6-1971

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Recommended Citation

J. Francois Gabriel, "An Experience with Space" in Essays to D. Kenneth Sargent, ed. Paul Malo (Syracuse NY, School of Architecture, 1971), 69-75

# ESSAYS PRESENTED TO D. KENNETH SARGENT

THE SCHOOL OF ARCHITECTURE
SYRACUSE UNIVERSITY SYRACUSE, NEW YORK

JUNE 1971

# AN EXPERIENCE WITH SPACE

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I assume that everybody agrees that man is partly shaped by the environment.

At this point in history, man's environment is mostly man-made. It is thus possible to say that, by shaping the environment, man shapes man. Therefore, the architect has power and responsibility when he is asked to perform. It is unfortunate that he is not asked to perform more often. The reasons why he is less and less called upon are many. One of them is that under tremendous pressures, he has lowered his ambitions. Another reason is that the public lacks sensitivity. "To have great poets, there must be great audiences too," said Walt Whitman. In other words, our society has the environment it deserves.

The priority today is survival. The fundamental question is Camus': to decide whether or not life is worth living. He goes on, saying rightly that the rest follows, being merely intellectual games. Those who answer this question positively from the bottom of their hearts are not many. But for those who do, the next question is: What life? If living is to become a matter of barely breathing and barely eating, it will hardly be living at all. Living fully requires more than the bare physical necessities. By saying that only luxury was indispensable to him, Oscar Wilde was not too terribly excessive. Walter Gropius was only a little more earthy when he phrased the same idea otherwise: "My inner comfort is as important as my physical comfort. Both expressed the ineradicable human longing for spiritual fulfillment, for joy, for poetry. This is why the architect, whose concern is the quality of the environment, is indispensable to survival, whether today's society recognizes it or not."

William Faulkner, in his speech of acceptance of the Nobel Prize, concluded by this statement: "The Poet's voice need not merely be the record of man, it can be one of the props, the pillars to help him endure and prevail."

Because he is concerned with the quality of the environment, the architect is one of the poets Faulkner is talking about.

It must be for some reason that one of the best designers of our time, Charles Eames, said, "Space is the greatest luxury there is." Obviously, Eames does not refer to the geometrical void, which is plenty and, consequently, cheap. Eames is referring to certain ways of handling space around man, for man's emotional and physical fulfillment.

Now that we have brought together the notions of survival, space and poetry, we are ready to look at an experience that Robert M. Haley and I conducted early this year in our second year Design course, at the School of Architecture of Syracuse University. This course is called "Introduction to Architectural Design." It means that our students are not to be exposed yet to the total architectural process, which is, according to Paul Malo, "handling complex variables simultaneously," but rather introduced a limited but fundamental aspect of architecture: form and space.

Space is shapeless. The only way to give space a form is to use physical elements. Physical elements are naturally numberless. They can define space in an infinity of ways. The first question to ask is: How are forms generated?

There seem to be only three ways:

1. Through geometry;
2. By understanding nature;
3. From the tops of our heads.

While I am not sure that the third way is even genuine, the first and the second ways often overlap, in crystal growths for instance.

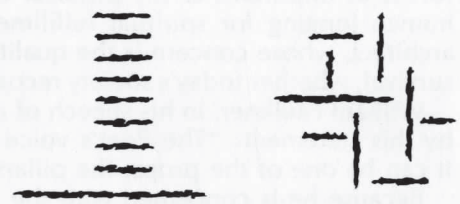
Whenever one tries to set the way for the students to understand design, one always runs into the problem of determining criteria, more so now than ever, since we live in a cultural crisis. A number of students consider it to be enough to justify any design when they declare, "I like it." Looking at this as a final statement, they render impossible for themselves a questioning of their values and block their own growth.

Geometry has the merit of containing its own sets of rules, which are both clear and objective. Surprisingly enough, those rules, far from being limitative, offer, on the contrary, a great variety of possible ways to generate forms.

Geometry is a very efficient means to learn intellectual discipline, consistency, and, finally, order. Order, consistency, and discipline are precisely what design is all about.

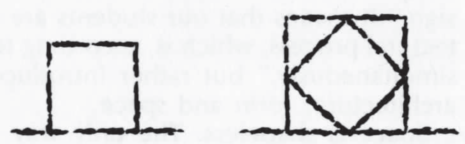
Man cannot live in chaos. Man is craving for patterns. Whether in politics, science, philosophy or architecture, the ultimate goal is to recognize a framework or system within which man fits and can orientate himself.

Most architectural systems are perpendicular. The preponderance of the right angle is based on two essential facts: simplicity of connection between parts and need for orientation, physical and symbolic. But since, on one hand, we have almost done away with the sun as a regulator of our lives, as with as much of nature as we can and, on the other hand, we live in a profane world, I suspect that our attachment to the right angle is due to our laziness: It is so much easier to draw projections of those planes which are parallel to the picture plane!



As a result we live, we work, we evolve in shoebox shapes. Space is simply chopped-off, horizontally by vertical walls and partitions, and vertically by floors. Naturally, floors should be horizontal and, since gravity forces us to stand vertically, it is natural that dividers be vertical. But the price we pay for sticking to what is mainly a habit (most habits being plain bad habits), is a very poor experience of space. Very few designers can still excite us much with shoeboxes because we have become immune to rectangles and parallelepipeds.

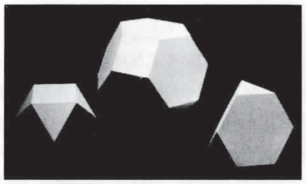
Geometry gives us the means to generate new forms without torturing our brains. I am amazed to see continually that geometrical processes generate forms that not even the wildest imagination could conceive.



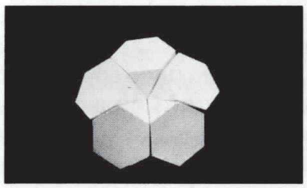
cube cuboctahedron

By simply connecting the faces of a cube by their corners, instead of along their sides, we create another solid, called cuboctahedron.

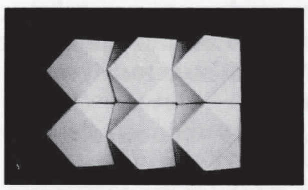
If we do the same operation to a tetrahedron (four faces, all equilateral triangles), we obtain an octahedron (eight faces, all equilateral triangles). If



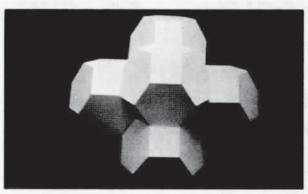
l. to r., Cuboctahedron, truncated octahedron and truncated tetrahedron.



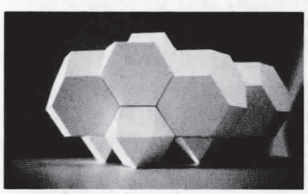
Five truncated tetrahedra.



Six cuboctahedra.



Five truncated octahedra.



Combination of truncated octahedra, truncated tetrahedra and cuboctahedra. (The five pictures above after a study by Elizabeth Heisler and Patrick Dressler.)

we repeat this operation with the octahedron, we end up also with a cuboctahedron like when we operated on a cube.

Whether we take an octahedron (12 faces, all pentagonal) or an icosahedron (20 faces, all equilateral triangles) we generate the same solid, an icosidodecahedron.

It is unfortunate that these simple solids must have scary names. We feel uncomfortable with a hexahedron, until we realize that we are simply dealing with a cube. These solids are not to be talked about. They are to be made, looked at and manipulated.

The five original solids, tetrahedron, cube, octahedron, dodecahedron, and icosahedron, are the only perfectly regular solids that exist. Even though they are well-known, their properties are generally ignored. A plane intersecting a tetrahedron can produce a square. A plane intersecting an octahedron or a cube can produce a hexagon. Three squares intersecting along their diagonals generate an octahedron.

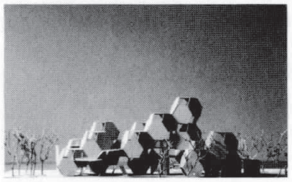
If we pile up cubes of the same size, we know that we can fill space solid. This is roughly what we do when we build high-rise buildings, or not-so-high. We can also fill space solid with tetrahedra, octahedra, truncated octahedra or rhombic dodecahedra. If we pile up two types of solids, we obtain a greater variety of spaces. We can use octahedra with tetrahedra, octahedra with cuboctahedra, cubes with rhombic dodecahedra, etc. . . . We can combine three types of solids, such as cuboctahedra with truncated tetrahedra and truncated octahedra. There are many more possible combinations.

Another way to generate forms is to branch prisms on the faces of a solid. For instance an octahedron. We can return to another octahedron through the intermediary of the adequate solid which is, in this instance, a tetrahedron. This process, resulting in what is called "branching structures," can be done with regular and semi-regular solids.

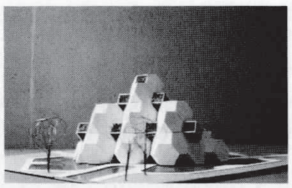
There has been little done to investigate the possible applications to architecture of the cellular systems. It seemed to us that these investigations were in their place in our design course, since the exploration of space and form along with the development of a fundamental architectural vocabulary is one of its purposes.

We had 34 students in our section. Twenty-eight different assignments were given, since a few students wanted to work in teams.

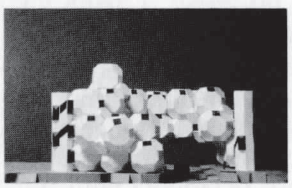
First, the student builds, out of cardboard, a num-



*Composition of truncated octahedra, appropriate for use as a student's dormitory. (This study by Edith Gray.)*

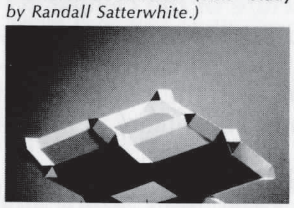


*Composition of truncated tetrahedra, truncated octahedra and truncated cubes, appropriate for use as a place of worship. (This study by Winthrop Gregg and Donald Gregory.)*



*Composition of truncated tetrahedra, truncated cubes and great rhombicuboctahedra, appropriate for use as a museum of natural sciences. (This study by Alanson Rogers and William Senecal.)*

*Study of openings in a system of cubes, cuboctahedra and small rhombicuboctahedra. (This study by Randall Satterwhite.)*



*Branching structure appropriate for use as a performing arts center. (This study by Clandette Stager and Michael Curcio.)*

ber of the units he is going to assemble. Here he is, facing a set of solids he is not acquainted with. He finds out how these solids fit together and tries out the different growth patterns of his set. This is the "kindergarten phase." Actual PLAY. (An analysis of the relationship between work and play does not belong here, even though it is most relevant to the educational process.) How many forms of order can be found with the same set of solids? What does gravity do to them, or, is glue necessary? What happens inside when the faces in contact are taken out? Is the enclosed space usable? What floor area is available? Should the cells be divided in two stories or more, or be left as they are? Can a number of cells be open onto each other in order to provide larger rooms without upsetting the integrity of the whole structure? In other words, what is the potential of this or that system, and how flexible is it? How will vertical traffic, stairways, elevators, and ducts be accommodated? How will natural light be provided? What shapes should openings take to respect the geometry of the faces and solids and still accommodate functional and structural requirements? These questions, and the answers the student gives them, constitute the second phase of the study.

The third and last phase depends on the answer given to the ultimate question: has the combination of cells which is developing under our eyes any architectural potential at all? Could it be that this potential be greater than that of rectangular boxes? Those are questions that the instructors, having more experience with varied programs, must help the students answer. We discovered that the forms the students were working with, feeling their way, were, in a number of instances, extremely appropriate answers to a particular program.

I said that 28 assignments were given. Twenty-five projects were completed, providing viable answers to 16 functions. Here are a few of these functions: Community Center, Museum, Performing Arts Center, Aviary Observatory, Motel, Student Housing, Church, School, Residence.

It might very well happen that one or several systems get nowhere. This should be expected, even in the hands of a talented designer, since there is no reason why every cellular system should find an architectural application. The only way to find out is to try. Such a failure would cancel the educational value of the experience, since each student learns about form, space and design anyway, through his own efforts on one hand and, on the other hand, from being constantly exposed to the other students' research. Our students were expected to work in the studio and actually did. We put great emphasis on the sharing of everybody's work with everybody else.

A university is a place for research and hopefully will continue to be so in the future.

The education of an architect takes place in the university and in an architect's office. I hope this too will continue. There is no point in paying tuition to be a student, to learn that which one can learn as well, or better, in an office —for pay. Trying to make a school of architecture a mock-up architectural office would be ridiculous.

The office is often a frustrating place. The designer fights a lonely battle there. Only the one armed with a terrific incentive survives. This incentive belongs to he who has found, at some point in his life, the opportunity to glance at new architectural possibilities. His university years are usually the only ones in an architect's life when he has the opportunity to fulfill his curiosity and expand his imagination. The university would fail the student if it did not provide him with this opportunity. Not only would the university fail the student, but it would also fail the public-at-large, since the architect has a social responsibility.

We have identified earlier two goals for the study of cellular systems. One has a unique educational value. The other has an even broader one: renewal of the forms used in the man-made environment for the enrichment of everybody's experience of space.

There is another good reason for looking in this direction and this reason is structural. In Wolfgang Schueller's words: "Presently, buildings are structurally inefficient. They weigh four to 14 times more than the load they are going to carry. Our cubical building systems concentrate load vertically and call for extra material to 'beef up' an otherwise unstable structure, thus enabling it to resist deviation from the vertical, which would result in collapse as a result of gravity. We adhere traditionally to bending stresses, an obviously impractical solution which wastes 50 percent of the material."

All structures can be reduced to three functions: bearing, spanning, and windbracing. Traditional structures, aiming at enclosing space in cubical shapes, are variants of the four-legged table. Wind-bracing is achieved by rigid connections or, in the case of a larger structure, by the introduction of triangular shapes. Combining bearing, spanning, and wind-bracing in triangular components, directly defining the spaces enclosed, can lead to more efficient, more rational and, as a consequence, more organic structures. A well-known application of this approach is the space-frame, rightly called three-dimensional.

As I said in the beginning, chopped-off space is two-dimensional. The true nature of space is unquestionably three-dimensional. Only a three-dimensional approach can lead to a sound use of space. Since space is inseparable from form, the application of geometrical systems carries with it the exploration of what I would call "curved space," "oblique space," and "twisted space" by opposition to "chopped-off space." It follows that a geometrical approach leads to a much richer use and awareness of space.

A question that we must now examine is that of feasibility.

No doubt a new approach to building is not easy to implement. The building industry is dragging itself behind all the others. Even behind the agricultural industry, which, traditionally, holds the last place. Prefabrication is frowned upon, even though Le Corbusier and others were advocating it in the 1920's, even though Joseph Paxton built the Crystal Palace in 1851. Prefabrication is somehow making its way, though. It is even accepted, for economical reasons, as long as the housing contractors can make it pass for Colonial or Georgian. It would be difficult, however, to give a Georgian touch to a cellular construction. But there is another pressure, which will be hard to ignore: the population explosion. If the population continues to increase at its present rate, the need for construction in the United States is that of the equivalent of a city for 400,000 people every month for the next 30 years. People then turn to the architects, who always are the scape-goats, and ask: "What are you doing?"

It is clear that architects do not have the answer. The answer lies in population control, which depends upon legislation, which depends upon public acceptance. Bernard Shaw foresaw the problem in the nineteen-hundreds and suggested that every woman be permitted but one child. He did not like the idea, in spite of the fact that he saw this infringement upon one's freedom as no more restrictive than allowing women only one husband at a time, restriction which is quite prevalent in our society. Back to the architects. Architects are doing something. They are, or at least some of them are trying to implement prefabrication. Prefabrication, to be rentable, carries the concept of modules. Which brings us back to cellular systems.

It is clear that the few weeks spent this year in our studio, on the sophomore level, with cellular systems, did not, could not bring about any readily applicable proposal. Any one of the systems we explored would require a competent, experienced team of architects, working together with structural consultants, engineers, industrialists, and financial experts for several years to come up with a technically workable, marketable product. But the task must be started somewhere, at sometime. What we know is that it is potentially viable.

We also know that we are not the only ones to look in this direction. All over the world, in this country as well as in Canada, in France, in Israel and in many other countries, cellular structures are actually being built. Anyone familiar with Expo '67 could not help noticing that many structures did away with the cubical concept. It is easy to predict that we will witness in the next years a proliferation of cellular constructions.

It upset me recently to read an article entitled "Technology Fails," describing an experimental housing complex made of cellular components. As if most of our new housing, based on obsolete concepts and built with archaic methods, were not failures. Even Edward Stone saw this when he exposed one obvious aspect of the failure of our modern environment in these words: "America was beautiful. In a few decades, men have succeeded in making it almost irreparably ugly."

When we are told that the United States will, in the next 30 years, build as much as was built since Christopher Columbus, we realize that we had better think twice of what we want to build.

Only newsmen and uninformed people can expect every architectural experiment to be entirely successful. Scientific experiments are made in the secrecy of laboratories. Only the successful experiences are published. An architectural experiment has to take place out in the open. We certainly can draw some conclusions from rats and guinea pigs, like John Calhoun's famous experiments with the effects of crowding; but a man is not a rat and architects must experiment with human material. This should not be done lightly. Pasteur's fears, on the verge of inoculating rabies to Joseph Meister, are well known. But there and then was the time for Pasteur to pass the Rubicon, and he did. Even he, Pasteur, could have failed.

I am not saying that technology will solve all our problems. All I am saying is that we have technology and that we should use it in architecture also.

I am not saying either that cellular systems constitute a universal panacea. I am only saying that they are worth investigating. Even if they were nothing but three-dimensional puzzles, it should be remembered that mathematical games led to amazing and serious discoveries.

Also, if "happiness is interest," as A. S. Neill believes it is, then an interesting environment can contribute to happiness.

Vernacular architecture, which finds its most popular form in the Mediterranean villages, appeals to our contemporaries. It is not hard to identify this appeal with a picturesque assembly of tasteful forms organized in a clear and pleasant pattern. "Habitat," the most glamorous residential address in Montreal and, even better, the Halen Colony near Bern are two rather successful attempts to create an honest, contemporary, and humane environment. This success is certainly due in part to the fact that they were both aiming at providing richness and variety within a well-scaled, orderly framework.

We cannot build Mediterranean villages, which were created slowly in a different cultural and social context, with construction techniques which are not available anymore; but today's industry can make available to us an environment of the same quality.

Design is a science. Science relies upon theories, which are discarded one after the other. We have, nevertheless, a tendency to look upon scientific theories as quasi-religious. Design also relies upon theories, not the least any more controversial than scientific ones.

To conclude, I would like to advance a theory.

It is often believed that man's alienation from nature leads to insanity. Ian McHarg reminded us that man is part of nature. Lonely people, or city people, more or less alienated from nature, keep pets. Lately, the village's inhabitants, in New York City, have taken to growing house-plants like mad. The Japanese or Chinese Sages used to grow little gardens in pots, complete with lake and mountain, not merely for their cuteness, or because they, the Sages, were alienated from nature (which they were not) but as symbolic microcosms before which they sat to meditate.

I do not see how a geometrical pattern in space could be denied the power to act as a hierophany or, in other words, as a link between man and nature, symbolically. Scientific theories are replaced by others but, in the case of Euclidian geometry it is worth noticing that other geometries have taken place besides, but have not replaced it. Euclidian geometry happens to be also called Natural geometry.

If we can still respond to symbols, then architecture as a microcosm could take a new form and reconcile man with nature. This means that the house, the temple and the city could become again what they were for centuries, sacred.