen at Ganzi, Botswana, around 1969.