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Circular or Rectangular Ground Plans: Some Costs and Benefits

Arwen L. Feather

Architecture, as a technological strategy, provides shelter from the environment with the minimum possible cost in construction and maintenance of dwellings. There is a significant cross-cultural relationship between ground plan shape and settlement permanence. Circular ground plans are associated with impermanent settlements and rectangular ground plans with permanent settlements. The structural strengths and weaknesses that exist in the dwellings with either circular or rectangular ground plans contrast with each other and affect selection. Architectural design, then, is determined by choices between the needs of people in a given environment and what costs adapting to that will incur.

Cross-cultural anthropological studies (Robbins 1966, Whiting and Ayres 1968, Binford 1990) have established that there is a relationship between the shape of house floor plan and settlement permanence. In these studies, circular floor plans are significantly associated with impermanent settlements and rectangular floor plans with permanent settlements. However, the amount of predictability of this association has been addressed only by Whiting and Ayres (1968), who found that they can confidently predict the association only between rectangular or quadrangular floor plans and sedentary settlement patterns, but not the association between circular and semicircular floor plans and impermanent settlement. The main objective has been to consider how floor plan could reflect aspects of social structure so as to be of use to archaeologists (Robbins 1966, Binford 1990, Whiting and Ayres 1968), assuming that the ethnographic record reflects the archaeological record (Robbins 1966, Whiting and Ayres 1968).

THEORETICAL FRAMEWORK

Whiting and Ayres (1968) assumed that there is a causal sequence “from culture to house type to floor plan” (Whiting and Ayres 1968:117), which is then seen in reverse in the archaeological record, but offered no definition of “culture” or how it influences house type or form. As yet, no one has specifically suggested a theoretical cause for the observed association between mobility and floor plan, except that floor plan, as a part of architecture, represents a technological strategy designed to solve social and environmental problems (Diehl 1992, Nelson 1991, Binford 1990, McGuire and Schiffer 1983, Flannery 1972, Rapoport 1969). However, there is some literature that implies that house shape is not a good indicator of residential permanence (Diehl 1992, Flannery 1972, Rapoport 1969), as it is either subordinate to greater technological considerations concerning energy investment (Diehl 1992, McGuire and Schiffer 1983, Rapoport 1969) or determined by social organizations in relation to village settlement, community food distribution and family procurement strategies (Flannery 1972).

Diehl (1992) developed a model for architecture (see Figure 1) that he adapted from a model by Nelson (1991), which concerned chipped stone tool design and distribution, and then combined this model with aspects of McGuire and Schiffer’s (1983) goals of architectural design, use, production, and maintenance. Nelson’s model for technological organization established a framework for analyzing the different strategies, defined as “problem-solving processes that are responsive to conditions created by interplay between humans and their environment” (Nelson 1991:58), that contribute to design, those “variables of utility that condition the forms of tools” (Nelson 1991:66). The theoretical variables she examined were reliability, maintainability, transportability, flexibility, and versatility (Nelson 1991).

Flannery (1972), however, suggested that settlement-shape selection is “merely the architectural manifestation...of social and political organization” (Flannery 1972:47) in his comparison of village origins in Mesoamerica and the Near East. He concluded that family procurement strategies that promote communal food collecting and sharing will utilize the circular hut compound, which is composed of round dwellings situated in a circle around a central compound. However, this limits potential community growth since circular structures are not easily added onto (though he does not explain why) (Flannery 1972).
Figure 1. Conceptual Model for Architecture as a Subset of Technology (adapted from Diehl)

**SOCIAL and BIOPHYSICAL ENVIRONMENT**

**SOCIAL and ECONOMIC STRATEGIES**

**SUBSISTENCE AND FAMILY PROCUREMENT STRATEGIES**

**MOBILITY STRATEGIES**

- infrequent residential mobility
  - designs which minimize maintenance costs
  - more durable structures
  - more building time invested

- frequent residential mobility
  - designs that minimize construction costs
  - ephemeral structures
  - less building time invested

Flannery continues, “However,...[in] societies where the individual household is the basic production unit and the sharing of storage more selective (such as those typically occupying rectangular-house villages), the opportunities for intensification greatly increase” (Flannery 1972:48). The villages he examined “are composed of rectangular houses designed to accommodate families, rather than individuals....The rectangular ground plan of these houses made it easy to add or subtract rooms [although he offered no reason for this],” (Flannery 1972:39) which in turn relates to the economic growth of the family. The ability to divide into separate family groups indicates that the family has attained enough economic stability to survive on its own. Given a strong political organization, the rectangular village is more advantageous than the space limiting circular hut compound (Flannery 1972).

McGuire and Schiffer (1983) theorize that architectural design is determined by choices between the needs of people in a given environment, costs of structure manufacture (energy of investment, value of materials used, expertise), and costs of structural maintenance. The costs of manufacture and maintenance are usually opposed to each other in that designs that require high manufacture costs lower subsequent maintenance costs, while designs that lower manufacture costs result in structures that require high maintenance costs (also touched upon by Binford 1990).

These theories imply that a technological choice must be made to adapt social and environmental concerns to house design and that most choices are made prior to investment. Diehl predicted that when the anticipated “duration of use of a structure is short (i.e. where residential mobility is high), its design should reflect low initial investment in construction... (and), where people anticipate a lengthy occupation of a structure (residential mobility is infrequent), initial investment should be high, thus minimizing long-term costs of general maintenance” (Diehl 1992:4-5).

Diehl (1992) then tested a sample of 29 simple societies, that do not experience climate extremes, for the relationship between the type of construction materials used, values being stone or prepared wood, mud and organic, and ephemeral and organic, against three variables and their corresponding values. These variables are: residential mobility, with values of high mobility (>19 moves per annum), low mobility (1-12 moves) and sedentary (no annual moves); duration of use, with values of long duration use (>244 days per year), medium use (123-244 days) and short use (<123 days per year); and, dwelling types, values being 1 or 2 types and 3 or 4 types used per year. However, he omitted hide structures from his statistics, as he had difficulty defining the duration use time in relation to construction cost.
He found that "the lowest-cost materials that are least resistant to deterioration [mud and organic materials] are most frequently used by groups with high and low mobility strategies and are rarely used by sedentary groups. By contrast, the highest cost materials that are most resistant to deterioration [stone or prepared wood] are used most frequently by sedentary groups, rarely by low mobility groups, and never by high mobility groups" (Diehl 1992:8-9). Therefore, groups with lower mobility are investing more in house construction whereas groups with high mobility are investing less in house construction (Diehl 1992).

However, Diehl (1992) did not test for the relationship between floor plan shape and permanence of residency. Whiting and Ayres (1968) chose their sample to reflect societies that were similar to prehistoric settlements in order to aid in the discussion and interpretation of archaeological sites. Robbins (1966), who found a highly significant relationship between ground plan shape and settlement permanence, used Naroll's diffusion arcs, a selection method that attempts to overcome Galton's problem of independence, to select his sample. However, Naroll (1961) stated that he measured the distance between societies along the arc and not across it and that there could still presumably be some measure of diffusion, which could influence the results (1961). Binford (1990) used his own data concerning hunter-gatherer populations.

The current research indicates that, although house shape and settlement permanence may be related, that relationship remains unexplained (Diehl 1992, McGuire and Schiffer 1983, Flannery 1972). However, if there is a significant relationship between floor plan shape and settlement permanence, then the explanation could be better approached in terms of investment in construction, rather than a prediction of settlement (Binford 1990). The research issue to be addressed is the relationship between floor plan shape and settlement permanence by conducting a statistical test; and, given that there is a significant relationship with some degree of predictability, to consider what could, theoretically, influence the selection of the different plans according to mobility strategy.

METHODS

Sample

A Standard Sample of 186 societies from the Ethnographic Atlas was selected, using the MAPtab computer program by Douglas R. White published through the World Culture Electronic Journal. Six variables were selected for testing: 1) types of dwelling, 2) fixity of settlement, 3) family form (monogamous or polygamous), 4) household form (multi or single family dwellings and single or multi-dwelling families), 5) compactness of settlement, and 6) dependence on agriculture. These variables were chosen to test the relationship between floor plan shape and settlement permanence, but also included were variables that Whiting and Ayres (1968), Robbins (1966) and Flannery (1972) had addressed in previous studies.

Two variables listed in the World Culture Journal were recoded: types of dwellings, number 65 of the World Culture Electronic Journal, was divided into the two types of floor plan shape, circular or rectangular, according to Murdock and Wilson's (1972) criteria. They had divided this variable into 14 types of dwellings, separated into five classes, depending on whether or not the roof and walls were distinct or not.

The first class of dwellings [types B, C, and D] consists of structures with a circular or occasionally oval ground plan. The second class of dwellings [types E and H] consists of structures with a rectangular or occasionally elliptical ground plan. The third class of dwellings [type A] consists of structures with a circular or occasionally polygonal ground plan. The fourth class of dwellings [types F, P, Q, and R] consists of structures with a rectangular, quadrangular, or occasionally hexagonal ground plan. The fifth class of dwellings consists of several types [S, T, U, and Z] which are defined by criteria other than shape [Murdock and Wilson 1972:258-259].

Classes one and three were primarily based on a circular ground plan so they were recoded as variable 1. Classes two and four were primarily based on a rectangular ground plan so they were recoded as variable 2. The fifth class of dwellings were omitted, since they were not coded for shape, which accounts for the 29 cases of missing data, dropping the total distribution number to 157.

Statistics

Pearson's Chi-square test was used to determine if shape of floor plan was independent of settlement permanence. $H_0$: There is no significant relationship between ground plan shape and settlement fixity. Pearson's R² value was then used to determine how much floor plan shape can predict mobility.

RESULTS

The type of ground plan, circular or rectangular, is compared to the kind of settlement fixity (Table 1). The variable of settlement fixity is divided into six values.
Migratory encampments are occupied "for brief periods successively throughout the year." Seminomadic settlements also consist of temporary camps, however, a "fixed settlement" is established for a particular season(s). Rotating communities have "two or more permanent or semi-permanent settlements occupied successively at different seasons." In a semi-sedentary settlement, the core population remains fixed, from which a segment "departs seasonally to occupy shifting camps." Impermanent communities constitute settlements that are occupied yearly, "but periodically moved for ecological reasons" or other unforeseen events (i.e. "epidemic or the death of a headman." Permanent settlements are "occupied throughout the year for long [undefined] or indefinite periods." However, the permanent settlement value is also used as the default code if a record contains no information regarding permanence of settlement (Murdock and Wilson 1972:256-257).

The chi-square test indicates a highly significant relationship (p<.00000) between floor plan shape and settlement fixity with the Pearson's R² value indicating an 18% chance of ground plan predicting settlement permanence.

**DISCUSSION**

Reasons for the high chi-square values could be 1) this is a large sample size and will, therefore, always yield a high value, and 2) 68% of the sample is distributed under rectangular house plans. However, the results warrant examination of the cause, since 18% of the sample indicated that ground plan shape is being selected for different mobility strategies. Many sources implied that houses, based on the different floor plans, had structural differences that could cause one floor plan to be selected instead of another (Wilson 1988, Flannery 1972, Rapoport 1969, Whiting and Ayres 1968, Fitch and Branch 1960). Wilson (1988), in a general discussion of the conceptual meaning of the house, offered an interesting statement illustrating the structural concept: "The house is a geometry, a series of relationships between objects rather than a collection of objects. The house that loses its geometry simply falls into ruins" (Wilson 1988:66). This statement suggests that geometric relationships must be maintained in order for a structure to perform as needed. Therefore, geometric structural strengths and weaknesses associated with the two ground plans could explain the cross-cultural selection of floor plan shape in regards to settlement permanence.

Rapoport suggests, "The collection of gravitational forces and their transmission to the ground usually requires materials having reasonable tensile strength and a reasonable weight-strength ratio" (Rapoport p.104).

Since there was little anthropological literature concerning the strengths and weaknesses of different house types, and most architectural literature does not address the structure of "primitive" houses, this author consulted Keith Sawyers (1996), a professor of architectural history, theory, and preservation at UNL, to supplement the information provided by articles and texts.

<table>
<thead>
<tr>
<th>Settlement fixity (Residential Moves per Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migratory</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Circular ground plan</td>
</tr>
<tr>
<td>Rectangular ground plan</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Pearson's χ² value = 34.88130  \( df = 5 \)  \( p < 0.00000 \)  Pearson's R² value = 0.1816975  \( p < 0.00000 \)
Figure 2. Interior Volumes

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Advantages of Circular Designs

Dwellings based on a circular ground plan, the dome, cone and cylinder, are more stable and resistant to physical and mechanical forces. These dwellings enclose the maximum available volume with the smallest structure, using the minimum number of materials, which reduces the amount of surface exposed and obstruction to high winds (Sawyers personal communication Dec. 2, 1996; Fitch and Branch 1960). Also, a stable structure can be established from lightweight, portable materials (Sawyers, personal communication Dec. 2, 1996; Flannery 1972, Rapoport 1968, Fitch and Branch 1960).

Disadvantages Of Circular Designs

These forms cannot be added onto without removing structural elements that would destabilize the dwelling. The interior has an over-all lower volume when compared to a square structure of the same dimensions (Figure 2), and, it is not easily subdivided into compartments. Second stories are difficult to construct without investing a great deal of time and effort. Also, roofing these structures, using more durable materials can cause weight distribution problems, which, in turn, can lead to collapse. These dwellings are more susceptible to environmental change (Sawyers personal communication Dec. 2, 1996; Fitch and Branch 1960).

Advantages of Rectangular Designs

The interior volume of these houses are almost double that of dwellings based on the circular ground plan (Figure 2). Both a dome, having a radius of 6ft. (diameter of 12ft.), and a cone, with a radius of 6ft. (diameter of 12ft.) and a height of 12ft, have the same volume of 452 cubic feet. A square structure that has a length and width of 12ft., and a height of 6ft. has a volume of 864 cubic feet. Another advantage to rectangular structures is that additions (either vertical or horizontal) can be made without destabilizing the dwelling (Sawyers, personal communication Dec. 2, 1996; Flannery 1972); the new section can utilize the already present load bearing walls. Also, roofs can be constructed of more durable materials in a manner that distributes the weight evenly. A final advantage is that a variety of windows can be added, which increases ventilation, without destabilizing the structure (Sawyers, personal communication Dec. 2, 1996).

Disadvantages of rectangular designs

Although the volume increase can be an advantage for interior space use, it also requires more fuel to heat the increased area (Fawcett 1988). However, the main disadvantage of the rectangular structure is that more construction effort must be invested in order to make the structure stable. Without diagonal bracing, the dwelling will easily topple if exposed to lateral forces, i.e., wind and earthquakes. For durable structures load-bearing materials are needed, which, consequently, will increase the weight. Light weight dwellings can be constructed, but more effort must be invested to ensure stability (Sawyers, personal communication Dec. 2, 1996).

OTHER TESTS CONDUCTED

Ground plan shape is also tested against family form (Table 2). Variable values are defined here as polyandrous (primarily monogamous with some plural husbands), monogamous, societies with less than 20% polygyny, and those with greater than 20% polygyny (Murdock and Wilson 1972). Testing the association between ground plan shape and family form revealed a significant relationship (p<.01) with 10% predictability.
Ground plan shape was then tested against household form (Table 3), composed of eight variables' values:

1) Large communal structures (i.e. longhouses) which housed the whole community, not just an extended family.
2) Multi-family dwellings which contain non familial groups (i.e. apartment houses).
3) Single family dwellings where one family resides in one dwelling without out buildings.
4) Family homesteads consist of single families residing in one dwelling with out buildings (i.e. plantation).
5) Multi-dwelling households which form a compound in which each dwelling contains a nuclear or polygamous family.
6) Multi-dwelling households which form a compound in which the husband rotates among wives who individually occupy each dwelling her children.
7) Mother-child households consisting of dwellings occupied by a married woman and her children and separate residences for the husbands.
8) Multi-dwelling households consisting of a large family compound in which each dwelling is occupied by an individual married man or woman, not married pairs. (Murdock and Wilson 1972)

The chi-square test indicates a highly significant relationship (p<.001) and has a $R^2$ value which suggests a 10.8% predictability between ground plan shape and household form.

Another test compared ground plan shape and settlement compactness (Table 4), composed of four variable values. Dispersed settlements consist of “isolated family homesteads, bands whose members live in dispersed family camps, or villages with dwellings strung out at appreciable intervals along a highway, shore, or river bank.” The second variable value is spatially separated settlements which are sub-settlements of small sedentary “hamlets or clusters” containing a few nomadic families. Partially dispersed settlements is another value, composed of a central town with “satellite hamlets or homesteads.” The last variable value is compact settlements defined as “nucleated villages or concentrated camps” (Murdock and Wilson 1972:257). There is almost a statistically significant relationship (p<.05752) between the two variables.

The final test was between ground plan shape and a society’s dependency on agriculture, which is ranked by percentage (Table 5). This test was conducted since archaeological theories suggest that, although agriculture is not dependent on sedentism, sedentism is advantageous to the practice of agriculture (Flannery 1972, Wilson 1988). This relationship is also significant (p<.01), with an $R^2$ value indicating 10% predictability between ground plan shape and dependence on agriculture.

### Table 2. Ground Plan Shape and Family Form

<table>
<thead>
<tr>
<th>Family Form</th>
<th>Polyandry</th>
<th>Monogamous</th>
<th>Polygyny &lt;20%</th>
<th>Polygyny &gt;20%</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular ground plan</td>
<td>0</td>
<td>3</td>
<td>23</td>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>Rectangular ground plan</td>
<td>2</td>
<td>24</td>
<td>59</td>
<td>22</td>
<td>107</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>27</td>
<td>82</td>
<td>46</td>
<td>n=157</td>
</tr>
</tbody>
</table>

Pearson's $\chi^2$ value = 15.58519  \hspace{1cm} df = 3  \hspace{1cm} p < 0.00138; \hspace{1cm} Pearson's $R^2$ value = 0.0970696  \hspace{1cm} p < 0.00007
Table 3. *Ground Plan Shape and House Hold Form*

<table>
<thead>
<tr>
<th>House Hold Form</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular ground plan</td>
<td>1</td>
<td>1</td>
<td>17</td>
<td>3</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>Rectangular ground plan</td>
<td>4</td>
<td>2</td>
<td>51</td>
<td>31</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>107</td>
</tr>
<tr>
<td>total</td>
<td>5</td>
<td>3</td>
<td>68</td>
<td>34</td>
<td>21</td>
<td>7</td>
<td>3</td>
<td>16</td>
<td>n=157</td>
</tr>
</tbody>
</table>

Pearson’s $\chi^2$ value = 27.95669  \( df = 7 \)  \( p < 0.00022 \);  Pearson’s $R^2$ value =0.1082212  \( p < 0.00056 \)

Table 4. *Ground Plan Shape and Settlement Compactness*

<table>
<thead>
<tr>
<th>Settlement Compactness</th>
<th>Dispersed</th>
<th>Spatially separated settlements</th>
<th>Partially dispersed settlements</th>
<th>compact</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular ground plan</td>
<td>2</td>
<td>7</td>
<td>17</td>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>Rectangular ground plan</td>
<td>16</td>
<td>12</td>
<td>20</td>
<td>59</td>
<td>107</td>
</tr>
<tr>
<td>total</td>
<td>18</td>
<td>19</td>
<td>37</td>
<td>83</td>
<td>n=157</td>
</tr>
</tbody>
</table>

Pearson’s $\chi^2$ value = 7.50146  \( df = 3 \)  \( p < 0.05752 \);  Pearson’s $R^2$ value =0.0028944  \( p < 0.50336 \)

Table 5. *Ground Plan Shape and Dependency on Agriculture*

<table>
<thead>
<tr>
<th>Dependency on Agriculture</th>
<th>0-5%</th>
<th>6-15%</th>
<th>16-25%</th>
<th>26-35%</th>
<th>36-45%</th>
<th>46-55%</th>
<th>56-65%</th>
<th>66-75%</th>
<th>76-85%</th>
<th>86-100%</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular ground plan</td>
<td>19</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>11</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Rectangular ground plan</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>14</td>
<td>25</td>
<td>27</td>
<td>12</td>
<td>12</td>
<td>3</td>
<td>107</td>
</tr>
<tr>
<td>total</td>
<td>28</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>15</td>
<td>34</td>
<td>38</td>
<td>17</td>
<td>13</td>
<td>4</td>
<td>n=157</td>
</tr>
</tbody>
</table>

Pearson’s $\chi^2$ value = 26.26170  \( df = 9 \)  \( p < 0.00185 \);  Pearson’s $R^2$ value =0.1012767  \( p < 0.00005 \)
Patterns

Structures based on the circular ground plan are more stable and can be constructed of light-weight, portable materials, minimizing construction costs. These structures have significant associations with those societies that are migratory or semi-nomadic, have greater than 20% polygyny, construct multi-dwelling compounds and depend less on agriculture, with an almost significant relationship with partially dispersed settlements (core community with satellite dwellings nearby).

Alternatively, rectangular structures are only stable after considerably more time has been invested in construction. These structures have a significant relationship with those societies that have at least two fixed seasonal settlements, are semi-sedentary, or permanently settled, monogamous or with minimal polyandry or less than 20% polygyny, single family dwellings or large communal structures, and a greater dependency on agriculture with an almost significant association with either dispersed or compact settlements.

Assessment of Predictions

Since there is 18% correlation between the relationship of ground plan shape and mobility pattern, the structural strengths and weaknesses of the different ground plans were examined. The research demonstrates that there are structural advantages and disadvantages for dwellings based on either the circular or rectangular ground plan that could influence the selection of house shape in relation to settlement permanence.

CONCLUSION

Stable structures, based on the circular floor plan, can be constructed using fewer and/or lighter materials. Impermanent settlements would benefit by using structures, based on this floor plan, as it reduces construction costs. However, stable rectangular structures distribute the weight of heavier materials (especially durable roofing materials) better but require greater investment in construction. Permanent settlements, though, could benefit from using structures based on this ground plan, since Diehl's study indicates that dwellings that use more durable materials need more initial investment in construction regardless of floor plan shape.

House plan shape and settlement permanence can be predicted at 18%. Also, house plan shape and family form (monogamous or polygamous) can be predicted at 10%; house plan shape and dependency on agriculture can be predicted at 10%. There is an almost significant relationship between house plan shape and compactness of settlement.

The findings support Diehl's model of architectural technology. It would seem that mobility and residential strategies strongly influence the type of material used in construction. Given how the structural strengths and weaknesses between houses based on circular and rectangular ground plans contrast with each other, it would seem a highly adaptive technological strategy to select a dwelling form that would either "minimize construction costs" or "minimize repair costs" (Diehl 1992: 5).

Some of the test results also seem to indicate that ground plan shape could also be selected to benefit certain social and political concerns addressed by Flannery (1972). The fact that circular ground plan shape can predict a 10% correlation between multi-dwelling house holds, high levels of polygyny and low levels of agricultural dependence could indicate, if all these cases occurred together, architectural selection based on communal organization that limits individual wealth acquisition and perhaps explain why 22 of the observed cases of circular ground plans were selected for permanent settlements. Subsequently, rectangular ground plans can predict a 10% correlation between single family dwellings, monogamy or low levels of polygamy, and higher dependence on agriculture. If all these cases occurred together under rectangular ground plans, then this would indicate a society that is capable of expansion (given a strong polity), where the single family has acquired enough wealth to survive with little or no communal support and intensified production could be rewarded with higher levels of economic stratification.

However, more research needs to be done to discover if or where the predicted variables overlap. Future research could also explore the impact of colonialism on primitive architecture forms and the social and technological repercussions. Another avenue of research could examine the reasons some societies choose a structure based on a round or rectangular floor plan even if it is not technologically advantageous to do so; and, why modern society continues to design and construct houses with wall and roof types more suited to the climate of Detroit, in other climate areas, increasing maintenance costs and "the social waste of energy and material" (Fitch and Branch 1960).
ENDNOTES

1 See Appendix A for a complete list of societies and original variable information.

2 These are the Masai, a group which uses a semi-cylindrical house form which has a rectangular ground plan but not necessarily a rectangular structure, and the Goajiro, who build a rectangular structure out of vegetal materials on the ground (no investment in subterranean digging or construction of raised floor on piles).

3 If the height of the cone is only 6 feet, as in the dome and the rectangular structure, then the volume drops to only 226 ft³, half the interior volume of the dome.

4 The rectangular ground plan also predicted by the relationship to large communal structures. However, this association would be caused by the structural strength needed to support such large dwellings; the weight of which is best distributed by the rectangular structure.

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Naroll, R

Nelson, M. C.

Rapoport, A.

Robbins, M. C.

Wilson, P. J.

Whiting, J. W. M. and B. Ayres

Arwen Feather is a graduate student in anthropology at UN-L. She has a Bachelor of Fine Arts degree from the Kansas City Art Institute, and maintains a wide variety of interests within anthropology and art.
APPENDIX
(Societies Used)

Nama Hottentot  Kenuzi Nubians  Semang  Manchu  Aztec
Kung Bushmen  Teda  Nicobarese  Korean  Polynuca
Thonga  Tuareg  Andamanese  Japanese  Quiche
Lozi  Riffians  Vedda  Ainu  Miskito
Mbundu  Egyptians  Tanala  Gilyak  Bri bri
Suku  Hebrews  Negri Sembilan  Yukaghir  Cuna (Tule)
Bemba  Babylonians  Javanese  Chukchee  Goajiro
Nyakyusa  Rwala Bedouin  Balinese  Ingilis  Haitians
Hadza  Turks  Iban  Aleut  Callinago
Luguru  Gheg Albanians  Badjau  Copper Eskimo  Warrau
Kikuyu  Romans  Toradja  Montagnais  Yanomamo
Ganda  Basques  Tobelorese  Micmac  Carib (Barama)
Mbuti  Irish  Alorese  Saulteaux  Saramacca
Nkundo Mongo  Lapps  Tiwi  Slave  Mundurucu
Banen  Yukar Samoyed  Aranda  Kaska  Cubeo (Tucano)
Tiv  Russians  Okoiva  Eyak  Cayapa
Ibo  Abkhaz  Kimam  Haid  Jivaro
Fon  Armenians  Kapauku  Bellacoola  Amahuaca
Ashanti  Kurd  Kwoma  Twana  Inca
Mende  Basseri  Manus  Yurok  Aymara
Wolof  Punjabi (West)  New Ireland  Pomo (Eastern)  Sirin o
Bambara  Gond  Trobrianders  Yokuts (Lake)  Nambicuara
Tallensi  Toda  Siuai  Paiute (North)  Trumai
Songhai  Santal  Tikopia  Klamath  Timbira
Pastoral Fulani  Utt ar Pradesh  Pentecost  Kutenai  Tupinamba
Hausa  Burusho  Mbau Fijians  Gros Ventre  Botocudo
Massa (Masa)  Kazak  Aje  Hidatsa  Shavante
Azande  Khalka Mongols  Maori  Pawnee  Aweikoma
Fur (Darfur)  Lolo  Marquesans  Omaha  Cayu a
Otoro Nuba  Lepcha  Western Samoans  Huron  Lengua
Shilluk  Garo  Gilbertese  Creek  Abipon
Mao  Lakher  Marshallese  Natchez  Mapuche
Kaffa (Kafa)  Burmese  Trukese  Comanche  Tehuelche
Masai  Lamet  Yapese  Chiricahua  Yahgan
Konso  Vietnamese  Palauans  Zuni  Aweikoma
Somali  Rha de  Ifugao  Havasupai  Cayua
Amhar a  Khmer  Atayal  Papago  Lengua
Bogo  Siamese  Chinese  Huichol  Abipon