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Structures as Sites: The Construction Process and Maya Architecture

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THE ARCHITECTURAL accomplishments of the Late Classic Maya embody an enormous array of collective human experience. They reflect economic prosperity, demand public attention, reify worldview, manipulate opinion, and express political relationships. As a consequence of the multiple dimensions of architecture, buildings can be studied by archaeologists through a variety of analytic and epistemological approaches. In a sense, the richness of the built environment requires that archaeologists subject architecture to the largest array of available analyses.

An important step in the study of ancient Maya architecture involves consideration of the behaviors associated with the construction, use, and abandonment of each structure. In proposing this approach, Michael Schiffer (1976) outlined what he termed “behavioral or formation processes”—those stages in the life history of an artifact that ultimately affect the archaeological record. In pursuing this analytic approach, I conceive of Maya architecture as the physical embodiment of articulated materials and behaviors involving costs, construction decisions, and human labor organization, and buildings are viewed as sites unto themselves that could be created only within a specific societal setting.

In this chapter, a sample of Late Classic Maya architecture is dissected into its constituent formation processes, essential as a precondition to deeper analysis. These various formation processes are then quantified, according to architectural energetic research conducted at Copan, Honduras (Abrams 1994), thus combining quantification with behavioral stages of construction. Together, what emerges is a more refined view of construction in terms of materials, behaviors, and sociopolitical organization.

EARLY OBSERVATIONS OF ARCHITECTURAL PROCESS

Architecture has been the focus of archaeological research in the southern Maya lowlands since the inception of Maya archaeology. The remains of Maya civilization, popularized by John Lloyd Stephens (1841), were in fact the remnants of elite architecture. The research conducted by the Peabody Museum, the Carnegie Institution, and the University of Pennsylvania placed great emphasis on large architectural works, producing some of the most comprehensive architectural studies in Maya archaeology, and in the process reinforced the association of civilization with architectural splendor (Morley 1946: 49).

Of their many contributions toward understanding Maya architecture, these earlier Maya archaeologists made three observations about construction that stand out and remain relevant to contemporary analyses. The first is the recognition that buildings were constructed in multiple and distinct episodes, with one building overlaying an earlier one. Complete excavation of Structure E-VII-Sub at Uaxactun (Smith 1950), for example, revealed the multiple stages of discrete episodes of construction as well as the evolving functions of those newly built structures.

A second important observation made by these pioneering excavators was that existing buildings were partially demolished for reuse in the construction of later, overlapping buildings—e.g., see Satterthwaite (1954); in effect, the razing of the old for the raising of the new. This suggests that spatial planning of future architecture was influenced in part by the location of existing structures to facilitate the reuse of materials.

Third, early studies were conducted on the specific engineering practices used by the ancient Maya for both elite masonry (Roys 1934) and commoner wattle-and-daub structures (Wauchope 1938). Roys (1934: 95) outlined the mathematics and mechanics of the corbeled arch, clearly illustrating the physics of stress and strain that had to be understood and controlled by the Maya architects if they were to successfully build arches and weight-bearing walls. At the same time, while excavating the Temple of the Warriors at Chichen Itza, Earl Morris and his colleagues (1931) collected data on lime plaster production; recent analyses continue to use these measurements to discern manufacturing patterns and costs (Abrams 1994). Wauchope's classic research illustrated the variability of commoner house types as well as their elements and methods of construction. Although there have been refinements in understanding the engineering of Maya structures—Littmann (1962) and Hyman (1970) have researched the chemical composition of plaster; Abrams (1994) has reevaluated the practice of breaking joints in wall construction and the sloping of roofs as a

means of collecting potable water—there have to date been no significant contradictions to the insights offered by these pioneering scholars.

THE CONSTRUCTION PROCESS

The total construction process can be divided into four specific but articulated operations: (1) procurement of materials, (2) transport of materials to the construction site, (3) manufacture of finished architectural components, and (4) assembly or actual construction of the building (Fig. 1).

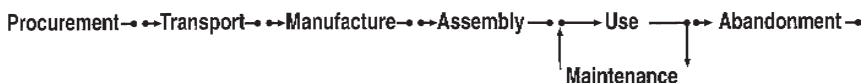


Fig. 1 Outline of the basic operations in construction.

Each of these operations can be further divided into specific tasks based on the components they are designed to provide in the structure. Thus, procurement includes quarrying stone for later manufacture into masonry blocks and cutting grass and palm for vegetal roofs. In manufacture, tasks include reduction of quarried stone into masonry blocks and sculpture as well as preparation of paints, wooden beams and lintels, and lime plaster. Depending on the specificity and appropriateness of the architectural and energetic data needed to quantify these tasks, researchers can design their own “flowchart” of construction behaviors. Researchers must also recognize the variability of these behaviors and thus their costs among sites. For example, at Copan (Abrams 1994: 44), the quarrying of tuff is a task that is distinct from facing the tuff into masonry blocks; at Nakbe (Hansen, this volume), the quarrying of limestone is largely equivalent to the manufacture of masonry blocks. The goal is not to infer some “perfect” set of behaviors for construction but rather to generate a reasonable set of formation processes that are site specific, quantifiable, and in accord with the analytic goals of the researcher.

The four operations and their subsumed tasks appear as linear stages in the construction process, but in fact many tasks were conducted simultaneously. In general, the operations were sequential in the sense that the assembly or construction of the building could not commence until some degree of procurement, transport, and manufacture had been accomplished. However, tasks must have overlapped or demanded variations in the sequence of work for both physical and organizational reasons. For example, limestone and tuff, stones used in masonry, begin to harden when exposed to the atmosphere; thus, ma-

sonry blocks had to be shaped soon after the initial quarrying and well before all of the stones necessary for construction were quarried. During the assembly of some buildings, additional masonry may have been needed, triggering the resumption of quarrying. In some cases, operations blended together, such as conclusion of transport of earth with the assembly of the earthen substructure. Ultimately, the simultaneous conduct of several tasks must have occurred if construction projects were to be completed before the rainy season.

In addition to the four operations identified above, others are relevant to the construction process (Fig. 2).

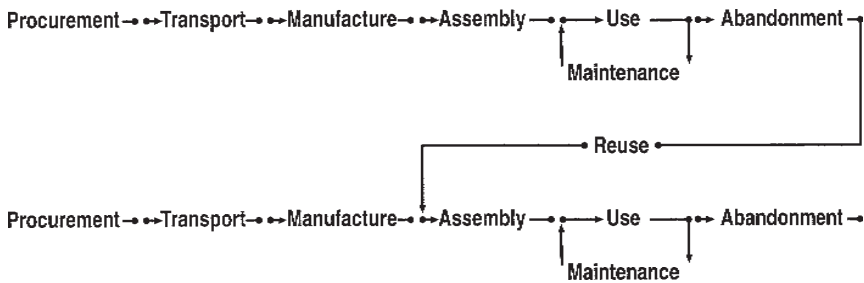


Fig. 2 Outline of the basic operations in construction with reuse of existing building materials.

The most important is reuse, which involves those processes that transform materials from one state to another within society (Schiffer 1976: 39). More specifically, “lateral cycling,” a type of reuse, involves “the many processes by which used, but useable, objects circulate within a sociocultural system and persist in time” (Schiffer 1976: 39). Although there may be some repair or maintenance between episodes of use, these modifications are minimal, and the use of the material—principally masonry—is unaltered. Although other types of reuse are evident in Maya architecture (for example, stelae cut and secondarily used as masonry), lateral cycling represents the primary type of reuse in exploitation of existing materials from underlying structures.

QUANTIFYING THE CONSTRUCTION PROCESS

Dissection of a single building into its various components and consideration of behaviors responsible for each of those components must precede quantification of architecture and the building process. Quantification makes two general observations possible. First, the flow of materials identified in the for-

mation process can be examined in greater detail. Although identification of tasks is critical to understanding Maya architecture, quantification of each task provides a basis for reconstructing labor organization and for the degree of economic specialization. Second, quantification of construction is an important means by which Maya architecture, traditionally measured on a nominal scale, can be rephrased or transformed into a more analytically valuable interval scale. That is, quantification allows the researcher to describe different architectural works not simply as “massive” or “monumental” but rather with a numeric cost, thus reducing all buildings to a single common denominator. Assuming that construction cost is related to power and/or status, the researcher can pursue quantification as an important analytic step in the comparative assessment of sociopolitical relations (Erasmus 1965; Carmean 1991; Abrams 1994).

To exemplify this quantification of buildings as dynamic sites, I consider three buildings from the site of Copan: Structures 9N-82 C, 9N-70, and 3O-28. The first two structures were masonry residences occupied by a very high ranking lord and a moderately ranked lord, respectively, during the Late Classic period. In contrast to these elite structures, the third structure is a commoner wattle-and-daub house. After each has been outlined and quantified, the organization of labor responsible for their construction is presented.

9N-82 C

Structure 9N-82 C (Fig. 3), the central building of “The House of the Bacabs,” is one of the most studied elite residential structures at Copan (Webster and Abrams 1983; Webster, Fash, and Abrams 1986; Webster 1989). Its second and final episode of construction, built in a.d. 787 (Riese 1989), with its thick masonry walls and its high vaulted roof, is one of the most energetically demanding work projects in the elite residential zone of Las Sepulturas, located east of the main center. The political position represented by the occupant of this structure, as reflected in the cost of residential architecture, was that of a maximal lineage head, second in social power only to the king of Copan (Abrams 1994: 85). It was selected for this analysis because it illustrates the construction process for high-cost buildings that underwent vertical expansion and renovation.

Let us consider the costs of building this structure as though it were built as a single construction event, with no reuse of underlying materials (Table 1, column 3). The total cost of this building was estimated to be 10,686 person-days (p-d), based on the method of quantification in Abrams (1994). Each stage of construction demanded unequal labor expenditures: procurement of materials required about 9% of the total cost, transport about 49%, manufacture



Fig. 3 Structure 9N-82 C without vaulted roof in place.

about 39%, and construction about 4% (Table 2). Thus, the dominant costs of construction were not in the final assembly of the building but rather in moving raw materials and manufacturing masonry and plaster. Moreover, if all of the costs associated with masonry (excluding the actual building of walls) and plaster are summed, we see that masonry demanded 6994 p-d, or 65%, and plaster required 2568 p-d, or 24%, of the total cost of construction. Collectively, these architectural components demanded 89% of the total cost, which reconfirms that status distinctions within Maya society can be justifiably inferred from the presence and abundance of plastered and faced masonry walls and roofs. These high costs further suggest that the reuse of masonry would have been a serious consideration in the design and placement of future architecture.

This reintroduces the question of reuse. Structure 9N-82 C-2, the stage immediately beneath the final construction, consisted of a masonry substructure, but the type and quality of the earlier superstructure is currently unknown. For illustrative purposes (Fig. 4), I have quantified the evident earlier substructure as savings toward construction of the final structure (Table 1, column 1). In addition, I have quantified that known masonry substructure and a hypothetical masonry superstructure with a beam-and-mortar roof because this type of building may also have been reused for construction of Structure 9N-82 C (Table 1, column 2). If we consider only the reuse of the substructural

Table 1. Costs of Building Structure 9N-82 C (in Person-Days)

	9N-82 C-2 Substructure Savings	9N-82 C-2 Substructure and Superstructure Savings	9N-82 C If Built with No Reused Materials
Procurement	304	507	928
earth	73	73	111
cobbles	44	44	68
tuff	187	390	749
Transport	1,327	2,156	5,217
earth	101	101	204
cobbles	269	269	414
tuff	957	1,786	3,825
plaster	0	0	774
Manufacture	488	1,020	4,164
masonry	488	1,020	2,370
plaster	0	0	1,699
sculpture	0	0	95
Construction	0	0	377
walls	0	0	218
fill	0	0	47
cobbling	0	0	17
plastering	0	0	95
TOTAL COST or SAVINGS	2,119	3,683	10,686

Table 2. Comparative Percentages in Construction Process of the Three Structures, Assuming No Reuse Savings

	82 C	70 D	30-28
Procurement	8.7	10.7	7.5
earth	1	0.4	0.6
cobbles	0.6	0.1	1.5
tuff	7	10.2	0
Transport	48.8	48.4	25.4
earth	1.9	0.5	9
cobbles	3.9	1.5	16.4
tuff	35.8	41.6	0
plaster	7.2	4.9	0
Manufacture	39	37.2	4.5
masonry	22.2	26.5	0
plaster	15.9	10.7	0
sculpture	0.9	0	0
Construction	3.5	3.7	62.7

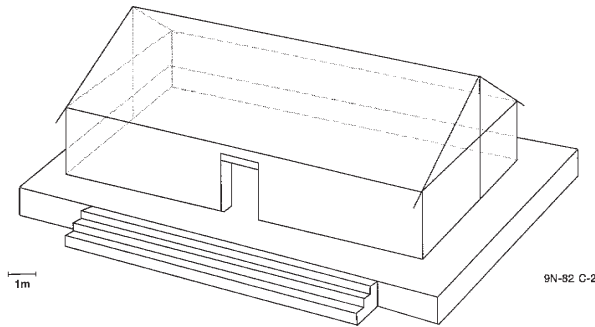


Fig. 4 Reconstruction of Structure 9N-82 C-2.
Drawing by Samuel Girton based on data from Webster, Fash, and Abrams 1986.

component, reuse would have reduced the final cost by 2119 p-d, or about 20%. This general figure does not include the cost of destruction or, more accurately, the cost of dismantling the masonry from the substructure. Most of the 2119 p-d saved are associated with masonry; in terms of manufacture savings of the masonry alone, reused masonry saved 488 p-d of a total of 2370 p-d, or about 21%. When all of the costs associated with masonry are reviewed, we see that about 24% of the masonry costs (1632/6944 p-d) are eliminated (from Table 1). If Structure 9N-82 C-2 consisted of the masonry substructure and a masonry superstructure supporting a beam-and-mortar roof and all available materials were reused to their fullest, then 3683 p-d of labor would have been saved in the ensuing construction of Structure 9N-82 C. This represents a savings of 34% on the cost of the final structure. If this earlier structure bore a vaulted roof, the savings through reuse would approximate a 45% reduction in the building of Structure 9N-82 C. The inference is that reuse of earlier materials was quite significant in reducing the cost of ensuing construction and, thus, provides a cautionary note concerning assessment of the evolution of power inferred from final-phase construction costs alone.

To build this latest structure, however, meant removing the entire superstructure, an easy task if it was composed of perishable material. However, if the superstructure was composed of masonry, then increasing the height of the substructure would involve block-by-block removal of the entire superstructure, with each block presumably placed in the courtyard. Although I have no specific costs for the dismantling process, we can presume at this stage of research that it was not particularly costly. I base this on two observations: (1) the cost of building a superstructure is itself low, comprising only 4% of the total

building process; and (2) to judge from observations of workers removing walls during the restoration process at Copan, dismantling took far less time than building. Nonetheless, more research needs to be conducted on this topic.

Collectively, we see that there is a sizable reduction in cost—between 20% and 45%—by reusing underlying structures. This certainly played an important role in decisions made by architects and the elite concerning the placement of houses and the orchestration of construction projects.

Building Structure 9N-82 C. Structure 9N-82 C, if built with reused materials from the substructure of 9N-82 C-2, required an estimated 8567 p-d (10686 minus 2119 p-d). If built over a period of 60 to 100 days, then approximately 80 to 130 workers participated in this building project. Because neither the immediate courtyard unit nor the collection of courtyards in this group could have provided sufficient laborers, given demographic and status parameters, commoners from rural courtyards must have been the actual laborers. As suggested elsewhere (Abrams 1994), these laborers most likely were members of the lineage headed by the lord residing in Structure 9N-82 C, with the labor being recruited within a system of rotating obligations to the lineage administrators. This type of recruitment was part of a broader institutional framework involving festivities and redistributive returns, although it is possible that this scale of work assumed some elements of *corvée* or mandatory labor obligation available to the highest ranking lords of corporate units within a lineage.

The overwhelming majority of laborers were nonspecialists, some of whom probably participated in more than one task, given the differential time requirements and the overlapping scheduling of tasks. The fact that upward of 90% of the labor force were nonspecialists allows for this use of workers in multiple activities. One important exception, however, is plaster manufacturers. These producers were seasonal specialists responsible for providing lime plaster on an annual basis for various levels of the elite (Abrams and Freter 1996). Not only was the demand for, and cost of, lime plaster relatively high in the initial construction of a building, but plaster was essential in the maintenance of elite structures. In terms of the formation processes involving maintenance, plaster stands out as a critical component—one that could not be overlooked.

9N-70

Structure 9N-70 is the masonry structure of a middle-ranked elite household located on the west side in Patio C of Group 9N-8 at Copan (Hendon et al. 1990). Four features made the building desirable for study: (1) it is more modest in cost than Structure 9N-82 C; (2) it experienced several episodes of construction and reuse; (3) it provides a comparison with the costs of building

substructures relative to superstructures; and (4) it illustrates the building process from the perspective of horizontal expansion.

The first form of this structure—9N-70 A—was a simple wattle-and-daub residence built on a low, 65 cm masonry substructure (Fig. 5). The cost of construction is estimated at about 125 p-d (Table 3), using the same method of quantification that was applied to all structures in this analysis. This stage itself represents a measure of status higher than commoner, being approximately twice the cost of the average commoner structure because of its masonry rather than cobble substructural retaining walls. The building was then significantly modified through horizontal expansion of the substructure, which now supports a masonry superstructure with a beam-and-mortar roof (Fig. 5). Without reuse of the previous building, this version—9N-70 B—would have cost 1413 p-d. By incorporating the reusable components of Structure 9N-70 A, the builders would have saved 58 p-d, thus reducing the cost to 1355 p-d, only a 4% savings.

The next modification, resulting in 9N-70 C, was a horizontal expansion of the substructure that provided added work surface (Fig. 6). Removing the north wall of the 70 B substructure and adding the necessary materials would have cost approximately 93 p-d, not a particularly costly project. Had no earlier material been reused, the total structure would have cost 1506 p-d.

The final modification discussed here—70 D—involved lateral expansion of both the substructure and the superstructure (Fig. 7). Adding the superstructure would have been more difficult architecturally; doing so would have required removing the superstructural north wall and supporting the roof during construction of the addition. Most of the new superstructure would have been built before removal of the north wall, and thus these stones would have been part of the new superstructural walls close to the edge of the old building. The materials removed from 70 C and incorporated into 70 D—essentially the north wall—would have saved 205 p-d, and the total cost to build the additional superstructure would have been 1031 p-d. Had Structure 9N-70 D been built with no materials from any ancestral structure, it would have cost 2537 p-d.

In terms of costs of construction, it is evident that horizontal expansion of a substructure was rather modest compared with lateral expansion of a superstructure (1031:93, or 11:1). Less obvious is that both of these types of modifications were quite limited in comparison with the vertical expansion witnessed for Structure 9N-82 C, which required more than 8000 p-d. A comparison of the percentages of labor expenditures per task for Structures 9N-82 C and 9N-70 D (Table 2), however, shows considerable similarity; thus, arguably the

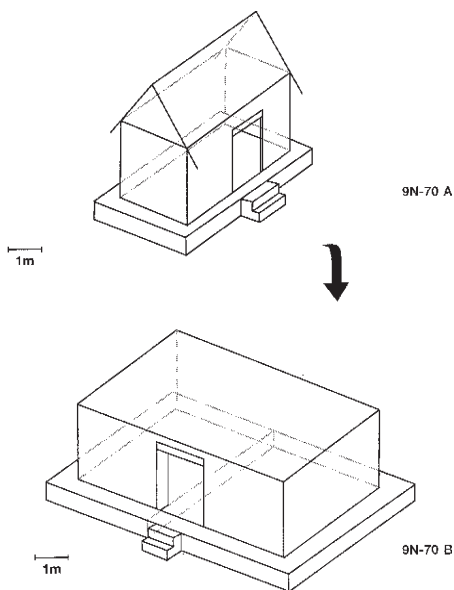


Fig. 5 Structures 9N-70 A and B.
 Drawing by Samuel Girton based on data from Hendon et al. 1990.

Table 3. Costs of Constructing Structure 9N-70 (in Person-Days)

	70 A	70 B	70 C	70 D
Procurement	13.3	147.1	156.3	270.3
earth	1.6	5.1	8.8	9.4
cobbles	0.3	1.5	1.6	2.6
tuff	11.4	140.5	145.9	258.3
Transport	57.4	673.2	712.6	1228.9
earth	2.2	7.0	12.1	12.9
cobbles	3.7	21.0	22.5	37.8
tuff	46.5	573.8	595.6	1005
plaster	5	71.4	82.4	123.2
Manufacture	40.7	522.8	560.5	943.2
masonry	29.7	366.1	380.1	672.8
plaster	11	156.7	180.4	270.4
Construction	13.8	69.6	76.6	94.3
TOTAL	125.2	1413	1506	2537
Reuse	58	1413	1506	
Cost minus savings	125.2	1355	93	1031

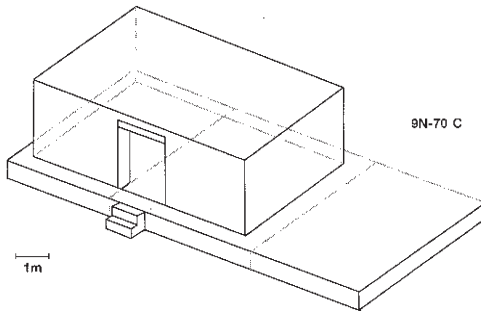
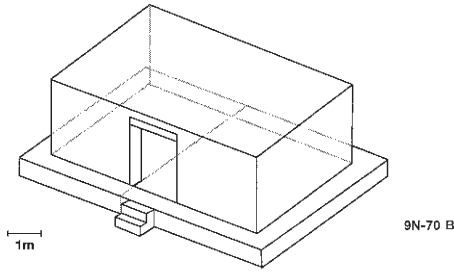


Fig. 6 Structures 9N-70 B and C.
Drawing by Samuel Girton based on
data from Hendon et al. 1990.

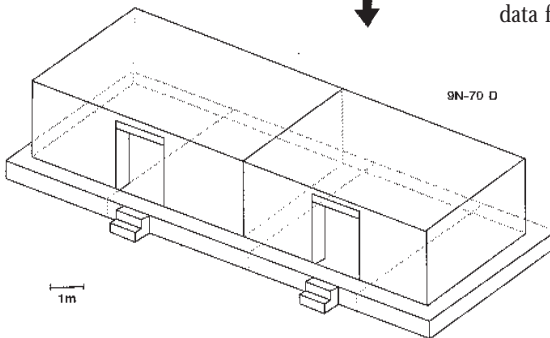
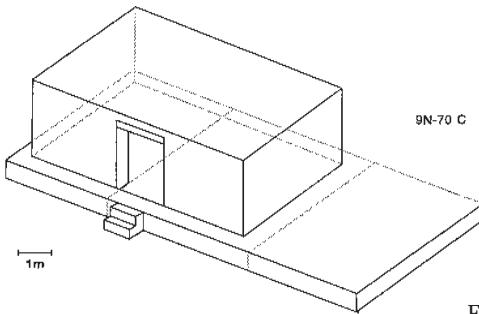


Fig. 7 Structures 9N-70 C and D.
Drawing by Samuel Girton based on
data from Hendon et al. 1990.

sequence of scheduling tasks and workers was similar, albeit with far fewer workers involved in the construction of Structure 9N-70.

Building Structure 9N-70. The number of laborers who participated in construction of even the most costly stage of Structure 9N-70 was likely between 15 and 20. These people were drawn from courtyards other than Patio C and were subordinate to the elite households of Patio C. The work would have been less strenuous and performed within the context of less sociopolitical distance between the lord and the laborers than existed in the construction of 9N-82 C; thus, the mood may have been more festive (Udy 1959; Abrams 1989).

There emerges an interesting pattern to constructing Structure 9N-70, assuming that the four episodes of construction were separated by time. The first and third phases required rather small expenditures of energy, whereas the second and fourth received more substantial and relatively equal outlays. These more costly building episodes involved between 10 and 20 nonspecialized commoners, whereas the first and third construction projects needed only three to five people. The first modification (70 B) may reflect then a rise in status and power—in essence, the establishment of that household within the expanding hierarchy of the elite in the context of instituting state-level power. The next modification is more a functional alteration than one relating to status, and it involved few workers. The final modification, however, did require the labor from a few sociopolitically attached commoner courtyards. This new construction may have commemorated the ascension of a new lord who celebrated his assumption of power by rebuilding and expanding his new residence or perhaps reflected some other measure of heightened social power, as expressed in a larger number of wives.

To speculate, some of the workers who participated in one building project may have contributed to that structure's subsequent modifications. For example, an adolescent who may have assisted in the substructural expansion of Structure 9N-70 C may, 10 or 20 years later, have been conscripted to build Structure 9N-70 D. Given that scribes and accountants probably monitored participation for each project, those familiar with a structure would have been the likely choice as laborers for later work. This notion of recurrent participation may ideologically reinforce the centripetal nature of homes as elements in a sacred landscape.

3O-28

Structure 3O-28 (Fig. 8), located in the Petapilla region of the foothills of the Copan pocket (Gonlin n.d.a; n.d.b), was a typical Late Classic commoner

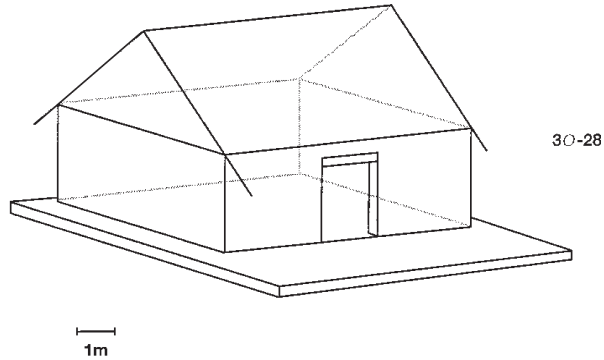


Fig. 8 Structure 3O-28.
Drawing by Samuel Girton based on Gonlin n.d.b.

residence. This wattle-and-daub structure was built in one episode, was occupied in one continuous span of occupation, and experienced no formal modifications. This pattern of short-term construction, use, and abandonment is quite typical of commoner structures in this foothill zone (Paine and Freter 1996).

The costs of construction are quite modest—only 67 p-d (Table 4)—and characteristic of most commoner structures. Far fewer components composed the structure; the absence of masonry and plaster, clearly the most costly components as well as sensitive indices of social power, accounted for the low building cost. As a consequence, the percentages of time expended in various tasks differed considerably for this structure compared with the two masonry buildings presented above (Table 2).

Building Structure 3O-28. The organization and recruitment of laborers in this work project was likely on a familial basis, involving two to five kin or peers of the household head of the residence. Whereas recruitment for construction of elite masonry structures was effected within the context of a redistributive network of obligations, recruitment for building the commoner residence was clearly within a reciprocal system; the low cost and scale of construction suggest as much.

CONCLUSION

The availability of the Maya architectural record, coupled with the cultural richness embodied by such architecture, make this category of artifacts especially well suited for archaeological inquiry. One of the key areas of study in Maya prehistory is the question of the emergence, acceptance, and use of po-

Table 4. Costs of Constructing Structure 3O-28 (in Person-Days)

	Costs
Procurement	5
earth	4
cobbles	1
Transport	17
earth	6
cobbles	11
Manufacture	3
cobbles	3
Construction	42
substructure walls	3
superstructure	39
TOTAL COST	67

litical power, and the study of power, as created and expressed by the ancient Maya, is perhaps best approached through architectural remains.

Architectural energetics, as the means by which architecture can be quantified, is used to describe the life history of three structures from the Classic site of Copan, Honduras. These three structures represent households that held distinct positions within a six-tiered structure of social power during the Late Classic period (Abrams 1994). Rather than rely on the final cost of construction as the basis for comparison, the present analysis quantified the changes in costs through the use life of these buildings. The methodology here explicitly involved quantifying reuse (when applicable) as part of the formation processes in the evolution of architecture. It was found that reuse can result in a 40+% reduction in subsequent expenditures for the largest of masonry structures. This direction of architectural research is offered to advance our ability to observe the expression of power from generation to generation concomitant with the dynamics of state growth and decline.

The effectiveness of analytic methods, however, is a function of the quality of the archaeological data. Future research must focus on quantifying more structures at many more sites, and excavation should be conducted with energetic analysis in mind. If this approach to architecture is furthered, it can lead to a richly documented, dynamic picture of the evolution of social power on a household basis for the ancient Maya.

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