

## Rapa Nui Rocks: Impressions from a Brief Visit

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### INTRODUCTION

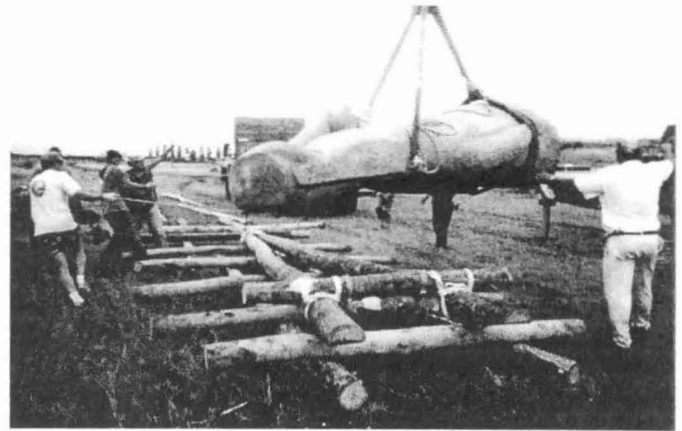
During late April and early May 1998, I was asked to take part in the filming of a NOVA TV special on Easter Island that examined hand methods for moving and erecting *moai* and duplicated the results achieved by the island's pre-contact Rapa Nui people. Featured was the field test of a scheme developed by a team of researchers at UCLA led by Dr Jo Anne Van Tilburg and previously published by her in *Archaeology* magazine (Jan/Feb 1995) and the *Rapa Nui Journal* (Vol. 10:4, 1996). I was to critique her methods as a neutral observer, unfamiliar with Easter Island, but experienced in handling large rocks elsewhere (e.g., with NOVA in Peru, 1994). Also, as a professional alpine guide and mountain rescue expert, I was to devise and field test a technique for safely hand-lowering *moai* from the quarry cliffs onto the gentler slopes below. Finally, based on 15 years in the Andes studying Inca architecture, I was to comment on Heyerdahl's hypothesis of Inca influence in the best-fitted stonework, as exemplified by the *ahu* at Vinapu 1.

Knowing little about Easter Island before NOVA called, other than Heyerdahl's *Mystery Solved* and Van Tilburg's three *Archaeology* articles, I read various other books and papers suggested by Georgia Lee, George Gill and my friend Charlie Love, to prepare for the trip. On the island, Sergio Rapu and his brother Rafael, Claudio Cristino and Edmundo Edwards all generously took the time to show my wife Nancy and me around and pass along their respective theories and insights. With the exception of Van Tilburg, who resented our presence and treated us accordingly, everyone on the island was extremely friendly, helpful and informative. The result was a three week crash course on Rapa Nui archaeology and culture. Nevertheless, the following observations and ideas are those of a newcomer to the field with a passion for rocks, but with much to learn about Easter Island.

### THE UCLA FIELD TEST

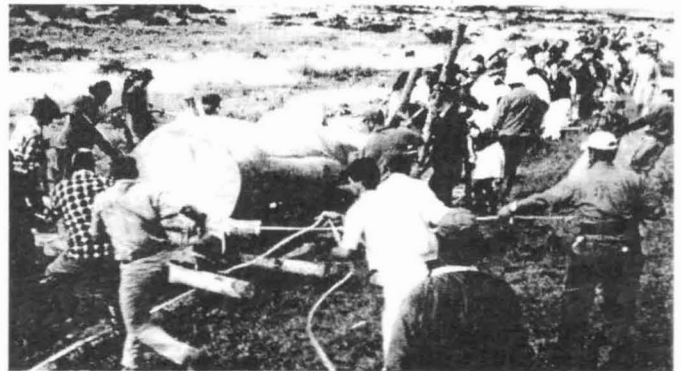
The plan was to make a 15 ton concrete replica *moai* and move it overland onto a replica fieldstone *ahu* constructed for the purpose, and leave it standing erect with a replica scoria *pukao* balanced on its head. With the exception that the finished *moai* weighed more like 9 tons, all of these goals were met in about a week's time and, in that sense, the test was successful. For a detailed description of the transport scheme, read either of the Van Tilburg references noted above. Simply stated, she proposed moving the *moai* 1) in a supine (and, finally, prone) position; 2) on a simple A-frame shaped sled; 3) dragged by pullers; 4) across log rollers laid over pairs of poles laid rail-wise on the ground. At the *ahu*, the *pukao* was to be rolled onto the sled, placing it at the top of the *moai*, and the entire sled then levered and chocked up to a vertical position.

Despite Van Tilburg's hostility, I went into the project with no theories of my own and a mind entirely open to her ideas. My only reservation centered on the use of rollers, which



The 9-ton UCLA cement *moai* being loaded onto A-frame sled.

I knew would be difficult to manage under field conditions. The opening moments of the test confirmed these suspicions, since the rollers went immediately askew and, pinned as they were under 9 tons of rock, took several hours to set right. To prevent a recurrence, the rollers were then lashed to the sled runners and effectively became sliders, across the longitudinal rails on the ground. A crew of about 40 then pulled the re-configured sled, apex-first, 50 or so meters quite easily. It occurred to me that the same fix would have resulted without changing the sled design by lashing the sliders across the rails ladder-wise and leap-frogging movable sections ahead of the sled. In any case, it was clear that notwithstanding the added friction, with a little lubrication on either the rails or the runners, sliders worked where rollers didn't.



UCLA *moai* and sled being pulled by about 40 people.

The next day required a change in the way the *moai* was loaded. Initially, Van Tilburg used a supine position with the head toward the apex of the A-frame on the theory that it was more "respectful" of the *moai* than prone transport would have been (upright was not considered an option). Also, her simple, triangular sled supported a supine *moai* without need of additional cross members to protect its fragile front profile. Nevertheless, it is obvious that supine transport would necessitate erecting the *moai* from behind the *ahu*, a practical impossibility

in most cases due to the terrain and proximity of most *ahu* to the sea. This means the supine *moai* must be rolled onto its face and the sled rotated 180 degrees prior to erection from the *ahu*'s inland side. At the beginning of day two of their test, the UCLA team had accomplished both movements with a large crane, meanwhile suggesting that both would be "trivial" done by hand. I very much doubt this. A damage-free roll-over, in particular, strikes me as sufficiently daunting to virtually rule out supine transport as a serious option.

All of day three was spent moving the sled the final two meters up to the *ahu* and called into question both the structural simplicity of Van Tilburg's sled design and her near-total reliance on pullers for mobility. The same conditions that rule out approaching most *ahu* from their seaward sides also mean that columns of pullers have no place to go as the sled reaches its destination. Ultimately, only levers solve this problem, but Van Tilburg's sled design offered no surfaces against which levers might push, especially rotated as it necessarily was with its apex to the rear. Her team tried to solve this problem by jury-rigging additional cross bars, but only a large crew of pullers on the open ground well behind her *ahu* was able to close the gap. Again, it was suggested these problems had been anticipated, but it was obvious they had not.

The final three days of the UCLA test were devoted to levering the sled up to a vertical position so that the *moai* could be deposited on its pedestal. It was a slow, tedious process, but it worked. Beforehand, Cristino placed a replica *pukao* on the sled, so that once the *moai* was erect, its topknot was balanced atop its head. It was, we were told, the first time a *pukao* had ever been placed by hand methods. At the outset, however, a final flaw in the UCLA scheme became apparent. The position of the *moai*'s base relative to the end of the sled became critical as the upward rotation begins. The sled forms the pivot point and the distance from there to the *moai*'s base must match the height of the pedestal. In this case the *moai* was much too far back, behind the single cross bar that completed the A-frame and made it structurally rigid. The result was that the butt end of the A-frame, including the cross bar, had to be cut off before erection could begin and a new crossbar jury-rigged farther back to keep the frame from coming apart. Van Tilburg commented that this and all the other modifications her team had made along the way were to be expected when engaged in such difficult, challenging work. Imagining that her 9 ton replica was an 80 ton monolith, I couldn't help thinking precisely the opposite—that the ancient Rapanui must have anticipated every aspect of getting the *moai* from the quarry to its pedestal and worked out every detail of the process, however small, before beginning work.

#### AN IMPROMPTU ALTERNATIVE

Watching the UCLA's team's glacial progress on day three, it occurred to me that there had to be a better way and the lessons of the experiment added up to a blueprint for a more workable alternative. I figured the ideal system should work for loads of *any* size actually moved in antiquity and anticipate all conditions encountered between the quarry and *every* known *ahu* without need of either shifting the load or re-rigging the sled. The crux of the problem is the final movement onto the *ahu*, since with enough people, almost anything can be dragged

across open country. In the Andes, in Egypt and elsewhere, big rocks are similarly found in locations too constricted for the large gangs of pullers necessary to drag them. How was it done? Maybe Archimedes had it right. Levers were the only tools any of these people had for multiplying the force each worker could apply to the load. Used properly, levers could greatly reduce the work force and, more to the point, the space it required. In theory, everyone could push from alongside and behind, eliminating the need for any pullers at all—exactly what was needed to get a large *moai* up onto its *ahu*.

It dawned on me that we may have had it wrong all along, misled by the few famous scenes from antiquity showing giant monoliths being pulled on sleds, with a few levermen hanging around to help out in a pinch. What if moving big rocks was like moving ships? Mediterranean galleys had sails for favorable winds and open water, and oars for close quarters and auxiliary power. A nautical analogy seems especially appropriate on Easter Island. For the film, the UCLA team made a point of hauling a boat up over the rocky shoreline on a Polynesian "canoe ladder" but failed to apply the exact same idea to their experiment when the need arose to tie off the rollers and turn them into sliders. Surely, the ancient Rapanui would have seen the similarity between the two situations. And didn't their ocean-going canoes, like the galleys half a world away, use both sails and paddles? If so, why not a sled moved over canoe ladders by pullers and/or levermen?

How would it work? First, let's assume all we have to work with is wood poles lashed together with rope, with the diameters of the poles determined by the weight being moved. Then, imagine several ladder-like frames laid down, end to end on the ground. The rungs, lashed across the tops of the rails about three rung diameters apart, are effectively fixed sliders and they project outboard of the rails several feet on each side. Now lay an identically constructed sled on top of the sliders, runners down. Both ends of the runners are fronts, beveled to avoid hanging up on the sliders, since no transport method avoids the need to rotate the *moai* 180 degrees somewhere between the quarry and *ahu*. The sled's cross-bars, lashed across the tops of the runner twice as far apart as the sliders, form the cargo deck. The *moai*, padded and supported as necessary to prevent damage, is laid prone atop the cross bars and tied securely in place with its bottom held back from the ends of the runners the same distance as the height of the pedestal it is to be erected on. Alternatively, the *moai* could be carried upright, with tight guy ropes from its neck to the four corners of the sled. This is the modern-day Rapanui favorite and makes some sense, since it requires the least manipulation of the load and, except for getting the statue onto and off the sled, it avoids the problems of "walking" the *moai* directly on the ground.

However loaded, the sled is then pulled and/or levered from one ladder to the next with the last one continually leapfrogged ahead and levered to provide a smooth, effectively endless roadway, regardless of terrain. Pullers would be used whenever possible, but levermen working between the projecting ladder rungs and the sled's projecting crossbars would help overcome static friction to get things moving, add extra power going uphill and nudge the sled onto the *ahu* as the space for pullers gets less and less and finally disappears. The spacing of the rungs and crossbars is critical. Like paddlers or oarsmen,

there should be as many levermen as possible, each with just enough space to work effectively and in unison. This dictates the spacing of the cross bars. To direct maximum forward force on the sled, their levers should never be more than about 15 or 20 degrees from vertical, and this dictates the spacing of the rungs. The system's mechanical advantage is the ratio of the vertical distance from the rungs to the cross bars vs. shoulder height of a man—about 3 for a man standing on the ground, 4 if he is on the ladder, and 5 if he rides the sled. If he stands atop the load with a long lever, the latter could be as much as 10. His added weight is trivial compared to the increased advantage. Assuming each worker can apply a maximum force of 100 pounds, either pulling a rope or pushing a lever, the desirability of levers is obvious. Levering one side forward and the other back rotates the sled 180 degrees without difficulty and erecting it vertically, if necessary, would be done pretty much as the UCLA team did it, with the additional cross bars on my sled perhaps an advantage when levering up.

Having arrived at this solution, I made a small model to illustrate the idea to NOVA and suggested we substitute a full



The V. R. Lee sled under construction.

scale test for my lowering exercise originally scheduled for the last few days of the shoot. Everyone seemed to agree about how *moai* had been lowered anyway, and the levering test would be a nice follow-up to the UCLA work. NOVA agreed and using some skinny leftover poles and a roll of small diameter cord we hastily tied up a sled and two ladders with which to try moving a "3 ton" rock promised by Rafael Rapu. Due to a shortage of material, we ended up with about half as many ladder rungs and crossbars as my design called for, but figured it wouldn't matter much with such a small rock. It finally arrived about 10 a.m. the final day of the shoot, weighing at least six tons and looking like a giant Idaho spud. Next to it, our sled and ladders seemed woefully flimsy and inadequate. The "crane" we expected for getting it off the truck and onto our sled turned out to be a 2-ton swing arm hoist mounted on the truck and proved all but useless. Instead, we rolled our "*moai*" off the truck's bed, shattering the edge planks in the process and watched it "thud" ominously and settle into a shallow ditch.

An earlier idea of attempting upright transport was quickly abandoned. Just getting the boulder onto the sled was a huge project. We levered it up onto one of its "edges" with loss of great chunks of rock, causing me to wonder how the UCLA team would have flipped a finished *moai* without defacing it, and then rolled it onto our sled, simulating a *moai* in the prone



The V. R. Lee sled loaded and being levered 180°.

position. The sled lay visibly crushed under the load with one runner cracked and both pressed tightly into the mud of the ditch bottom with no sliders underneath. As the camera rolled we began levering the grossly overloaded tangle of poles up out of the ditch and onto the first ladder, prying between the projecting cross bars on the sled and the ground. It was horrendously inefficient. The levers "kicked out" as they approached the vertical, so that much of our force went up instead of forward. Also, as we got onto the ladder, the hastily-done lashings beneath the sled's cross bars tended to hang up on the sliders. Somewhat to our amazement, the sled nonetheless moved and in about an hour we got it nearly onto the first ladder. With time, energy and daylight running short, however, NOVA asked us to switch gears and try rotating the sled. That proved easier since it let us turn off the fall line and across the slight grade we'd been fighting all afternoon. In a few minutes the sled rotated about 30 degrees.

At one point, Van Tilburg was asked her impression on camera and said, "Look at it. It's a mess!" I had to agree, but for one thing: it worked. Even doing everything wrong, my 12 man crew had levered a six ton rock about 15 feet in an hour and a half; with each man moving 1000 pounds of rock with no help at all from pullers. Had we done everything right, our performance would have been much more impressive, but even as it was, our rate of progress (say 80-100 feet per day) was about the same as the UCLA team had managed with 4 to 6 times as many people—and we could have gotten to the *ahu* without anyone working on its seaward side. But could our method move an 80 ton *moai*? The problem is simple arithmetic. If each of the 40 or so UCLA pullers exerted, say 90 pounds of force on the 18,000 pound load to move it, the coefficient of friction of rails over sliders must have been about 0.2. Applying this to an 80 ton load requires 16 tons of forward force or 356 pullers. My levermen were each applying about 200 pounds of force, which would reduce this number to 160, but by proper application of my idea, the required crew could probably be reduced to half that or less, an entirely manageable team if clustered closely alongside and behind an appropriately large sled. But did the ancient Rapanui do it this way? We may never know—but I have yet to see another way to get an 80 ton *moai* those last few hundred feet up onto a seacoast *ahu*.

#### THE INFAMOUS INCA CONNECTION

During the filming of an early sequence at Vinapu intended to deal with this issue, Van Tilburg noted the existence of "lots of good stonework" elsewhere on the island and sug-

gested that Vinapu was not, therefore, especially unusual. In the days that followed, I set out to see for myself if I agreed. She mentioned one place in particular, that I visited with Edmundo Edwards. Called Ahu Marari, it is half a mile inland from Akahanga, seldom visited and unusual in many respects. Only three stones remain in place, forming a waist-high wall less than two meters long facing the sea from atop a low rise of ground. Several similarly carved stones built into a nearby cave entrance and chicken house were probably part of the original structure, but even with these it is hard to imagine it ever added up to anything like a finished *ahu*. A fallen *moai* lies several hundred meters to the south, seemingly abandoned en route to someplace else. It appears likely the project was never completed, and what purpose was intended by its builders is now impossible to say.

More to the point is the character of the stonework, which is nearly identical to Vinapu except that here the stones are full depth and free-standing. This contrasts with the often-heard comment that the resemblance of Vinapu to Cuzco masonry is superficial since the former is only a "veneer." The same can be said of the large blocks at the east end of Ahu Te Pito te Kura which, though now tumbled, was almost certainly similar in character to Ahu Marari when standing. Even Vinapu is not technically a veneer, since its stones are large and appear to be self supporting on broad, deep bases. Only their exposed upper edges are relatively thin. This pattern is found commonly elsewhere on the island, in the low, typically well-fitted front walls of most *ahu*, for example. As Van Tilburg suggested, in fact, there is a lot of well-fitted masonry to be found, but only at Vinapu, Ahu Marari, and (perhaps) Te Pito te Kura did I see work that bears comparison with that of the Incas.

In making such comparison, it should be understood that even the Incas' classically fitted, mortar-less masonry comes in a wide variety of styles: solid vs. veneer; small, one-man stones vs. giant boulders; flat or nearly flat faces vs. deep joints between strongly pillowed faces; near-rectangular ashlar vs. wildly polygonal shapes. Only two principles seem common to all examples. First is a relentless avoidance of geometrically true right angles, straight lines or flat planes. None will be found, on close examination, in even the most "regular" Inca stonework. Second, and less easily defined, is a certain "feel" or spirit in the handling of the material. Despite the presumed difficulty of shaping, moving and fitting the blocks, the joinery invariably disregards practicalities in favor of artistry and even playfulness.

Applying these two standards to Easter Island, a fair amount of work there adheres to the first. Like the Incas and a relatively few other masonry cultures, the Rapanui never made the transition to true ashlar stonework. Apparently absent a pre-fabricated brickwork tradition of their own or contact with ashlar builders elsewhere, there is no reason they should have. In contrast, the Tiwanakans, a culture with long history of mud brick construction, began using geometrically true blocks very early in the Andes. Why the Incas never did so is an interesting and unanswered question, given both their familiarity with the earlier Tiwanaku work and their extensive use of adobe bricks.

It is the second standard that narrows the field for comparison to just Vinapu, Marari and Te Pito te Kura. All three exhibit the subtlety of style typical of Inca work. Joints are

finely fitted, faces are gently pillowed, corners are rounded. Vinapu, the largest and most intact of the three, has much the feeling of the so-called First Wall at Ollantaytambo. The two small chinks fitted between Vinapu's large blocks recall similar patches in the Temple of Three Windows at Machu Picchu. As in Inca work, no effort has been made to maintain a running bond between the upper and lower courses. On the other hand, if anything about the Rapanui examples seems less than Inca, it is the simplicity of their joint patterns. Almost all stones meet in roughly horizontal bedding planes or at approximately vertical rising faces, by far the two easiest joints to fit. Nowhere are found the L-shaped, U-shaped and entirely irregular patterns so common in Inca walls. Also, the trademark pecking pattern on the faces of Inca stone (fine near the joints, coarser on the fields) is not duplicated on the Rapanui walls—though this may result from the softer volcanic material or the extreme maritime weathering of Easter Island.

None of this definitely answers the question of contact between the two cultures. It is not possible to prove that something did not happen. Certainly the stonework doesn't prove that it did. If Vinapu, Marari or Te Pito te Kura were found in South America, there would be little doubt of Inca influence, but they also have clear roots in the many less fine walls of Easter Island. Leaving aside the whole issue of transoceanic voyages, the window of opportunity during which the Incas had the requisite skills to export is very small, probably no more than the last half of the fifteenth century. The difficulties of Rapa Nui chronology are such that there is no way to date these three *ahu* precisely to that period. The total absence of Andean artifacts on the island despite years of looking would seem to rule out any massive Inca presence, but a boatload of castaways might have brought ashore little but their knowledge. If so, their influence might be expected to be either localized or (less likely) general. The stonework are neither. They are both very rare and widely dispersed across the island, occurring in areas known to have been occupied by different tribal groups. Most likely, the Rapanui invented and refined their own indigenous masonry style without the need of any outside influence, but its similarity to that of the Incas remains a remarkable example of cultural convergence.

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