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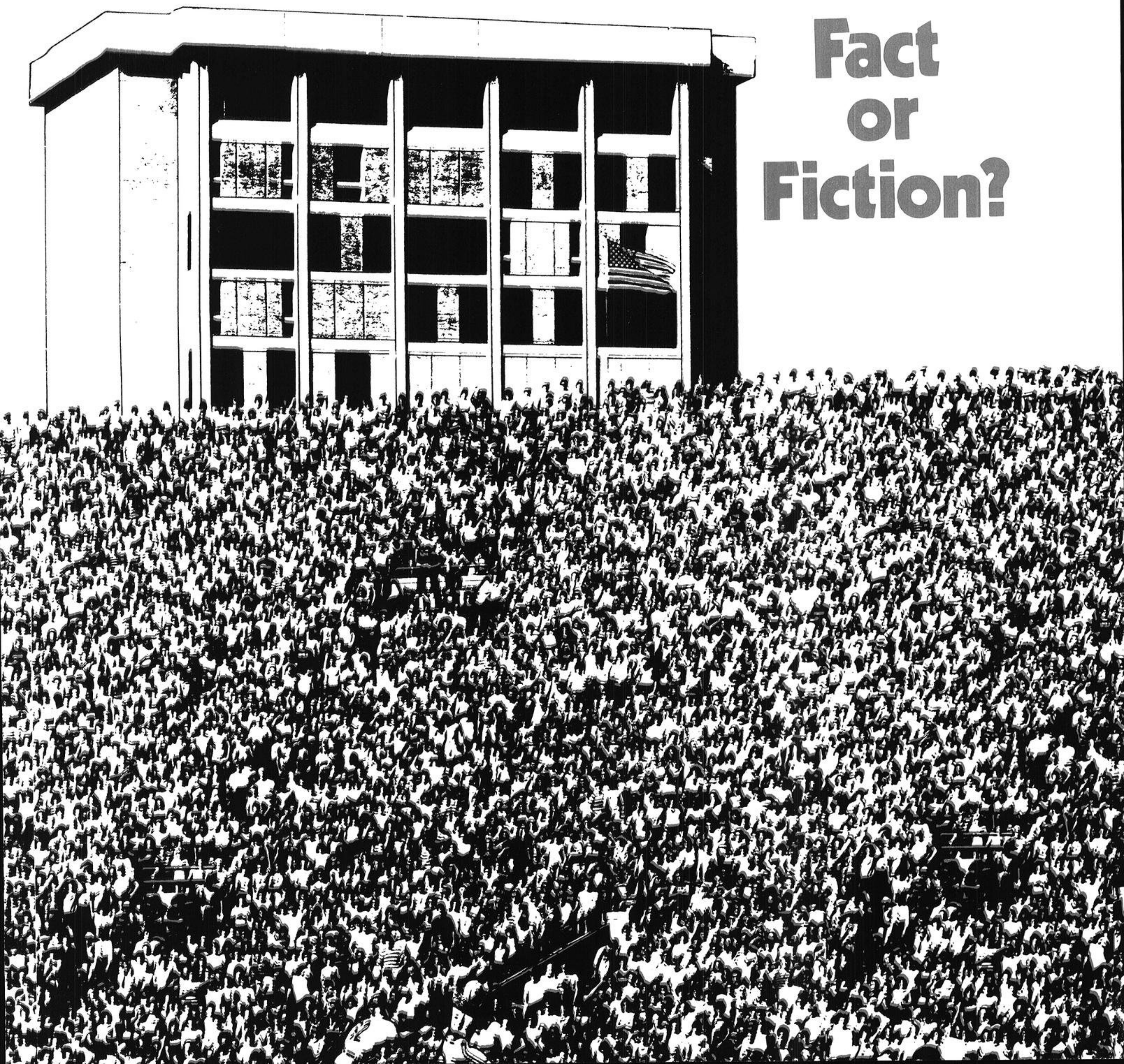
Volume 85, No. 1 October 1980

wisconsin engineer

The Camp Randall Crash: Fact or Fiction?



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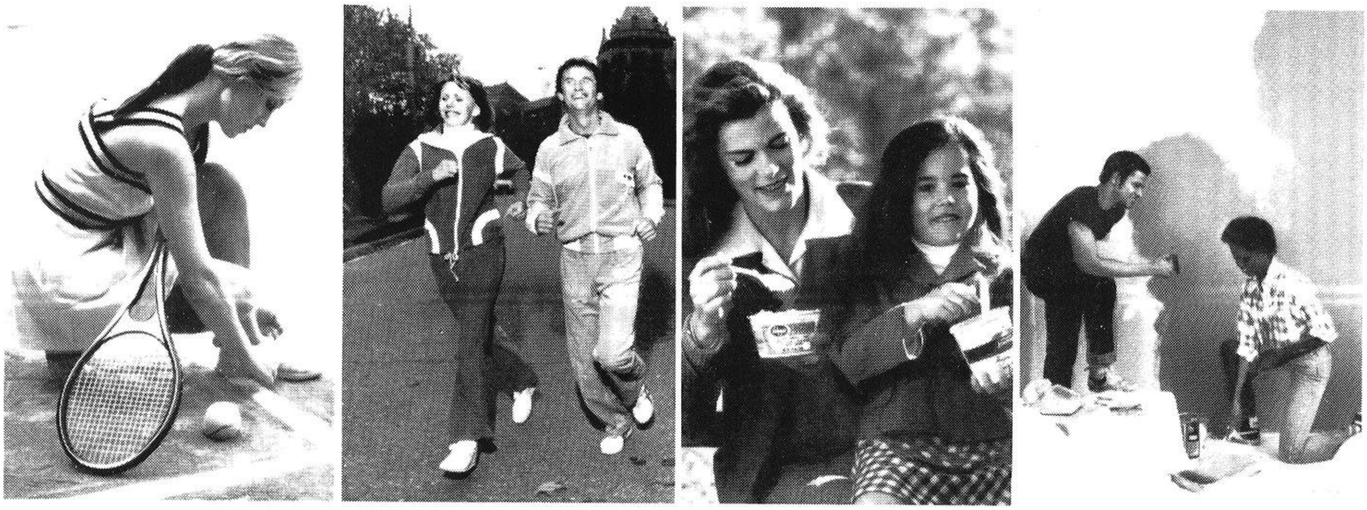

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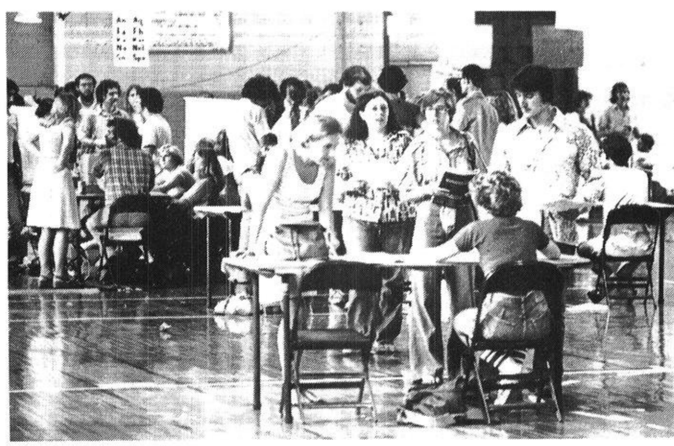

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Water over the dam

by David Barnas

The development of alternative energy sources has been the topic of extensive research in the last few years. David Barnas, a sophomore in Civil and Environmental Engineering at UW–Madison, is becoming a part of this research effort. As a member of Triangle (a social-professional engineering society) he is investigating the background for a project to be entered in this year's Engineering Expo. We asked David to provide us with information that he has gathered on an alternative energy source in Wisconsin.

In 1882, nearly 100 years ago, the world's first hydropower plant was put into operation in Appleton, Wisconsin. First used in Wisconsin's paper industry for grinding pulp, hydropower was producing 45 percent of the state's energy by 1945. Today, in 1980, it produces less than 3 percent of our energy. In response to the dwindling supplies of coal and oil, the government and researchers are re-evaluating hydropower's potential as an energy source.

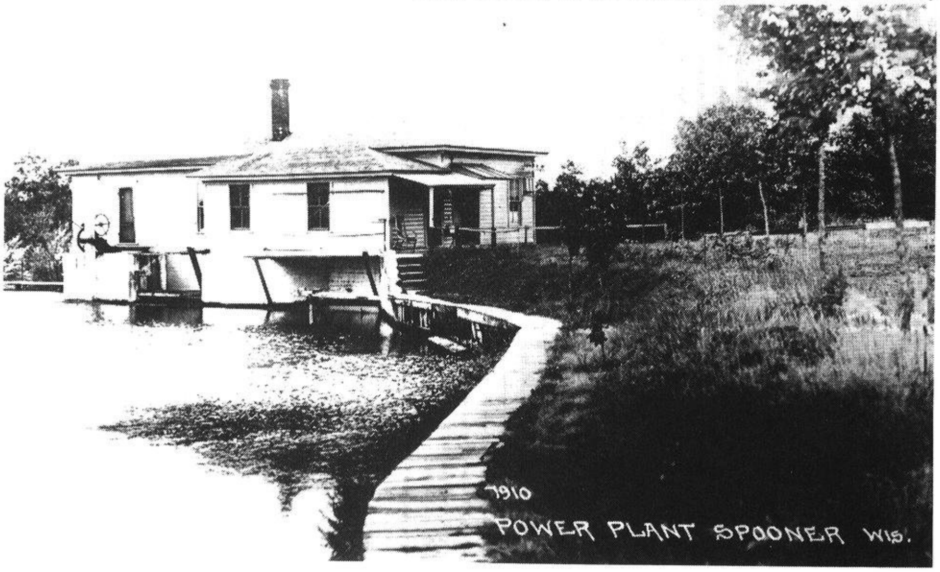
Since hydropower makes use of water motion to generate energy, regions with easy access to flowing water become areas of prime interest. Naturally Wisconsin, with its plentiful rivers, is one of these areas. Currently, the government is making an effort to re-establish hydroelectric power as a viable source of energy through the use of these waterways.

In 1979, Washington, D.C. was the scene of the first international symposium on the potential of small-scale hydropower production. Following this step, the government began a full-scale evaluation of the na-

Photo courtesy of the Wisconsin State Historical Society

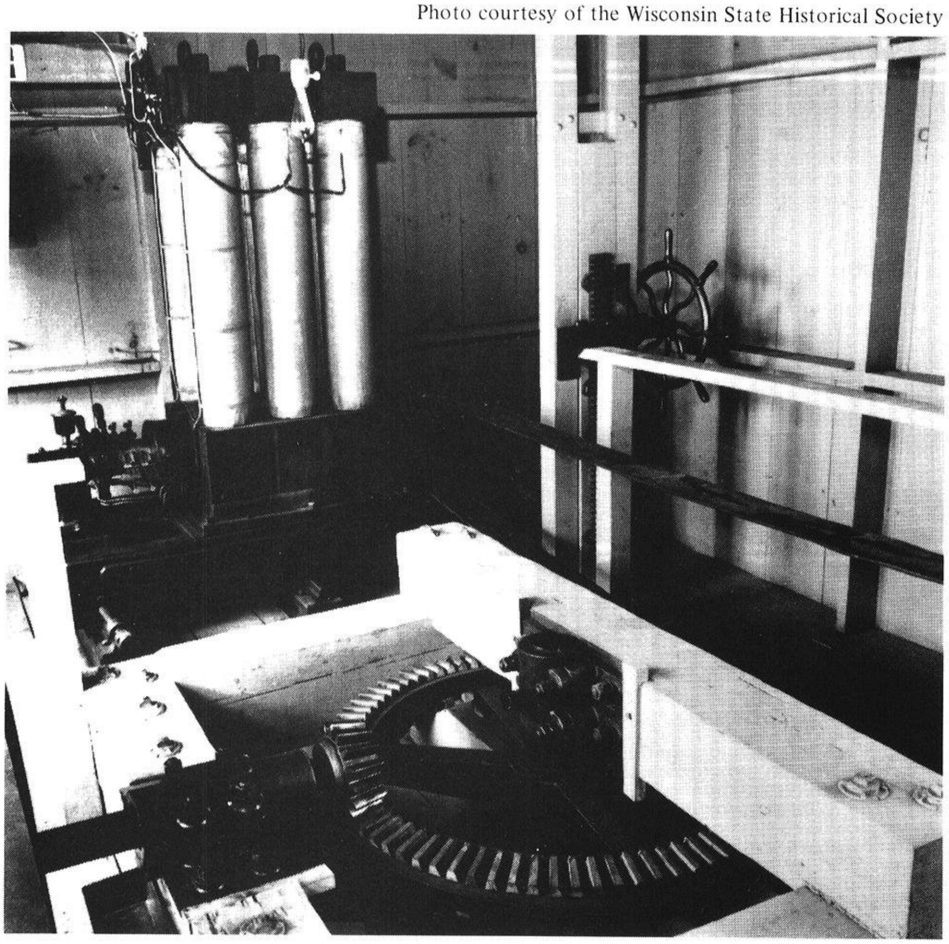
Now a state historical site, the Appleton hydropower station was the first of its kind.

Photo courtesy of the Wisconsin State Historical Society



For decades, small hydropower plants, such as this one in Spooner, were common sights in Wisconsin.

Photo courtesy of the Wisconsin State Historical Society



Though not technically advanced, the Appleton facility proved that hydropower was a viable source of energy.

tion's hydro-electric potential, initiated studies of hydropower's environmental impact, and began a series of economic incentives to encourage its use.

Hydropower's Potential

The U.S. Army Corps of Engineers, the U.S. Department of Interior-Water and Power Resources Services, and the Department of Energy are the major agencies involved in the initial assessment of our hydropower potential. Their findings identify four alternatives to increase hydropower's use: Upgrading existing dams and generating equipment; installing additional new equipment; developing of dams with no present generating facilities; and constructing new dams and generating plants where none presently exists. The first of these alternatives is the most economical.

The greatest potential for hydropower in the U.S. lies in the Pacific Northwest and the New England areas. The U.S. Army Corps of Engineers reports a potential 21,000-megawatt capacity, if existing hydroelectric dams are refurbished. An additional 33,600 megawatts of potential could be developed if powerhouses were installed at some dam sites. (These figures are based upon 5,000 dams nation-wide deemed economical and technically feasible to rehabilitate). If the dam already exists, small-head hydroelectric power facilities could be installed in as little as three years.

The 1979 *Preliminary Inventory of Hydropower Resources* concludes that Wisconsin has 213 sites with hydropower potential. Eighty-four of the 213 sites are generating electric power, and 145, including the aforementioned 84, have incremental potential.

The total installed capacity in Wisconsin, as of 1978, was 456 megawatts. The 1979 estimated capacity was 10,047 megawatts.

Advantages and Disadvantages

Incremental development of hydropower has many environmental and societal advantages. If a river is running smoothly and in proper equilibrium, slight changes in oxygen content and temperature will occur. However, the installation of additional equipment can make these changes negligible.

There are several drawbacks to incremental development. An erratic river flow cannot produce constant energy and is therefore unsuitable for use. Locating replacement parts for older generators is difficult. The cost of erecting transmission lines in isolated areas may prove prohibitive. These and other considerations must be judged objectively: this will not be an easy task.

Economic Incentives

Three hundred million dollars have been allocated to pay for feasibility studies of selected small dams and to finance construction of worthy dam sites. The goal of the Rural Energy Initiatives (REI) program, currently being coordinated by the Department of Energy, is 100 dams funded by 1981 and 300 by 1985.

Many agencies are participating in the effort to provide financial assistance. About 15,000 applicants are being screened by the U.S. Corps of Engineers. So far, twenty-eight loans have been granted to cover the cost of feasibility studies and the cost of obtaining a license. More are being added as the policies and procedures are finalized. The program provides $50,000 or 90 percent of the cost with the stipulation that the direct loan is negated if the site proves unworthy.

Two provisions in the Crude Oil Windfall Profits Tax of 1980 affect small hydro projects. First of all, there is an 11 percent tax credit available for investments at sites where there is existing generating capacity. The new credit is in addition to the long-standing 10 percent investment tax credit. Secondly, tax-exempt status has been authorized for industrial development bonds, providing for generating facilities at existing dams.

Clearly, the recent legislation concerning hydropower is in response to dwindling availability of other energy sources. Developing our total nation-wide hydropower potential would save an estimated $1.35 billion per year. Furthermore, small-scale hydropower provides individuals and communities with a means of becoming energy independent. Hopefully, the return of hydropower as a viable source of energy in Wisconsin will become a reality in the near future.

Photo courtesy of the Wisconsin State Historical Society

In the past, Wisconsin relied heavily on hydropower, but few plants remain in operation today.

Fate: the driving force

by Rob Scheibe

Engineering students have the opportunity to join a multitude of organizations here at the UW–Madison. Rob Scheibe, a senior in Mechanical Engineering, is a founding member of the newest, and certainly the most unique club ever organized on the Engineering Campus.

Walking around the engineering campus, you may have noticed a number of black tee-shirts with a white skull and crossbones on the front and a bold white 'Team Fate' on the back. You may have been puzzled as to what they meant. Is it the insignia of a softball league, a bowling league, a club, or a motorcycle gang? The answer is, a little of each. Perhaps the latest issue of *Getting Around* defined it best as, "Team Fate Timing Association: A social organization open to all students interested in high performance automotive engineering."

Usually referred to as simply 'Team Fate', the organization is comprised of over seventy members, including several faculty. The governing of Team Fate is handled collectively, as all members are automatically elected president upon joining.

It all began in the spring of 1971 when Electrical Engineering Professor Andy Frank earned the unofficial title of 'Professor Fate', after a character in a late 1960's movie, *The Great Race*. It was then that he and several students (after a quick course in vehicle dynamics) built a race car out of scrap tubing and iron and an array of surplus Corvair parts.

The car was built over a 4-month period during lunch hours and idle Friday nights over a few Point beers (the official beer of Team Fate). Beneath its cardboard body was placed the heart of this incredible machine: a 180-horsepower turbocharged Corvair engine. In the truest of Team Fate tradition, it was shod with a set of old racing tires and painted in the distinctive Team Fate color scheme: flat black. Finally, it was christened 'The Fatemobile'.

The Fatemobile has always been a colorful addition to the slalom races around Madison and Milwaukee. When the local slalom "pros", dressed in their silver glow-in-the-dark driving jackets, arrive in their gleaming cars they can be seen cautiously keeping their distance from the Fatemobile. They stand back snickering and looking condescendingly down their noses, past their designer sunglasses, at the Fatemobile. Often, though their pride is shattered when the Fatemobile leaves them in the dust fumbling for excuses about how the sun was in their eyes.

Currently, however, the Fatemobile engine is down for repairs. (One of its connecting rods chose to depart from the crankshaft during the last race.) As of late, there has been talk of retiring this masterpiece to the Team Fate Memorial Museum in favor of a new car, Fatemobile II.

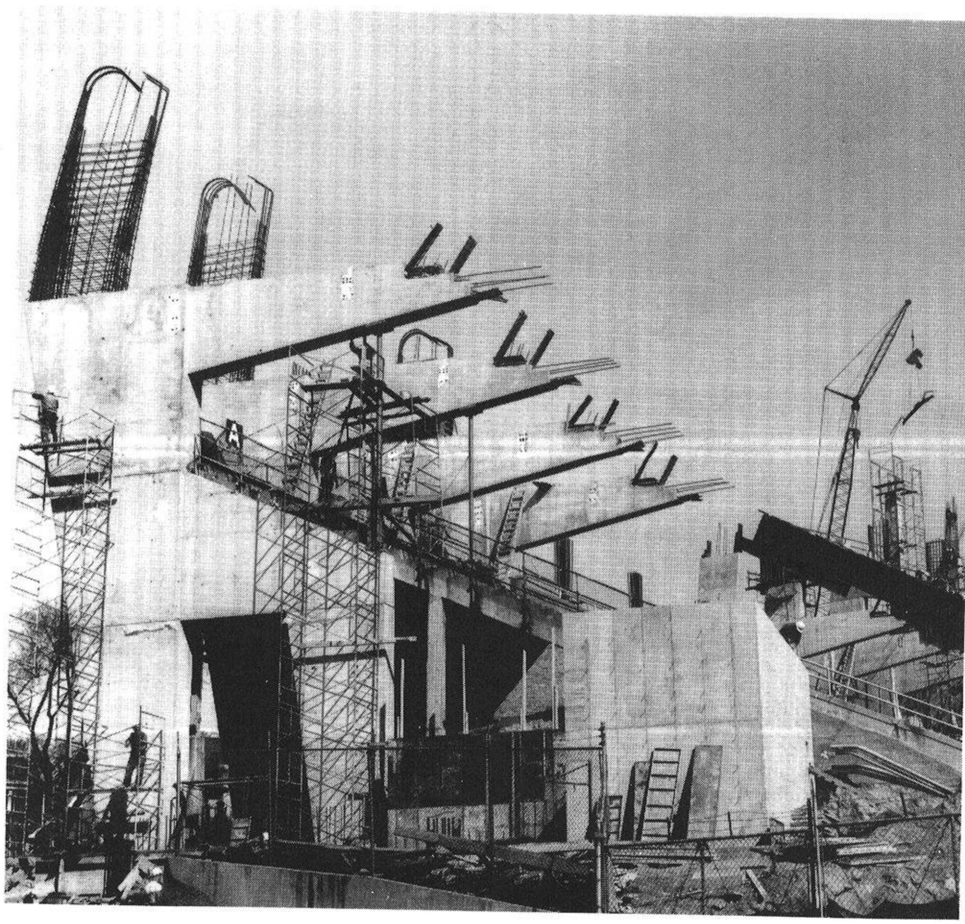
Team Fate is more than just an organization: it is a tradition, a byword, and a way of life. And, although The Fatemobile may be 'down for the count', there's no doubt that Team Fate will make sure that the Fatemobile continues its great tradition. (That is, if the team's supply of Point beer holds up!)

Team Fate's pride and joy: 'The Fatemobile'

The Camp Randall crash: fact or fiction?

by Russ Poeppel

The WE sought the real story on a banning of the "Bud Song" ritual at Camp Randall. Russ Poeppel found it, and more. Russ is a sophomore majoring in Electrical and Computer Engineering.



Concrete supports can be seen reaching out over the lower stadium. This unusual design eliminates the need for columns which would block the view from the lower decks.

Around a year ago, Badger fans sitting in the upper deck area of Camp Randall stadium noticed vibrations of the deck while the famous "Bud Song" was being played. These movements alarmed university officials. Consequently, engineering experts were called in to find the cause of the vibrations, to inspect the deck for damage, and to determine whether these movements were a threat to the safety of the building, or more importantly, the fans. One of these experts was Professor Bill Saul, from the Department of Civil and Environmental Engineering, UW–Madison. His findings are as follows.

The deck's movement is the result of sympathetic vibrations. This means that vibrations in one object can be transferred to another object. An example of this is the rattling of a window by a loud noise. The energy of the sound waves is transferred into the window and is then dissipated in the form of vibrations. When all of the energy absorbed is dissipated, the window stops rattling. The frequency at which an object will vibrate, as a result of sympathetic vibration, is called the fundamental frequency.

The fundamental frequency of the deck has been calculated to be approximately 2.3 hertz, which just happens to the beat of the "Bud Song". Therefore, as multitudes of ecstatic fans jump and stomp in unison to the beat of the "Bud Song", the deck absorbs this energy through sympathetic vibration and begins to move.

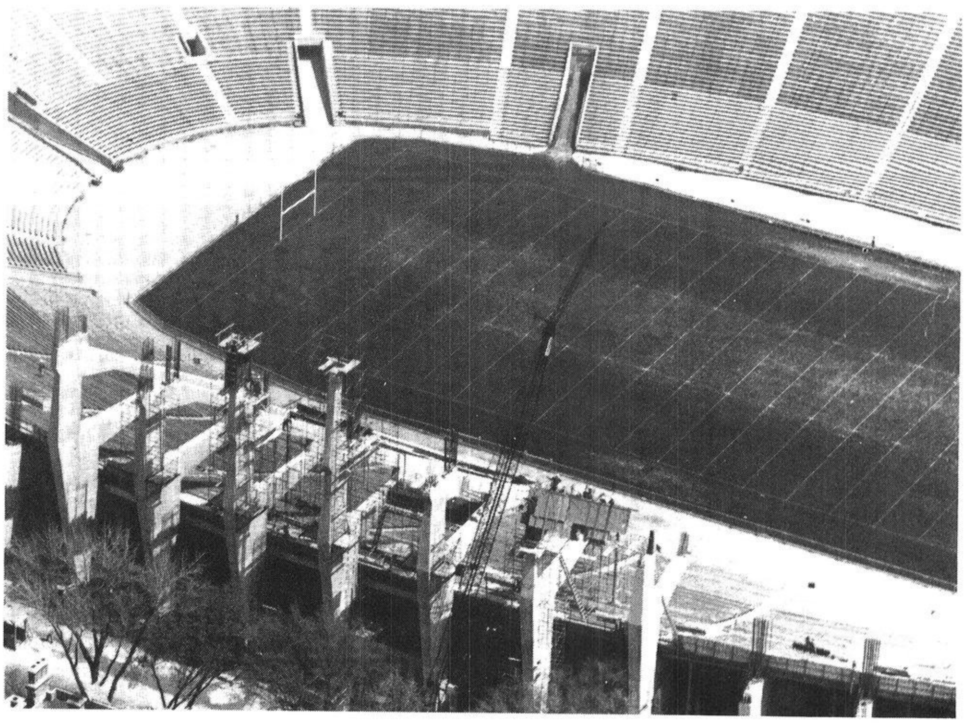
You may be wondering, "How far does the deck actually move?" To determine this, Professor Saul used a modern measuring technique which involves the use of a laser. A mark was placed on the deck area and a thin laser beam was focused on it from an adjacent building. As the deck vibrated, the marker was moved in and out of the laser beam. The distance that the deck moved was found to be a mere tenth of an inch.

Additional measurements were acquired through the use of three seismometers. Through inspection of the seismometer data, it was found that the vibrations stopped almost immediately after the music ended. This occurs because the building is well damped. Damping is a term for the energy dissipated as the object

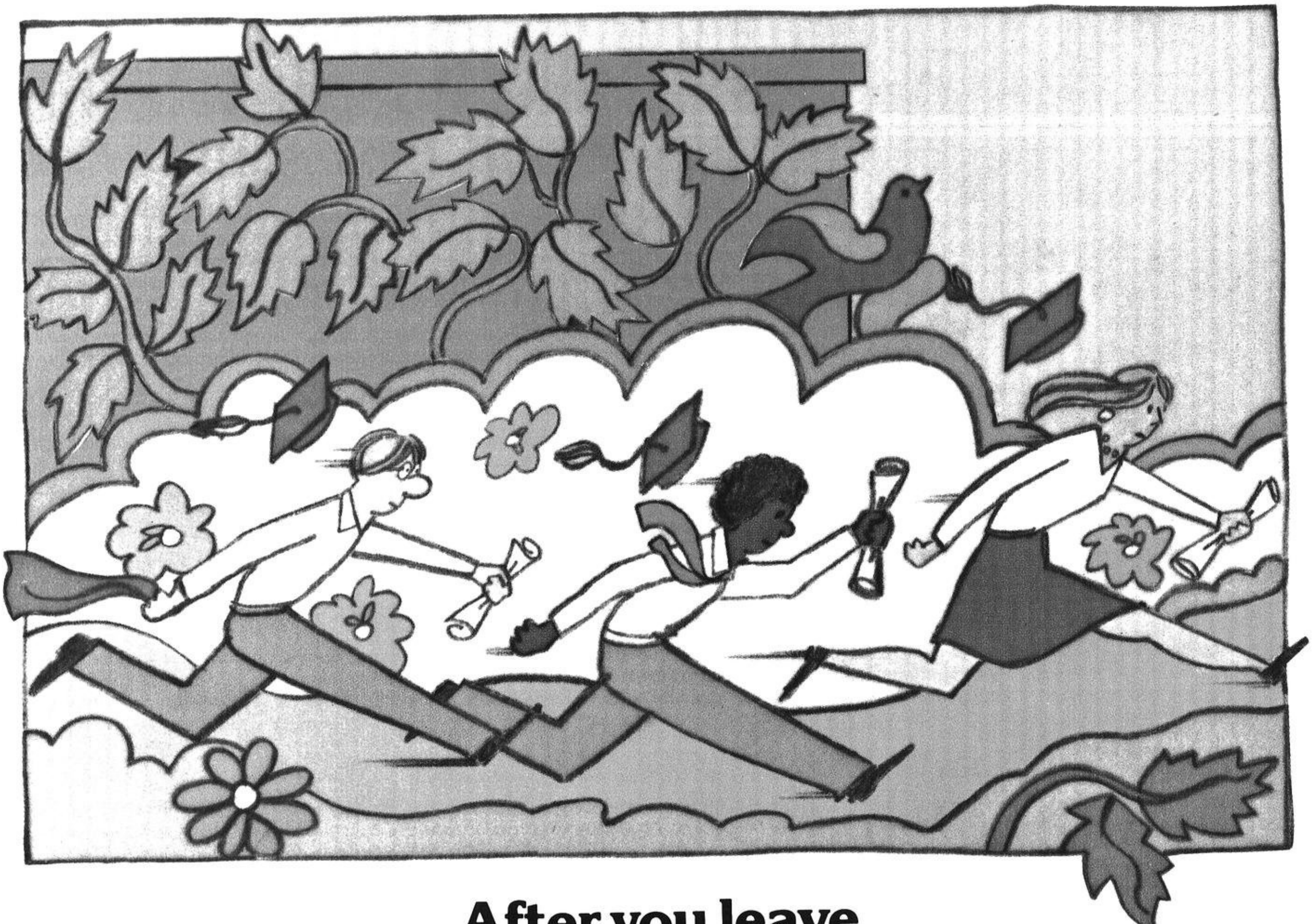
The reason for the initial concern is readily apparent. Collapse of the upper deck would endanger hundreds of fans.

is vibrated at its fundamental frequency. An object which is well damped will dissipate a large amount of energy. Due to the massiveness and the relative inflexibility of the cement structure, it is highly resistant to vibration and therefore, it only takes a short period of time for the deck to dissipate its incurred energy.

The movement of the deck is very small when one considers the fact that tall buildings will sway a number of feet. Also, the entire mass is moving simultaneously. If it were not for this, the cement would buckle and separate slightly as it is moved, causing structural damage. An inspection of the structure revealed no such damage to Camp Randall Stadium. Therefore, because the deck movement is very small and because the deck is vibrating as an entire mass, these movements are of no threat to the building or the safety of the fans. The "Bud Song", however, is no longer played during the game in consideration of the more timid Badger fans who feel uncomfortable sitting in a deck which seems to be dancing along with the music.



In 1966, the upper deck nears completion.



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The calculated risk of freshman registration

by John Wengler

Perhaps the most important ritual of the semester, registration can be a frustrating experience. Freshman, especially, are acutely affected by this process. A first taste of bureaucracy combined with the enormity of a Big Ten school results in a very harrowing experience. John Wengler, a native of Wilmette, Illinois, provides the details. John is a Civil and Environmental Engineering freshman.

Freshman registration: it's the first cold slap in the face of the fledgling engineer, the first taste of hard college reality. Anyone who has been through it (and lived) probably remembers all too well how they were sure they would never make it through the labyrinths of academic bureaucracy.

This freshman engineer found himself at the end of yet another assignment committee line, sincerely doubting that he would ever make it through his college career if they closed that last section of Chemistry. (Sure enough, they did.) Entering the Red Gym at the end of the day, he paid his tuition, even though his course list was incomplete and his class schedule added salt to the wound with its numerous 7:45 a.m. lectures. All this Madison freshman

The first letter of the student's last name bears a direct relationship to his place in line.

could do was to wonder whether it was all worth it, and call home with the bad news.

As with all engineering problems, we can attempt to examine the enigma of freshman registration difficulties with the aid of mathematical equations. Our given variables are Dean Liedel's Office of Freshman Engineering and some 1176 new students. Dean Liedel's responsibilities are vast, so he is assisted by Professors Greenfield and Maxwell, for whom registration is only 1/2 and 1/3 of their appointed duties, respectively. The rest of the office staff includes; one secretary, four or five students, and six professors, who are assigned to assist.

If we take the staff and divide it by the number of freshmen, we find:

[(Dean Liedel) + ½ (Prof. Greenfield) + 1/3 (Prof. Maxwell) + (12 member staff)] ÷ 1176 freshman

to be equal to quite a registration workload. For those students who were unsuccessful in registration, the office continues to work to create new sections or find satisfactory replacement courses for them. The energy put in by the office is always appreciated by those who seek their help, but these advisors cannot seek out each student; as a result, there are always a few students who are disappointed.

A major source of registration woes comes from the uncertainty of the faculty course planners as to how many sections will be in demand for the next semester. There are many factors of error involved here. The first is the fact that the departments must decide how many sections will be needed months before registration even enters the minds of the new freshmen. The decisions must be printed in the timetable, which in itself takes months of planning, editing, printing, and distribution. We find a direct relationship between time and the number of things that can go wrong:

(Decisions & number of months before registration) ÷ (Number of things that could go wrong) = Tricky Business

Another source of uncertainty is directly related to the freshman himself. When applying to the university, he will declare an intended major. He may change this major before he arrives at the SOAR program or before he arrives in Madison in the fall. This uncertainty in the student's mind is difficult for the departmental planners to anticipate. The possible error could include:

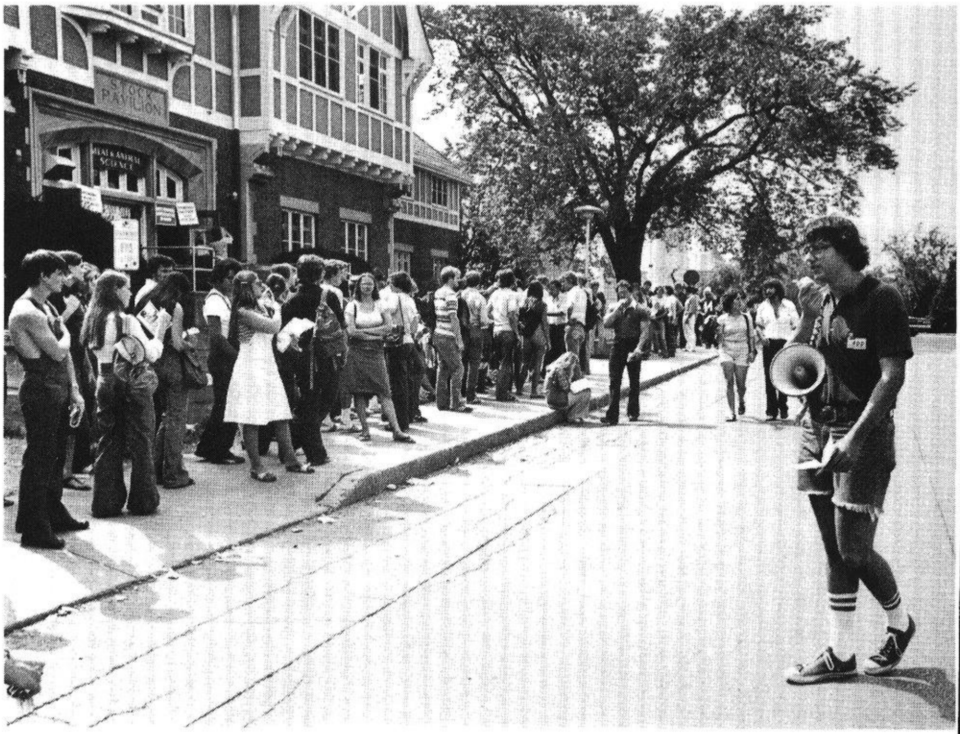
(% change major: pre-soar + % change major: pre-registration) x (1176)

This explains the number of sections that were not filled, and the number of sections that had to be added at the last minute.

The total for these and other problems that occur are found to be directly proportional to the number of phone calls from angry parents demanding to know why their kids are paying so much and receiving so little for it.

In response, the University is initiating some changes in the Engineering College. Since the engineering campus accounts for the largest portion of university growth, new acceptance requirements are also being put into effect to limit the enrollment to a healthier number. Also, those who are already in the engineering college will have to earn the right to remain, as a new GPA requirement has been installed to ensure only the hard-working take the few seats available.

Having finished with registration, the freshman can only return to his empty dorm room with a hollow feeling inside. He looks at the calendar and starts counting the days until Christmas. Hopefully things will work out for him, as they always seem to in Madison. With the campus growth and the dedication of its students and faculty, the university should always be able to produce outstanding graduating classes —successful seniors who never thought they would make it through freshman registration.



As his list of desired courses approaches zero, the student finds himself at the limit of his patience.

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Who's Jim Khana?

by Becky Geimer

Becky Geimer found out that it's not "who", but "what." A junior in Secondary Education, Becky went to her first Gym Khana race this fall.

A wide variety of vehicles were present to compete in the SAE's annual "Gym Khana" time trials at UW-Madison. Everything from sleek Corvettes and MGB's to humble "Bugs" and Honda Civics raced around the pylons of Lot 60 in an attempt to secure the lowest time around the course. Even a go-cart and a hybrid experimental car showed up to participate in the "Great Race".

The Gym Khana is an annual race held by the UW-Madison chapter of SAE (Society of Automotive Engineers). This year's race was held on September 27 at Lot 60, a large parking lot on the UW-Madison campus. Anyone who could pay the entrance fee and meet a few minimal requirements was welcome to compete. The entries were classified according to the type and model of the car.

A course was set up in the parking lot using pylons for markers. The entrants are given a trial run or two to get accustomed to the course, and then take turns making a number of timed runs. These runs are recorded, with the best run being their ranking time. There was a time penalty for knocking over pylons.

Most of this year's entries were clocked within a range of 1:40.0 to 1:50.0. The fastest time was a Corvette clocked at 1:35.4, this year's slow time was 2:10.7.

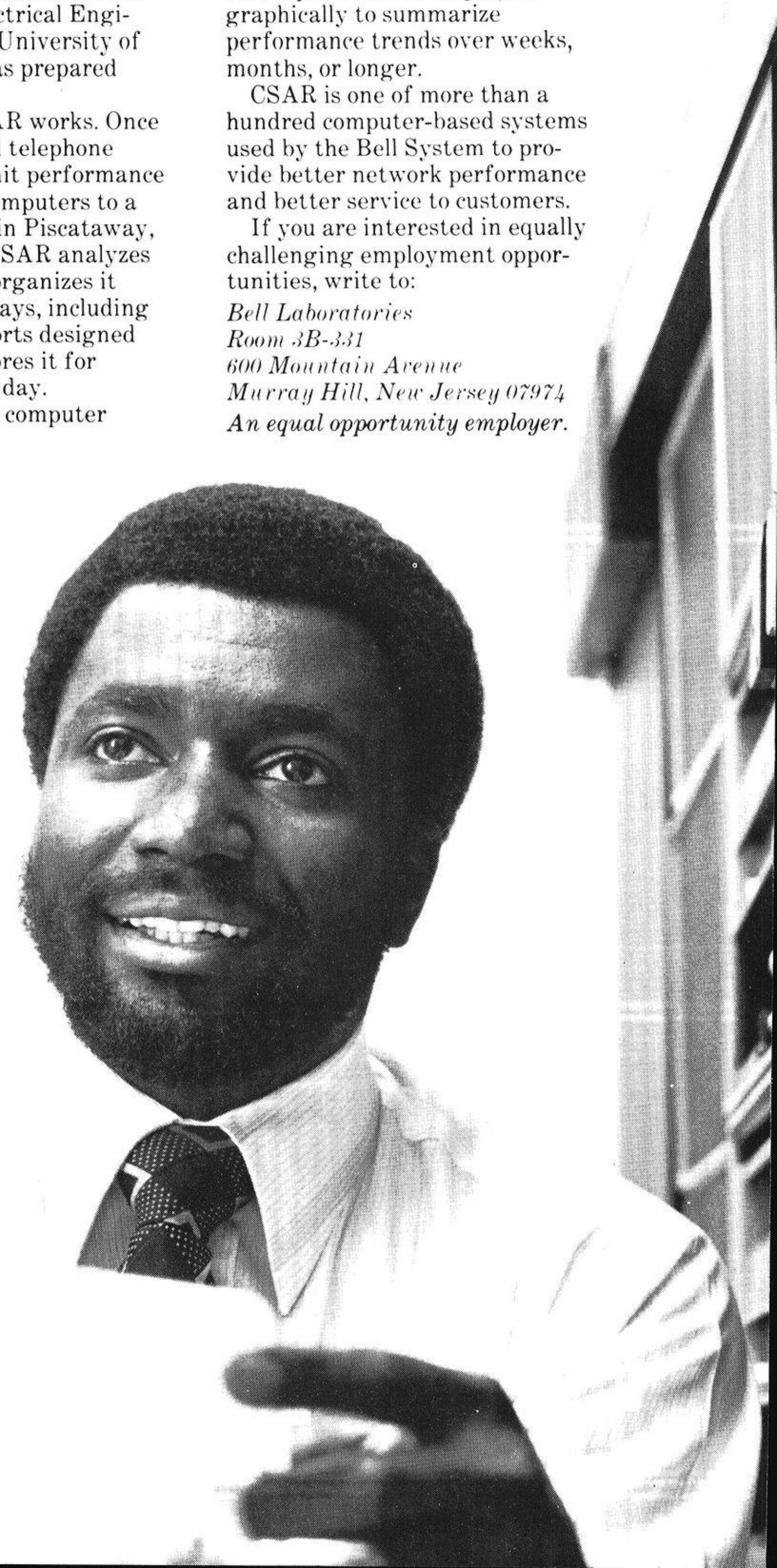
Whether it is the car, the driver, or a combination of both that makes for the best time, the Gym Khana makes for a fun and interesting way to spend a fall afternoon.

Is it coming or going? This hybrid experimental car is comprised of the front sections of two Saabs welded together. Not ideally suited to racing, it received the slowest time of the day.

An unusual entry to the race, this go-cart receives a start from a separate electric starter.

The drivers and cars line up across Lot 60.

Drivers are required to remove all loose and nonessential equipment from the cars prior to racing.



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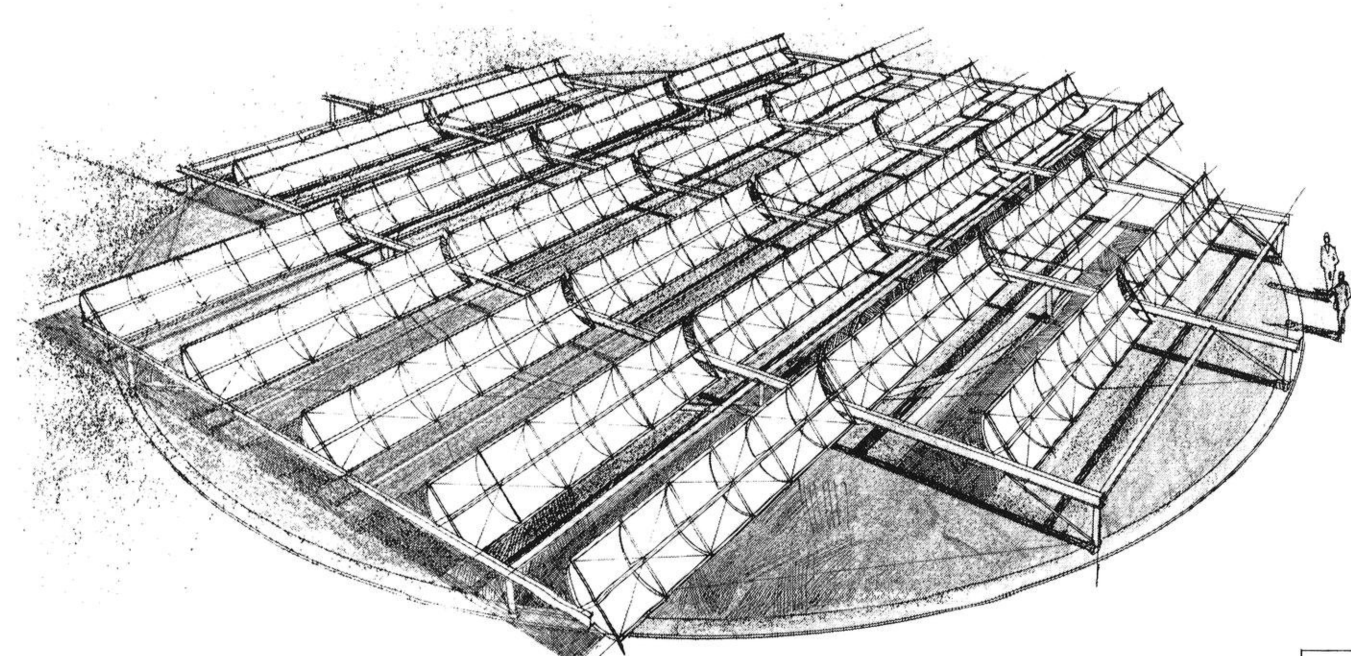
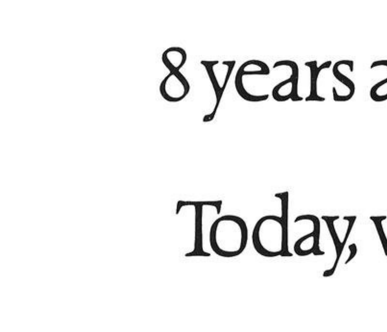


8 years ago, we designed turntables to track records. Today, we're designing turntables to track the sun.

What you're looking at is a turntable that measures 146 feet in diameter — a turntable programmed by computer to track the sun's azimuth while concentrators track the sun's elevation. Nine of these turntables are being designed to power marine-mammal life-support systems at Sea World in Florida.

The photovoltaic concentrator system uses high-intensity silicon solar cells to convert sunlight into electric power and is under study by General Electric for the U.S. Department of Energy. Parabolic troughs on each turntable are formed of aluminum sheets covered by a reflective film laminate. They are angled to concentrate energy on a focal line of solar cells. DC power generated by the photovoltaic cells will be converted to AC power providing up to 300 kw of peak electricity — enough power to service about 40 average homes.

SOLAR CELL RECEIVER ASSEMBLY



Water circulated through copper coolant piping in the solar cell assembly and carried to absorption chillers would be used to air-condition a shark exhibit. The generation of electricity and simultaneous ability to air-condition makes the GE system unique.

Our Sea World application is a test project. It will include researching ways to reduce costs to make photovoltaic systems practical for commercial or industrial-scale use.

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