cing of the 200-Gev accelerator at Batavia, Illinois, in a gingerly way, but this year has taken the plunge of seeking authority to obligate $102 million for construction. Expenditures on the project, however, would amount to $20 million in fiscal 1970.

In the medical and health research sector no dramatic movement is called for in the budget. For the National Institutes of Health, Congress is asked to appropriate $1.49 billion in fiscal 1970 as compared with $1.40 billion this year. The budget request for the National Institute of Mental Health is $367 million compared with $350 million this year. For medical research this will be, in a double sense, a transition year, since not only is a new administration moving in but NIH's old friend and patron Senator Lister Hill is leaving the Senate and his strategic chairmanships on the Labor and Public Welfare and Appropriations committees.

The new budget is virtually bare of requests for big increases. There are some incremental raises asked in the mass of new education, social, consumer protection, and environmental programs passed in the Johnson years. But the outgoing administration seems to have resisted whatever temptation there may have been to bloat its farewell budget and thus leave its successor with the difficulty of reducing requests.

Last week was a time of arrivals and departures in Washington. The swan songs heard at agency budget briefings were tinged with regret that time and money had run out, but the mood was more of leave-taking than stocktaking.

One interesting obiter dictum came from Ivan L. Bennett, deputy director of the Office of Science and Technology (OST), who handled the OST briefing. Bennett was asked, in effect, what he thought accounted for the hold down in growth of federal science in recent years. (Bennett, who is taking over as director of New York University Medical Center and an NYU vice president, came to Washington from Johns Hopkins where he was head of the Department of Pathology.) Making clear it was one man's opinion and not an agency view, Bennett said he did not think the malaise in federal science funding could be attributed primarily to the impact of the Vietnam war. Bennett said that in the 1960's rapidly increasing federal science spending had acquired political "visibility." The science budget now represented about a third of controllable expenditures in the federal budget and had reached a size where it would continue to be "examined very closely." Bennett found the pathology of the federal science funding not all gloomy, however. He said he felt the science budget would begin to grow again, probably at a rate close to the rate of increase of the gross national product, and that the new surge forward would perhaps begin in "two or three years."—JOHN WALSH

# Steam Cars: Jet Tycoon, Others, Espouse the Cause

*Reno, Nevada.* While the auto industry and the federal government continue to study the feasibility of alternative forms of automotive power that will not emit harmful pollutants into the air, William P. Lear is putting his business experience and his money into the production of such systems right now. At a former Air Force Base 10 miles north of here, Lear is developing steam engines, and he plans to be producing 1000 engines a day by the end of 1970. Developments here and at Newport Beach, California, where Donald Johnson of Thermodynamic Systems, Inc., has developed a small and highly efficient steam engine for automotive use, indicate that relief from contaminated air may be not too far away. Lear promises to have steam cars on the market by the middle of 1970—both a moderate- and a high-priced model.

The multimillionaire's arrival on the steam scene came just at the right time, as far as advocates of steam are concerned. Last spring, when the Senate Commerce Committee and Air and Water Pollution Subcommittee of the Public Works Committee held joint hearings on steam-powered automobiles, the steam people said lack of available money was delaying development of their engine systems (*Science*, 5 July 1968).* They were primarily seeking government support at that time, but mainly they were interested in money—anybody's money. They explained how they had solved all the historical problems associated with steam automobiles—slow start-up time, problems of freezing, heavy and complex engine systems. They felt that they had a feasible solution to the problem of automotive air pollution, and that their engine was competitive, in both cost and performance, with the internal-combustion engine. Calvin Williams and Charles Williams showed the senators their steam car, which had been tested for emissions after 25,000 miles and found to have released about 1 percent of the pollutants that an uncontrolled internal-combustion engine emits. But the Williams brothers—and the other steam experimenters who testified—were almost broke (the Williamses have since gone out of business), and no money was in sight.

"I looked around," Lear told *Science* in a recent interview, "and saw that if somebody didn't do something, the auto industry would bury steam just like it had done before." So he decided to do something.

Lear had already decided to bring industry to Reno, in the hope of providing some diversification for the gambling-dominated economy. Besides the steam project, Lear has set up Titanium West, which will produce titanium ingots; he also plans to produce power alternators and automatic airplane pilots, and to start a charter jet service and a precious-metal refinery. He sees his enterprise as providing the industrial base for a future technical community here that would also include the nearby Desert Research Institute and the University of Nevada (*Science*, 23 August 1968).

All of this would probably sound fantastic were it not for the fact that

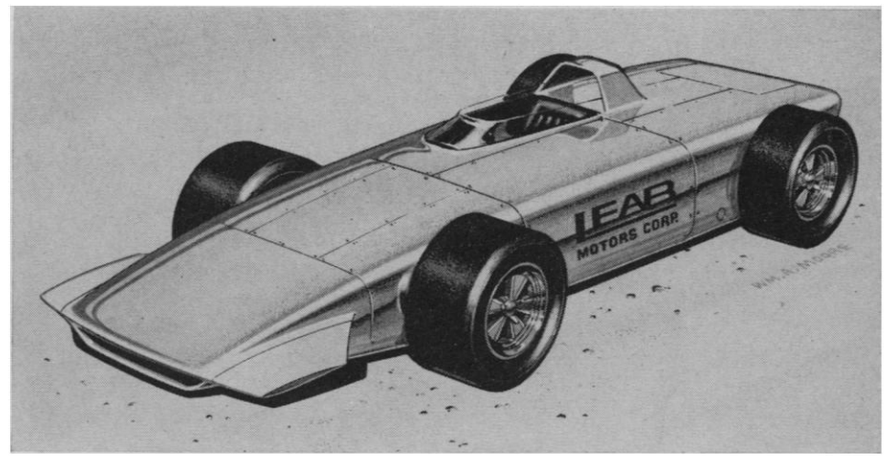
*A Senate Commerce committee study report based on the hearings is expected to be released in late February or March. Sources in the committee indicate that the report will carry a recommendation for possible legislation backing research to aid in the development and marketing of a viable steam car engine.

Lear has made a name for himself as an industrial innovator, in addition to accumulating a considerable fortune. He likes to tell people how his fellow industrialists said he was crazy when he began to develop the Learjets, which became a very profitable undertaking. With the steam automobile he is apparently treading on even more perilous ground, but he seems willing to accept the risks. He realizes that he is, as he puts it, "incensing" the auto companies with his plans, but he seems to feel that he will win. "In 20 years," Lear says, "the internal-combustion engine will be an oddity."

Many people feel, however, that Lear's cars will not be competitive with Detroit's cars for a long time to come. "There's still a lot of work that has to be done on steam before it will be able to supplant the internal-combustion engine," John Maga, executive officer of the California Air Resources Board, said in a recent interview. "It will have to be able to do more than simply drive a car down the highway. Until I see a couple of hundred steam cars and see reports from people who were satisfied with them, I'm afraid I will continue to be skeptical."

To turn his plans into reality, Lear has bought the services of some talented engineers, one of whom, Ken Wallis, played a major role in designing the STP gas turbine car that ran so well in the Indianapolis 500 in 1967. In fact, Lear has plans to enter two steam cars in this year's Indianapolis race, with famed driver Parnelli Jones behind the wheel of one of them.

But steam cars still face difficulties, no matter how much money is put into them. The auto companies remain critical, as they were at the Senate hearings. They continue to cite the problems historically associated with steam-driven automobiles. In an effort to find out what steam cars can really do, the California legislature has asked the California Highway Patrol to put steam engines in six of its patrol cars and to evaluate the performance and emission characteristics of the vehicles. The program, as one California official put it, is to "show that the technology exists right now that can solve the air-pollution problem." Some air-pollution authorities are more cautious in their judgments, but all realize that there is a need to find some solution to the air-pollution problem in this country. Federal officials are looking into steam, but, like the auto companies, their efforts are aimed mainly at studying, not




Drawing of steam racer being built for possible entry in the Indianapolis 500.

# An Inspirational Film on Apollo 8

NASA released a 28-minute film entitled "Debrief: Apollo 8" last week, which shows the first manned flight around the moon and gives several excellent photographic views of the moon and the earth from Apollo 8. Like other NASA films, this 16-millimeter color movie may be borrowed without rental charge.*

As well as being a documentary, this film on Apollo 8 is an interesting public relations document, made with keen attention to strengthening NASA's national political base. From suits to nuts, the movie credits the states of the Union that produced various parts of the project (first-stage engines from Louisiana, astronauts' space suits from Delaware . . .). "The genius and the sweat of literally the entire nation ride the mission," the narrator says.

Interspersed throughout the film are comments in praise of the space program by such national luminaries as historian Arthur Schlesinger, Jr., Bob Hope, Henry Ford, and science-fiction writer Isaac Asimov. Harvard astronomer Leo Goldberg talks about the "enormous scientific importance" of Apollo 8. IBM's Board chairman Thomas J. Watson, Jr., expresses his thanks that the United States is now leading the Russians in the space race. The film ends with a close-up of a giant American flag and the word of Lyndon Johnson's favorite philosopher, longshoreman Eric Hoffer, about Apollo 8: "I'm just tickled to death that this thing is being done by squares—you know by average Americans, not by these pretentious intellectuals."

The film-makers also emphasize the importance of religion. In addition to featuring the astronauts' reading from the Book of Genesis, the film is given an inspirational beginning, to the accompaniment of low music and pictures of the heavens, with a statement of Norman Vincent Peale, the popular preacher who performed the recent marriage ceremony for President Nixon's daughter.

At the end of the film, philosopher Hoffer spectulates on the "fancy" that men may have originated in outer space: "Hence our preoccupation with heaven, with the sky, with the stars, with a God who is somewhere out there in outer space. It's a kind of homing impulse . . . we are drawn to where we come from."

Perhaps NASA is on the right track toward building popular and budgetary support for the space effort. After all, how can congressmen bring themselves to vote against programs which bring the nation closer to God?—BRYCE NELSON

* Those wishing to borrow NASA films should write their nearest NASA Research Center or NASA Headquarters, Code FAD, Washington, D.C. 20546 (listing alternative showing dates). A booklet giving details on the other "general interest" NASA movies and a list of "selected professional and technical films" may also be obtained from NASA headquarters.

# NEWS IN BRIEF

• **HANDLER ELECTED**: Philip Handler, chairman of the National Science Board and professor of biochemistry at Duke University, has been elected President of the National Academy of Sciences. He was unopposed.

• **SOBELL FREED**: Morton Sobell, an electrical engineer convicted in 1951 with Julius and Ethel Rosenberg for allegedly aiding in the conspiracy to transmit atomic secrets to the Soviet Union, was released on 14 January, after serving almost 18 years of a 30-year term. The efforts to bring about Sobell's release on grounds that the evidence was flimsy and that the lengthy sentence was generated by Cold War emotion (see *Science*, 23 Sept. 1966), sparked the raising of funds estimated at nearly $1 million for legal action. Sobell was released not because of court action, but because his sentence was reduced for good behavior.

• **PRINCETON AGREES TO COEDUCATION**: The Board of Trustees of Princeton University has approved, in principle, coeducation for the 223-year-old school. Robert Goheen, Princeton's president, said that no date or specific plan for admitting women will be announced until late spring. Princeton, which has an undergraduate enrollment of about 3200, is expected to provide for an additional 1000 women undergraduates. In making the decision, the trustees said that Princeton's noncoeducational status has been hurting it in admissions.

• **GIFT TO GEOLOGICAL OBSERVATORY**: A gift of $7 million—one of the largest single gifts in Columbia University's 215 year history—has been given to the Lamont Geological Observatory in Palisades, N.Y., by the Henry L. and Grace Doherty Charitable Foundation. The gift will be used to stabilize the salaries of research scientists who do not have academic appointments and have been dependent in the past on federal grants for their subsistence; it will also be used for the enlargement of research opportunities. (It is estimated that nearly a half of the Observatory's research funds are devoted to oceanography; about 40 percent of its budget is spent on seismology and earth research; about 10 percent is earmarked for space physics and planetary sciences.) The name of the 20-year-old observatory will be changed to the Lamont-Doherty Geological Observatory in honor of Doherty, who was a businessman in the gas, oil, and electric industries. The Observatory has an annual operating budget of $9 million, about $7.9 million of which consists of federal grants and contracts (about $3.9 million of these are Defense Department contracts.)

• **EARTHQUAKE RESEARCH PROPOSAL**: A federal report recommending research to reduce the potential losses resulting from earthquakes has been released by the Office of Science and Technology. Unlike a 1965 interagency report (*Science*, 15 Oct. 1965), which dealt primarily with earthquake prediction, the present report discusses research on the prevention and minimization of potential earthquake damage through engineering devices, better land use, and subsurface stress relief attempts. The report recommends that the government fund an earthquake hazards study program for a 10-year period at a total cost of $220 million. *Proposal for a Ten-Year National Earthquake Hazards Program* may be obtained for $3 from the Clearinghouse for Scientific and Technical Information, Springfield, Virginia.

• **OE STUDENT PARTICIPATION**: The Office of Education (OE) is moving ahead in efforts to give college students a voice in educational programs that affect them. OE officials recently told *Science* that four OE advisory groups have already appointed student representatives and that 11 such groups are in the process of adding student members. Five students now serve on advisory groups for graduate education, the teacher corps, vocational education, and student financial aid. OE plans to pay their expenses to Washington several times a year for conferences, seminars, and the advisory group meetings. Pending the new commissioner's approval, the program will also include an informal student advisory group, which would provide OE with a sampling of student opinions on other educational issues. The new program will also seek to expand and improve OE's present summer intern program, which now involves some 300 college students in OE projects.

developing. John Middleton, director of HEW's National Center for Air Pollution Control, has said his agency will have a prototype steam vehicle ready in 5 to 8 years. Lear promises to have steam vehicles on the market in about a year and a half. "The government is finally beginning to realize that we may have something," Lear says, "but so far there has been no official interest expressed."

Lear has bid on the Highway Patrol program. But he is not alone. Thermodynamic Systems has also bid, and that company has a complete engine system already built. Although D. S. Leuthje, inspector at the Highway Patrol and head of the steam program, said recently that he would probably select one steam engine maker for all six engines, it may be that both Lear and the Thermodynamic Systems people will participate in the program.

Both engine systems, their developers claim, have completely eliminated all the problems formerly associated with steam. Both use a working fluid of water mixed with soluble oil (5 percent) to solve freezing and lubrication problems. Both systems will be lighter than the present automotive engine systems and will occupy about the same amount of space as present systems. Kerosene, diesel oil, gasoline, or paint thinner can be used as fuel; any of these will provide about as many miles per gallon as gasoline does in today's cars, the developers claim.

R. G. Smith, the vice-president of Thermodynamic Systems, told *Science* that his company was not planning to produce steam cars. They will begin to produce steam engines (about 25 to 30 a month) in February, Smith said, and are interested in other applications, such as helicopters, stationary power plants, boats, and airplanes. "We just don't have the kind of money that is needed to fight Detroit," Smith said. But it seems that Lear does have the money and the interest to do just that.

Lear's engineers were trying to complete the engine system by this month. With his flair for the dramatic, Lear plans an unveiling of his racing car and of a prototype passenger car in mid-February. The two cars will have the same basic engine, but the racer's will probably be larger, to produce greater speeds. The engine has three crankshafts arranged in a triangle, with six cylinders and 12 pistons. As in all steam systems, there is no transmission. Lear says his system will start in 20 seconds at 20 degrees below zero. The

generator (or boiler) is a monotube that will operate almost forever on a supply of water, since the water is recirculated through the condensing system. The generator, condensor, and radiator will all be under the hood of the car, while the engine will be underneath the car. Lear says the engine in the standard model will be about 400 horsepower and will weigh about 65 pounds. The entire system will weigh about 650 pounds—a bit less than the engine system weighs in a regular car. As the size of the boiler is decreased (Lear hopes to bring it down to about two-thirds the present size) the weight of the system will also decrease. A small turbine engine, powered from the boiler, will handle the auxiliaries—air conditioning, power-assist systems, radio, and so on.

The Thermodynamic Systems engine, developed by Johnson, has six cylinders arranged around the shaft axis. Johnson uses a cam, rather than a crank, to convert the reciprocating motion to rotary motion. This, he says, makes his engine lighter and smaller than ordi-

# Scientists Plan Research Strike at M.I.T. on 4 March

A group of professors and graduate students have scheduled a voluntary research halt at M.I.T. on 4 March to focus attention on how the "misuse of scientific and technical knowledge presents a major threat to the existence of mankind." From present indications, the research stoppage will spread to a number of institutions; activities on 4 March are being planned at Cornell and at other universities.

The idea of stopping research as a "practical and symbolic" expression of the apprehension felt by scientists seems to have originated among graduate students and professors in the M.I.T. physics department but, in the past few weeks, has spread to other M.I.T. departments as well. The heads of three departments were among those signing the original faculty statement supporting the research stoppage—B. Magasanik (biology), J. Ross (chemistry), and V. Weisskopf (physics).*

As well as stopping research, the day of 4 March will be devoted to a discussion of problems and possible ways for scientists to initiate political action. Senator George McGovern (D–S.Dak.) will speak on reconverting the U.S. economy from defense to domestic production, Cornell physicist Hans Bethe on the ABM, Harvard biologist Matthew Meselson on chemical and biological warfare, author Gar Alperovitz on scientists and the atomic bomb, and M.I.T. linguist Noam Chomsky on the responsibility of the intellectual. Panels will be conducted on the world food crisis, urban problems, and finding jobs for young scientists and engineers outside the defense industry.

At the beginning, the concern of the graduate students largely focused on Vietnam, but due to faculty feelings, the aims of the research halt have been expanded. The activities are being managed by a steering committee which is equally divided between graduate students and faculty members. The original faculty statement was signed by 47 senior faculty members; last week the statement was sent to the whole faculty for signing. Physicist Steven Weinberg, a member of the steering committee for the 4 March activities, says that "we expect very broad faculty support; on the order of a majority of the faculty."

The faculty statement asserts that "Through its actions in Vietnam our government has shaken our confidence in its ability to make wise and humane decisions. . . . The response of the scientific community to these developments has been hopelessly fragmented . . . The concerned majority has been on the sidelines and ineffective. We feel that it is no longer possible to remain uninvolved. We therefore call on scientists and engineers at M.I.T., and throughout the country, to unite for concerted action and leadership." Among the points which the faculty group proposes are:

► "To devise means for turning research applications away from the present overemphasis on military technology towards the solution of pressing environmental and social problems.

► "To convey to our students the hope that they will devote themselves to bringing the benefits of science and technology to mankind, and to ask them to scrutinize the issues raised here before participating in the construction of destructive weapons systems.

► "To express our determined opposition to ill-advised and hazardous projects such as the ABM system, the enlargement of our nuclear arsenal, and the development of chemical and biological weapons."

The separate statement signed by M.I.T. graduate students also affirms that technology should be redirected "from destructive to constructive ends" and protests the control exercised by the Selective Service System over the work of young scientists and engineers. A canvass will be held in February to enlist the support of more M.I.T. graduate students and undergraduates.

The stopping of research will be done on a voluntary basis; no effort will be made to enforce a compulsory research halt. The planning for the 4 March session is in no way an official M.I.T. activity. One M.I.T. scientist described the attitude of the M.I.T. administration as "friendly but disengaged" toward the research halt, neither opposing the activities nor supporting them.

The M.I.T. organizers are actively encouraging scientists at other universities to schedule similar activities on campus. The M.I.T. protest is indicative of what seems to be a growing desire among the nation's scientists to devote greater attention to social problems and to redirect scientific effort away from military research. Although the thrust of the ideas of the organizers will displease some scientists and engineers, the M.I.T. effort does represent a kind of cooperation between the generations which is rare at universities these days.

—BRYCE NELSON

* Other signers of the faculty document supporting the stopping of research include:
*Linguistics:* N. Chomsky, M. Halle, and G. H. Matthews
*Electrical Engineering:* M. Eden, P. Elias, J. Y. Lettvin, S. Mason, G. Pratt, and A. C. Smith
*Physics:* B. T. Feld, H. Feshbach, K. Gottfried, J. King, F. Low, P. Morse, B. Rossi, and S. Weinberg
*Biology:* S. Luria
J. Feigenbaum, a graduate student in physics, is the coordinator of the Science Action Co-ordinating Committee.

nary crank-type engines. Like the Lear system, the water to be converted to steam is mixed with soluble oil; this eliminates freezing and lubrication as problems. Johnson's system can get up steam in about 15 seconds.

"If it's gone about in the right way," Johnson says, "steam cars could be produced in 3 years." And although his company is not interested in producing such cars themselves, it looks as if Johnson's technology could help show the disbelievers that steam works. "We were originally just looking for a power source suitable for driving a low wing aircraft," Johnson said in a recent interview. "After 3 years of research on all kinds of power systems—turbines, Rankine, internal-combustion, everything—we found that the Rankine-cycle steam engine could do the best job in terms of power-to-weight ratio, torque, and noise. We weren't even interested in emissions. We were just looking for the best power source."

But the emission characteristics have became important. Since a steam car burns almost all its fuel, there is very little unburned material emitted, unlike the case with the internal-combustion engine. Maga, the California Air Resources Board executive, says the improvement in air quality that can be achieved by controlling internal-combustion-engine emissions is very slight. "Last year we had a six percent reduction in hydrocarbons in Los Angeles," Maga said recently. "That kind of progress is very slow." But Maga is cautious in his appraisal of steam cars. "What seems to have been needed up to now," he says, "was somebody with a lot of money. If Lear has been able to solve the problems that have historically been associated with steam, then maybe steam cars will be able to compete with internal-combustion cars. And if they can, that would be very good for air pollution."

—ANDREW JAMISON

*Andrew Jamison, a Harvard junior, last summer worked as a* Science *news department intern.*

# TRACES: Basic Research Links to Technology Appraised

The belief, cherished by most scientists, that basic research plays a vital role in technological innovation was questioned in 1966 by the Department of Defense report *Project Hindsight*, which concluded that contributions to defense from basic research since 1945 have been small. The National Science Foundation (NSF) has recently released the results of a study which found that basic research was of overwhelming importance in five recent technological innovations of wide value. The NSF report, *Technology in Retrospect and Critical Events in Science (TRACES)*, does not rebut the *Hindsight* conclusion, but rather shows that the Department of Defense evidently did not go back far enough in assessing the role of basic research in technical innovation. *TRACES* found that about 90 percent of the basic research behind an innovation has been accomplished a decade before development of the innovation. The *Hindsight* conclusion was apparently correct as far as it went.

The study was made by the Illinois Institute of Technology Research Institute under a $164,000 contract with NSF, and was similar in method to the DOD study. A list of some 20 recent technological innovations of wide importance and diverse application was assembled, from which five were randomly chosen for detailed study—magnetic ferrites (materials used in computer memories and similar applications), the video tape recorder, the oral contraceptive pill, the electron microscope, and matrix isolation (a technique which is revolutionizing certain chemical processing industries). In the detailed study of each innovation a team of experts traced the critical findings, experiments, reports, and so on, backward in time to the innovation's origins in basic research. Each of these was termed a "key event" and was classified as due to "nonmission research," "mission-oriented research," or "development and application." Events were traced as far back as the 1850's.

To take a simple example from the trace of magnetic ferrites, the development of hard ferrites in the late 1950's at the Philips Research Laboratories (Holland) was preceded by two mission-oriented research efforts at Philips in the early 1950's. These in turn were preceded by a sequence of nine nonmission events in crystal chemistry, including Pauling's bond theory of crystals in 1929, Bragg's work on x-ray diffraction in crystals between 1914 and 1920, and Roentgen's discovery of x-rays in 1895. In addition to crystal chemistry, the fields of telecommunications, ceramic materials, and magnetic theory contributed traces of nonmission research, mission-oriented research, and development and application in the history of magnetic ferrites. The traces often interconnect, revealing communication between disciplines, and the overall trace is quite complicated.

The traces for the five innovations show *what kind* of key event occurs *when* in the history of a technological innovation. Separate graphs of nonmission events, mission-oriented events, and development and application events plotted against time reveal some basic facts about the process of technological innovation.

*TRACES* found that, of the 341 key events documented, about 70 percent were nonmission research, 20 percent were mission-oriented research, and 10 percent were development and application. The number of nonmission events per decade reached a maximum two or three decades before the innovation, and 90 percent of the nonmission research was completed 10 years before the innovation. Mission-oriented events and events in the development and application category reached a maximum in the decade preceding innovation. Interplay between nonmission and mission-oriented research and communication between disciplines were important to technological innovation, and in some cases it was evident that mission-oriented research stimulated nonmission research which, in turn, produced events of crucial importance to the innovation.

The team of experts who searched