were removed. The process is visible in two rare examples where the clamps were being pried out when something interrupted their removal (Fig. 12).

What did the ancient Greeks know about civil engineering that allowed them to build such an earthquake-resistant structure? It hardly need be said after the fatal earthquakes of August and September, 1999, in Turkey and in Greece, respectively, that Nemea lies in a very active earthquake zone. Although my friends in the engineering department will probably tremble at my way of expressing it, I think they will agree that the Greeks had discovered the principle of flexibility in their construction. Thus, in the earliest years of Greek temple building, the columns were monolithic; the Temple of Apollo at Corinth of about 540 B.C. will serve as the example nearest to Nemea. By the time the Temple of Nemean Zeus was constructed 200 years later, columns were made up of individual drums—13 in each column at Nemea[11]—that could absorb the shock of earthquakes. The drums might slip and "dance," but the effect of whiplash in a rigid monolithic column was minimized by the flexibility that the horizontal joints of the column allowed. Although I await a graduate student to carry out in a dissertation the necessary detailed analysis of the ancient texts and monuments

Fig. 11. Photograph of the Temple of Nemean Zeus in 1908, from the east, by Boissonnas.

Fig. 12. Two ancient iron clamps partially pulled from their blocks.

that will prove this theory, it seems that ancient architectural nomenclature indicates its validity. The ancient column drum was called a sphondylos (σφόνδυλος); the basic meaning of the word sphondylos, however, is vertabra. The human spinal column with its flexibility served as the model for the ancient Greek column.[12] In other words, the study which has been a necessary prerequisite to the physical reconstruction of the Temple of Nemean Zeus has resulted in an expansion of our knowledge of the underlying principles of ancient architecture.

So, too, the physical reconstruction itself has already given us new understanding of ancient construction techniques. That reconstruction actually began with the foundations in 1984, but financial problems prevented the work from going forward. Nonetheless, advances in our knowledge were gained already then. I will offer one example here. One of the hallmarks of ancient Greek masonry was the ability to create joints between blocks that were so tight that neither water nor even air could pass through. The examples of such joints are nowhere better known than on the Athenian acropolis and particularly in the Parthenon where wooden plugs 2,450 years old are still preserved between the drums of the columns. But the Athenians were working with Pentelic marble of fine quality.

The stone of the Temple of Nemean Zeus came from quarries lying 3 kilometers to the east where roughly worked column drums—prepared but never moved to the temple or used (Fig. 13)—still lie. The stone is a sandy limestone with pockets of "rotten" stone or even earth interspersed with areas of very hard stone. This is the stone which we must cut and use to replace the blocks robbed out of the base of the temple centuries ago.

Fig. 13. Rough worked column drums still in the quarries.

Our attempts to make perfect joints between new blocks of this irregular limestone were unsuccessful, for the chisel would gouge out the soft areas and bounce off the hard and leave a surface that might match that of the adjacent block perfectly in one place, but leave a gap between the surfaces in another. Different chisels and abrasives were tried, electric grinders and even marble floor polishers were used, but the perfect joint eluded us. Finally, in frustration and contrary to what we are taught in modern books about ancient stone masonry, the local workmen resorted to the woodworker's trick of running a saw through the joint in

order to create precisely conforming surfaces—if the saw went a little more deeply into the surface of one block, it automatically left a corresponding convex bulge in the surface of the adjoining block (Fig. 14). The surfaces were not necessarily perfectly straight, but they were perfectly parallel. Not only did this use of the saw solve our problems, but it forced us to look at ancient joint surfaces where we discovered that there are still clear traces of saw marks from antiquity (Fig. 15). The local workmen were proud that they had discovered one of the secrets of their ancestors, and became convinced that the saw was the tool of choice on our sandy limestone, including even the creation of the horizontal joints between column drums. Again, the workmen were correct for the ancient surfaces show the long and curving lines left by the saw. And again, I await a graduate student to do a dissertation on the use of the saw in ancient stone masonry.

Fig. 14. Sawing a joint.

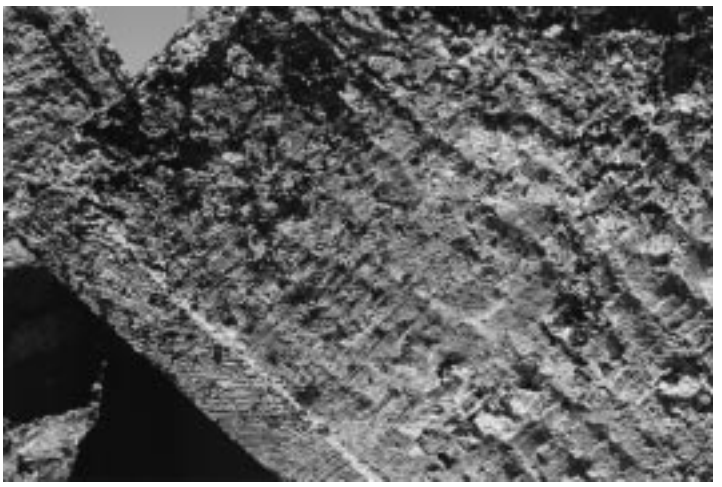

Figure 15: Saw marks on narrow joint surface of epistyle block contrasted with chisel marks on recessed, non-joint (anathyrosis) surface to the right.

The Temple of Nemean Zeus is a laboratory and a classroom where we learn and share our newly rediscovered knowledge. We are returning to that classroom thanks to the generosity of an Athenian businessman, Theodore Papalexopoulos, who has provided the funds to re-erect those two columns that were planned already fifteen years ago. At the end of November 1999, they were growing (Fig. 16) and are now more than half done. Our hopes do not stop there, however. It is now our goal to see not three, nor five, but twelve columns re-erected including the whole of the eastern facade by the time of the Olympic Games in Athens in 2004.

We recognize that, beyond the need to preserve this monument of our past and beyond the new knowledge that we gain from the reconstruction, there is another, deeper reason for putting the Temple of Nemean Zeus back together again. The original construction of this building more than 2,300 years ago was not an act of necessity, nor is its reconstruction forced upon us today. Nonetheless the ancient Greeks and we share—through the desire to build this temple then and to rebuild this temple now—a fundamental creativity that marks the human spirit at its best; we share an impulse toward a higher civilization that leaves a record of human accomplishment, and that serves as a beacon to future generations.

Fiat Lux.

Fig. 16. Two "new" columns going back in place (six drums set on one, two on other, of total 13 in each) on November 29, 1999.

ENDNOTES

1 The first modern record of the Temple of Zeus was in the drawing by William Pars published by the Society of the Dilettanti in *Antiquities of Ionia* II (London 1797) pl. 15, and the verbal description by Richard Chandler, who visited Nemea with Pars in 1766, in *Travels in Greece* (Dublin 1776), 244-245.

2 E.g., by Abel Blouet, *Expédition scientifique de Morée* III (Paris 1838), 33: "In reassembling the fragments of geisa, architraves, friezes, and capitals (which are quite well-preserved and which exist here and there in a very large number) it would be easy to re-establish the temple in its entirety." (trans. from French).

3 Bert Hodge Hill, *The Temple of Zeus at Nemea* (Princeton 1966).

4 Nemean Zeus should be carefully distinguished from Olympian Zeus. The latter is the well-known King of the Gods, thunderer and philanderer, who rules from Mt. Olympus and whose best-known sanctuary is at the site of Olympia, 170 miles away from the mountain—as the crow flies— and much further over the rugged terrain that intervenes.

Nemean Zeus seems to have been the god of shepherds and of grazing as the root of the word implies. The verb νεμειν ("to pasture, to drive to pasture, to graze") seems to have applied to our

site because it naturally is a swampy basin surrounded by low hills and suitable only for grazing. The cult of Nemean Zeus was not widespread, but it did exist elsewhere. For example, the poet Hesiod was told by an oracle that he should "beware the pleasant grove of Nemean Zeus for there death's end is destined to befall you." Hesiod never visited Nemea, but inadvertently entered the Sanctuary of Nemean Zeus at Oinoi in Lokris in central Greece. There he died. See Thucydides 3.96, and Alkidamas, *The Contest of Homer and Hesiod,* 119-129.

5 The museum was built thanks to the generosity of Rudolph A. Peterson (Alumnus of the Year, 1968; see *A Career in International Banking with the Bank of America, 1936-1970, and the United Nations Development Program, 1971-1975* [Berkeley 1994], 382-387) and it was opened to the public in 1984. The study and conservation rooms in the museum are the center of work by students and faculty from the University of California and elsewhere, and they serve a central need of the ongoing excavations.

6 The situation toward the west end (right in Fig. 8) is not so desperate as it appears. Subsequent excavations west of the temple have revealed that 11 blocks from the west end of the temple had fallen into a river of Byzantine times.

7 Frederick A. Cooper, Stella G. Miller, Stephen G. Miller, and Candace Smith, *The Temple of Zeus at Nemea: perspectives and prospects. A Guide to the Exhibition* (Athens 1983).

8 Many of the missing blocks were reused in the Early Christian Basilica (constructed ca. A.D. 475) that lies less than 100 meters south of the temple, and it was clearly the construction of that monument that accounts for much of the missing material. See Mark Landon, "The Basilica and the Early Christian Community," in *Nemea: A Guide to the Site and the Museum* (ed., Stephen G. Miller, Berkeley and Los Angeles, 1990), 78-90.

9 Hill, *Temple of Zeus,* 1-2.

10 Stephen G. Miller, "Poseidon at Nemea," *Filia Eph* I (Festschrift G. E. Mylonas, Athens 1986), 261-271.

The workmen who were at the temple on the afternoon of September 6, 1999, when the earthquake hit north of Athens report that the two columns of the pronaos seemed not to move at all, but that the single column of the exterior rocked back and forth. After the earth stopped shaking we could find no sign of damage.

11 The number of drums in each column at Nemea—13—is standard throughout the building, but the heights of the drums are not. These variations are visible, for example, in Fig. 8, and seem to be due to the size of the blocks that could be quarried from the stone layers that vary dramatically in thickness.

12 Lest it be thought that the visual impact of the drummed column occasioned the comparison with the vertebrae of the human spinal column, we should remember that the ancient column was covered with plaster and the individual drums (sphondyloi—vertabrae) were not visible in the finished building.

University Library, 1893. Librarian Joseph C. Rowell at left.
Photograph by O. V. Lange. *University Archives (UARC PIC 700:22)*.