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AUTHOR Brann, James
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ABSTRACT

The inflation of the vinyl bubble by Antioch students and faculty climaxed more than a year of study, planning, dealing with contractors, county officials, manufacturers of equipment and materials--and maturing the technology of pneumatic buildings. These activities were combined into what Antioch calls a "process-oriented curriculum." This experimental and federally-financed program of study was developed as part of the bubble project. The success and failures of the project and the curriculum are described, and some suggestions are made to other colleges that might attempt such a process-oriented effort. The appendix contains outlines for courses given in relation to the project and working papers generated by the Antioch team during the project. (Author/KE)

THE MAKING OF AN AIR-SUPPORTED CAMPUS

Antioch's Bubble

The story of Antioch's pneumatic campus--how students acquired knowledge, skills, and academic credit while planning and erecting a huge vinyl bubble.

On November 4, 1972, a 32,400 square-foot pneumatic dome of .012 polyvinylchloride film was inflated by a five-horsepower, electrically-driven fan on a meadow at the Columbia, Maryland Campus of Antioch College. Classrooms and offices of the Campus were moved into the bubble in May of 1973, providing a pragmatic living-learning test of the air-supported structure.

FINAL REPORT ON

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The narrative portion and the analysis of the educational experience provided the Antioch students was written by James Brann, associate professor of journalism at Boston University. He is a former Assistant Editor of The Chronicle of Higher Education and a former editor-at-large of Change Magazine. Mr. Brann has observed innovative urricula throughout the nation for the past decade and his articles on higher education and societal change have appeared in major magazines. He observed the Antioch bubble project from its inception and attended many of the classes and working sessions in the 1971-72 year at Columbia, Maryland.

ANTIOCH PNEUMATIC CAMPUS - FACT SHEET

PROJECT NAME & ADDRESS:	ANTIOCH COLLEGE Wilde Lake Village Green Columbia, Maryland 21044 301-531-5611
PROJECT MANAGER:	Cameron Tucker
SIZE:	32,400 sq. ft. 180' x 180' (square plan) 15' to 25' in height
SCHEDULE:	Ground breaking: June 8, 1972 Inflation: November 4, 1972 Occupancy: May, 1973
FUNCTION:	To serve as temporary base for Antioch students working in independent study programs in the new town of Columbia, Md.
NORMAL OCCUPANCY:	100 persons
CONSTRUCTION COST:	Total: $178,200 roof $0.50 mechanical & electrical 2.00 site preparation 1.00 flooring and interior 2.00 $5.50 per sq. ft.
ESTIMATED OPERATING COSTS:	$17,500 per year
ROOF LIFE EXPECTANCY	3 to 5 years (roof replacement cost $18,500)
INFLATION:	5 hp blower, 10,000 cfm capacity at 1 1/2" pressure Secondary blower, 3 hp propeller fan with 15,000 cfm capacity Back-up blower 5 hp blower delivering 7,000 cfm Normal operation at .3" water column (inflation pressure) and 10,000 cfm ventilation Heat recovery wheel and responsive control system change inflation pressure as a result of wind speed, cable tension, etc.
HEATING/COOLING:	90 tons airconditioning, 1 million Btu's heating, oil fired furnace

MATERIALS AND CONSTRUCTION:	Roof .012 unreinforced polyvinylchloride film Main cables 1-1/8" diameter 6 X 19 IWRC galvanized cable, 37,500 lb design load maximum, breaking load 114,000 lb Secondary cables 5/16" diameter aircraft cable, 2,200 lb design load maximum, breaking load 10,000 lb. Internal tie-downs on roof at four points with drains Earth anchors: buried concrete on primary cables; screw anchors on secondary cables Second skin hangs below first between cables to create insulation space Sits on perimeter earth berm which contains all 7 entrance air-locks including one large service entrance.
DESIGN PARTNERS:	Architect Rurik F. Ekstrom, A.I.A. Columbia, Maryland. Research and Design Institute Providence, R. I. Ron Beckman, Executive Director Howard Yarme, Associate Director Charles Tilford, Inflatoenvironmentologist Columbia, Maryland
RESEARCH & TECHNICAL CONSULTANT:	Blair Hamilton c/o Educational Facilities Laboratories New York City
STRUCTURAL ENGINEERING CONSULTANT:	Goodyear Tire and Rubber Company Research Division Akron, Ohio
ELECTRONICS CONSULTANT:	Joseph Seale Greenfield, N. H.
MECHANICAL & STRUCTURAL ENGINEERING CONSULTANT:	D. G. Carter Associates Silver Spring, Md.
RESEARCH STUDY GRANTS:	Educational Facilities Laboratories New York City Harold B. Gores, President U.S. Office of Education
LAND GRANT:	Howard Research & Development Co. Subsidiary of the Rouse Company.

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NARRATIVE ACCOUNT AND EVALUATION OF LEARNING EXPERIENCE

The inflation of the vinyl bubble by Antioch students and faculty in November, 1972, climaxed more than a year of study, planning, dealing with contractors, county officials, manufacturers of equipment and materials--and maturing the technology of pneumatic buildings.

These activities were combined into what Antioch calls a "process-oriented curriculum." This was an experimental and federally-financed program of study, developed as part of this project. And this unusual curriculum has to function as it was being built. Students received academic credit for efforts as varied as telephoning orders to manufacturers, computing stress forces on the steel cables that gird the bubble, begging material and equipment from large corporations, negotiating with Howard County, Maryland, officials for building and zoning permits, designing the building shell and interior classrooms and offices--and acquiring essentials of drafting and design and a working knowledge of what it takes to construct a building.

"These students know much more of the real world than my students (in architecture) at the University of Maryland," observes Rurik Ekstrom, the architect who served as an Antioch adjunct professor environmental design during the planning and construction of the pneumatic campus.

"There they learn a great deal about design, but they get almost no contact with the real world. These kids here (Antioch) are down hassling with county officials over building permits and fire safety regulations and learning what it's like to function in real life."

Ekstrom appears to be correct. The traditional architectural curriculum does appear to insulate its students from the difficulties of day-to-day life in the world of work, equipping them not at all to deal with contractors and cautious bureaucrats. In the Antioch process-oriented curriculum, students learn a little about many aspects of design and construction. But few master design, structural theory or drawing as completely as the better students in a conventional curriculum. In the six months following the erection of the Antioch bubble, students (some salaried, some volunteers) worked to stabilize the building, secure the joints in the vinyl, install flooring, plant grass and gardens on the interior slopes of the perimeter earth berm, install a 90-ton capacity air conditioner to ward off the effects of the Maryland searing summer sun, and a 1-million BTU furnace, four toilets, one shower, several faucets and electrical outlets, and a heat recovery wheel to reduce the cost of heating and cooling the bubble.

Also, the students worked with faculty, administrators and other students of the Antioch Columbia community planning and preparing office and classroom spaces for occupancy in May of 1973.

And the students and former students and consultants began a series of experiments to determine the strength and versatility of the vinyl bubble and its cables, the pattern of air movement and light transmission, heat and cooling costs, acoustical characteristics, and the effect of life in the bubble on its occupants and plant growth. Most of the experiments were seeking information not previously available.

The Antioch bubble experience and its related curriculum projects produced an unusual learning experience.

The building of the bubble and the environmental focus of the Columbia, Maryland Campus resulted in other and related accomplishment-oriented projects. Often these produced experiences of substantial impact.

A student involved in restoring a river, mapping illegal sand and gravel operations, mobilizing citizen support to obtain action by county officials, ordering the complex components of a plastic bubble, and coping with the zoning and fire and materials standards----learns much about how the world functions.

Such experiential learning--when combined with Antioch's required liberal arts base--prepares a student well for dealing with the world after graduation.

However, like the conventional lecture system, this process-oriented learning experience is not successful with all students. And it remains unclear what type of student profits best from this action-oriented learning experience.

The Antioch bubble project and its experimental curriculum resulted in a curious combination of incredibly hard work, accomplishment, and drift. Some students seemed disoriented throughout the 1971-72 year. Others became intensely involved in projects and worked incessantly at them.

The drift and lack of focus throughout was in part a result of a coming together of two different worlds--the pragmatic "get the job done" attitude of conventionally-trained architects and the contemplative philosophical have characteristic of students in their early twenties. And perhaps more characteristic of Antioch students than most.

Commented one graduate student consultant: "The design people here--the real architects--have been taught throughout their education and their professional life to: DO IT! DO IT! If you can't do it this way, try it that way, but get it done!

'Don't let your mind stagnate for a minute.'

"That's where Rik and Ritchie (faculty) are coming from, and the REDE people (consultants).

"That's where none of the kids are coming from. Antioch students aren't like that. At times, the architects find the Antioch students boring and unenergetic."

Some students did become turned onto learning by themselves and they learned well. Others were bitter at the lack of help proferred while they were attempting complex technical tasks.

The process-oriented curriculum of the bubble project reflected the characteristic strengths and weaknesses of Antioch. Learning through involvement in real life had been a mainstay of Antioch's education for a century. Typically, the new Antioch School of Law in Washington uses a clinical form of education similar to that of medical schools, rather than the sit-in-the-classroom-deal-with-theory approach of traditional American law schools. At the Antioch campus in Baltimore, liberal arts undergraduates receive academic credit for working in projects to improve urban life or to do Nader-style examinations of public agencies. Some of these are superbly done--and some of the projects founder on the inexperience and immaturity of the students.

Former Antioch President, Arthur E. Morgan, the engineer who originated the College's alternating work and study program 50 years ago, observed that "by doing real things, living in a real world of action, plus one of thinking, an individual could get as full a life as possible."

Academic Vice President Morris Keeton explains Antioch's systems philosophy today:

"Antioch's philosophy and purpose call for the use of work settings and social environments as key vehicles for learning and maturing on the part of students.

"The result is that Antioch has evolved from a small campus in a village in Ohio into a national network of learning centers. The network permits entry of students into Antioch at the place most suitable for their circumstances and educational objectives, and then facilitates the movement of students into and out of other locations as appropriate to their evolving educational needs."

The Antioch campus in the new planned city of Columbia, Md., was founded as a field center in 1969 with a strong orientation toward innovation in education and a mission to overhaul society and social planning.

The young city, then largely the meadow and mud of new construction, seemed an ideal place for experimentation. Located in the countryside between Washington and Baltimore, Columbia would have a population of more than 120,000 by 1980 in an area the size of Manhattan.

Said an Antioch brochure at the time:

"Rarely does an institution have an opportunity to start with a clean slate in an environment where there is widespread commitment to finding new answers . . . Its Field Center in Columbia offers an opportunity to try simultaneously a whole set of fresh alternatives, perhaps to develop a pattern that can be repeated elsewhere in higher education . . .

"Try to put out of your mind any preconceptions about college education consisting of a campus with students taking course, earning credits, meeting pre-set requirements, getting grades, taking tests, doing artificial exercises or assignments, majoring in a subject defined by an academic department . . . we are developing a program which defines a degree in new terms . . . our concern is less to certify than to provide the means for growth and learning."

Today, the major thrust of the Columbia campus is ecology, environmental design and community planning and sociology. Those students and faculty members who want to overhaul the existing social order left Columbia to establish campuses in Baltimore (1970) and Washington (1971), after discovering that Columbia's citizens were essentially happy with their upper-middle-class lot and had little interest in efforts to redo society.

The concept of the bubble developed in a strange manner, a pattern of events that could happen only at a place such as Antioch. A 21 year-old named Blair Hamilton transferred to Columbia from the Yellow Springs Campus and began--in late 1969 and early 1970--experimenting with "funny event things, funny environment things." A Berkeley native with a driving curiosity and unlimited enthusiasm, Hamilton convinced a Baltimore foam rubber manufacturer to give him three truckloads of scraps, which he brought to Columbia as toys for College students.

Blair became fascinated with the planning processes of the Rouse Company, the developer of Columbia. And he began spending time in the offices of the most maverick of Rouse Architects and planners. One of his favorites was Wallace Hamilton (no relation) then the company historian, the director of institutional planning and the man responsible for the negotiations that brought Antioch to Columbia. Several Antioch students had worked in Hamilton's office. Hamilton had also negotiated Columbia's open-space design schools with Howard County Officials and helped design Columbia's community medical package. Blair often dropped by to talk with him. One day in early 1970, Hamilton asked Blair, "What's your latest kick?" "Inflatable buildings," replied Blair, "Let's do one for Antioch."

Hamilton picked up his telephone and dialed the number of Harold Gores, president of Educational Facilities Laboratories in New York. When he had Gores on the line, Hamilton said, "I've got this crazy guy in my office who wants to build inflatables." And he handed the telephone to Blair.

Blair, who had learned a bit about inflatables, explained his views to Gores, who soon hired a consultant to "go down and check out this guy Hamilton and his hippie friends and see if this is the kind of thing we ought to be looking into."

In May of 1970, Blair conducted a "spring rites festival". It featured an array of unconventional building materials--foam and plastic sheets. The Antioch festival was attended by students from the University of Maryland, Johns Hopkins University, and the Maryland Institute. It was a beautiful spring day with temperatures in the nineties. A spirit of fellowship and good will was pervasive. One of the students was a Good Humor man. For the first half hour, he sold his ice cream, then distributed the remainder of his truckload free.

Among the University of Maryland contingent was Rurik Ekstrom, an Associate Professor at the School of Architecture. Ekstrom and his students shaped huge sheets of vinyl to form a 20' by 7' bag, then inflated it. With six students inside, the huge bag was shoved out into Columbia's

Lake Kittamaqundi. The student-carrying vinyl bag stayed afloat. The students found it an odd sensation. Their legs were sticking into the water, with vinyl clinging tightly, and they remained completely dry. After a few moments, the clinging and unfamiliar sensation became uncomfortable to most of those who attempted it.

Ekstrom is a skilled and imaginative architect with a substantial record of experimentation with unconventional architectural forms. He had been with lightweight structures since 1960. In 1965, Ekstrom had designed a mile square winter garden city to house a shopping center, truck garden and homes under a huge inflatable dome in Alaska. The project has been unable to attract sufficient financing, but it was a daring and apparently feasible concept at the time.

Following Spring Rites Day, Ekstrom and his students constructed several small inflatables at the University of Maryland.

"To this day", observed Blair Hamilton in the summer of 1972, "I haven't found another architect really interested in bubbles. Mostly they kind of figure someone else will do it."

"One reason that architects are not very interested is that they see this not as architecture, but engineering.

"In a way, inflatables are in the business of putting architects and engineers out of business."

Blair convinced EFL to provide a planning and demonstration grant to Antioch of approximately $20,000. The money arrived in July, 1970, only five weeks after it had been requested. With these funds, Blair began planning construction of a large bubble to serve as prototype for an acre-sized enclosed campus.

There had been several play structures built by Blair and his compatriots in early 1970, including a black bubble, 15' by 15' by 7', with TV tube lighting and a crawl tube entrance. A larger bubble, 40' by 30' and ten feet high, with a green and white bottom was constructed for the Spring Rites festival. Then followed several prototypes. A silver and white bubble was constructed of polyethelene and silver mylar for an educational TV demonstration in the Fall of 1971. It was 15' by 20' by 15' high. Also, a silver and white bubble with red and blue stripes was constructed of polyethelene in 1971 and inflated at Antioch, Columbia; Maryland Institute, Baltimore; Antioch, Yellow Springs, Ohio; and at Whiz Bang Quick City II in Woodstock, N.Y. in 1972. Its dimensions were 70' by 70' by 25' high.

Prototype I was a polyethelene sphere, 50' in diameter, anchored to the ground by nylon parachute cord tied to wooden stakes, but it blew away in a strong wind.

Prototype II was erected early in 1971 and for a while actually served as a home for a student. It was 36 feet in diameter and its joints were welded, not taped as had been done in earlier bubbles. Power to the motor that powered the fan that kept the structure inflated was supplied by an electric generator. But it failed from lack of gasoline on a stormy night and the bubble skin ripped as it collapsed onto pipes and scaffolding. The following day, the Baltimore Gas and Electric Co. delivered a long-promised power line to the site. If the line had arrived a day earlier, the bubble probably would have remained inflated throughout the storm and have survived it.

The Goodyear Company was generous throughout the experimental stages of the bubble effort and supplied much of the material for the skins of the various prototypes and considerable technical advice.

Prototype III, erected in the spring of 1971, was constructed of 12-mill vinyl and was 36 feet in diameter. Two students lived in it for several weeks. And flowers and plants flourished inside. But sunlight made the clear transparent structure unbearably hot. The interior thermometer broke at 126 degrees. It was clear that a bubble would require air conditioning in the Maryland summer if there was to be functional space for teaching and learning.

With the EFL grant in hand, Blair had begun a persistent lobbying campaign to convince Antioch administrators of the feasibility and desirability of attempting an air-supported campus. He persuaded them that the inflatable building concept was not only a fascinating and a worthwhile venture, but one that might well attract other grant money to Antioch.

Blair built agreement upon agreement. After receiving permission to accept the grant and put up prototypes and a major bubble, Blair went to then Antioch Washington-Baltimore Dean, Stephen Plumer and argued in effect: OK, if kids are going to build it and use it, we need a program in environmental design.

And that was the origin of the environmental design curriculum at Antioch's Columbia, Maryland campus--the dream and determination of a student supported by some EFL cash.

Blair argued that an air-supported campus was not only feasible, but necessary in this period of high costs and tight college budgets.

Blair's argument essentially said that Antioch had no choice. He opened one of his written arguments at the time with a quotation from Pascal which translates approximately as:

"You must bet. You have no choice: you are in the game."

Blair continued: "Due to the nature of the facilities crisis--and because the college does exist--we are caught in Pascal's Bet Situation: It is not merely a question, as some seem to assume, of saying yes or no to the inflatable; it is a choice, in which there are three alternatives. The first is to make no decision at all, which means on an individual level that the individual who refuses to choose becomes powerless to affect the decision-making process; if no decision is made on an institutional level, it means the end of Antioch in Columbia. The second possibility is to find alternative space; we have tried, and we wish you luck. The third, of course, is the one we have argued so long and hard for, the one we believe is the only logical choice: the inflatable. As Kierkegaard pointed out, there are situations in which one must either take a step into the dark, or live in perpetual doubt and anguish. This is one of them--one, moreover, in which the second possibility is all but eliminated."

So Blair, then a senior, established with Ekstrom and Brendan Doyle, a Rouse Company architect and himself as faculty--the environmental design program of Antioch College. Thus, an undergraduate became a real faculty member with a letter of appointment from Yellow Springs attesting to his new status.

Three classes were conducted that first semester (Fall 1970-71). One dealt with the erection of the prototype. Another was titled, "Readings in Environmental Design and the Psychology of Education." The third was a workshop in inflatable construction techniques.

(The federal grant from the USOE would come later in 1971-72 -- a grant of $100,000 for the purpose of developing a process-oriented curriculum in conjunction with construction of the bubble. And Antioch agreed to contribute $128,000 in some form.)

So the bubble would be built. And it would be built by students and they would learn something during the process. And they would receive academic credit for the experience. But how this was to be accomplished was unclear.

The Antioch team would be working with a new technology--one that had not yet been described and defined at all comprehensively on paper. There are other air-supported plastic domes. There have been several erected as covered tennis courts, military field hospitals, warehouses, and pavilions at international exhibitions. But this would be one of the largest, covering nearly an acre. It would be both heated and air-conditioned. And it would contain people working year round at real tasks--teaching, learning, and administrating. It would be an unprecedented experience in living and learning in this unusual environment.

(When the bubble was finally erected in November, 1972, Harold Gores of the Educational Facilities Laboratory, a longtime supporter of the project, was notified in New York. He was told that the bubble was up, but that there were technical problems that threatened to collapse it within a day or two. Gores is reputed to have replied, "I don't care if it's only up for five minutes so long as someone does something in it besides play tennis.")

A major goal was to assemble a curriculum that could serve as a guide for others.

Some elements of the Antioch bubble experience do lend themselves to export. The director of an inflatable project for another college could learn much here. However, he would not find a comprehensive and proven curriculum package ready to be carried home and inserted into his own campus catalog.

Perhaps this will be possible by 1974.

What such a director would find is a fascinating philosophy of architecture and its relationship to the way people live and view the world. He would find discriptions of unusual courses in bubble design and construction and management, some of which did not develop in quite the way that they were described.

The approach of the Antioch curriculum and students was perhaps best summed up in the description of the course titled, Advocacy I:

> "For years, architects and planners have been applying formula solutions to the environmental problems they have attempted to solve. People had been taught to be grateful for the service rendered by these gifted practitioners. The results were that the theories and concepts developed in the studios and cloistered academic communities grew farther and farther from the real needs and desires of the people living in the areas that were being planned.
>
> "A few years ago, after several classic examples of the gross misuse of the "planning process", neighborhoods around the country began to make their needs known to the officials and planners who were supposed to be serving them. Led by people from the neighborhoods, assisted by a small trained group such as architects, lawyers, and planners; the local communities first stopped many of the poorly conceived planning and highway projects and then suggested alternative projects that would better serve the needs of the people. These teams of "advocacy planners" combined the special knowledge and education of the neighborhood people and their first hand understanding of the problem with the special "problem solving" techniques of the architects, lawyers, and planners. The work being done by these teams around the country is beginning to show results in terms of projects designed by the people to be served.
>
> "The process is still in its infancy and many false starts, mistakes and wasted efforts accompany every success. However, the successes seem worth the effort - particularly in the social bridges that are being built across the chasm that separates the cultures represented in our society.
>
> "Course Goal: The goal of this course is for the students to begin to gain an understanding of the problems confronting low income communities and to share in the experience of trying to implement meaningful change in the environmental quality of these communities.
>
> "Methods: The students and staff will work with neighborhood people; first identifying problems, then seeking solutions to these problems and finally implementing these solutions. The work will range from carpentry to financial and physical planning of housing and community facilities. Field work will be supplemented with a weekly student seminar."

This, then, would be the thrust of the Antioch curriculum--a reexamination of the American approach to architecture and building. Throughout the descriptions and discussion of program ran the following theme:

"The pace and fluidity of contemporary life presents man with a challenge of how to better utilize existing space and create new space which will effectively serve his rapidly changing needs. Imagination must be coupled with the potential offered by expanding technology of environmental design to meet the demand for space and flexibility of form. New environments must be created, tested, and evaluated on the basis of changing human needs. Traditional methods of teaching and learning in this area have not kept pace with changing needs and often limit the student's capacity to make an innovative response to a design program.

"Therefore, it is our aim to develop an experimental interdisciplinary, process-oriented curriculum which will provide the student with perspective and skills to approach the complexities of contemporary environmental design."

Did it work?

Did Antioch develop such a curriculum and provide satisfactory learning experiences for most of the students involved in environmental design?

Not quite. Long steps were taken in that direction. But the curriculum fell short on providing the promised grounding in theory and philosophy.

And there existed from the beginning of the curriculum planning a disagreement between the two key faculty members--Ekstrom and Margaret (Ritchie) Axtell--about how the project should be conducted. Miss Axtell, now a Washington architect, was a student and part-time instructor in the school of architecture at the University of Maryland. She served as administrator of the bubble project and coordinated the hired consultants and faculty and continually attempted to inject some coherence and efficiency into the effort.

Technically, she was a full-time employee of Antioch and Ekstrom was a guest lecturer and the project architect. She had been a student in his classes at the University of Maryland. (Ekstrom said that he had never seen anyone so capable at evaluating people and assigning tasks. During some of the cooperative efforts on early inflatables with UM students and Antioch students, Miss Axtell had coordinated the UM fledgling architects. And Antioch students had been astounded by their professionalism. When they saw a UM student accomplish a technical drawing, they were watching the very best drawing student, selected by Miss Axtell, from that university. In turn, the UM students were astonished by the verbal capabilities, the audacity, and the skills in dealing with people of the Antioch students.)

Both Ritchie and Ekstrom were eager to attempt new ways of creating and imparting knowledge in the Antioch 1971-72 bubble project. Both had had extensive experience in traditional educational institutions and were convinced that the conventional lecture system produced little real learning.

Though this general agreement existed, their views on how the process-oriented curriculum should be implemented were far apart. Miss Axtell wanted some sort of continual planning and structure and agreement upon goals, while Mr. Ekstrom conducted his crucial-bubble-erecting course in a task-oriented, spontaneous manner.

A typical class during the 1971-72 year consisted of four to six students sitting around a table discussing with Ekstrom and Ritchie the problems of getting the bubble up. Often, this was a fascinating, if essentially unplanned process. They might discuss county zoning and fire laws and the progress of negotiations with officials on these matters. Reports were given by students or consultants on progress in begging materials or machinery from manufacturers. There was often a discussion of the budget and current costs.

And during the spring of 1972, there were frequent and detailed reports on laboratory tests in several cities of the flamability of different materials and coatings for vinyl.

From such exposure, students learned much about the real world--probably considerably more than they realized. But Ekstrom's class (Construction and Architectural Management for Campus) was haphazard and unstructured. Ekstrom often gave brilliant technical explanations of architectural principles as they applied to the design of the bubble. And he provided substantial help and leadership in the constant redrawing of the bubble plans by students. And the actual physical raising of the bubble and the design and furnishing of the interior were largely built on Ekstrom's energy, expertise, and infectious enthusiasm.

Throughout the project, students often on their own initiative, gathered for late-night talk sessions and parties at the Ekstrom home.

But in the end, it wasn't enough. Most of the students--perhaps conditioned by years of traditional teacher-student relationships--felt that the curriculum had not justified the time, energy, tuition and effort they had expended.

Throughout the 1971-72 year, there existed considerable strain between the two key faculty members and their viewpoints. Miss Axtell contended that the "process" was the most important factor and that students could and should learn much even if the bubble failed to go up. Ekstrom, on the other hand, obviously placed the highest priority on the practical matters of getting the bubble up.

The difference in view was demonstrated repeatedly. For example, there were repeated trips necessary to Howard County, Maryland, officials to obtain building permits and zoning variances. On such occasions, Miss Axtell would always suggest that Ekstrom take along several students to such meetings. And he sometimes did. But he often preferred dealing with county officials alone, feeling, with considerable justification, that they were easier to persuade when not distracted by other visitors. (Howard County had been essentially rural until the founding of Columbia and some county officials had exhibited unease about the long-haired weirdly-clad Antioch students.)

Also, it was obvious that there should have been more planning to providing some sort of curriculum experience for the students during slack periods when no work could be done on the bubble because the plastic was being joined in a factory or the project was delayed by fire regulations.

Ekstrom often argued that the division of the curriculum--associated with the bubble project-into courses had been unreal. The courses had been 'reluctantly' divided and described for the purposes of the college catalog, he said. Actually, maintained Ekstrom, the learning and work experience involved in erecting the bubble was a continum, with no real division into courses possible.

When the project was going well and work was progressing, Ekstrom inspired much warmth and admiration from students. He is a charismatic and highly talented man. His charm and his obvious competence and his past achievements clearly led the students to regard him as extraordinary. Thus, the doldrums that plague construction projects and the lack of pattern in the curriculum produced a disappointment that probably was greater than would have occurred if Ekstrom had appeared an ordinary mortal to them from the first.

Some 35 to 40 students passed through the courses offered in the Environmental Design Curriculum in 1971-72. However, some of these were interested in and registered only in drawing. The hard-core students interested in design, building technology and the bubble remained about eight to ten. (Antioch's academic bookkeeping system is oriented toward the student individual records--rather than the course-section-faculty emphasis of more conventional colleges. And there were continual transfers in and out of the bubble-related courses, thus enrollment figures are imprecise and difficult to compute.

Among the environmental design courses offered in conjunction with the bubble project: Construction and Architectural Management for Campus; Basic Drawing; Advocacy Planning and Basic Construction Skills; structural Engineering Tutorial; Design of Spaces Within the Campus Bubble.

(NOTE: A description of these courses is contained in the appendix.)

The student experience and the reaction to the environmental design curriculum was mixed. There was substantial questioning of the Antioch ethic, a favorite pastime of all Antioch students. And the handful of students who were involved in the creation of the bubble tended to be pessimistic about the project when it was stalled and optimistic when things were going well. During the long period from September, 1971 to inflation in November, 1972, there were several periods in which most students and faculty members believed that the bubble would never be completed. Interviews conducted at such times captured considerable anger and frustration.

It is clear that most of the students involved in the project felt that it had been oversold to them. It was represented, they say, as a project in which they would acquire building and design skills while working and learning together.

The reality seemed to several students to fall considerably short of this. Creating the bubble was a complex process that often required the assistance and employment of consultants or graduate student-types possessing the required skills. In an on-going process-oriented curriculum, these might well have been considered instructors or graduate assistants.

Of course, the erection of the bubble was a learning experience for everyone involved---students, architects, consultants, and the graduate assistant types. However, at times, it seemed to the handful of undergraduates actually involved that they and their educational concerns were subordinate to the interests of their older colleagues and subordinate to the daily problems of erecting the bubble.

Some who had attended other colleges and were aggressive and self-motivated, appeared to profit substantially from the experience of planning and constructing the bubble. More typical students in their early twenties and the late teens were clearly adrift and often complained that they felt left out of the action.

Not only was the construction of the bubble an academic effort without precedent, but the creation of a curriculum to accompany and produce such a project was unique. Thus, the Antioch personnel and consultants were engaging in two concurrent endeavors without much pattern or precedent.

It is also clear that the students learned much about dealing with the real world, and often these experiences were clearly labeled or appreciated as learning experiences.

It is clear that students do learn much about dealing with the uncertainties of the professions. One faculty member, who also taught architecture classes at the University of Maryland, commented, "As a University of Maryland student, you know that you have to get a building permit, but no one there could tell me how. Here, they know how."

One middle-aged mother of teenagers who was enrolled in another curriculum of Antioch's Columbia center described the peculiar ethos of the campus thusly: "What this place gives you is an ability to establish priorities and a way of analyzing what is happening that enables you to take hold of your personal environment and shape it."

However, most of the students in the environmental design curriculum complained that they did receive insufficient help from Ekstrom and the consultants and assistants.

Some typical comments, favorable and unfavorable, from students involved in the bubble project, follow:

"I need to have deadlines and tests and things because this makes me get my shit together.

"This process-oriented curriculum turned out to be a bunch of bullshit. When you have something to do, you call somebody who is an expert in the field. I really question whether you learn more than if you were sitting in a classroom. But you probably don't learn less.

"But the tuition is too high here and it disturbs me that some of my classes don't exist. The environmental design classes are mostly sitting around and talking about what's happening and what's not happening with the bubble.

"I think Antioch really works out well for people who have gone to other colleges and know what they want to do--and they can come here and do it. But it is a ridiculous place to come if you don't know what you want to do--because it doesn't offer that many things."

"It is valuable to have been able to define a problem, evaluate what is available and go and get it and bring it back.

"It seemed like this was not a student-oriented project. It was oriented toward those who could work the complex stuff. It didn't seem that anyone was willing to help anyone else.

"The whole fall quarter, it was obvious that we needed to pull ourselves together. Every class turned out to be: 'You do this. You do that.'"

Mrs. Palmer's house was the one saving grace. I learned a lot there."

(This was a reference to a related project in which students working under the direction of local craftsmen renovated and essentially rebuilt the home of an elderly Negro woman in Scotland, Maryland. The work and the employment of craftsmen was coordinated by Miss Tommie Smith, an assistant professor, who worked beside and with the students and area plumbers and electricians. Those students who participated felt that this project was extremely valuable and educational--and they enjoyed the continual debate with the Maryland blue-collar craftsmen on issues of race and equality and economic opportunity. And the students developed a close--and educational relationship--with the owner of the home. Mrs. Palmer had successfully raised two families and built her own home, against incredible economic odds.)

"This has taught me basics for what I need to know about helping people who need new buildings. And I've gained a considerable amount of self confidence."

The consultants on the bubble project were an interesting group. They have been described by professional title and degrees and accomplishment in earlier progress reports to USOE.) The majority were architects, often involved in experimentation with new forms of building on the East Coast. Some were in private practice or employed by the Rouse Co. or were teaching at the University of Maryland and other area universities. Others were young graduate student types who possessed some special knowledge or who had been employed to assist the faculty in the program.

One of the most hardworking consultants was Charles Tilford, who holds a masters degree in engineering from Columbia University and has had wide experience with inflatables and domes and other unconventional architectural forms. Tilford, who describes himself as an "inflatoenviromentologist," is mentioned in the Whole Earth Catalog as an expert on inflatables and unusual building forms.

He assisted with the planning and construction of the bubble and taught a course on structural engineering. The course was rather seriously structured, with both a mid-term examination and a final (both open book). But the teaching style was informal in nature, with students and instructor usually seated on the floor, with Tilford often drawing on bottles with magic markers to illustrate lines of force, stress and shearing. Text for the course was, Structural Design in Architecture by Salvadori and Levy. The book cost $14 and this price resulted in a loss of some students.

Some of the course work was related to actual construction and stress problems with the bubble. But much of the material dealt with basic theory of tension and stress in construction.

An example of an examination problem:

> "A concrete spherical shell spans 150 feet with a rise of 25 feet. It is 4 inches thick and carries a snow load of 30 psf. Evaluate the maximum compression stress in the shell, the membrane thrust exerted by the shell on its support, and the reinforcement in square inches/feet at the shell boundary."

Not untypically, only three students remained with the course throughout the spring, 1972 term. But they found the course so useful that they asked that it be continued into the summer. Asked what he believed the students had learned, Tilford said that at a minimum their use of terminology had improved and they had learned where in construction one must be precise with calculations and where it is possible to be less cautious.

An ideal example of how the "process-oriented" curriculum should function was provided by a soils expert from the University of Maryland who came (at no charge) to advise the students on erosion difficulties caused by heavy rainfalls. The rains in late of 1972 were pouring off the bubble roof at a fierce velocity and tearing huge chunks from the loose dirt berm which surrounded the bubble and enclosed an apron of vinyl.

The soils expert surveyed the damage, then pointed out to the Antioch student who was escorting him the steps that could be taken immediately to lesson the erosion, the long-range steps that should be undertaken immediately (planting, etc), what should have been done as the bubble was constructed to prevent such wear, and the ideal long-range and costly solutions which could only be implemented if the students were successful in obtaining a substantial grant or gift.

It was a brilliant lesson in soil characteristics and construction theory. And the visitor's advice proved sound and effective. Unfortunately, and not untypically, only one student had been present on the walk around the bubble with the soils expert.

CONCLUSION

Constructing an air-inflated plastic dome was a substantial, indeed a glorious accomplishment.

The project required complex dealings with county state and federal government agencies, foundations, large and small suppliers, several components of the Antioch College network, and offices of the Rouse Company, the developer of Columbia, Maryland. An Antioch computer at Yellow Springs, Ohio, was used -- by students -- to coordinate the project and ensure that materials--air conditioners, fans, steel doors, electric motors, plastic skin, cables, plumbing, wiring, wood, etc.--arrived when they were needed, but not so early that they would have weeks of exposure to weather or expensive warehouse storage.

Much of this planning and coordination and dealing with public officials and begging and purchasing materials from suppliers was done by students, as was much of the technical work on experiments to analyze and prepare the site and to discover the rules, physics, nature and economics that govern life and work in a plastic bubble.

In accomplishing these tasks--assisted by faculty members and consultants--students acquired a substantial knowledge of how the world operates. Most did not acquire anything approaching the technical skills that would have been imparted in conventional schools of architecture or engineering. But that was not the expectation. Most did learn some drawing (artistic and technical) and some knowledge of architectural and social planning. They learned a smattering of engineering--though almost no advanced mathematics. But chiefly, they learned to cope with the real world--ordinances, bureaucrats, developers, manufacturers and their secretaries, foremen, fire officials, foundation staffers, architects, engineers, carpenters, plumbers, college officers, and hordes of sightseers. This was no small achievement. Other related aspects of the environmental design curriculum provided stimulating and tangible, if unusual learning experiences--the renovation of Mrs. Palmer's house, the work with the Elkridge Community to force the county to face the fact of annual flooding and to provide minimal social services, assisting citizens to make an assessment of the resources and social services and political clout available to them.

The side-effects and the curricular knowledge gained by the building of the bubble probably will have a substantial long-term impact upon Antioch College. The experience of living and learning and administrating in a college located in a plastic dome will be carefully analyzed and will provide a base of experience and observations useful to other groups and institutions.

On the negative side, there was substantial drift and lack of focus in the major bubble construction courses throughout the 1971-72 year. The majority of students involved felt that the courses did not live up to promise or expectations and that they focused too narrowly on the day-to-day problems of erecting the bubble. Undergraduates believe that much of the technical work was not sufficiently explained to them, but was too often performed for them by hired consultants.

In fairness, it should be added that college-age males--and all but two involved in the bubble curriculum were boys--in their early twenties are at a drifty age themselves. Though they often worked very efficiently for long hours, it sometimes seemed difficult for young men of that age (who enrolled at Antioch) to keep appointments, complete paperwork, follow through on difficult negotiations, or even to clean their debris out of the working area of colleagues or roommates. It is difficult to combine this natural lack of focus and aggressiveness with a curriculum different than the students have ever faced before. It is a curriculum that required a high degree of self-starting ability and initiative on the part of students.

It is clear in retrospect that the faculty and consultants should have spent more time in early planning and reached some sort of agreement on educational philosophy and goals--and developed a process for changing goals and direction if students needed a different approach.

And the goals should have been clearly communicated to the students.

The number of Antioch undergraduates actually involved in the project was small--a core of 8 to 10. With such an enrollment, the project was quite possibly too large and too complex and too expensive.

The role of the consultants should have been better defined. Were they to act as teachers or students? Was everyone to learn together? The answer is clearly yes to the latter question on a project with so little precedent. But this should have been made clear to all at the beginning. Rurik Ekstrom is a brilliant and innovative architect and is highly articulate and compelling when analyzing what is wrong with American planning and building--and his solutions are brilliantly innovative and they seem plausible and workable. But in the classroom, he never systematically tied this together for students. He gave them pieces of it in brilliant conversation, but failed to pull together and synthesize his theories. It appeared that he was underestimating or ignoring the educational impact of the written word. It seemed to this observer--and to several students--that it would have been extremely useful and to have his views on architecture and planning in writing, perhaps Xeroxed and distributed to all who enrolled in bubble-related courses.

And of course, such materials would have been invaluable to other colleges attempting to put together a similar program.

Some suggestions (based on the Antioch experience) for other colleges which might attempt a process-oriented effort:

--Those who will conduct the program should spend a substantial amount of time designing a course framework and forming some agreement among themselves on the goals of the curriculum. (Certainly, there should be substantial student input into the operation of a process-oriented curriculum, but the faculty do have a responsibility to lay down a framework of goals and philosophy, even if only to provide a focal point for revision).

--The goals should be clearly communicated to students. Some Antioch students felt that they had been misled as to the nature of the endeavor. It was clear that the Antioch effort never produced agreement on philosophy and educational goals.

--The curriculum has to be unstructured and flexible enough to adapt to delays and postponements (such as zoning battles).

--The housekeeping matters, particularly finance and communication, should be established in advance. Repeatedly, the faculty and several students had to drop everything for several days and weeks and put the books in order and battle with the Yellow Springs central offices on matters of money and red tape.

--The role of the consultants should be clearly defined in advance. And the consultants should reach some agreement with the faculty on what is expected of them.

--It should be decided at the beginning how decisions will be made.

--Considerable time should be built into the schedule for evaluation of the effectiveness of each major step in the curriculum.

--A program of this complexity should admit only students who have had some substantial background in related academic work. This was clearly no place for freshmen. (The student who feels that he needs deadlines and examinations to prod him should not enroll in a curriculum that by definition places heavy emphasis on self-motivation and independent work.

--A curriculum of this sort should include--or have as a prerequisite--serious courses in drawing, mathematics and structural design.

Most of the above suggestions are based on the Antioch experience--suggesting that the curriculum as it functioned there in 1971-72 and 1972-73 should have been built on some solid advanced planning.

HOWEVER, most colleges and universities are just the opposite of Antioch. They are too structured and too tight and too timid. An effort such as the Antioch bubble would be crippled by faculty politics at most campuses. Most of the successes and the sense of commitment that occured during the bubble project were due in large measure to the atmosphere of freedom and openness that characterizes Antioch's 25 campuses today.

APPENDIX AND WORKING PAPERS

CURRICULUM

COURSE SYLLABUS

COURSE TITLE: Advocacy Planning and Basic Construction Skills

PLACE: Columbia

NAME OF FACULTY: Smith & Staff

DAY: Class-Thurs. 9:30-10:30 a.m.

INTENDED BEGINNING & END DATES: Spring Quarter 1972

TIME: Lab-Thurs. 10:30-4:30 and Fri. 10-4 p.m.

NUMBER OF CREDITS: Variable

Class meeting one morning per week to discuss history and development of advocacy planning and to review work in progress. Fieldwork on specific projects to develop understanding of construction skills and to work directly on existing projects.

The work will include carpentry, drywall application, electrical and plumbing work, roofing, insulation and painting. The project during the spring quarter will be "Mrs. Palmer's House" in Scotland, Maryland. Students will work with faculty, research staff, project architect, general contractor, craftsmen, and neighborhood residents.

COURSE SYLLABUS

COURSE TITLE: Construction and Architectural Management for Campus

PLACE: Columbia

NAME OF FACULTY: Bubble Staff

DAY: Mon. 9-11 a.m.

INTENDED BEGINNING & END DATES: Spring Quarter 1972

TIME: Tues. 9:30-11 a.m.

NUMBER OF CREDITS: Variable

Class meeting two mornings per week to review work in progress and assign work to be done. Field work during day to include:

1. Continued work on the computerized timing schedule.
2. Updating of final cost analysis.
3. Placing orders for all materials and labor required for all divisions of work.
4. Coordinating orders, deliveries, assembly and installation of materials.
5. Carrying out and supervising ground breaking and site preparation.
6. ERECTING BUBBLE FACILITY.

Students will work with faculty, research staff, project general contractor, project architect, and consultants on a daily basis with individual and group assignments.

COURSE SYLLABUS

COURSE TITLE: Design of Spaces Within the Campus Bubble

PLACE: Columbia

NAME OF FACULTY: Thomas, Axtell, REDE

DAY: Wednesday

INTENDED BEGINNING & END DATES: Spring Quarter, 1972

TIME: 7-....

NUMBER OF CREDITS: Variable

Class meeting one night per week to discuss design techniques and application, the work in progress, and to assign work to be done. Studio work during day to:

1. Develop interior micro-environments in response to user needs.
2. Research available alternative systems for the division, definition, and manipulation of interior space.
3. To obtain sources, cost and delivery data for available systems--to test our resourcefulness.
4. To design and experiment with alternative solutions to interior needs using appropriate communication devices; i.e., drawings, models, simulations, etc.
5. To experiment with full scale examples of as many devices as possible.

Students will work on a daily basis with faculty, research staff, project architect and engineers, and with consultants from the Research and Design Institute of Providence, Rhode Island.

COURSE SYLLABUS

COURSE TITLE: Structural Engineering Tutorial | PLACE: Columbia

NAME OF FACULTY: C. Tilford | DAY: Tues. 7-9 p.m.

INTENDED BEGINNING & END DATES: Spring Quarter 1972 | TIME: Fri. 10:30-12:30 p.

NUMBER OF CREDITS: Variable

Subjects covered include: loads, material properties, tension, compression, torsion, beam action, arches, geometry of shell surfaces, membranes, and shells. Emphasis is on comprehension of basic principles. Approximately half of each session is spent on problem-solving.

Text: Structural Design in Architecture, Salvadori & Levy, Prentice-Hall.

See Instructor before registering.

COURSE SYLLABUS

COURSE TITLE: Basic Drawing

PLACE: Columbia

NAME OF FACULTY: Axtell

DAY: Thursday

INTENDED BEGINNING & END DATES: Spring Quarter 1972

TIME: 6-8 p.m.

NUMBER OF CREDITS: 3

Introduction to the fundamentals of drawing and use of basic drawing media. Aimed at developing student's freehand sketching ability for purposes of rapid visualization so that the student may better conceptualize design ideas and communicate these ideas in a non-verbal language.

Approximately four additional hours per week must be arranged between instructor and student.

WORKING PAPERS

Note: Nothing captures the intensity, complexity, hard work and intellectual challenge of the Antioch bubble project so well as the papers and memos generated during its planning and erection.

On the following sixteen pages are reproduced some of the working papers generated by the Antioch team during the heat of the working day.

CONCRETE DETAILING FOR THE CORRUGATED PROMENADE AT ANTIOCH PNEUMATIC CAMPUS

by Phil Hawkey
August 1, 1972

FORM WORK:

In this case it is critical that we do not pour more concrete than we need because the doors fit tightly and any extra height in the floor would result in problems trying to fit them.

Also, the culverts have caved in slightly since their installation, further contributing to the problem.

When the desired floor level has been selected, install 1x stock at this level.

Check its placement with a level and use the transit to assure at least a 6-inch drop to the outside.

Since the tubes are not exactly round, the floor levels in each tube may need to be different. The parameters are the dimensions of the doors; therefore, a minimum floor width of 4'2" must be maintained. There must be a clearance of at least 7'3" at the ends of a 4'2" line along the floor where the doors are to be installed. This should be done with string before any concrete is poured. The 1x stock used for the end plugs should be nailed to 2 x 4 stakes 1" o.c., driven at least 18" deep with the 2" edge adjacent to the 1x.

After the form is complete, sidewalk mesh (6" x 6" #10 x #10 welded wire mesh) shall be cut to length and placed in the tubes. It might be advisable to use a vibrator on this job, both in terms of the quality we are hoping to achieve and in order to get some experience with the tool before we do the primary anchors, where we can't afford to mess up.

Tool List: (Supplies)

trowel, extended
1 x 6 on long 2 x 2
96' of 6 x 6, 10 x 10 Welded Wire Mesh
45' of 1 x 12
9 5' lengths for expansion joints
Exactly 10.66 yds. concrete order
3yds.

APPENDIX A:

If we hold off until the concrete casing is stripped, we can use the same wood and save money.

Tool List:

- shovel
- hammers
- string
- plumb rob
- stakes
- level
- cross cut saw
- sabre saw
- 8d, 12d nails
- transit
- sledge
- vibrator
- gen
- zig-zag rule
- 12 or 10 ft. tape

SEQUENCE:

- Clear the way
- Determine required levels
- Place stake & backfill 1x plugs
- Cut & place expansion joint
- Cut & place w. w. mesh
- Pour, trowel, cure & strip

APPENDIX B:

Expansion joint -

It was felt that the possibility of buckling due to temperature differentials during the winter (where it would not be exceptional to have a 70° differential) merits the use of an expansion joint. These can be easily made by placing a 1 x 12 cut to form at the points where doors occur.

JOB SPEC FOR THE FORMS FOR THE CONCRETE
FOR THE PRIMARY ANCHORS FOR THE PNEUMATIC CAMPUS

Phil Hawkey
August 10, 1972

We will need two sheets of plywood for each. These will go on the angled face which is facing the structure. The walls of the hole will do a sufficient job in forming the other faces.

First we should clean out each hole; the bottom should be level so that the rebar cage sits right. Bricks should be put underneath the cages to allow coverage of the lower bars. The north and south wall should be 7.5' apart and everything should be fairly square and clean. Then the rebar cage goes in, (4.75 from the inside of cage to outside of hole) be careful not to knock too much dirt in during this operation, as it will be hard to remove and hard to put concrete where dirt is. We'll probably want to lower them in from the side facing the building, using canvas webbing and several people so we don't chew up much dirt. Then wack the rod in, get the 22° angle correct with the transit and tie it to the cage with an additional length of rebar and some tie wire, recheck its placement and backfill it enough to make sure it won't wobble out of place.

Then, the plywood sheets can go in; each sheet should be cut down to 4 x 7'. The bottom edge of the plywood should be 5' from the back face of the hole:

Measure 6' vertically and 3½' horizontally to place the top edge. Cut grooves into the north and south walls so the combined 8' pc may be wedged in tightly. Then measure and cut slot for the rod to fit through (this should be 2.75' approx. from the bottom of the plywood); make this fit as tightly as possible. (This cut should continue to the bottom of the plywood so that the assembled piece can fit on.) Bricks should be placed between the cage and the plywood to keep the desired distances.

In order to assure proper assembly, rake off a large, level work space to assemble the plywood. But the pieces together and nail some 1' x 4"-9" x 6'-8' above the rod groove 2'oc.

Then the stakes may be installed by driving rebar perpendicular to the face of the cage, protruding 6" from the face of cage. Bricks should be placed between the cage and the plywood to insure the 6" margin.

Then backfill, foot-tamping the fill in front of the bottom edge, fill the rest loosely up to the lip of the form. Pour the concrete, 1' at a time, vibrating it well after each layer has been poured. After the concrete has been curing for 30 hours, the backfilling and tamping should continue with a mechanical tamper.

STRUCTURAL EVALUATION

first priority: -- CABLE
-- FABRIC
-- AGING EFFECTS

second priority: -- ANCHORING OR FOUNDATIONS (AS APPROPRIATE TO STRUCTURE)

Test	Location	Equipment	Source	Services	Source
				(assumes resident student-technician)	
LEVEL ONE					
1. put load cells on major cables - dial (manual) read out and record	ANT MIL	2-6 load cells; single signal conditioner/ instrument (equip. shared)	purchase $100-300 ea. Univ. of Md. loan or rent	four days consulting by R. Schafer or similar	$100/day
2. correlate above with wind speed, direction, and inflation pressure	ANT MIL	anenometer, wind vane, with dial-read out (two required)		negligible	-
3. cut out samples of fabric at regular intervals for lab testing	all	none	-	testing donated	-
LEVEL TWO					
4. use cable-deflection or strain link device on secondary cables	ANT	strain measuring device for light loads	purchase $200 max.		
5. record under dynamic conditions from all sensors simultaneous	ANT MIL	oscillograph; automatic switching and balancing unit (equipment shared)	included in services	contract with Schafer & Heinz (U. of Md.)	
6. apply strain gauges on membrane	ANT MIL LAV	fluidic strain gauges; temporary use of above signal conditioner, etc.	included in services	two days+ consulting from John Skelton & donated time of Kent Hubbell (Yale)	

STRUCTURAL EVALUATION

(continued)

Test	Location	Equipment	Source	Services	Source
LEVEL THREE					
7. add digital recording or conversion and analysis	ANT MIL	digital tape recorder or conversion from graph to punch cards	included in service or from NBS	contract with Schafer & Heinz	
		computer analysis		contract with above or Prof. Shinozuka at Columbia U. with Dave Geiger	
8. test anchor capacity	ANT	two jacks and hardware; replacement anchor	rent max$25	negligible	-
9. add automatic, intermittant recording of loads	ANT MIL	longer use of above equipment or duplicate set up at other site	same as above	same	same
10. add additional gauges on cables	ANT MIL	same as above	same	same	same

THERMAL PERFORMANCE

first priority:
- --air transfer
  - (inflation flow)
  - (exhaust flow)
  - (bar. pressure)
  - (inflation pressure)
  - (leakage)
  - (response time)
- --wind speed and direction
- --humidity
- --temperature
- --heating and air conditioning equipment
  - (output)
  - (energy consumption)
- --heat transfer

second priority:
- --condensation
- --hydrology under structure
- --fire
- --gas analysis
- --odor
- --ventilation distribution/ stratification

Test	Location	Equipment	Source	Services	Source
LEVEL ONE					
11. measure flow in ducts at various inflation pressures	all	pilot tube (can be shared)	ANT		
12. correlate flow curves with pressure info to determine leakage and response time	all	available pressure differential read out	-		
13. determine temperature levels at numerous points inside and outside structure over time	all	2000 feet thermocouple wire tt each structure and quick tips	purchase (except ANT)		
14. record fuel and electrical consumption	all	-	-		
15. measure mean radiant temperature in structure	all	globe thermometer (can be shared)	purchase or NBS loan		
16. measure humidity inside and out	all	sling pychrometer or simple drum recorder (3 req)	purchase or NBS loan		
17. measure solar radiation	all	pryheliometer (shared)	purchase or NBS loan		
18. measure wind speed and direction	all	as in test #2	-		

THERMAL PERFORMANCE

(continued)

Test	Location	Equipment	Source	Services	Source
LEVEL TWO					
19. condensation analysis	all	humidity and temperature from tests 13 and 16 and observation	-		
20. simple gas analysis	all				
21. add graphic read out to wind test 18	all	strip chart recorder	purchase, NBS loan, or test #5 recorder		
22. add graphic read out to inflation pressure transducer	ANT MIL	strip chart recorder	"		
23. fire and smoke tests	all				
24. determine air flow patterns and rates, stratification (including thermal)	all	thermocouple set up from test 13	-		
		flow set up from test 11	-		
		tracer gas equipment	NBS or other loan		
LEVEL THREE					
25. add digital recording and analysis	all	instrument from test 3 and 7 or similar	NBS, loan, or contract		

ILLUMINATION AND ACOUSTICS

ILLUMINATION

first priority: --simple night, day and average values for illumination

second priority: --spectral distribution
--quality, glare, aesthetics

ACOUSTICS

first priority: --simple measurement of noise level at various locations and times

second priority: --acoustic analysis of structures

Test	Location	Equipment	Source	Services	Source
ILLUMINATION					
LEVEL ONE					
26. measure outside incident light, transmission, at different hours on different days. determine extremes and average	all	light meter	purchase ($20) or loan		
27. measure illumination from night electrical lighting	all	"	"		
LEVEL TWO					
28. use better instrument for above tests 26, 27		"	purchase ($150) or loan		
29. determine spectral transmission and reflection values of roof membrane (as material ages, repeat)	all	field or lab tests with spectrophotometer	GE labs or similar		
ACOUSTICS					
LEVEL ONE					
30. simple measurement of noise level at various locations over time	all	sound level meter	purchase or loan		
31. acoustic analysis	all	included in contract	-	contract with acoustic consultants	

HUMAN RESPONSE AND PLANT RESPONSE

Test	Location	Equipment	Source	Services	Source
HUMAN RESPONSE					
LEVEL ONE					
32. observation - simple	all	-	-		
33. interviews - informal	all	-	-		
LEVEL TWO					
34. observation - systematic	all	-	-	consultant such as C. Tucker	
35. interviews - systematic	all	-	-	"	
36. automatic use, number, time, flow, etc. info and analysis	all			consultant such as S. Wellesley-Miller	
PLANT RESPONSE					
37. record what grows or dies	all	-	-		
38. systematic program of plant growth monitoring	all				

INTERIORS

(Space Design with Research and Design)

A. Major Activities and Directions

1. Continued focus on hardware acquisition and specifying hardware needs.

2. Basically still trying to develop a fantastic interior on $5,000 and do it with the active participation of the user.

3. Developing an index of interior components.

4. Developing visual design skills and producing visual documentation: models, drawings, etc.

5. Working with students, community groups, HEC staff and program people, and other individuals to narrow down who the users will be.

TECHNICAL DEVELOPMENTS

A. Metallizing

National Metallizing is laminating metallized mylar to our clear vinyl (1,000 yards for $550); completion promised on March 30. A flame-retardant adhesive is being used. They have supplied test pieces to Mr. John Hall, University of Maryland Department of Agronomy, who is testing the survival of different grasses under the metallized skins.

B. Skin

Mike Krinsky, Freddie Allen, and I met on March 16-17 with Don Weir and Dick Arcouti (Goodyear), Roger Payne (ESI), and Sid Sugg and Jorge Diaz (Rubber Fabricators). A reinforcement detail was developed (for skin separation point), using coated fabric patches coated with an experimental Goodyear urethane-based glue and heat-reactivation. The skin joint at the primary cables was changed to occur under the primary cable; the Goodyear clip joint was replaced by a 10" wide coated fabric strip heat-activated on-site. Rubber Fabricators will begin production April 10; delivery is scheduled for May 10. The prototype skin was "loaned" to Rubber Fabricators to erect for an elementary school play-space.

C. HVAC

The heating units were changed to operate on #2 fuel oil, on the basis of lowest operating cost and hassles in getting natural gas to the site. The Mammoth Co. salesman told us that if the unit is properly adjusted, it will burn as cleanly as natural gas. Return ducts have been relocated; they travel from the units on the berm, penetrate the berm, and stop. If we find that air needs to be picked up in a more central location, we can make appropriate modifications later.

D. Control System

Schematics have been drawn and a shopping list is being finalized.

(This section by C. Tilford)

STATUS OF FINAL DRAWINGS AND SPECIFICATIONS RELATING TO PERMITS

A. Rurik Ekstrom and subcontractors, Implementation, have been working with Howard County and the Columbia Architectural Review Committee to inform planning and building officials of developments related to the Bubble.

B. The Architectural Review Committee has given up the go-ahead advising that machinery external to the building must be visually and acoustically softened.

C. The specifications are 30% completed and are being done by Implementation.

D. The final drawings lack only minor revision and are 95% complete. The final drawings are being done by Rurik Ekstrom with Implementation.

E. Howard County is providing helpful educational consultation in terms of soil conservation.

F. Permits are just weeks away.

PHASING PLAN FOR CONSTRUCTION MANAGEMENT

A computerized timing schedule has been prepared by students in the program. (Bart Burstein and Phil Hawkey).

Bart describes the process this way:

"PERT (Project Evaluation and Review Technique) is an organizational tool we are using to project our progress during the construction phase. The basic structure is a network of circles (events) connected by arrows (activities).

The network was first drawn on acetate. After a period of modification, the network was input to a Control Data 6400 computer.

Output includes expected and latest allowed completion date for each activity. It also shows the time remaining, the length of activity time and the person reponsible for each activity. Presently there are 200 such activities."

COMMUNITY ADVOCACY

(Mrs. Palmer's House)

M E M O R A N D U M

March 4, 1972

To: Advocacy Class & Those Interested

From: Tommie

Re: Advocacy Class Schedule

Advocacy Class Schedule for March -- Meet at Mrs. Palmer's house at specified time.

Week 1

Thursday, March 2, 9 a.m.	Blocking, Spackle, Drywall, Tear out Drywall -- Mr. Doyle
Friday, March 3, 9 a.m.	Spackle, Drywall, Sand Blocking Center Wall Partition, Reconstruction-- Mr. Doyle. Electrician -- Old Wire out 2nd Floor, Check out new -- Mr. Doyle

Week 2

Wednesday, March 8, 12 noon	Tear out stair, prepare for new stair. Electrician: New Panel Box and wire homeruns to Box -- Mr. Doyle
Thursday, March 9, 9 a.m.	Carpenters: New stair, Front door, Drywall, etc. -- Mr. Doyle Old tub, out.
Friday, March 10, 9 a.m.	Carpenters: Stair, Front Door, 2nd Floor Windows, Drywall, etc. Trips to Dump -- Mr. Doyle

Week 3

Thursday, March 16, 9 a.m.	Prepare Bath for Plumber, Bedrooms, Hall, Stair. Spackle, Drywall, Sand. Mr. Doyle
Friday, March 17, 9 a.m.	Kitchen Partition Drywall, Guest Room Closet, Stair Partition -- Mr. Doyle

Week 4

Tuesday, March 21, 9 a.m.	Fix Roof Leaks, Drywall, Ceilings out 1st floor -- Mr. Doyle
Thursday, March 23, 9 a.m.	Closets - Shelving, Partitions, Drywall.

(Note: Mr. Doyle is the contractor who is an adjunct faculty member, a resource person, and a friend.)

On Thursday, March 23, the community video program produced a tape documenting the process. Mrs. Palmer and her two great grandchildren told of the history of their home and their community. A fine tape!

Note: It was vital throughout the construction of the bubble that precise accounting records be maintained concerning the expenditure of the $180,000. It was a complex task, requiring the coordinating and timing of purchases of hundreds of items and tools and services. Much of this complex record-keeping was done on an Antioch computer at Yellow Springs, Ohio, with data fed by students at Columbia, Md. Barton Burstein, an undergraduate, served as paid project manager much of the time, and coordinated money and details throughout the hectic spring and summer of 1972. He has been succeeded by Cameron Tucker, a young architect, who serves as bubble manager. The following two pages provide an illustration of the sort of paperwork that guided the project and at the same time provided a learning experience for the participating students.

ANTIOCH COLLEGE
HUMAN ECOLOGY CENTER
COLUMBIA, MD. 21044

MEMORANDUM

TO: Files

FROM: B. Burstein

RE: Budget Category Line Item 4

DATE: May 18, 1972

As shown in the attached memorandum dated April 11th, this line item could run $368.01 (12.2%) over budget. Purchase Orders 2588 and 2617 are items 1 and 3 of this breakdown (funds committed). Other prices in attached breakdown represent firm quotes except for 2 and 7. If 2 and 7 cannot be cut by 68.01, approval for overage will have to be obtained.

cc: M. Axtell
S. Plumer

BB:nr
Attachments

April 11, 1972

1.	Cable (secondary)	$ 854.90
2.	Cable (primary) overage	750.00
3.	Connectors	
	100 @ $1.25	125.00
	4 @ $180.00	720.00
4.	90 dips @ $1.73	155.70
5.	200 nicopress @ $44.61	89.22
6.	nicopress tool	57.99
7.	Cable grip and equipment (can be tools - expendable)	50.00
8.	Cable spacers - 180 @ $3.14	565.20
		$3,368.01

INCOME AND EXPENDITURES

CONCERNING THE DEVELOPMENT

OF A

PROCESS-ORIENTED CURRICULUM

IN CONNECTION WITH CONSTRUCTION

OF A

PNEUMATIC CAMPUS

AT

ANTIOCH COLLEGE

COLUMBIA, MARYLAND

BUDGET ANALYSIS

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION SHARE

PROCESS-ORIENTED CURRICULUM

Budget # 24800

CATEGORY		EXPENDITURES
36 SALARIES		
36a	Administ. Group	$ 9,200.00
36b1	Axtell	7,500.00
36b2	Ekstrom	3,000.00
36b3	Carpenter	500.00
36b4	Plumber	4,000.00
36b5	Electrician	5,000.00
36b7	Tilford	4,000.00
36b8	Tucker	4,200.00
36c1	Research group	12,780.00
		50,180.00
37 SALARIES		
37b9	Burstein	4,752.00
37b10	Accounts Clerk	525.00
37c2	Resource Group	8,300.00
		13,577.00
42 CONSULTANTS		
42a	REDE	3,600.00
42b	Tilford	3,400.00
42c	Carter	2,900.00
42d	Doyle	9,000.00
42e	Brann	2,500.00
42f	Misc.	1,000.00
		22,400.00
50 STATIONERY		
50a	Office Supplies	60.00
57 DUPLICATION		
57a	Typing	279.95
57b	Printing	600.05
		880.00
60 TRAVEL		
60a	Travel	900.00
60b	Bus	150.00
		1,050.00
61 EXPENDABLE EQUIPMENT		
61a		5,400.00
65 COMMUNICATION		
65a	Postage	200.00
65b	Telephone	200.00
		400.00

69 CONTINGENCY 69a	6,053.00
TOTAL BUDGET	$100,000.00

BUDGET ANALYSIS

ANTIOCH COLLEGE MATCHING SHARE

AIR SUPPORT STRUCTURE

Budget #24801

CATEGORY		EXPENDITURES
01 GENERAL CONDITIONS		
(1)	Contract Documents	$ 3,000.00
(2)	Zoning Fee	130.00
(3)	Building Permit	25.00
(4)	Land Lease	1.00
(5)	Construction Materials	600.00
		3,756.00
02 SITE PREPARATION		
(1)	Service Entry	1,700.00
(2)	Earthwork	4,900.00
(3)	Entrance Culvert	4,500.00
(4)	Pedestrian Doors	3,500.00
(5)	Filler-Units	300.00
(6)	Access Pathway	2,000.00
(7)	Ductwork	4,000.00
(8)	Footings	1,700.00
(9)	Retaining Walls	6,150.00
		28,750.00
03 INFLATION PACKAGE		
(1)	Fans	1,150.00
(2)	Filters	150.00
(3)	Generator	2,641.00
(4)	Emergency Controls	100.00
(5)	Housing for Pressure Controls	500.00
(6)	Sheet Metal Work	2,000.00
		6,541.00
04 ENVELOPE		
(1)	Film	5,726.00
(2)	Welding	5,000.00
(3)	Skin	1,000.00
(4)	Cable Fittings	3,400.00
(5)	Secondary Anchors	1,200.00
(6)	Install. Sec. Anchors	1,700.00
(7)	Misc. Fabric	500.00
		18,526.00

05 ELECTRICAL		
(1)	Main Panel	3,500.00
(2)	Conduit	1,000.00
(3)	Area Power Panels	1,200.00
(4)	Distribution Panels	250.00
(5)	Distribution Assemb.	200.00
(6)	General Lighting	4,000.00
(7)	Emerg. Light/Fire Alarm	1,050.00
(8)	Telephone Dist. System	510.00
(9)	Wiring HVAC Units	1,400.00
		13,110.00
06 HVAC		
(1)	Heating/Air Conditioning	24,500.00
(2)	Heat Rec. Wheel	4,390.00
(3)	Dampers	1,750.00
		30,640.00
07 UTILITIES		
(1)	Sewer Line	7,060.00
(2)	Water Line	5,000.00
(3)	Oil Tanks	3,000.00
(4)	Electrical Conn.	4,000.00
(5)	Telephone	1,500.00
		20,560.00
08 PLUMBING		
(1)	Subcontract	4,000.00
09 INTERIORS		
(1)	First Phase	5,000.00
10 CONTINGENCY		
(1)		13,117.00
	TOTAL BUDGET	$144,000.00

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WASHINGTON ALERT

Air structures reviewed in 32,000 sf 'bubble'

By ERNEST MICKEL
Daily Journal Washington Editor

WASHINGTON—The state of the art for air structures, particularly regarding their use for housing educational activities, was reviewed in detail at the recent two-day conference sponsored by the Building Research Institute and Educational Facilities Laboratories at Baltimore and Columbia, Md.

Site of some of the sessions was the 32,400 square foot "bubble" built by architectural students for Antioch College at Columbia. This $178,000 structure, maintained at an estimated cost of $17,500 per year, was the subject of a presentation at the May 23 meeting.

Architectural details were covered by Rurik Ekstrom, himself an architect, who, in telling of the philosophy of constructing an air inflated building for this purpose, said:

"We felt we should get rid of the egocentric character of architecture. We considered that if later we decided Columbia, Md., was not a good place for Antioch East, we wouldn't have a large building investment which might force us to remain there against our will."

The structure can be deflated and moved. Its function is described as serving "as temporary base" for students working in independent study programs in the new town of Columbia.

It has required about three years to design and build. Basically, the shelter consists of 36 pieces of vinyl skin welded into six sheets which were assembled by the Goodyear technique over four centrally-spaced tiedowns that are anchored in dry wells to receive rain runoff.

Many of the problems of design and erection were described to delegates by the students who worked on and now live in the project.

EFL contributed a feasibility study grant and spokesmen said that several agencies—Housing and Urban Development, National Science Foundation and Environmental Protection Agency as well as National Education Assn.—had expressed an interest in researching feedback now that the prototype was completed.

The program presented case studies on air structures work in Canada and some European locations in addition to U. S. projects.

Keynote speaker Cedric Price, a practicing architect in England and a pioneer in air structures development, said that in his country these buildings were still in the "make do and amend" stage of development.

Air structures can, if viewed in a certain light, distort time and space, he said, to their great advantage.

At the same time, he said this type of construction should never be considered merely as a cheap substitute for enclosing space in the conventional way.

Price, who since 1968 has been commissioned by the Ministry of Technology to undertake a survey of air structures use in construction, said "we may have to wait for a serious shortage of warehouse and similar space to really get air structures moving."

In a general introduction to the conference, Harold Gores, president of EFL, New York, expressed a view that "if anything pulls down this new venture, it will be the overextending of the technology."

He advised the industry not to pursue encapsulation to the ultimate, not to "cover the earth" until smaller sections are proved out in practice, adding that he hoped the private sector can be encouraged to participate with risk capital and help develop this new art form.

It was agreed that the state of the art has advanced markedly since a similar conference was held in Chicago a couple of years ago. Robert M. Engelbrecht, AIA, Chicago, was chairman for both the Chicago and the Columbia and Baltimore conferences.

Dr. Frei Otto, director of the Institute for Lightweight Structures, Stuttgart, W. Germany, traced the development of light weight units which he referred to as biological

Cont. on Back Page, Col. 1

Cont. from Page 1, Col. 3

structures, deriving this description from his photography of cellular structures.

He cautioned that all envelopes should be considered as experimental, not permanent, structures and he described large envelope enclosures as "protective clouds over the landscape."

The technique exists now, he added, for building air structures to withstand the heaviest snowfall and the highest wind velocities, "if you are willing to pay for it." Of the 40,000 odd such buildings existing today, some are very good examples of the principle while many are very bad, this German expert observed.

He compared pneumatic structures to single cell formations in nature and illustrated his remarks with many slides showing contour lines etched on various objects. He advocated closer study of the lightweight forms of nature, especially the single cell, "because all derive from the natural pneumatic form."

Antioch project was undertaken for the many lessons it has taught those involved in its design and construction.

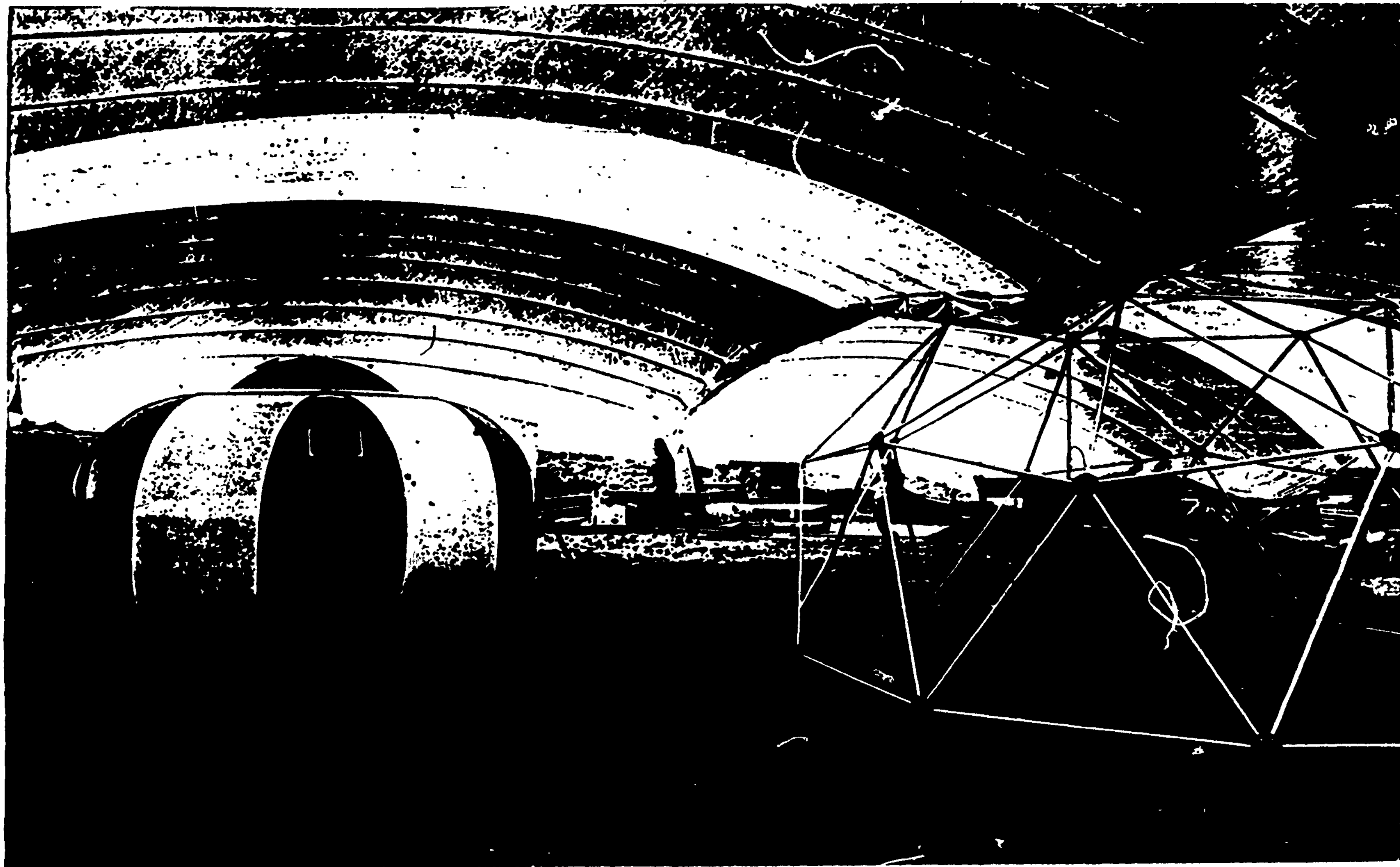
Those people learned a lot about how hard it is to build air structures, he commented, and that you must do it over and over again. He called this experimental architecture.

Also discussed at the BRI-EFL conference were form variations for these "bubble" installations, acoustical problems, long spans, and their use for community activities. There was a special emphasis on the use of these types of structures for athletic activities, at least in the first day's presentations.

The European experience was covered by speakers from London, Paris, Amsterdam and Ulm University in West Germany.

More than 360 were registered, an unusually large number according to BRI.

The nation's first pneumatic campus at Antioch College branch campus in Columbia, Maryland. The vinyl film structure, supported only by air pressure, covers an acre, enclosing portable classrooms, offices and studios. When the campus is no longer required the air will be let out, the "building" rolled up, and the site returned to a meadow. (Photo by Robert Wang)



Inside the pneumatic campus at Antioch College in Columbia, Maryland. The acre of space is divided up by ready-made industrial units such as the portable fiberglass ski hut (left) which snaps together to make a faculty office, and a freestanding geodesic dome (right) which, when enclosed, will be used for seminars. (Photo by Blair Hamilton)