Wisconsin engineer. Volume 78, No. 8 May 1974

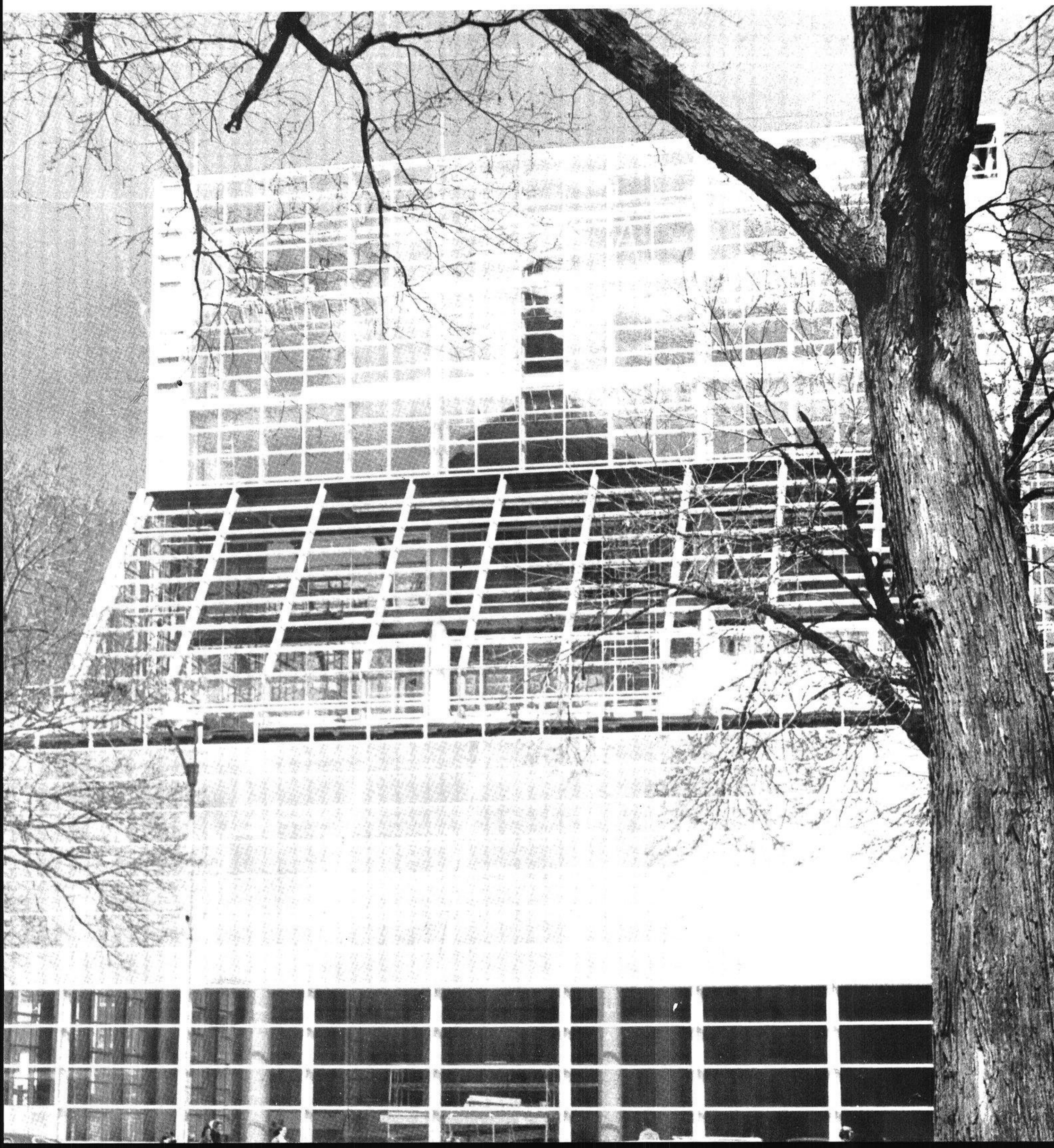
Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

OLUME 78, NUMBER 8 35 CENTS APRIL 1974

wisconsin engineer

The Case of the Bungled Blueprints • Nature on the Drawing Board • Arcology



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Layout .... Bill Schultz, Mat Joyce, Mary Anne Dieracks, Rick Norton
Art Editor .... Mat Joyce
Writers .... Ed Bark, Steve Tuckey, Tom Clark

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Second Class Postage Paid at Madison, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized Oct. 21, 1918.

Published monthly from October to May inclusive by the Wisconsin Engineering Journal Assn., Subscriptions: one year—$2.00; two years—$3.75; three years—$5.25; four years—$6.50. Single copies are 35 cents per copy. 276 Mechanical Engineering Bldg., Madison, Wis. 53706. Office Phone (608) 262-3494.

Innovations for Newcomers

Dean Frederick Leidel

The mission of the Engineering Freshman Office is twofold. One, it is to assist freshmen in having as successful and pleasant a freshman year as possible; two, to see that as students leave for any reason, such as promotion to sophomore standing, they are pointed in a direction consistent with their aptitudes and interests. An extension of the first part of the mission is to keep not only the College of Engineering facilities and administration, but also the entire Madison campus faculty and administrations, sensitive to the performance, aspirations, and needs of students — especially freshmen students. We look upon this as being very important. It has been time-consuming but very gratifying.

Two bits of legislation have been proposed to the college faculty and approved this year, that we feel are especially good and in the best interests of our students. This provides a wonderful opportunity to make more of you aware of the changes.

We have been disturbed about the trend of incoming freshmen to lack pre-calculus mathematics in increasing numbers. The problem is complicated, and its cure is complicated. However, we proposed that Mathematics 112 and 113 be allowed as free elective credits counting toward graduation, up to the number of free elective credits available in any curriculum, as encouragement to the student who is really caught in a bind caused by a philosophical difference between high school and college. After many meetings and much debate, College of Engineering faculty legislation was passed allowing, departments within the college to count these two courses as free electives if the department wished. Subsequent departmental action in a sense ratified the college legislation, and in all engineering departments, students are now allowed to count Math 112 and 113 credits as proposed.

The Department of Mathematics of the College of Letters and Science was sensitized to the problems of engineering students as a result of the discussions, and this must have stimulated their approval of a new math course, Math 114, 5 credits, an integrated and hopefully more effective algebra-trig course to be taught for the first time next fall. Another of our proposals was approved by the engineering faculty at its March meeting. It was contained in a new set of "Regulations Regarding Enrollment, Scholarship, and Graduation in the College of Engineering of the University of Wisconsin-Madison" made necessary by the new campus grading system and other changes brought about by the merger of the University of Wisconsin and the Wisconsin State University systems. In effect, it states that the point-credit ratio (in effect the student's graduation g.p.a.), probation, and graduation with honors or high honors, shall henceforth be determined using only those semesters containing the last 60 credits taken in residence. For the engineering student who begins on the Madison campus as a freshman, this regulation makes the calculations for the listed items the same as for the student who comes to us, say at the beginning of his junior year, as a transfer from another campus or college. The transfer student brings with him only his credits, and not his grades, which can be unsatisfactory (less than a 2.0 g.p.a). Under the new regulation the student beginning on the Madison campus, who has a poor freshman record will eliminate the effects of the poor freshman record upon the items mentioned (point-credit ration, etc.) by the time he finishes his junior year, just by the act of survival.

There is one final bit of information we would like to pass on to you. We were in favor of the repeat-F provision of the new grading system. We were, however, surprised by the required procedure for removing an F from your grade point calculation. The procedure can be found on page v of the Timetable for second semester, 1973-74, and required a form to be deposited with the Registrar during the first two weeks of the semester in which the course is being repeated, for the purpose of removing the F. Our message is that if any of you are having difficulty because you have not followed the specified procedure (hopefully out of lack of knowledge of the rules), please come to me or to Dean Asmuth for assistance in accomplishing what you intended by repeating the course.

We spend much of our time helping students with problems. Lest you get the idea that all of our students have problems, let me say that we were very pleased and encouraged by the number of students who made the Dean's Honor List this past semester. Our sincere congratulations go to all of you! WE

New Engineering Library Planned . . . Someday

by Judy Endejan

After years of being tossed about by both university and legislative planning committees, a new $3.8 million dollar Engineering and Physical Sciences Library will be constructed next to Union South starting in the early summer of 1974.

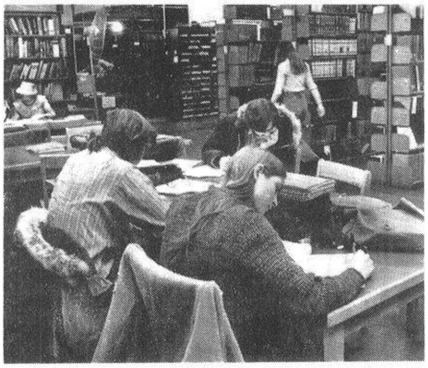
The proposed building will provide space for approximately 240,000 volumes, including microforms, documents and other printed materials. About 500 stations of various types, ranging from carrels to group study rooms, will provide seating for the engineering student. These stations will be scattered throughout the building and among the stacks.

The new library will provide a sharp contrast to the present Engineering Library, located on the third floor of the Mechanical Engineering Building. The present library's collection is scattered in four different locations on campus, the chief of which is the basement of the Zoology Research Building. It houses nearly half of the library's material.

LeRoy Zweifel, chief librarian at the Engineering Library, describes the conditions of the present library as "deplorable". It has a maximum of 24 reading spaces and woefully overcrowded conditions in archaic Room 375, Mechanical Engineering.

When the Union South was built in 1970, a new Engineering and Physical Sciences Library (EPSL) was also to be included in the construction. Space was alotted on the corner of W. Dayton and N. Randall Streets for the EPSL. The proposed stucture was intended to complement the architectural style of the Union. However, construction was canceled at the time.

It wasn't until last March that the State Building Commission approved the funds for the building, after it reversed an earlier decision canceling funding. Governor Patrick Lucey had voted "no" on the measure, originally. But he changed his mind when he was assured that even with funding for the new library ,the 1973-75 biennial building program would fall far below the $55 million dollar ceiling that he had set.



A poor facility now houses a valuable collection

Librarian Zweifel said, however, "When I see bulldozers digging holes over there (next to Union South), I might believe that the library will be there . . . but I reserve my judgement until that time." When Zweifel came to the Engineering Library 25 years ago, a new library was a top priority item. Since then the planning for it has encountered a stream of ups and downs.

Assistant to Zweifel, Enid Simon said, "When and if our building gets built, it will be the first time in ten years that we'll have the entire collection under one roof."

The planning of the new library consists of two phases, Zweifel explained. The first phase will be predicated on engineering and computer sciences and will provide in-depth coverage for those areas. It will give a broader coverage to the physical sciences.

Phase two calls for an expansion of phase one, if it is deemed necessary. This would include an expansion of the phase one facilities, a more in-depth physical sciences collection, a significant environmental collection because of the library's proximity to the Institute for Environmental Studies, and a general undergraduate reading area.

The state legislature has requested that the new library use the latest possible techniques to prevent the need for phase two by such means as the miniaturization of materials, so that no new massive structure will have to be built.

Zweifel said, "We're trying to find the means so that phase two won't be necessary, but so that library services will not suffer. Since we're one of the top engineering schools, it's asked of us to have the top technology and the latest type of library services."

Zweifel felt that the engineering school had been short-changed on a library for too long a time. He said, "We have one of the poorest physical plants for one of the finest collections in the country."

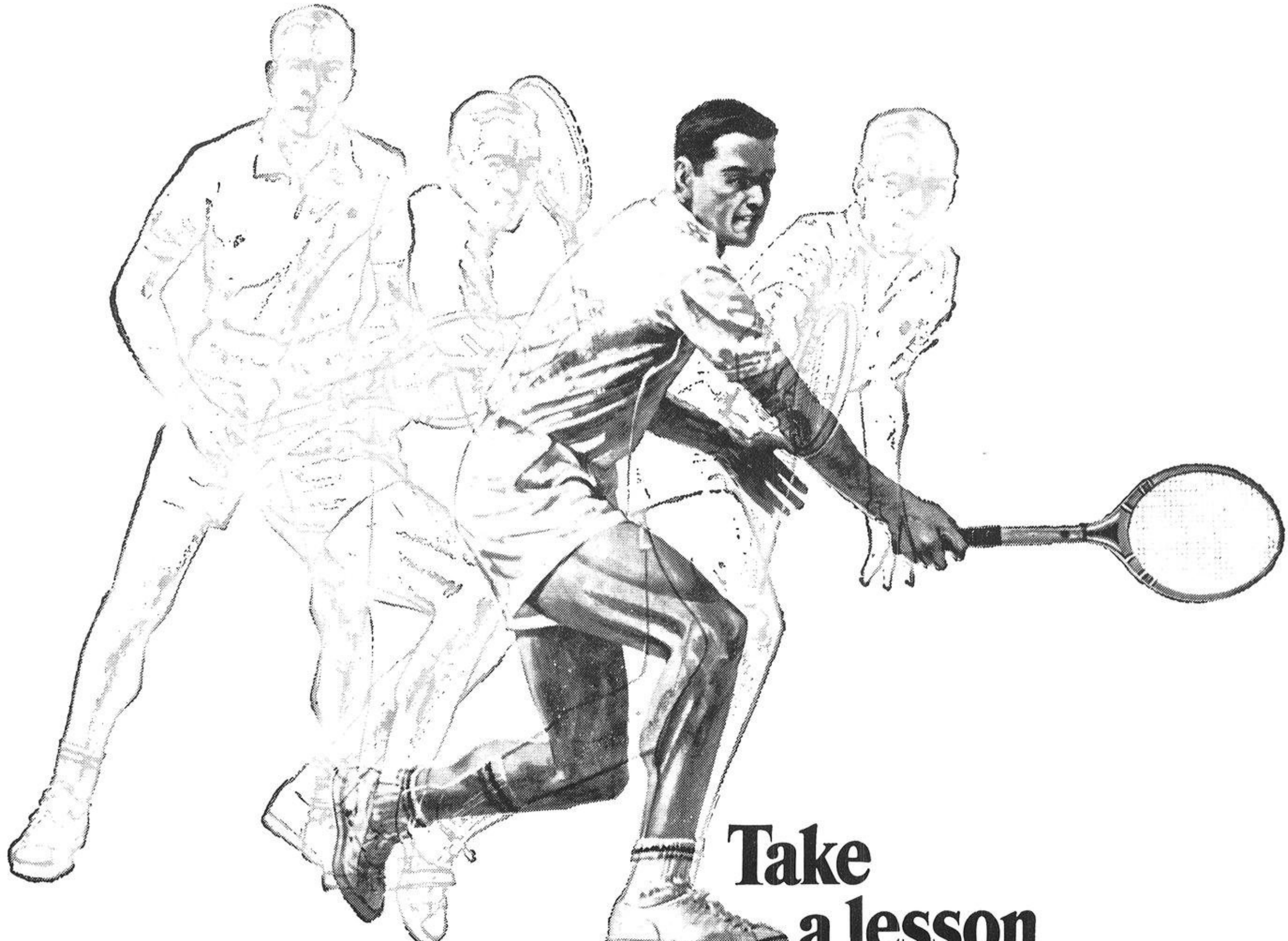
On the construction of the new library, Zweifel said, "It certainly is a needed facility for a major engineering school. We're very, very pleased."

Zweifel complimented Dean Marshall for his efforts to obtain a new engineering library. "He worked very, very hard, personally, to get it."

The four-story structure will be erected adjacent to Union South. It has been designed by the Madison architectural firm of Strang Partners, who have also designed the Steenbock Agriculture and Life Sciences Library. The building will be executed in a modified triangular form and will be faced with a brick similar to that of the Union and other recently constructed buildings in the area.

The interior of the library is being planned on a "syphon basis", meaning that the lower floors are designed for the heaviest usage and will house the materials requested most often.

Completion is planned for July, 1976. WE



The Case of the Bungled Blueprints

by Ed Bark

The housing failure of the century lay in explosive disarray. Pruitt-Igoe, a $36 million mid-fifties development, is undergoing dynamite therapy, courtesy of the St. Louis Public Housing Authority.

* * *

From a distance, it resembles a gigantic outhouse. That is not what the planners of Boston's 60-story Hancock Insurance Building had in mind.

* * *

New York's World Trade Center, the archetypal example of energy waste, is cleaning up its act. The first halting step: removal of one-eighth of the interior lighting system.

* * *

Architects have long been aware that poor selection of building materials or ignorance of occupant needs, can lead to prematurely dilapidated, outmoded structures. The Hancock Insurance Building and the Pruitt-Igoe development typify these traditional planning missteps. The impact of the energy crisis has introduced a third concern, unplanned for by the majority of architectural firms.

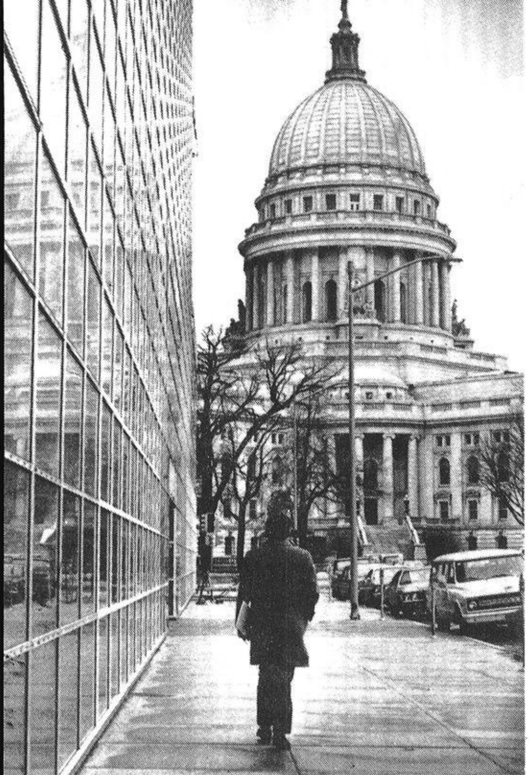
Says New York architect Richard Stein, long active in finding methods to help conserve energy and, heretofore, a crier in the wilderness: "One of the longtime premises of architecture was that we have unlimited resources to build and unlimited energy to operate our buildings. Neither of these is true today."

The World Trade Center is suddenly a highly visible scapegoat and architects are returning en masse to the drawing board. An updated definition of "architectural disaster" has emerged. Many of those who thought they had escaped the onus must now defend their monuments against charges of gluttonous consumption.

But before dealing with energy waste and the havoc it has raised with today's blueprints, it is instructive to study two recent disasters — Pruitt-Igoe and the Hancock Building — which needed no help from the energy crisis to rank in the forefront of building fiascos. The structural shortcomings exposed remain a vital concern of the present-day architect.

The Pruitt-Igoe development in St. Louis, completed in 1955, was initially hailed by *Architectural Forum* as a revolutionary concept in low-cost housing. Thirty-three 11-story buildings housed almost 11,000 inhabitants. An "ingenious" system, in which elevators stopped only at every third floor, permitted 11 ft. deep by 85 ft. long "galleries" at each of the stop floors. The galleries would be "vertical neighborhoods," where children could play in glass-enclosed safety while parents did the family wash in adjoining laun-

Lighting problems originally plaqued a new Wisconsin state office building. Due to a computer breakdown, lights burned 24 hours a day.



Buildings under glass are "fantastically inefficient"

dry rooms. Stairwells at either end of the galleries permitted "easy" access to individual living units.

Ten years later, in "The Case History of a Failure," *Architectural Forum* described a nightmare: "The undersized elevators are brutally battered, and they reek of urine from children who misjudge the time it takes to reach their apartments. By stopping only on every third floor, the elevators offer convenient settings for crime. Every so often, assailants will jam the elevators while they rob, mug or rape victims, then stop at one of the floors and send the elevators on with the victims inside. The stairwells, the only means of access to almost all the apartments, are scrawled with obscenties. Their meager lighting fixtures and fire hoses are ripped out; and they too provide handy sites for predators. The tenants called the galleries gauntlets (they were supposed to be cheery social enclaves) through which they must pass to reach their doors. Children play there, but they are unsupervised and their games are rough and noisy outdoor pasttimes transferred inside. Heavy metal grilles now shield the windows, but they were installed too late to prevent three children from falling out."

The director of the St. Louis Housing Authority claimed the "sheer size and scale of Pruitt-Igoe (it is four times the size of the second largest project) thwarted all attempts at effective management."

Co-architect Minoru Yamasaki agreed: "The Public Housing Administration forced us to double the density of the project. The best we could do then was to eliminate the low-rise and add more slabs." Yamasaki was shocked at the ensuing vandalism. "I never thought people were that destructive," he said. "As an architect, I doubt if I would think about it now. I suppose we should have quit the job. It's a job I wish I hadn't done."

A Catholic priest, whose church is adjacent to Pruitt-Igoe, lamented the lack of recreational facilities: "To build a place and offer no services to 2,800 units is ridiculous. The kids have nothing to do; they might as well pull pipes out of the walls and break windows."

The Public Housing Administration sank $7 million into Pruitt-Igoe, mostly to improve recreational facilities, in a vain attempt to remove well-publicized egg from its face.

In March of 1972, the St. Louis Public Housing Authority decided to put the project out of sight and out of mind. Twenty of the 33 buildings were scheduled for total destruction. The remaining 13 were to be reduced to a height of three or four stories. In the reluctant words of *Architectural Forum,* the development was "an unmitigated disaster in human, architectural and economic terms."

Boston's Hancock Insurance Building has become a city joke; but the architects (I.M. Pei & Partners) connected with the project aren't doubled over in laughter.

There was opposition from the start to building a 60-story skyscraper in the heart of historic Copley Square. The building's inauspicious beginnings hardly helped to quell the outcry. As the foundation was being dug, the streets and sidewalks in the neighborhood began caving in. When the walls of historic Trinity Church began to crack, Bostonians had had enough.Subpoenas were delivered by the fistful; the Hancock Building was up to its 60-stories in lawsuits.

Ultimately, things were settled. The streets and sidewalks were repaired; the cracks were sealed. And then, in the summer of 1972, the first of the giant, five hundred pound, double-glazed thermopane windows, which composed the building's facade, began to crack and tumble. Sheets of plywood were installed as a temporary replacement. Soon, whole floors were wood paneled and police became accustomed to sealing off traffic whenever a strong wind kicked up.

Four thousand panes (most of which cracked rather than tumbled, posing an ominous threat) were eventually replaced with plywood panels. Wind tunnel tests at Purdue University finally revealed a tentative answer: the original windows, consisting of two panes with a reflective coating between them (the building was to be a 60-story mirror, blending in with the surroundings; it wouldn't overshadow historic monuments, but would mirror them) were victimized by "heat stress breakage."

Explains Boston Architect Huson Jackson: "The mirror coating causes light to make a 'double pass' through the window, one pass real, one reflected. The slightest error in engineering can trap that solar energy, cause heat buildup and 'heat stress breakage,' maybe just a tiny crack which bursts the window apart when the wind hits it."

In October of 1973, it was decided to replace all 10,348 windows with monolithic glass, a single paned substitute, non-existent at the time of construction. One lingering question remains: Who will pick up the $7 million tab? At present Pei, general contractor Gilbane Building Company, curtain-wall sub-contractor Cupples Inc., and glass manufacturer Libbey-Owens-Ford are slugging it out in court.

In retrospect, perhaps the falling glass was a signal to the Hancock people that their building was destined to become an energy-gulping anachronism. The "sealed glass box," requiring constant artificial ventilation, has suffered a rapid decline in popularity among architecture critics. Richard Stein, one of the most persistent, calls buildings under glass "fantastically inefficient."

"The average 50-story building," he says, "is occupied 3,100 hours per year and 500 of these hours are in the temperature range in which outside air could be introduced with neither heating or cooling. This would result in a 19 per cent reduction in energy for air cooling."

Glass is also a poor insulator, which adds to both heating and cooling costs. "Mirror" glass (the same which fell from the Hancock Building), which reflects the sun's rays, helps lower air conditioning costs but is no help with the heating bill.

New York's well-sealed World Trade Center (co-designed by Minoru Yamasaki of Pruitt-Igoe fame) is a distressingly large scale monument to energy waste. Some of its drawbacks are:

- No windows can be opened in the Center's two 110-story towers, and most occupants cannot turn off their own lights.
- The Center requires 80,000 kilowatts of generating capacity, or as much electrical power as the city of Schenectady.
- Due to the building's staggering height, requirements for elevators, pumps and other mechanical systems are greater, exacerbating the energy drain.
- The facade of the Center is composed of aluminum, a high energy consuming metal.

Wisconsin is one of the first states to lay down the law to architects.

Some energy conservationists are actively working to prevent recurrence of such massive resource wasters. Lawrence Spillvogel, who co-teaches a University of Pennsylvania course entitled "Energy Conservation in Buildings," has discussed the idea of an energy saving building code with the National Bureau of Standards in Washington.

The code would require buildings to "contain minimum levels of insulation or meet 'energy budget' limitations which would be worked out through a formula that would take into account a building's size, use, location and materials. Buildings which exceeded their budgeted energy would pay a penalty."

The "light at the task" concept is now mandatory for all newly constructed government buildings. This is the use of movable lights, concentrating illumination over a given work area.

According to Walter Meisen, assistant commissioner for construction of the General Services Administration (the nation's largest single landlord), "The government is now installing one light where four would have once gone. In the last year, while 30 new buildings have been occupied, overall energy consumption has dropped by nine per cent."

State governments have also revamped building guidelines. Wisconsin is one of the first states to lay down the law to architects, according to Environmental Affairs Officer Gordon Harman.

"The ground rules have changed," Harman says. "Emphasis used to be on initial low cost. Now it's a whole new ball game as far as design is concerned. Architects who say 'I can give you a building which is going to cost $20,000 more, but in five years, it'll be paid for and you'll be home free' are now being given a respectful hearing."

Wisconsin's new energy-conscious state office building code requires lighting designed for "expected activities. Where task positions are fixed and known, the lighting should be designed accordingly with less lighting provided in surrounding work areas." Outdoor decorative lighting is banned.

"The poorly planned orientation of Van Vleck causes the small rooms on the east side with huge windows to get like hot boxes' in the summer"

Lighting problems originally plagued Madison's newest state office building, located at 201 E. Washington Ave. and opened in November of 1972. The ambers burned 24 hours per day, due to a breakdown of an automated computer which controls lighting of the entire building. The lighting system also made a mockery of the "light at the task" concept. Explained Curtis Johnson, the building project manager, "There are no light switches in individual rooms. The lights are part of an automated panel, which will be manned by one person."

The computer was not programmed to turn on lights in one room; the smallest possible area of illumination was one quarter of a floor.

Today, the building is more attuned to energy awareness. "Because of the emphasis on saving power," Johnson says, "there have been a whole series of light switches installed locally." The state picked up the check. Admits Johnson, "There are some things that may have been done better. The roof, for instance, might have been more insulated."

The revised state office building code has strict insulation guidelines, as well as suggestions on how to best exploit the advantages and minimize the drawbacks of solar energy. Architects are cautioned to "consider building orientation in relation to solar effects on heating and cooling systems; and consider window location and orientation to take advantage of prevailing breezes and to limit window exposure to the sun during the cooling season."

University of Wisconsin Professor Alain Peyrot offers a further tip. "Windows should face south and be recessed," the structural engineering specialist says. "In the winter the sun's desirable warming rays are more horizontal. But during the summer, the sun is higher, and cannot penetrate a recessed window. Taking seasonal advantage of the sun can lower a building's energy needs. It pays to put in a little bit more money in the beginning, and save in the long run."

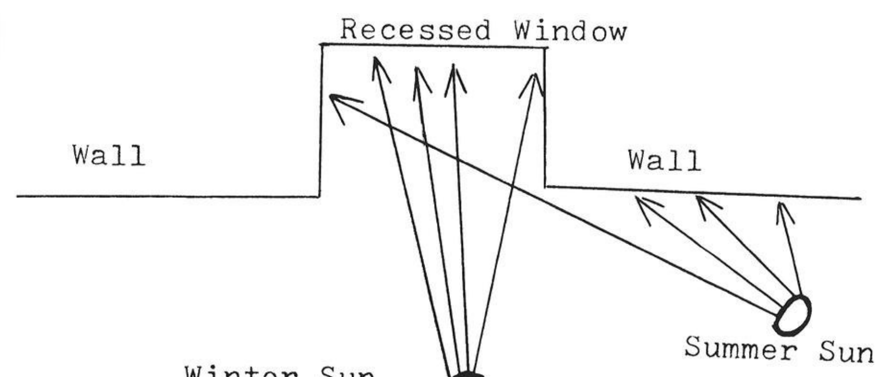
According to Prof. Dean Jensen, a mechanical engineering specialist, "The poorly planned orientation of Van Vleck (a campus building) causes the small rooms on the east side with huge windows to get like 'hot boxes' in the summer."

Ironically, the Campus Planning Committee, in the summer of 1970, urged architects to consider alternatives to a proposed extensive block of windows in the Lathrop Drive courtyard of the Physics-Astronomy Building. The committee sought to conserve student energy. Said Letters and Science Dean Stephen C. Kleene, "Trashing could occur in the future. I fear the courtyard will be a perfect place to throw rocks."

The nearly completed 9-story, glass-sealed First Wisconsin Bank is a sign that methods of protest have changed. Located on East Washington Avenue, it is a mere stone's throw from the State Capitol dome. But, according to Environmental Affairs Officer Harman, the building would not meet the amended guidelines to which state-owned buildings must adhere.

Thus, the planners of the bank, who took special pains to design a structurally sound, aesthetically pleasing building, may eventually be humbled, along with many of their contemporaries, by an energy shortage unprepared for in their blueprints — and unstressed by customers seeking the lowest first cost.

WE



"In the winter, the sun's desirable warming rays are more horizontal. But during the summer, the sun is higher, and cannot penetrate a recessed window."

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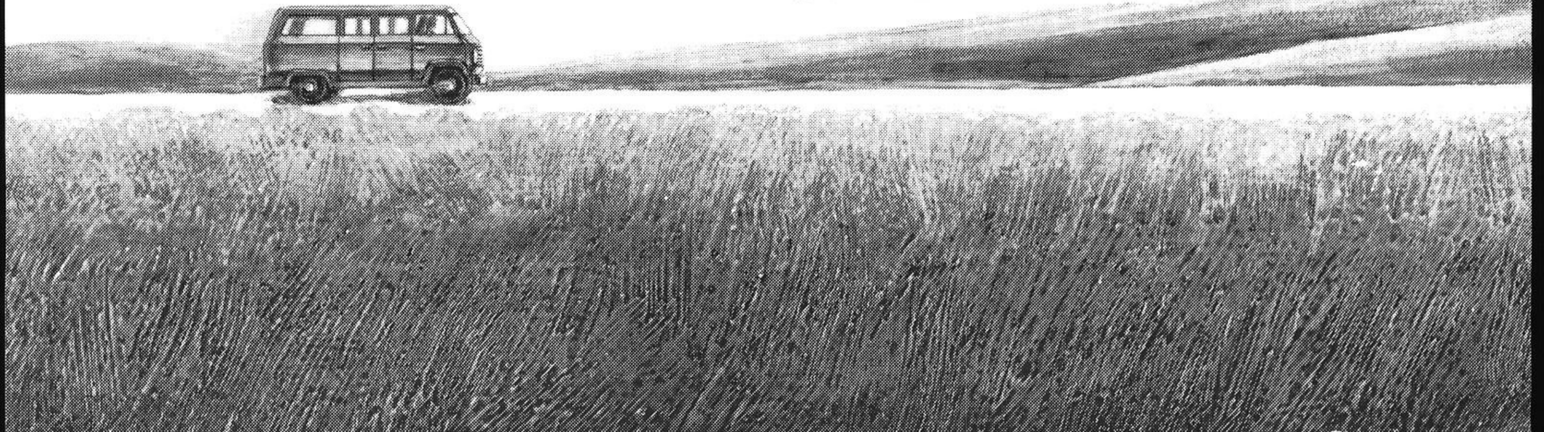


Miniaturizing Cities

by Tom Clark

Although they probably wouldn't look out of place in a poster shop, the arcology drawings of Paolo Soleri are actually blueprints for unique and provocative alternatives to conventional urban design.

Soleri's arcologies are literally self-contained cities with emphasis on high population density and minimum use of land area. They rise upward into the sky instead of outward over the landscape in the usual urban sprawl. They can fit into preexistent hollowing like canyons, quarries, and dams; they can rise against cliffs or even float on the seas.

Admittedly, this sounds fantastic and, in fact, no arcologies have yet been built. But the theoretical basis of their design, buried deep in Soleri's abstruse terminology, may hold important implications for urban design of the future.

Soleri, formerly a student of Frank Lloyd Wright, believes that the evolutionary process is steeped in miniaturization, or "the progressive complexity of matter within progressively smaller frames." Much of this theory is derived from Pierre Teilhard de Chardin, a Jesuit paleontologist, who saw evolution as an ever-developing complexity.

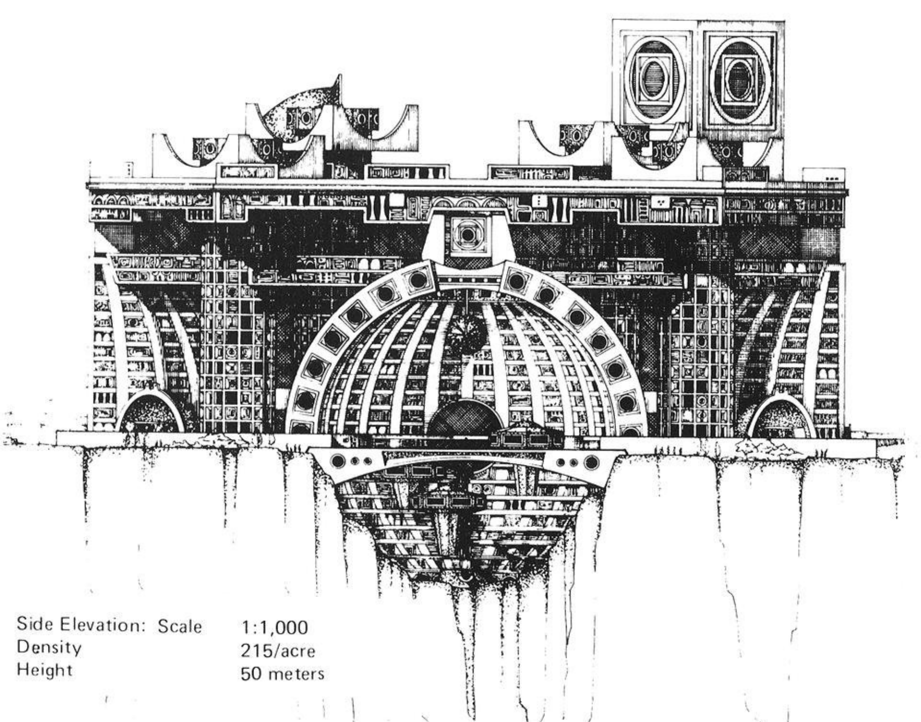
The application of this theory to urban design is Soleri's purpose. As he see it, the cosmos was miniaturized in successive evolutionary stages: from geological matter, to organic stuff, to organisms, to animality, and finally to reflectivity or thought (man).

Since man is a social animal, and since the imperative container of society is the city, Soleri reasons that the miniaturization of this container is dictated by evolutionary logic. In other words, arcologies, with their high population densities and relatively low land usage, are a logical and perhaps necessary step in mankind's continued social evolution.

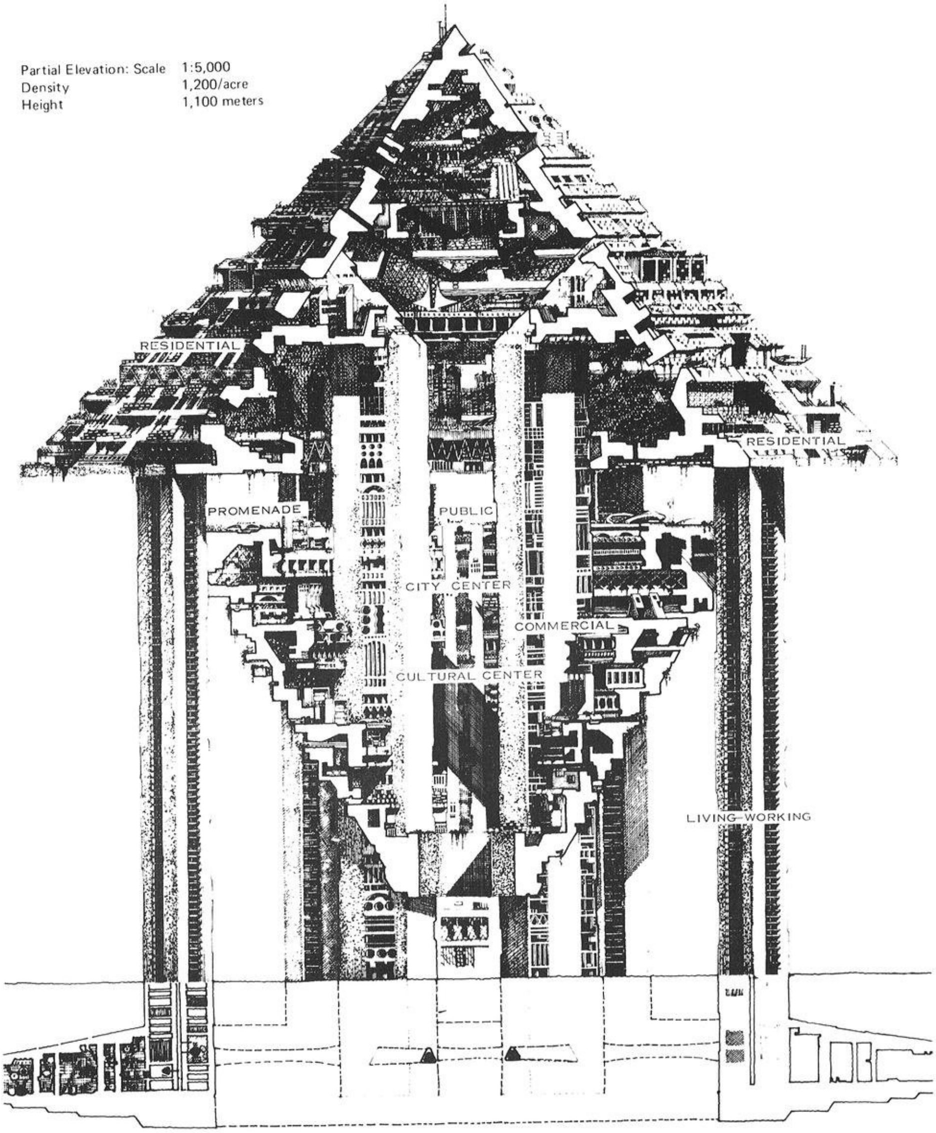
In Soleri's mind, the modern metropolis is a doomed phenomenon. The structural as well as social decay, easily observable in most cities, proves they do not offer satisfactory lifestyles. Instead of following a miniaturization process, modern urban design seems to be spreading like a relentless stain across the landscape, defying what Soleri interprets as the law of evolution. This defiance dooms them, according to Soleri, and he staunchly refuses to seek conventional solutions to the problem. Only when cities as we know them become hopeless — perhaps even to the point of self-destruction — will humanity realize the viability of such totally different alternatives as arcology.

Soleri says the population of New York city could be housed in a self-reliant megastructure that would occupy only ten percent of the city's present land. There would be a population density 35 times as great as at present. However, no cars would be permitted inside the structure and, if it were located in a previously unspoiled area, everyone would have a view, and a stroll in the country would be a matter of a short walk.

While this may seem a bright and positive alternative to current conditions in New York, it does point to a largely unexplored question raised by the proposal: can so large a group of individuals be subjected to ever greater population density without adverse behavioral effects?



In the mesas of Arizona, Soleri and his team of futurists are working on realizing the first arcology, Arcosanti I. Over an area of 7 acres, this city will house 1,500.



Hexahedron, an arcology designed for any environment, can maintain a community of 170,000. Although that's about the size of Madison, Wisconsin, Hexahedron occupies the land surface of only one square kilometer — about the length of State Street. —Sketches from *The City in the Image of Man* by Soleri.

Professor Leo Jakobson of the U.W. Department of Urban and Regional Planning doesn't think so. "The inherent pluralism of human behavior doesn't allow a high density situation to be an extended solution," he says. "Arcologies require great uniformity of life style for development, and I'm skeptical of that possibility." Jakobson finds Soleri's work an "interesting extreme," and predicts that "it may find utility as a far out stimulant to more practical applications.

Robert Hartmann, a Landscape Architecture professor at U.W., agrees that high population density is a problem which may prevent success in arcology development. "Everyone is familiar with the classical experiment in which rats are subjected to a high population density environment," he says. "They soon develop extremely aggressive and generally negative behavioral patterns and characteristics."

We have already seen some negative behavioral patterns (crime, poverty) in many of our large, densely populated cities. Would arcologies help solve or merely intensify these problems?

After visiting Soleri's workshop in Scottsdale, Arizona in 1972, Hartmann believes that some arcology may be useful, but on a much smaller scale than proposed by Soleri. "We're definitely seeing a trend toward megastructure," he says. "The shopping malls are as good an example as any. I think small scale arcologies are definite possibilities as, say, campus enclosures in colder climates."

Hartmann adds that the small structures he saw in Soleri's workshop seemed very attractive and livable. However, he doubts the viability of an arcology housing two or three million people. "The sheer size of many Soleri designs is difficult to comprehend," he says. "Likewise, there are tremendous technological problems."

Soleri's beliefs are totally opposed to those of skeptics about high density structures. He believes compression vitalizes urban existence, that "clustering etherealizes," as he puts it. In this belief he claims to be following nature's example of miniaturization.

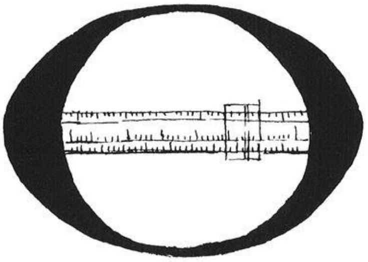
Soleri's sensitivity to the nature order is reflected in a statement about his work by fellow architect Peter Blake. Blake writes, "There is an inherent logic in the structure and nature of organisms that have grown on this planet. Any architecture, any urban design, and any social order that violates that structure and nature is destructive of itself and of us. Any architecture, urban design, or social order that is based upon organic principles is valid and will prove its own validity."

At 50, the Italian-born Soleri may not live to see that proof. Yet work goes on at Scottsdale, where he and a dedicated group of followers are attempting construction of a small scale arcology scheme. One observer claimed all that had come of the project were "several mounds of dirt." (Mounds of soil are used as molds for concrete dome structures.) The work is entirely privately funded and this handicaps the group. But it continues on the assumption that sometime in the future its work may be useful, if not necessary.

When he developed the concept of arcology in the late 60's, Soleri wrote *Arcology: The City in the Image of Man,* in which he said he was "engaged in the betterment of man's condition and in conservation of Nature, inasmuch as both depend on the creation of efficient and human cities." That purpose is unchanged. Yet society and technology remain less than receptive to his creations.

Nature on the Drawing Board

Ecology and Sliderules



by Steve Tuckey

In the 1960s the war on poverty captured the imagination and idealism of an army of industrialists, politicians, and academicians determined once and for all to end the plight of the poor. In the early 1970s, with the war on poverty slipping into inconclusive oblivion, this army was suddenly confronted with a new enemy—themselves.

Like the war on povery, which spawned a whole series of courses and material for academic research, the war to save the environment is also finding its way into university catalogues, especially in the field of engineering. For instance, the Department of Civil Engineering here at Wisconsin changed its name to include the word environment. It is now difficult to find a course which in some way does not mention the word environment in its description.

Specifically, the field of environmental engineering is one of the most rapidly growing in the engineering field. Basically, what the environmental engineer does is apply the principles of engineering to the control of environmental factors that influence man's well-being. The need for environmental engineers is growing as people realize the need for a comprehensive view of the relationships of all environmental factors. The environmental health engineer holds an engineering degree and has specialized training which helps him deal with how best to prevent air and water pollution from becoming serious health hazards.

"We are definitely trying to incorporate the concerns of the environmental movement into our curriculum and in some way try to make intelligent forecasting," said Professor Lee Crandall of the Department of Civil and Environmental Engineering. "Take for instance a highway engineer. In the past he or she would usually just go the quickest way but now we have to take in other considerations, such as how will a highway affect, the neighborhood and how many families will be displaced."

While not related to the environment, Crandall raised another point which emphasized how engineers are becoming increasingly conscious of different types of issues. "We are now dealing with the 'Agnew problems' (a reference to the number of engineers caught giving bribes to Maryland officials, including the former vice-president). We are trying to make this business more ethical. It has become a real issue in the past year."

While the Watergate blacklash is now apparently affecting even engineering, a much stronger backlash is threatening the profession in more profound ways. In modern times our cities and highways were "engineered to pollute" because that was the most economical way it could be done. Today, public opinion by law, is placing new constraints on the engineer and forcing him to undo the damage — however unintentionally wrought yesteryear.

Until a few years ago, environmental engineers were few, but today there is a steady growth in the recruitment of persons with engineering skills. Advertisements such as "Environmental engineers — 3-5 years experience in urban planning or environment impact assessment wanted" and "Designer engineer join up! Fight water pollution" are becoming increasingly common in such places as the *New York Times*.

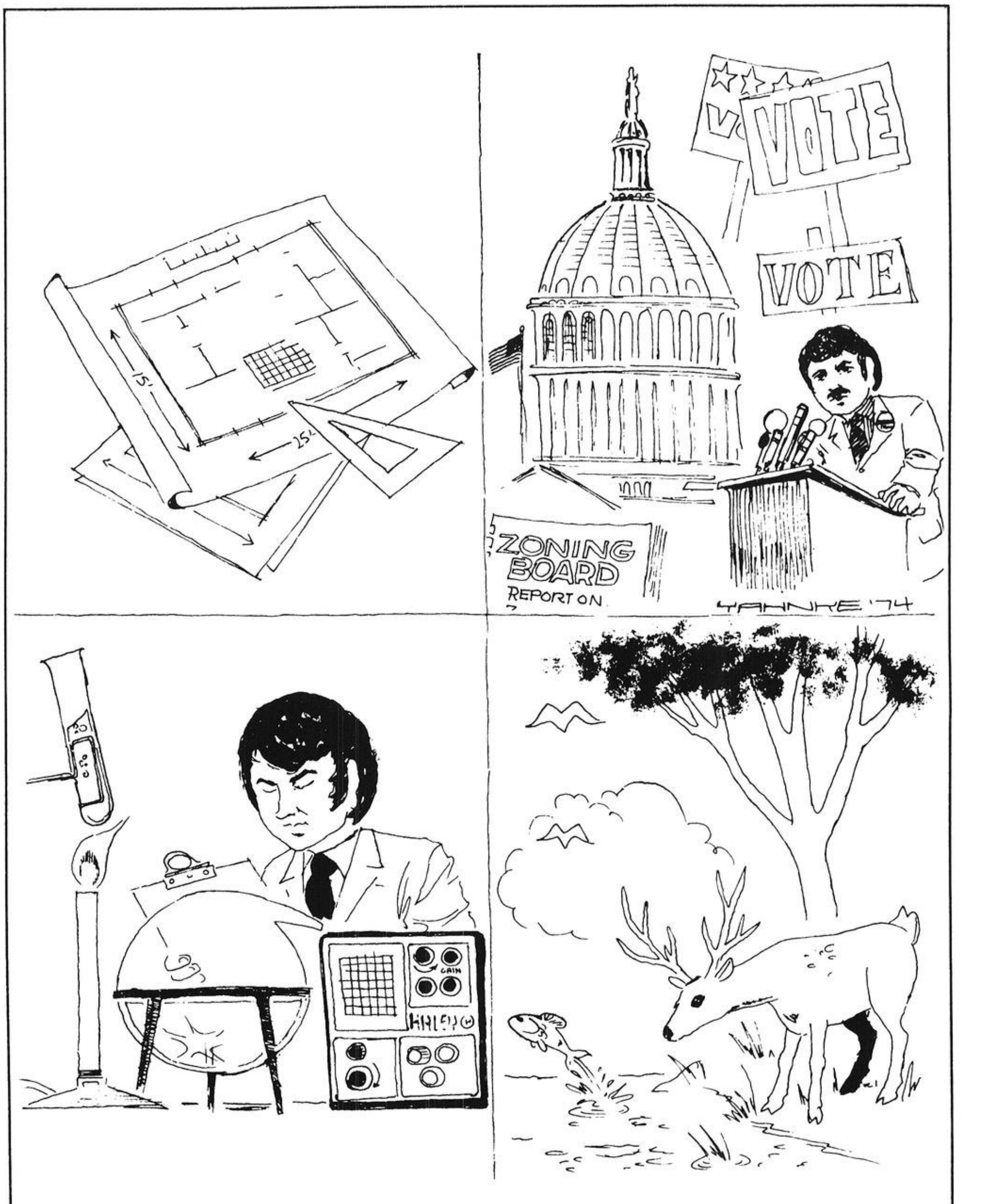
Environmental engineering, like the profession in general, grapples with a wide variety of problems, including how we dispose of our waste and provide for our energy needs. Aside from scientific knowledge, the environmental engineer must be acquainted with various aspects of law, business, economics, and political science.

Most of the top 500 engineering companies have designated officers in charge of environmental affairs. The U.S. Environmental Protection Agency is probably the largest employer of environmental engineers, but it also employs scores of other staff members experienced in agricultural, chemical, design, and other branches of engineering. "Simply knowing the level of water quality is not enough," said one EPA official. "Our aim is to achieve water quality at the least cost. The engineer who works on such a problem must understand first, the engineering approach, second, the environmental approach, and third, the economics of making it work in a society which is willing to pay only so much."

The Department of Labor predicts that by 1980 there will be a shortage of engineers, and a survey conducted last year of placement directors of some 260 engineering colleges foresees good prospects for those entering the engineering job market — especially in areas concerned with the environment. "The expected push to solve social and environmental problems will have to involve engineering," was the response of one Wisconsin placement director.

What are the universities doing to meet these expected demands? It is one thing to change the name of the department but it is quite another to actually provide the courses to justify the nomenclature. At Wisconsin, a number of courses in civil and environmental engineering focus on just these needs. Environmental Pollution Control for Non-engineers is designed, according to the catalogue, to "convey the engineering approach to pollution problems, to outline solutions based on current technology, and to consider technical and economical constraints on solutions." Other courses deal with solid waste disposal, air pollution, and man's attempt to conserve water.

Wisconsin is by no means the only campus to offer environment-related courses. At the University of Rochester in New York, students select a major interest in the environmental field. In addition to learning, the students also deal with large firms and urge them to modify their environmental policies.



Environmental engineering grapples with a wide variety of problems.

The University of Wisconsin-Green Bay is organized by colleges based on themes of the environment rather than according to the traditional disciplines. The four colleges are: community sciences, human biology, environmental sciences, and creative communications. The central theme of the College of Environmental Sciences is resource management.

During the summer of 1968, the National Science Foundation supported a project at the University of California at Pasadena which was aimed at air pollution research. Students initiated the program, in which they urged business leaders to do something about pollution. The class was so successful that the Foundation is now offering other grants along the same lines.

All 208 member colleges of the American Society of Engineering Education offer courses relevant to environmental management. Of course, all offer the basic sciences, with most specializing in such specific fields as ocean engineering and water quality. An increasing number of universities also are offering graduate programs in environmental engineering.

With so many of the universities getting on the bandwagon, what are some of the issues with which environmental engineering deals?

One aspect, which is becoming more and more important, is environmental engineering planning. Comprehensive planning ideally should take into account the physical, social, economic, and ecological factors of an area and blend them into one unit that will support a healthful society. People are demanding not only clean air and pure water and food, but also the right to live without excessive noise. In planning a highway, office building, country club, or any intrusion into the natural state of things, the planner has to avoid merely looking at the single purpose of the one structure. He must see the effect it will have on the environment as a whole.

For example, cities will no longer be able to construct major highways without first taking into account such things as the availability of ample solid waste storage facilities, and the effects on adjoining communities' exits and entrances. Environmental effects, such as erosion control during construction, along with the movement of dust and sediment, will have to be dealt with. The pollution effects of the water supply intakes from streams and lakes, and the disposal of trees and stumps without causing air pollution, are other factors. Nearby water supplies might also be affected by herbicides, de-icing chemicals, and dust.

A number of communities, including Madison, are realizing that the smallest practical unit for imposing environmental controls is the county. Regional planning is now a necessity if pollution abatement measures, land-use controls, and solid waste disposal plans are to have any effect in improving the quality of life of residents in the affected areas. Federal and state planning services can be utilized in order for these controls to be effectively implemented.

"Knowing the level of water quality is not enough. . ."

Another area dealt with by the environmental engineer is waste management. The improper disposal of human waste and sewage presents one of today's greatest threats to good health. Maintenance of disease barriers and forceful application of sanitary engineering principles is needed to protect persons from such diseases as hepatitis and dysentery. Even though it is hard to believe, there are still many urban, suburban, and rural areas in which untreated sewage lying in the roadside is commonplace.

The disposal of solid wastes presents a wide variety of problems not readily appreciated by the general populace. There are numerous types of solid wastes and a large number of processes to deal with them, including incineration, composting, and energy conversion. Disposal methods exemplify the environmental interrelation of air, land, and water and also the importance of salvaging and recycling. All these steps involve an increasing number of constraints — social, political, economic, and technological, that must be incorporated into the problem.

While environmental engineering is now very much in vogue, it does present one very interesting paradox which, to a certain extent is causing the engineering profession to undergo something of a role redefinition. As one prominent engineer once said: "All engineering acts are violations of nature. When the deleterious results are sufficiently unacceptable to the public, society will react and readjustment will occur."

Engineers and technologists have always considered themselves protagonists and leaders in man's struggle against nature. The 100-story building, the mile-long bridge — all these are considered to be accomplished inspite of the environment. Yet each time engineers achieve another environmental "conquest," several negative spillovers result. Even the solutions to the spillovers themselves result in more negative effects. Taken together, these negative effects are the crux of our environmental problems today. According to many knowledgable persons in the field, engineers will have to take a wholly different attitude if man and his environment are ever to exist peacefully together.

President James Perkins of Cornell University puts it this way: "The University has a great obligation to work with society on the difficult task of re-ordering its institutions to deal effectively with our new purposes. It is an assignment not only of social engineering but of the blending of knowledge and purpose that must infuse those who will graduate to work at our new assignments."

Engineer David Hertz calls this new purpose of engineering the "technological imperative" which results from our society's undue emphasis on growth. This, he points out, requires increasing the amounts of resources per capita. "Clearly a new kind of curriculum is needed in engineering schools and schools of technology," Hertz writes in the Annals of the American Academy of Social and Political Science.

". . .Our aim is to achieve water quality at the least cost."

Hertz goes on to say that the curriculum of technology and engineering schools should include what he calls the systems approach, which basically helps the engineer to view the world through the eyes of others and realize that it is restricted. He continues, "Therefore it seems imperative that the engineering curricula begin to provide a new and broader type of analyst — not one with mere social awareness or sentimental regrets but one who can make convincing analyses of the environmental effects of technlogical alternatives. Ultimate equilibrium rather than continued growth would seem to be the only possible thermodynamic goal of a world that should be (if it is not) committed to the preservation of the planet and the human race for the sake of its own posterity."

Environmental engineering therefore is just one more manifestation of man coming to grips with the fact that he is not omnipotent and that he can only lose by his continued belief in such a notion. Of course, Gaylord Nelson and Ralph Nader were not the first persons to reach this conclusion. The 19th century philosopher Auguste Comte said "Short as is our life, and feeble as is our reason we cannot emancipate ourselves from the influence of our environment."

WE

Acknowledgement is gratefully given to Odom Fanning for information about the status of environmental engineering programs in other universities.

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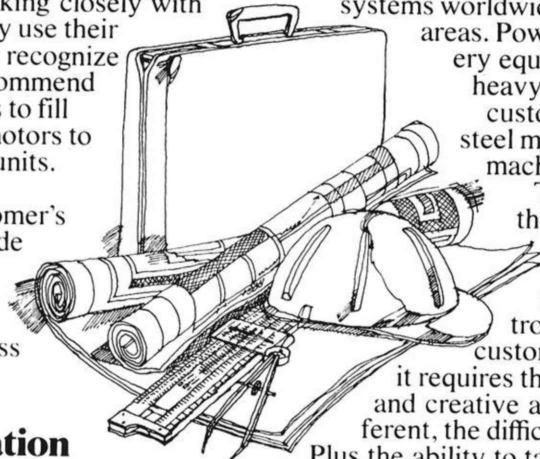

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