Pulling string to build pyramids

No one knows exactly how the pyramids( ) were built. Marcus Chown reckons( ) the answer could be 'hanging in the air'( ).

The pyramids of Egypt were built more than three thousand years ago, and no one knows how. The conventional( ) picture is that tens of thousands of slaves( ) dragged( ) stones on sledges( ). But there is no evidence to back this up( ). Now a Californian software consultant( ) called Maureen Clemmons has suggested that kites( ) might have been involved. While perusing( ) a book on the monuments ( )of Egypt, she noticed a hieroglyph( ) that showed a row of ( ) men standing in odd( ) postures( ). They were holding what looked like ropes( ) that led, via( ) some kind of mechanical( ) system, to a giant( ) bird in the sky. She wondered if perhaps the bird was actually a giant kite, and the men were using it to lift a heavy object.

Intrigued( ), Clemmons contacted Morteza Gharib, aeronautics( ) professor at the California Institute of Technology. He was fascinated( ) by the idea. 'Coming from Iran, I have a keen( ) interest in Middle Eastern science,' he says. He too was puzzled( ) by the picture that had sparked( ) Clemmons's interest. The object in the sky apparently( ) had wings far too( )short and wide for a bird. 'The possibility( ) certainly existed that it was a kite,' he says. And since he needed a summer project for his student Emilio Graff, investigating( ) the possibility of using kites as heavy lifters( ) seemed like a good idea.

Gharib and Graff set themselves the task of raising a 4.5-metre stone column( ) from horizontal( ) to vertical( ), using no source of energy except the wind. Their initial( ) calculations( ) and scale-model wind( )-tunnel ( )experiments convinced( ) them they wouldn't need a strong wind to lift the 33.5-tonne column( ). Even a modest( ) force, if sustained( ) over a long time, would do. The key was to use a pulley( ) system that would magnify( ) the applied( ) force. So they rigged up( ) a tent-shaped( ) scaffold ( )directly above the tip of the horizontal column, with pulleys suspended( ) from the scaffold's( ) apex. The idea was that as one end of the column rose, the base would roll( ) across the ground on a trolley( ).

Earlier this year, the team put Clemmons's unlikely( ) theory to the test, using a 40-square-metre rectangular( ) nylon( ) sail( ). The kite lifted the column clean off( ) the ground. 'We were absolutely stunned( ),' Gharib says. 'The instant( ) the sail opened into the wind, a huge force was generated and the column was raised to the vertical in a mere 40 seconds.'

The wind was blowing( ) at a gentle( ) 16 to 20 kilometres an hour, little more than half what they thought would be needed. What they had failed to reckon with was what happened when the kite was opened. 'There was a huge initial force—five times larger than the steady state force,' Gharib says. This jerk( ) meant that kites could lift huge weights, Gharib realised. Even a 300-tonne column could have been lifted to the vertical with 40 or so men and four or five sails. So Clemmons was right: the pyramid builders could have used kites to lift massive( ) stones into place. 'Whether they actually did is another matter,' Gharib says. There are no pictures showing the construction of the pyramids, so there is no way to tell what really happened. 'The evidence for using kites to move large stones is no better or worse than the evidence for the brute( ) force method,' Gharib says.

Indeed, the experiments have left many specialists unconvinced. 'The evidence for kite-lifting is non-existent,' says Willeke Wendrich, an associate professor of Egyptology at the University of California, Los Angeles.

Others feel there is more of a case for the theory. Harnessing( ) the wind would not have been a problem for accomplished( ) sailors( ) like the Egyptians. And they are known to have used wooden pulleys, which could have been made strong enough to bear the weight of massive blocks( ) of stone. In addition, there is some physical evidence that the ancient Egyptians were interested in flight( ). A wooden( ) artefact ( )found on the step pyramid at Saqqara looks uncannily( ) like a modern glide( )r. Although it dates from several hundred years after the building of the pyramids, its sophistication( ) suggests that the Egyptians might have been developing ideas of flight for a long time. And other ancient civilisations( ) certainly knew about kites; as early as 1250 BC, the Chinese were using them to deliver messages and dump( ) flaming( ) debris( ) on their foes( ).

The experiments might even have practical( ) uses nowadays. There are plenty of places around the globe( ) where people have no access to heavy machinery( ), but do know how to deal with wind, sailing( ) and basic mechanical principles. Gharib has already been contacted by a civil engineer( ) in Nicaragua, who wants to put up buildings with adobe( ) roofs supported by concrete( ) arches( ) on a site that heavy equipment can't reach. His idea is to build the arches horizontally, then lift them into place using kites. 'We've given him some design hints( ),' says Gharib. 'We're just waiting for him to report back.' So whether they were actually used to build the pyramids or not, it seems that kites may make sensible( ) construction tools in the 21 st century AD.

By manning