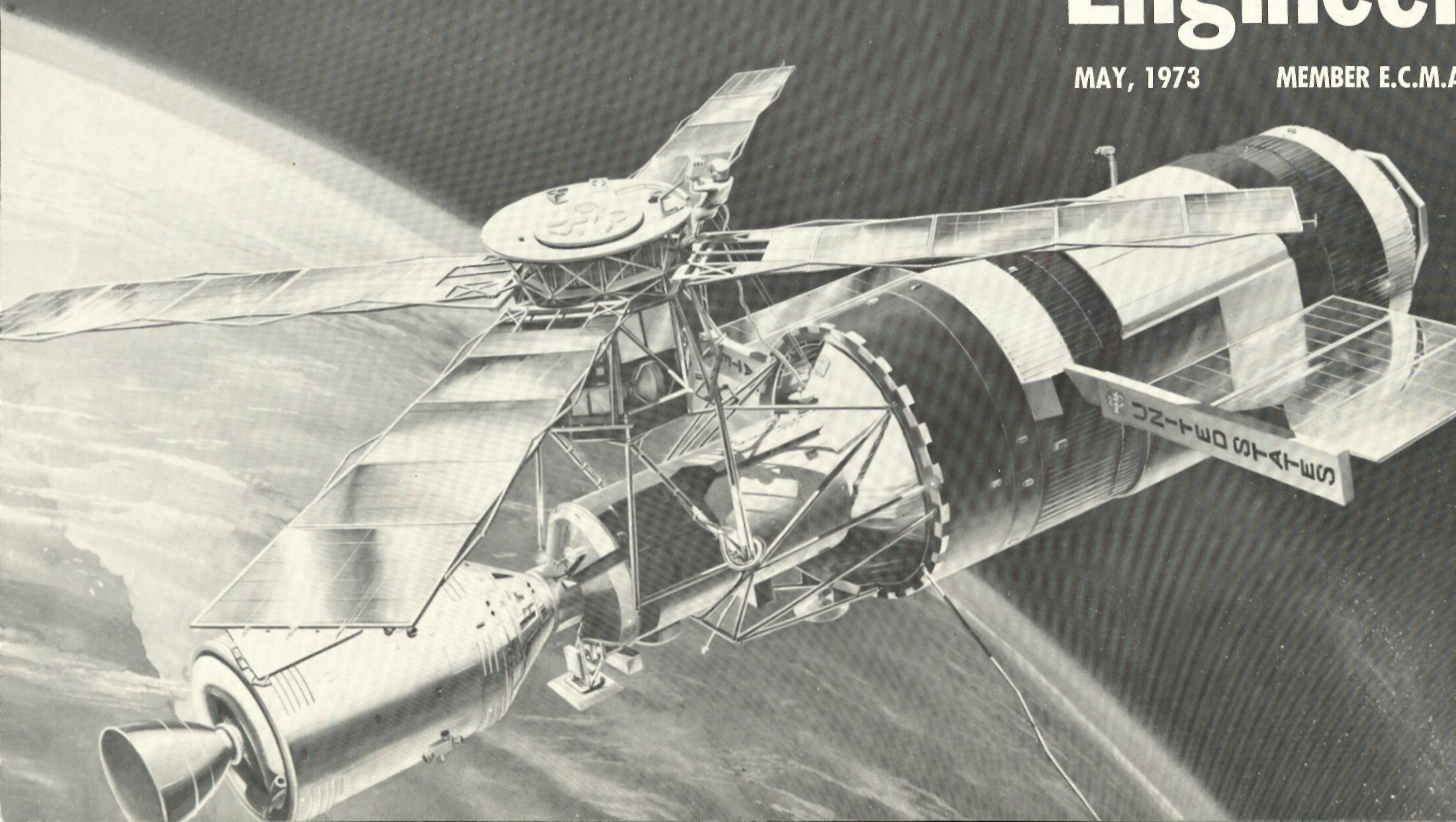
Colorado Engineer

MAY, 1973

MEMBER E.C.M.A



Engineer, which do you want... field or desk? Westinghouse offers both.

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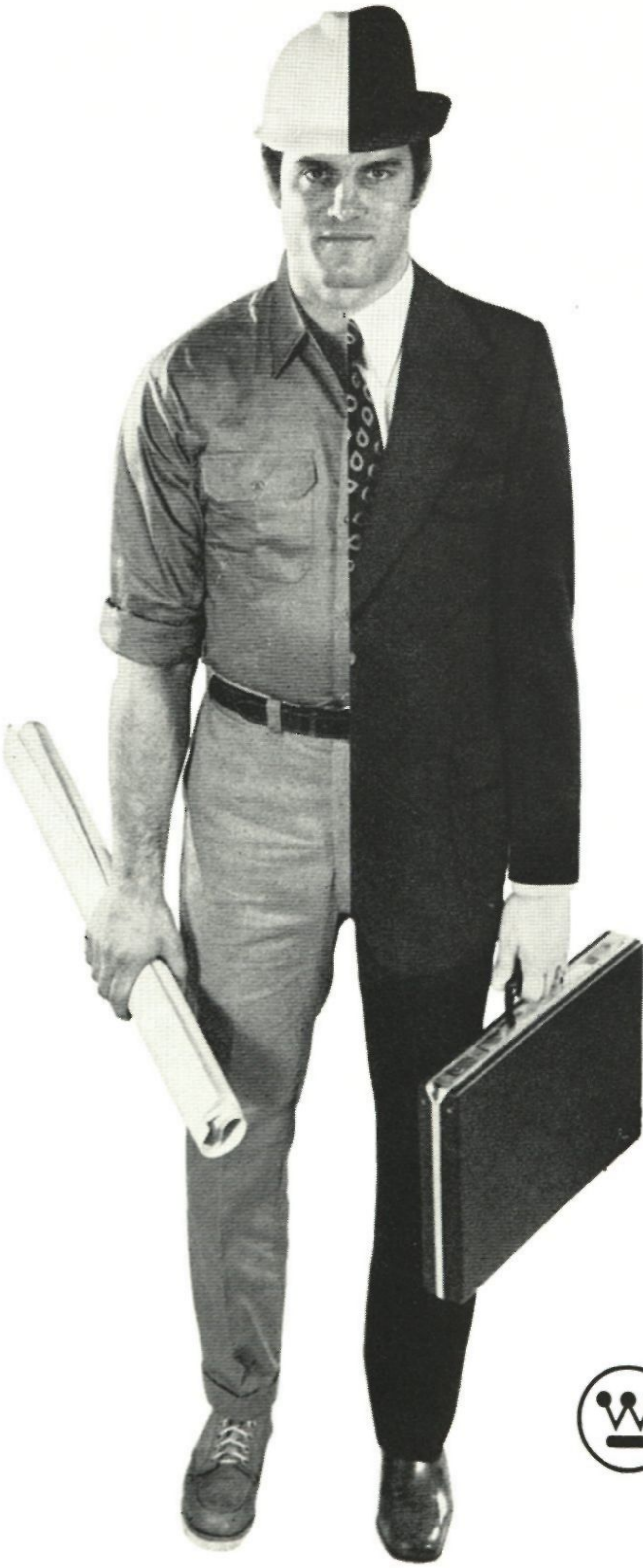

Westinghouse

ENGINEERS GUIDE TO COMPARATIVE VALUES

IN ZINC vs. PLASTICS

Unreinforced Plastic vs. Die Cast ZINC*

RATIO OF COSTS FOR EQUIVALENT LEVELS OF VARIOUS PROPERTIES

Material	Tensile Strength at 24°C	Tensile Strength at 80°C	Flexural Strength at 24°C	Tensile Creep (100 hrs.) at 24°C	Un-notched Tensile Impact Strength at 24°C	Flexural Fatigue Strength at 24°C
ABS	2.54	3.46	1.37	12.3	2.78	0.91
Nylon 6/6	4.72	5.40	2.70	85.6	1.64	1.91
Polyacetal	3.09	5.00	2.40	29.0	3.60	1.42
Polycarbonate	3.82	3.60	2.33	20.0	1.70	3.40
Polypropylene	2.00	3.13	1.10	37.7	1.09	0.52

***SAE 903 Die Cast ZINC = 1.0** ****Costs as of January 1970, (carload lots or maximum quantity bracket). All calculations are based on these figures.**

Glass Reinforced Plastic vs. Die Cast ZINC*

RATIO OF COSTS FOR EQUIVALENT LEVELS OF VARIOUS PROPERTIES

Material	Tensile Strength at 24°C	Tensile Strength at 80°C	Tensile Stiffness at 24°C	Tensile Stiffness at 80°C	Flexural Strength at 24°C	Flexural Strength at 80°C	Flexural Stiffness at 24°C	Flexural Stiffness at 80°C	Tensile Creep (1000 hr.) at 24°C	Notched Tensile Impact Strength at 24°C	Flexural Fatigue Strength at 24°C
Gl. Re. Nylon 6/6	1.91	2.68	8.42	8.90	1.82	1.91	20.5	16.7	7.85	3.83	1.96
Gl. Re. Polycarbonate	3.36	2.68	10.0	5.27	2.56	2.05	20.4	3.05	5.46	9.24	2.88
Gl. Re. Polyacetal	4.73	5.40	12.7	11.1	4.20	3.78	26.4	5.04	9.45	20.9	2.81
Gl. Re. Polypropylene	2.83	2.74	5.26	11.4	2.48	2.39	13.1	6.30	6.51	13.2	1.69
Gl. Re. Polysulfone	4.00	3.21	12.7	6.66	3.39	2.78	23.7	5.44	4.83	16.5	3.76
Gl. Re. SAN	1.63	2.14	4.37	2.78	1.70	1.49	9.70	1.84	1.90	10.1	1.14

***SAE 903 Die Cast ZINC = 1.0** ****Costs as of January 1971, (carload lots or maximum quantity bracket). All calculations are based on these figures.**

ZN-495

These charts are based on information from two extensive engineering evaluations conducted by U.S. Testing Co., for the International Lead Zinc Research Organization Inc. These studies showed that in almost every instance die cast zinc gives you more performance for your money than any of the plastics tested. ☐ For example, the results showed that an unreinforced Polycarbonate rod would cost 3.82 times more than a SAE 903 rod to withstand the same tensile load. Glass reinforced Polycarbonate would cost 3.36 times more than zinc. ☐ Reprints of this "Engineers Guide" are available. Just let us know the quantity you would like.

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Colorado Engineer

COLLEGE OF ENGINEERING • UNIVERSITY OF COLORADO

VOLUME SIXTY-NINE NUMBER FOUR MAY 1973

IN THIS ISSUE

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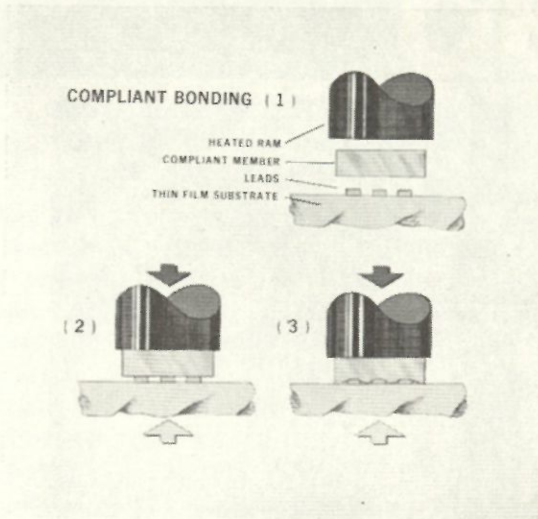
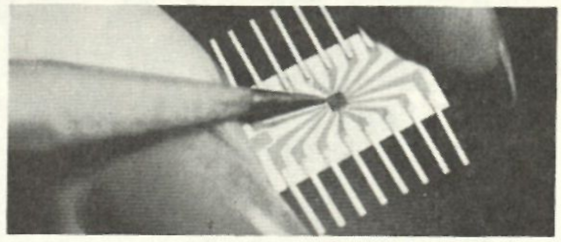
THE COVER: An artist's portrayal of the U.S. space laboratory, Skylab. Courtesy of Martin Marietta, Denver Division.

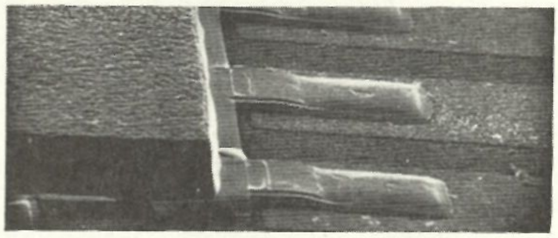
WESTERN ELECTRIC REPORTS



When heat and pressure are applied to the compliant medium, it begins to deform around the gold-plated leads. Deformation of leads is controlled by the flow stress properties of the medium. When the medium bottoms out, it stops the ram and the delicate metal parts are instantaneously and permanently bonded without damage.



Slightly magnified, the pencil points to a beam-leaded circuit chip which has been bonded to 16 gold conductors that converge on it. Within the silicon chip are dozens of microscopic transistors, diodes, resistors.



Greatly magnified, we can see gold beam leads projecting from a chip bonded to thin gold conductors on a thin ceramic substrate.

A new and better way to bond integrated circuits.

Engineers at Western Electric's Engineering Research Center (ERC) and Allentown Works have come up with a revolutionary but simple solution to some very complex circuit bonding problems. It's called compliant bonding.

As in other solid state bonding methods, heat and pressure are used to bond tiny integrated circuits to other components. (Some circuits have fifty or more delicate leads.)

However, our process differs in a very important way. ERC researchers added a compliant or yielding medium between the energy source and leads being joined. On contact, the medium compresses and transmits an equal amount of controlled, predictable bonding pressure to each lead.

There are many advantages to this new technique.

First, it is more reliable. Under heat and pressure, the compliant medium spreads the bonding pressure to all the leads uniformly. It automatically compensates for surface and lead irregularities. Strong, reliable electrical connections are assured for every lead.

It is also more versatile. We can now bond more than one circuit at a time, even with leads of different thicknesses or area widths. The compliant medium perfectly controls lead deformation in even the most complicated multiple bonding. It's no longer necessary to design and test complex bonding tools for each bonding job.

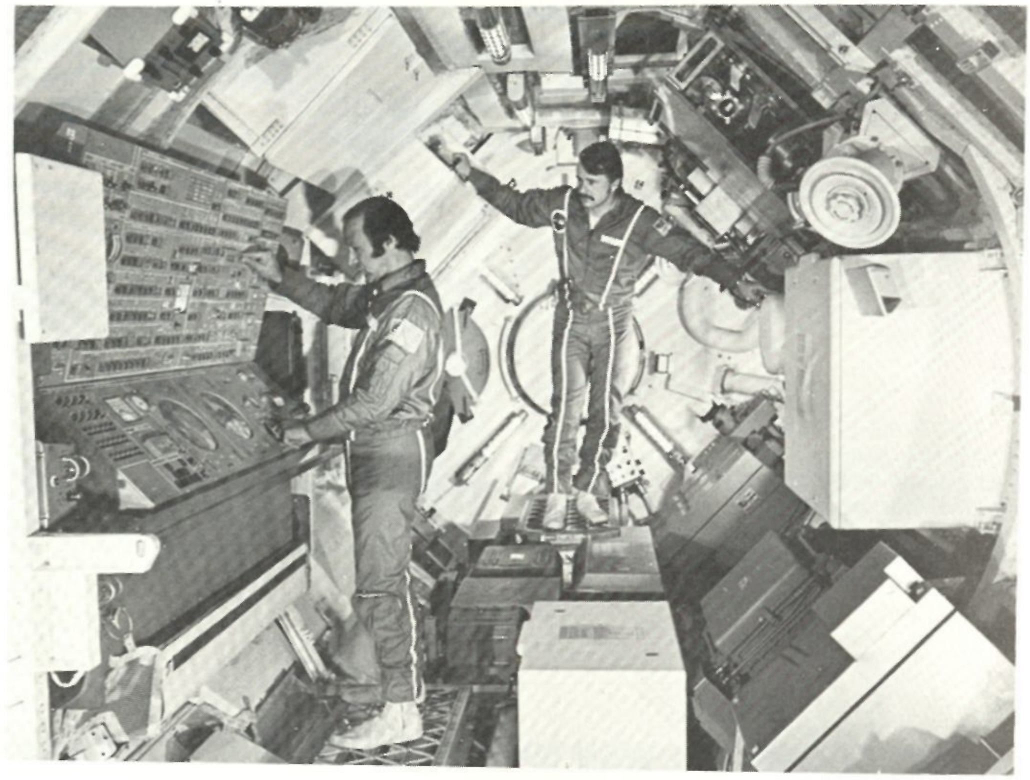
Engineers at Allentown are working to apply the process to large-scale manufacturing. They have developed the first production machines using the process. These machines are now in growing use at Allentown and many other Western Electric plants.

Conclusion: Compliant bonding is technically and economically superior to other solid state bonding techniques. Combined with automated production, compliant bonding promises reliable, high-speed production of circuit packages.

Western Electric

We make things that bring people closer.

Skylab



By John Sundheim

A full-scale training model of the Skylab experimental space station's Multiple Docking Adapter at Martin Marietta.

In an effort to better understand man's first spaceship, the earth, an experimental space station named skylab is planned to be launched.

The 118-foot-long skylab will orbit 270 statue miles above earth, providing a home and work area for three astronaut teams resulting in a total of 140 days in space.

Besides earth resources sensing, the astronauts will conduct experiments in solar and stellar astronomy. While evaluating new equipment for future cosmic use, they will serve as subfects for biomedical testing to determine the effects of prolonged weightlessness.

Skylab will prodigiously effect the Congressional declaration of 1958 which stated that, "The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind."

Past NASA programs: Mercury, Gemini, and Apollo have extensively enlightened mankind in the areas of agriculture, astronomy, communications, earth resources, navigation, oceanography, and weather prediction.

Agricultural capabilities of orbiting devises permit periodic observation in routine operation from distant, all-inclusive views which can make use of multi-spectral scanners, infra-red sensitive film, television and conventional photographic techniques.

Previous space exploration has helped astronomers discover additional X-ray energy emissions from stellar sources, detected ultraviolet and soft X-ray energies coming trom the Sun, and discerned radio waves emanating from earth that resemble waves which appear to be coming from Jupiter.

One communications satellite can transfer 9,000 phone calls and 12 color television programs between North and South America, Europe and Africa. Satellite costs approximate $4,000 per channel per year as compared with $25,000 per year by submarine cable.

From space man has obtained a new and comprehensive view of earth's resources. Because every chemical element reflects of rediates a distinctive signature across a spectrum of wave lengths, photographs by film sensitive to these radiations provides hitherto unavailable information concerning natural resources.

Navigation via satellite enables man to determine the positions of ship and aircraft within one mile almost anywhere on the globe.

Because two-thirds of the earth is covered by oceans, only observation from space has proved effective in evaluating the oceans as a food source, detecting their influence on weather, and in general understanding the consequences of those vast bodies of water.

Until an observation point in space was used to report weather, far less than 20 percent of the earth was observable at any one time. Over fifty nations now use satellite weather reporting daily to insure safe transportation, alert farmers, and warn of possible disasters.

Skylab will enable man for the first time to conduct this research and study so vital to man's future in a space laboratoty and workshop from a long-term earth orbit.

The orbital station consists of five major elements: the Orbital Workshop (OWS), consisting of a work area and crew puarters with 10,644 cubic feet of habitable space, the Airlock Nodule (AM), which enables the astronauts to leave Skylab for extra-vehicular activities, the Apollo Telescope Mount (ATM), Skylab's solar observatory, the Multiple Docking Adapter (MDA), the space dock and receiving center for astronauts arriving in an Apollo spacecraft and also an experiment control cinter, and finally the Apollo spacecraft which serves as a taxi between earth and Skylab.

The OWS will allow medical experimentation to investigate the effects of long duration space flight on the crew and evaluate man's metabolic effectiveness in space to determine future requirements for logistics resupply, environmental control, and task planning.

Subjects of medical investigation include nutrition and musculoskeletal function, cardiovascular function, hematology and immunology, neurophysiology, pulmonary function, and metabolism.

The ATM's emphasis will be on observations that are impossible for observers on the ground because of the earth's atmosphere.

Observatory experiments extend research in fields including geophysics, physics of the upper atmosphere and the interplanetary medium, galactic and intergalactic astronomy including a partial survey of the Milky Way star fields, and solar studies.

With a work space of 1140 cubic feet alone, the MDA allows over nine major experiments in a wide range of fields involving technology and engineering.

Some of the experiments in the MDA involve a study of materials processing in space, including welding in zero gravity, growth of large single crystals for possible electronic applications, and metal casting.

Other experiments will study the flammability of various nonmetallic materials in the spacecraft atmosphere while six cameras photograph selected sites on earth with different film and filter combinations to determine how multispectral photography can be used to evaluate earth resources in such

Skylab space station's optical window was meticoulously hand-polished for weeks to attain an optical quality that will allow six cameras to scan Earth as if no window were present.

areas as agriculture, urban planning, mapping, meteorology, and mineral exploration.

The integrated series of earth sensing and evaluation devices is called the Earth Resources Experiments Package(EREP).

EREP will support development of oribital sensing to broadly survey such resources and conditions as crops, geological formations, underground water, seasonal advances of snow wind, sea, and weather conditions, rainfall and flooding in remote regions.

EREP's data will come from the 75% of the earth which Skylab's flight path covers. Skylab's flight path, repeated every five days during the eight month lifetime of the program, will include the entire United States except Alaska.

During the eight months of the program, there will be three manned missions separated by two periods of unmanned operation.

Astronaut Maneuvering Unit backpack, powered by nitrogen gas jets, incorporates four different control systems for flight evaluation in the Workshop.

The first launch will be unmanned and will include the first two stages of a Saturn V launch vehicle which will place the Skylab into earth orbit.

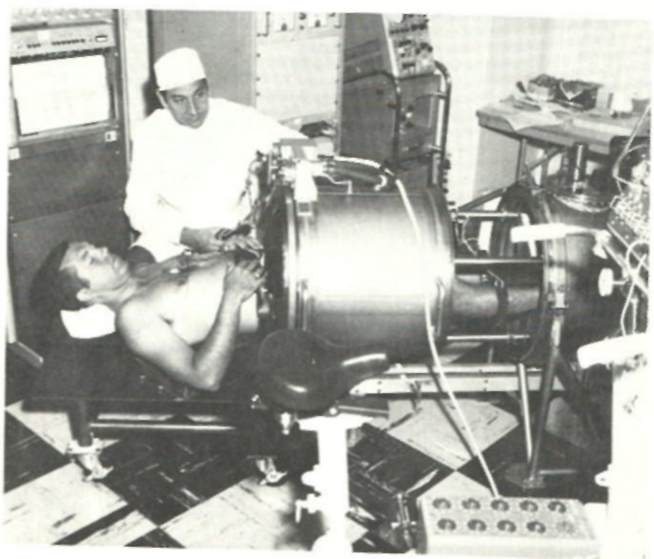
A modified Command and Service Module (CSM) will be launched the next day with Skylab's first three-man crew by the smaller Saturn 1B launch vehicle. The crew will then dock with and activate Skylab.

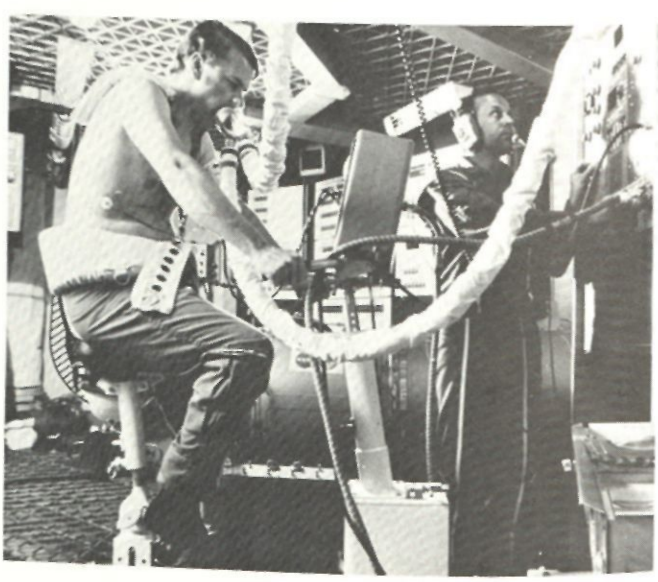
After four weeks in space, the first crew will return to earth via the CSM with a second crew returning to Skylab about 60 days later. The second crew will spend 56 days in orbit when a third group replaces them a month later by spending another term of 56 days aboard Skylab.

Skylab will skim around the earth in an easterly direction in a orbit canted 50 degrees from the equator's plane at 18,000 miles per hour and at an altitude of 270 statuate miles.

Within 3450 miles north or south of the equator, Skylab will be visible for up to ten minutes at sunrise or sunset as a large star streaking northeast or southeast across the night sky.

Engineering and coordination for Skylab and its myriad of experiments was done through the Office of Manned Space Flight, the Marshall Space Flight Center, the Manned Space Flight, and Kennedy Space Center with the help of five major Skylab program contractors.

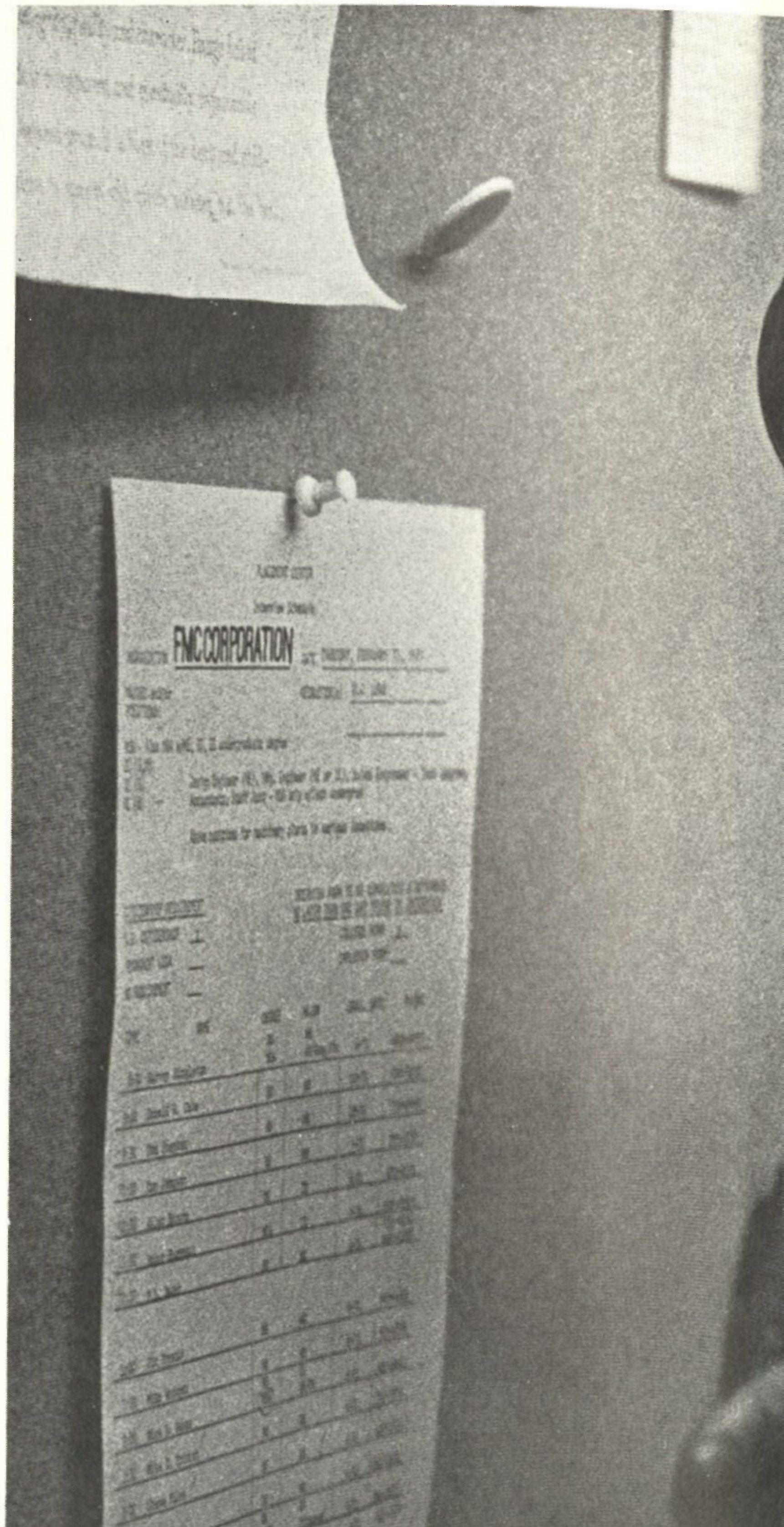


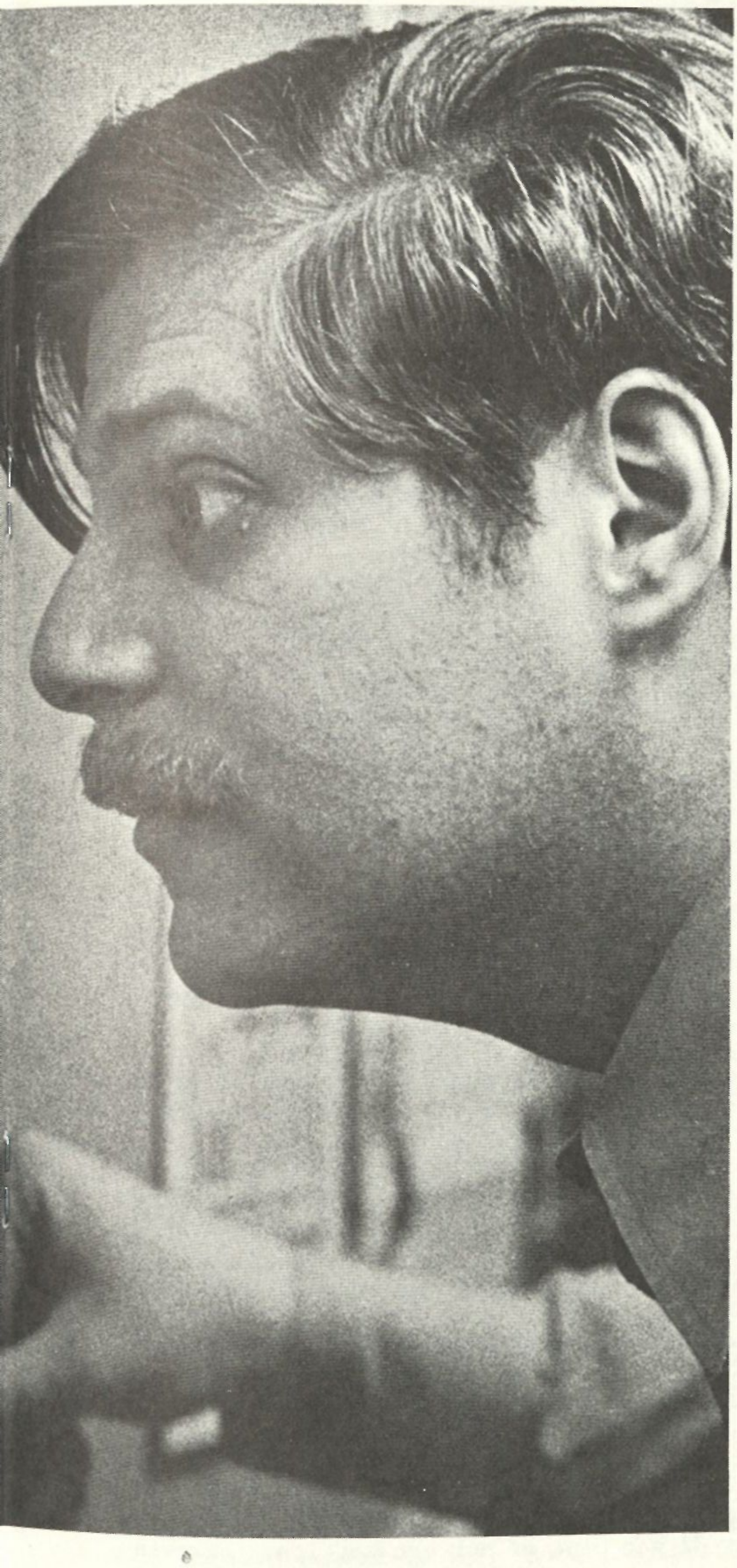


Experiment

Number	Title	Agency	Investigator	Flights 2	3	4
S009	Nuclear Emulsion	MSFC	Dr. M. Shapiro, USN Research Lab	X		
S015	Effects of Zero G on Human Cells	MSC	Dr. P. Montgomery, Dallas County Hospital	X		
S019	UV Stellar Astronomy	MSC	Drs. K. Henize, J. Wray, Northwestern Univ.	X	X	
S020	X-Ray, UV Solar Photography	MSC	Dr. R. Tousey, USN Research Lab	X	X	
S052	White Light Coronagraph	MSFC	Dr. R. MacQueen, High Altitude Observ., Boulder, Colo.	X	X	X
S054	X-Ray Spectrographic Telescope	MSFC	Dr. R. Giacconi, American Science & Engineering, Cambridge	X	X	X
S055	UV Scanning Polychromator/ Spectroheliometer	MSFC	Dr. L. Goldberg, Harvard Observ., Cambridge	X	X	X
S056	X-Ray Telescope	MSFC	Mr. J. Milligan, MSFC	X	X	X
S063	UV Airglow Horizon Photography	MSC	Dr. D. Packer, USN Research Lab	X	X	X
S071	Circadian Rhythm, Pocket Mice	ARC	Dr. C. Pittendrigh, Princeton		X	
S072	Circadian Rhythm, Vinegar Gnat	ARC	Dr. R. Lindberg, Northrop Corp.		X	
S073	Gegenschein Zodiacal Light	MSFC	Dr. J. Weinberg, Dudley Observ.	X	X	X
S082A	UV Coronal Spectroheliograph	MSFC	Dr. R. Tousey, USN Research Lab	X	X	X
S082B	UV Spectrograph	MSFC	Dr. R. Tousey, USN Research Lab	X	X	X
S149	Particle Collection	MSC	Dr. C. Hemenway, Dudley Observ.	X	X	X
S150	Galactic X-Ray Mapping	MSFC	Dr. W. Kraushaar, Wisconsin Univ.			X
S183	Ultraviolet Panorama	MSFC	Dr. G. Courtes, Laboratoire d' Astronomie Spatiale, France	X	X	
S190	Multispectral Photography	MSC	Mr. K. Demel, MSC	X	X	X
S191	Infrared Spectrometer	MSC	Dr. T. Barnett, MSC	X	X	X
S192	Multispectral Scanner	MSC	Dr. C. Korb, MSC	X	X	X
S193	Microwave Radiometer/ Scatterometer/Altimeter	MSC	Mr. D. Evans, MSC	X	X	X
S194	L-Band Radiometer	MSC	Mr. D. Evans, MSC	X	X	X
D008	Radiation in Spacecraft	AF/MSC	Capt. M. Schneider, USAF	X		
D024	Thermal Control Coatings	AF/MSFC	Mr. C. Boebel, WPAFB	X	X	
M071	Mineral Balance	MSC	Dr. G. Whedon, National Institute of Health	X	X	X
M073	Bioassay of Body Fluids	MSC	Dr. C. Leach, MSC	X	X	X
M074	Specimen Mass Measurement	MSC	Col. J. Ord, Brooks AFB	X	X	X
M078	Bone Mineral Measurement	MSC	Dr. J. Vogel, U.S. Public Health Service	X	X	X
M092	Lower-Body Negative Pressure	MSC	Dr. R. Johnson, MSC	X	X	X
M093	Vectorcardiogram	MSC	Capt. N. Allebach, M.D., Naval Aerospace Medical Institute	X	X	X
M111	Cytogenetic Studies of Blood	MSC	Dr. L. Lockhart, Texas Univ. Medical Branch	X	X	X
M112	Man's Immunity — In Vitro Aspects	MSC	Dr. S. Ritzman, Shriner Burns Institute	X	X	X
M113	Blood Volume, Red Cell Life Span	MSC	Dr. P. Johnson, Baylor	X	X	X
M114	Red Blood Cell Metabolism	MSC	Dr. C. Mengel, Missouri Univ.	X	X	X
M115	Special Hematologic Effects	MSC	Dr. S. Kimzey, MSC	X	X	X
M131	Human Vestibular Function	MSC	Drs. A. Graybiel, E. Miller, USN Aerospace Med. Inst.	X	X	
M133	Sleep Monitoring	MSC	Dr. J. Frost, Baylor School of Medicine	X	X	
M151	Time and Motion Study	MSC	Dr. J. Kubis, Fordham Univ.	X	X	X
M171	Metabolic Activity	MSC	Dr. E. Michel, MSC	X	X	X
M172	Body Mass Measurement	MSC	Col. J. Ord, Brooks AFB	X	X	X
M415	Thermal Control Coatings	MSFC	Mr. E. McKannon, MSFC	X		
M479	Zero G Flammability	MSFC	Mr. H. Kimzey, MSC		X	
M487	Crew Quarters Habitability	MSFC	Mr. C. Johnson, MSC	X	X	X
M509	Astronaut Maneuvering Equipment	MSC	Maj. C. Whitsett, USAF	X	X	
M512	Materials Processing in Space	MSFC	Mr. G. Parks, MSFC	X		
M516	Crew Activities, Maintenance	MSC	Mr. R. Bond, MSC	X	X	X
T002	Manual Navigation Sights	ARC/AF MSFC	Dr. R. Randle, ARC	X	X	X
T003	Inflight Aerosol Analysis	MSFC/DOT	Dr. W. Leavitt, U.S. Dept. of Transportation	X	X	X
T013	Crew Vehicle Disturbances	LaRC	Mr. Bruce Conway, LaRC	X		
T018	Precision Optical Tracking	MSFC	Mr. J. Gould, MSFC	X	X	X
T020	Foot-Controlled Maneuvering Unit	LaRC	Mr. D. Hewes, LaRC		X	
T025	Coronagraph Contamination Measurement	MSC	Dr. G. Bonner, MSC	X		
T027	Contamination Measurement	MSFC	Dr. J. Muscari, Martin Marietta Corporation	X	X	X

Don't let our name confuse you.





POWER

Interval	Cumulative Energy Consumption
A.D. 1 - 1850	9 Q
- 1950	13 Q
- 2000	maximum 22 Q
- 2050	0minimum 72 Q
	maximum 487 Q

(1Q 1.0 x 10 BTU, equivalent to 38 billion tons of bituminous coal)

Courtesy Westinghouse Electric

"Just how bad is the energy crisis?" This is a question being asked by a lot of people today, people who a year ago wouldn't believe that we were headed for severe shortages of fuels. Now, the shortages are indded upon us. Fuel oil is short in many areas, natural gas supplies are interrupted and industrial production affected, electric utilities are being restricted from burning gas, and there is talk of gasoline rationing in the future.

Some people say that this situation is merely a short-term problem--that there is plenty of oil and gas in the ground, and all that's needed to solve the problem is to sink the wells, build the refineries, step up exploration, increase prices, import more oil, and develop solar and geothermal power.

At least that's the way some people explain it.

However, I am afraid that the current energy shortage is a bit like some of the ads you have all seen. In large, bold type at the top, it reads "SEX". In the small type at the bottom it says, "Now that I've got your attention, let me give you a pitch about my particular product."

And now that the energy shortage has got the attention of almost everyone in the country, I am afraid that the flood of policy recommendations now surfacing everywhere are often self-serving statements by special-interest groups who are capitalizing on this problem to hawk their own special brand of patent medicine.

I believe that the problem is quite different in nature from that defined by many of the present protagonists, and that national energy strategy and policies should be quite different from those proposed by many of these groups. I would like to discuss some of these thoughts with you today.

To begin with, short-term solutions to our current oil and gas shortages -- solutions which involve increased exploration and production -- merely hasten the day when our real problem arrives. Let's take a look and see where we're headed.

In terms of heat content, expressed at 10^{18} Btu which I will label as "Q", there are about 280 "Q" of fossil and nuclear fuels estimated to be ultimately recoverable in the world. The U.S. has 52 "Q" of that total. Without the breeder reactor, most of the U.S. and world total would be coal; the world has 170 "Q" and the U.S. has 33.

If we failed to develop the breeder reactor, the total energy content in uranium is 70 "Q" worldwide with 16 in the U.S. Oil and gas, however, present a different story. There are 13 "Q" of oil and 10 of natural gas in the world. The U.S. has one "Q" of oil and eight-tenths of a "Q" of gas.

But when we compare these reserves with the present usage rate of these fuels, we see a very disproportionate picture. Natural gas, for instance, represents one and one-half per cent of U.S. energy reserves but 32 per cent of our consumption. Likewise, oil accounts for a little over two per cent of our reserves, but 44 per cent of our total energy demands. Coal, on the other hand, represents 63 per cent of our U.S. energy inventory but it supplies only 22 per cent of the demand. Looking at the world energy picture, similar disparities are evident between what's available and what's being used.

From these figures it is obvious what fuels are in real trouble and why.

Projecting rates of consumption against reserves of these fuels, we find the following.

First, if the world continues at its six per cent a year rate of growth in energy consumption, all naturally occurring conventional fuels will be gone by the middle of the next century. If the world slows down to the U.S. rate of energy use growth -- four per cent -- we merely extend depletion to the end of the next century.

If the U.S. were forced to supply all its oil internally, we would be out by 1995. By importing oil, we can buy another 25 years before everyone is out -- worldwide.

The situation with natural gas is even bleaker. New gas findings are down drastically to below current usage rates, and our current reserves to production ratio is down to a 12-year supply at 1970 usage levels.

The natural gas industry in the past was adding 900,000 new customers a year. The future for gas, taking into account projected new finds, imports, liquified gas and gasified coal, looks very bleak. Even with optimistic projections, maximum future gas production will remain essentially flat, at current levels. Thus, new gas customers will drop virtually to zero.

And those potential new customers cannot, or certainly should not switch to oil, because we already have an oil shortage. Some feel our oil shortage can be filled by imports, but that seems completely unrealistic for two reasons. First is that projected 1985 oil imports would require tankers spaced every seven miles between the Middle East and the U.S. Atlantic Coast and would cause a staggering balance of trade drain in the order of 30 billion dollars a year. Second is the fact that total world oil productions including the Middle East, will peak out within two-three decades.

Obviously, what is required is that substitutes be found for gas and oil wherever possible. Coal is one substitute, electrical power from a nuclear energy base is another.

But let's look at what is involved in substitution, and to do that the principal end uses of our energy by the four major consuming sectors must be broken out. The industrial sector directly consumes the most energy on an end-use basis, 40 per cent. Transportation is second at 28 per cent, residential is third at 18 per cent and the commercial sector fourth at 14 per cent.

Looking further at the direct uses of energy, we find that electricity represents only a fraction of the energy used in homes, businesses and industry -- in fact, nine per cent of the total energy consumed directly on an end-use basis. This means that within the four consuming sectors of the economy, 91 per cent of their direct energy consumption comes from coal, oil and gas.

Let's break down one of those consuming sectors -- residential -- which we can all relate to more easily. Here is a profile of current energy purchases by households in the United States, including the family car. Residential electricity sales in 1971 were 480 billion kilowatt hours. However, the energy content of residential gas and heating oil was five times the electrical input, and an almost equal amount went into the family car. In a quantitative energy sense, the household use of electricity is much like a mouse sharing a bed with a couple of elephants. A very minor change in the use patterns of gas and oil could produce tremendous changes in electricity growth rates.

For example, if just 10 per cent of the oil and gas heating load were dumped onto electrical systems, the nation's residential load would increase by 50 per cent.

It is apparent to me that the nation has to begin thinking now about substituting electricity for the gas and oil used in the homes in addition to finding ways to improve building insulation, increase appliance efficiency and to conserve energy.

As many of you know, air conditioner efficiency is becoming something of an issue in the trade. Consolidated Edison last summer advised consumers to purchase more expensive high-efficiency air conditioners, and legislation is being considered in New York requiring that the annual cost of operation, and hence, power consumption, be printed on air conditioner tags.

One would expect that similar efficiency ratings will be called for on all appliances; beyond that we would well see a large national program aimed at producing more efficient appliances and conserving energy of all forms.

As efficiency becomes more and more of an issue and as gas and oil supplies dwindle, the benefits of the electric heat pump become more and more attractive. Misinformed critics have attacked electric house heating as wasteful of energy -- such criticism is not valid where heating is done by heat pump.

Although gas furnaces may exhibit efficiency of 75 per cent under laboratory conditions, this drops to as low as 40 per cent in actual operating service. By comparison, the heat pump operates at 200 to 250 per cent efficiency -- that, for each unit of electricity it consumes, the heat pump can produce two to two and a half units of heat. The reason is that the main source of heat for the heat pump is the outside atmosphere itself, <u>not</u> the electrical input energy. The electrical input merely serves to raise the temperature level of that heat energy which originated from outside. Thus we have a peculiar situation where it takes <u>more</u> Btu of energy to burn gas directly in a home furnace than it would to use that gas to generate electricity for driving a heat pump.

One analysis indicated that if all the dwellings in the United States were heated by heat pumps, the net savings to the country would be 29 per cent of the present space heating energy requirements.

Increases in efficiency will also be obtained by switching to electricity for water heating, clothes drying and cooking in the home. The substitution of electrical appliances for gas units seems inevitable to me, and fortunately such substitution can be effected relatively easily.

Considering the transportation sector, we must look at cars, trains and industrial vehicles as possibilities for substitution of electricity for gasoline. A fuel synthesized from coal for aircraft and trucks is a possibility, but it seems that petroleum will be reserved as long as possible for these vital uses.

Let's compare an electric car with a gasoline powered car. When you follow the electric gas back through its energy transformation processes, you find that much more fuel is required to power a gas engined car than an electric one. Moreover, the electric plant kilowatt installed capacity versus the crude oil Btu input is down by a factor of seven. The net result is that switching to electric powered cars would

Where are the bikeways?

You've probably heard a lot about today's bicycle boom and the many advantages bicycling offers. It is clean, quiet, inexpensive, energy-efficient, healthful — and fun. You might say the bicycle is one of the world's greatest inventions!

However, there *is* one big, sobering drawback: Bicycling in North America today simply isn't safe! An estimated 900 bicycle riders will be killed and more than 40,000 injured in bike-auto accidents this year alone in the United States. Most of these accidents could be avoided with adequate bikeways — separate pathways just for bicycles and safe routes in conjunction with roads.

But: *Where are the bikeways?* This country's 80 million cyclists have only 16,000 miles of bikeways, or about *13 inches for each bike rider*! Compare that with the 3 million miles of paved roads available to 90 million motorists. And most of the existing bikeways are far from ideal. Instead of protective curbing to separate bikes from autos, you usually find just white lines or signs along the road's edge, which do little more than lull both cyclists and motorists into a false sense of security.

Who is holding things up?

Why aren't our millions of bicycle-riding taxpayers provided with better, safer facilities? Because most government bodies continue to pump *our* money into still more roads, highways, and freeways. Their actions make us even more dependent on automobiles, which results in more smog, noise, and traffic congestion — not to mention depletion of the world's natural resources.

And what about the citizens who *must* rely on alternate transportation? Half of our nation's adults do without the automobile, by need or by choice. Yet no major bikeway, bus or rail transit funds have been made available, and proposals fall ridiculously short of the *real needs.* The problem is further compounded by the fact that attempts to solve our transportation dilemma with gas tax funds continue to meet vehement opposition from powerful road and highway lobbies.

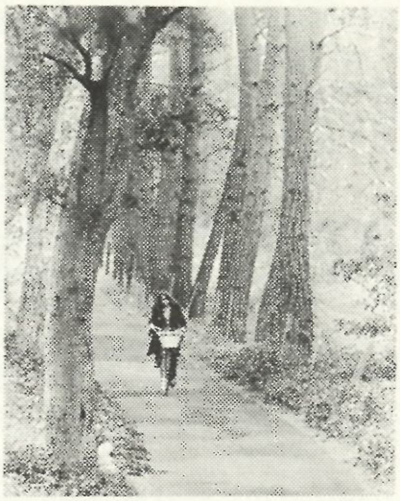


Photo by Jack Wilson

What could a bicycle community be like?

Here's a practical, viable alternative. Well-defined bikeways, separated from cars, radiate from residential neighborhoods to schools. On-street car parking gives way to protected bikeways on key thoroughfares. Bicycle storage facilities are located throughout the city. Commuters bicycle to public transportation stations, store their vehicles, and continue by bus or rail into commercial sectors of the city. Buses going into the countryside have racks to hold bicycles. Adequate bus and rail facilities play a key role, especially during bad weather. That's what we could have!

Friends For Bikecology is trying to help

Friends For Bikecology has been working two years for more and safer bikeways. We sponsored National Bikecology Week in May 1972, involving thousands of people in more than 70 cities throughout the nation. This activity served to publicize our ideas and goals and to win the support of many legislators and planners.

We have two main objectives. First, to see that bicycle, bus, and rail transportation receive an equitable share of public funds. In 1972, *$22 billion* of our gasoline and *property taxes* were spent in the United States for roads and highways, while *less than one billion* went for public transportation. And practically nothing was provided for bikeways! We must convince policy makers to support a balanced transportation system, including bikeways. Motorists will also benefit because congestion on roads and highways would be relieved.

Our second objective is to convince planners to "THINK BIKE!" They should see the bicycle as an essential part of the larger transportation system and an integral part of community life.

The facts are on our side. Traffic studies show that 43% of all urban work trips made by automobiles are four miles or less; and in 9 out of 10 trips, the driver is the sole occupant. These trips could just as easily be made on bicycles. Bicycles will even conserve the taxpayers' dollars. For example, a downtown auto parking structure costs approximately *$4000 for each car space* — enough to build an enclosed facility that can hold *150 bicycles*!

How you can help Bikecology help you

We can help bring about needed changes that will benefit everyone.

Bike rider or not, if you are interested in a safer, more sensible transportation system, please send us a contribution of $5 or more. You can also help by writing your local, state and federal representatives, asking them what they are doing to support bicycling and public transportation facilities.

As a Bikecology supporter, you will receive a copy of our poster-style newsletter, *"Serendipity"* — a mosaic of bike-related items.

Please mail the coupon and your check for $5 or more to help Friends For Bikecology continue this important work. Thank you.

KEN KOLSBUN, Executive Director

Friends For Bikecology
1035 E. De La Guerra St.
Santa Barbara, Ca. 93103

I am enclosing my contribution of $5 or more to help Friends For Bikecology in their endeavor to obtain sound transportation including more and safer bikeways.

Amount enclosed $______

Name______

Address______

City______ State______ Zip______

Please make check payable to **Friends For Bikecology**

SOME MEMBERS OF OUR NATIONAL ADVISORY COMMITTEE

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STEWART UDALL
Former Secretary
of the Interior

GAYLORD NELSON
U.S. Senator

require an additional 280,000 megawatts of new electrical generating capacity by the year 2000.

Next, let's look at the industrial and commercial sectors in terms of the end uses involved. Process steam is perhaps the largest of these end uses. There is no problem in furnishing process steam directly from a nuclear reactor. There is a logistical problem in getting the steam to the user, but perhaps in the future we may be building industrial plants in clusters around nuclear steam generating facilities as a matter of course.

This switch in energy source adds a requirement for 800,000 megawatts by the year 2000. Direct heat end uses will probably be served by resistance and induction heating. Although these processes are not at efficient as the heat pump, none of their heat goes up the flue as with a combustion process, so that the waste heat that would escape during the burning of conventional fuels can be saved.

Direct heat applications require 700,000 megawatts of additional installed capacity. Incidentally, from a Btu standpoint, they will save an equal number of equivalent megawatts of capacity by eliminating energy lost "up the stack". Space heating applications in the non-residential areas can also take advantage of the economics which come with the use of heat pumps. This would call for an additional 300,000 megawatts of capacity. Water heating and other miscellaneous applications would require 130,000 megawatts of additional capacity.

What will be the total effect, then, of substitution of electric power for our rapidly depleting energy forms, oil and gas?

First, let's look at a conventional projection of electric generating capacity through the year 2000, one which assumes no "energy crunch" and no substitution for these depleting energy fuels. On that basis, generating capacity would grow from roughly 380,000 megawatts today to 670,000 megawatts by 1980 and to 2 million megawatts in the year 2000.

Adding up the extra requirements for electric power caused by substitution for direct energy fuel end uses in the residential, commercial, industrial and transportation sectors, we find that 2.8 million additional megawatts of power will be needed, resulting in a total installed electrical generating capacity in the U.S. of 4.8 million megawatts in the year 2000.

This would require that the average annual growth rate between 1980 and 2000 would be 10 per cent instead of 6.5 per cent as now assumed. Capacity would be doubling every seven years, and yearly generating additions would be more than triple previous estimates, reaching 600,000 megawatts in the year 2000.

And it should be pointed out that through the substitution of electric power in the use of heat pumps and electric vehicles energy savings equivalent to 3.5 million megawatts of capacity are achieved.

Now, what does all of this mean?

First, it should be realized that the foregoing is <u>not</u> a projection -- it is merely an exercise to determine the upper limits of electric power capacity additions <u>IF</u> we were to accomplish 100 per cent substitution of electric power for all existing and future gas and oil end uses. What it does tell us, however, is traditional forecasts are much too conservative -- that we are going to need more than 2 million megawatts of electrical capacity in 2000 AD. Somewhere between 2 million and 4.8 million megawatts of power. In addition, we do not take into account future technological changes relating to improvements in efficiency in generating, transmitting and consuming power which cannot be foreseen today. It cannot foretell changes in economic and social behavioral patterns which may come about and affect the energy consumption in such sectors as commercial and transportation. For instance, as we become more tightly linked together in a communications network the housewife of the future may never have to go shopping; she can simply order her groceries via closed circuit television from a nearby supermarket which is never physically open for business. Expanded communications may well obviate the need for tomorrow's executive to drive into the office -- he may have his office at home and conduct his business through the use of sophisticated communications media such as holographic TV, which could project a three-dimensional "presence" in an office miles away. Trips to the dry cleaners may be a thing of the past as clothing that does not soil or wrinkle is developed. These and many other changes may well affect our energy use patterns, lowering by a substantial amount the energy required in the transportation and commercial sectors but increasing by a smaller fraction residential energy consumption.

While it may be amusing to speculate on what the world will be like tomorrow, there is one fact that we cannot overlook today; and that is that we do not have enough of the energy fuels upon which we depend most heavily to get us to that world of tomorrow.

Substitution of energy sources is not just a possibility, it is inevitable.

I am certain that the implications of this fact are obvious. While we as a nation struggle to increase our production of gas and oil, we must at the same time consciously be paving the way for substitution of electric power for these dwindling fuels. As we devote record levels of funding to energy research and development, we must also be developing the high efficiency battery for electric commuter cars and sophisticated mass transit facilities which are electrically powered. While we improve the insulation of our homes, we must strive for more efficient appliances and promote the substantial benefits of the heat pump for space heating. While we explore for additional reserves of gas and oil, we must assure the orderly installation of electric power generating plants using coal and nuclear power, not gas and oil, as fuel.

Coal and nuclear power do have the capability to meet our energy demands essentially for centuries to come. The technology of pollution-free coal combustion is within sight, and the breeder reactor program, which is now under way, will have the effect of extending the potential energy contained in our uranium reserves for centuries into the future.

Incidentally, our projection of additional capacity installations necessitated by substitution of electric power for gas and oil uses, calls for a substantial increase in the use of coal -- a consumption of five and a half times the 1970 level by the year 2000. Thus, the coal industry should have nothing to fear from nuclear energy or any other fuel source. Coal will complement nuclear power, and the outlook for the industry is bright indeed.

Let me briefly comment on certain other potential energy sources which have been touted as holding the solutions to all our problems.

There are four non-depletable sources of power which have been highly publicized lately -- geothermal energy; wind energy; tidal energy and solar energy.

Geothermal can furnish but nine-thousandths of a "Q" of energy or the equivalent of 100,000 megawatts of power. This is the theoretical limit on the available energy from the world's known geothermal steam resources. Wind energy is probably good for 30,000 megawatts, and this, of course, is intermittent. Tidal energy, while it can potentially furnish nine million megawatts, assumes such unlikely events as damming the Chesapeake Bay and other port facilities throughout the world,which seems both impractical and unlikely.

Solar energy is plentiful, but there are three major areas which will require significant technological development before solar energy can make any substantial contribution to the energy problem. These relate to energy collection, transportation and storage. Development of solar power plants is expected to be on the same time scale as fusion, so that even if development is successful, solar power will not be available until after the turn of the century.

Fusion holds the real promise -- and I underscore the word promise -- for almost limitless energy, since it would be able to use the deuterium content of the oceans as its basic fuel. Of course there are many problems to be solved before fusion becomes a reality. However, I believe it should be possible to demonstrate the feasibility -- that is, to show that you can get more energy out than you put in -- within the next decade or so. A fusion demonstration plant could be expected during the 1990s. Even if we achieved this timetable, widespread commercial use would be several decades beyond the 1990s, not soon enough to provide a meaningful solution to the energy problems of the 1980s and 1990s.

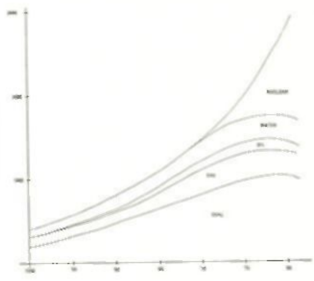

Fig. 1: Sources of electric power in the U.S.

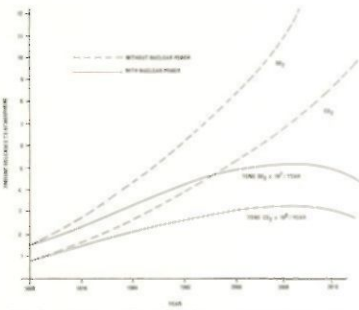

Fig. 2: Projected releases of CO_2 and SO_2 pollutants by the electric power industry.

Unidentical twins.

What do you call two stereo systems that have identically the same insides, but not the same outsides?

Well, you call one a Sylvania compact stereo system. It's stacked and compact with tuner/amplifier, turntable, and tape player all in one unit.

And you call the other a Sylvania component stereo system. Each unit is separate so you can spread it around any way you want it.

Inside, though, they're the same. Both have an RMS rating of 12.5 watts per channel (20 watts IHF) with each channel driven into 8 ohms. There are identical FETs, ICs, and ceramic IF filters in the AM Stereo FM tuner/amplifiers. Both offer the same switchable main and remote speaker jacks, headphone jacks, aux jacks, tape monitor, and built-in matrix four-channel capability for the new quadrasonic sound. The turntables are Garrard automatics with magnetic cartridges and diamond styluses. The 4-track stereo record/playback cassette decks are the same. And both air-suspension speaker systems contain two 8-inch woofers and two 3-inch tweeters.

So if they're the same, how come they're different?

Because different people want the same great stereo sound different ways. So we give it to them.

Come on down to your Sylvania dealer's for a look and a listen.

Then you can pick the shape you want as well as the sound you like.

GTE SYLVANIA

Sylvania Entertainment Products Group, Batavia, N.Y.