that will do the jobs it must do. Scientific computers are more economical than general-purpose computers for scientific problems. An engineering school can obtain some "off-brand" machines which are very attractive in an engineering environment. Time sharing and the use of consoles should be approached with great care. These methods provide quick solutions to simple problems at considerable cost; they impede the solution of large, complex, long problems. Reprogramming is a very costly and difficult process. Most machines should be purchased with the idea that they will be used for a long time.

The number of available machines, and their variety, is staggering. A broad and intelligent survey is essential. Table 1 gives a small sample of the range of machines that would be wrong for a given job. Certain summary data (*1*) may be valuable in making an initial appraisal. Manufacturers' representatives are very helpful in supplying specific data on price and configuration, but they are naturally biased when giving advice on what type of machine a particular institution should have to handle its problems most economically. Actual experience in programming and executing problems on a number of machines is highly educational. This exercise is worth the substantial difficulty, time delay, and expense involved, particularly if it is done by the head of the computation center. Advice from disinterested experts who are themselves using a variety of machines is also helpful.

Tomorrow, all may be different. Computers are changing rapidly—too rapidly for easy integration with present methods. A machine which is best for all purposes may appear tomorrow; a programming system which makes consoles cheap and powerful may be completed. Specific recommendations can change quickly. However, an understanding of the costs involved and the capabilities required in solving specific, important problems will continue to provide the basis for intelligent selection.

References

1. *Computer Characteristics Quart.* (Adams Associates, Bedford, Mass.); "Auerbach Standard EDP Reports," *Auerbach Information, Inc., Philadelphia Pubs.; Computer Industry Annual* (Computer Design Publishing Corp., West Concord, Mass.); *Data Processing Systems Encyclopedia* (American Data Processing, Inc., Detroit).

NEWS AND COMMENT

Steam Automobiles: Advocates Seek Government Support for Research

Unlike the aircraft industry, which has always been closely tied to government research and regulation, the automobile industry grew up in a tradition of paying its own way and more or less doing as it pleased. But now, with the automobile pinpointed as a major source of social ills—ranging from air pollution to gore on the highways—the government has begun to get involved. It has set up safety standards, and recently established emission standards for 1970-model cars.

In successfully waging the struggle for less stringent safety standards, the automotive industry demonstrated its strength. Now, its autonomy and independence are again challenged, this time by an alternate form of propulsion—steam—that many regard as a solution to the problem of automotive air pollution. What role the government decides to take regarding the support of research on these new steam-powered vehicles may have a significant effect on the development of automotive transportation in the United States.

In late May, the Senate Committee on Commerce and the Public Works Committee's Subcommittee on Air and Water Pollution held joint hearings on the steam car. The hearings generally concentrated on one point: should the government subsidize research and development in an industry that traditionally has financed its own activities. Representatives from the automobile companies said such action would be undesirable and unnecessary. Proponents of steam cars said that in the interests of cleaner air, government support was essential.

So far the government has shown an unwillingness to subsidize research and development of steam cars, electric cars, or any other low-pollutant vehicles. Its position, as expressed by a Department of Transportation spokesman, has been to "leave it all to private enterprise." And private enterprise's position, as expressed by Henry Ford II and others, has been all but to ignore steam-powered vehicles because, as auto company spokesmen have candidly stated, they have a huge investment in the internal combustion engine. Ford and General Motors are conducting research on steam cars, but, as attested to at the Senate hearings, they feel that their most advantageous approach to pollution problems is the development of better emission controls for internal combustion engines.

The steam proponents testified, however, that internal combustion engines could never reach the low emission levels of steam engines without impractical and cumbersome controls. Charles and Calvin Williams, two steam engine manufacturers who have spent over 20 years developing steam vehicles, took Senator Edmund S. Muskie (D–Me.) and Senator Howard H. Baker (R–Tenn.) for a ride in their steam car. They said that their car had been tested for emissions of pollutants after 25,000 miles. It had produced a hydrocarbon level of 20 parts per million, a carbon monoxide level of 0.3 percent, and a nitrogen oxides level of 35 ppm. By comparison, the standards recently set for 1970 vehicles by the Department of Health, Education, and Welfare are 275 ppm for hydrocarbons, 1.5 percent for carbon monoxide, and 1500 ppm for nitrogen oxides. Even the Ford representative said that he found it difficult to envision a way to reduce the internal combustion engine emissions to the level already reached by steam cars. "Low emission is not an option with steam power," Charles Williams told the senators, "it is built in, requiring no 'clean air packages,' expensive catalytic mufflers, or other devices whose complexity requires tuning and maintenance."

This testimony led Muskie, chairman of the Subcommittee for Air

and Water Pollution, to take a fairly critical view of the pleas the auto manufacturers made in behalf of the internal combustion engine. Muskie contended that the commitment to the standard engine was based on investment, consumer acceptance, and consumer familiarity, rather than on any actual superiority. "Doesn't all this," Muskie concluded, "add to the momentum of the status quo in a way that may run counter to the public interest?"

By their own admission the automotive companies have not expended the same time, energy, and commitment to steam car research that the "other side" —the steam car advocates—have. The companies' research has been minimal, and it has been heavily biased against steam cars. Ford and GM representatives contend that boiler explosions occur frequently in steam cars. They told the Senate Committee that steam vehicles would also be more cumbersome, expensive, and less efficient than the internal combustion vehicles. The proponents of steam presented an opposite picture. They said that their cars would be cheaper, less complicated mechanically, and safer. Not only were boiler explosions a thing of the past, they said, but the steam car's need for less fuel, and less flammable fuels at that, make it safer than an internal combustion vehicle. In addition, they argued, the steam car would produce practically no pollutants, and would be relatively silent. The Williams brothers said that, with some financial support, their cars could compete favorably in terms of performance with the present internal combustion vehicles.

Steam cars have come a long way since the days of the old Stanley Steamer. The Williams car, for example, can reach speeds of up to 100 miles per hour, and takes less than 30 seconds to start up in any weather. It does away with many of the parts of the internal combustion vehicles, having no need for a carburetor, muffler, distributor, or air-pollution control equipment. It also employs a much simpler transmission and starter. However, steam cars have components that the internal combustion engine does not need, such as a boiler and combustion controls. Many of the basic components are the same for both, however—such as the pistons, cylinders, crankcase, and valves—so that, on a mass scale, there should not be a great deal of difference in price between the two; steam proponents actually claim that theirs would be significantly cheaper to produce. The Williams car can use any distillate fuel to heat the water, although kerosene has been standard. It averages about 30 miles per gallon of kerosene, and can go about 500 miles on 10 gallons of water; seepage causes the need for refilling. Although the Williams brothers claim that they use regular tap water and have had success with it, they admit that distilled water is, in the long run, better for the engine.

However, without government support, steam cars face difficulty. Lloyd D. Orr, professor of economics at Indiana University, told the senators that economic factors, such as resistance to change and so-called barriers to entry, including the high capital commitment necessary to establish a new automotive corporation, all play a part in keeping the steam producers from successfully competing with the internal combustion manufacturers. Theodore Johnson, executive vice president of Thermo Electron Corporation, a company that has tried to work with the motor companies in producing steam engines possibly for boats and golf carts, raised another point. He said that "consumers today do not perceive freedom from pollution in the exhaust

University Heads Seek More U.S. Aid

Presidents of 42 of the nation's major universities issued a statement on 25 June that called for greater federal assistance to higher education.

The appeal, contained in a 30-page paper, was prepared by a five-member committee headed by Robert F. Goheen, president of Princeton University.*

The presidents warned that the "staggering gap" between university expenditures and incomes is widening. They said that despite the high federal costs of defense, the Vietnam war, and urban problems, the federal government cannot ignore the "worsening fiscal crises" in colleges and universities until after these other issues are resolved.

The Association recommended that the federal government expand undergraduate and graduate scholarships and loans, increase support for construction programs, and initiate "broadly based" general aid programs.

The 42 universities that endorsed the position paper together award 52 percent of the nation's graduate and professional degrees and 75 percent of all Ph.D.'s. They supervise more than three-fourths of all federally sponsored research performed in universities. Association executive committee leaders said that the timing of the statement was intended to alert political candidates, Congress, and the Administration to higher education needs.

Executive committee members stressed that besides the fiscal problems which confront private universities, graduate education poses special problems. They said that graduate enrollments may more than double by the end of the century and the cost of educating a graduate student is three to six times that of educating an undergraduate.

The committee also warned that new areas of study, particularly in the sciences, will require large expenditures in the future. They pointed to such fields as molecular biology, oceanography, and the introduction of quantitative methods programs into the social sciences. The committee emphasized that greater federal aid should not be a substitute for, but rather a supplement to, other sources of university income. Pointing out that present corporation and business funds represent less than 5 percent of university income, they said "there is no reason to expect a major break-through in corporate philanthropy" whereby industry and business would pick up a substantially larger share of the support than they give at present.—MARTI MUELLER

* The report and recommendations for federal financing were prepared by a five-member committee of the Association of American Universities. Chairman of the committee was President Robert F. Goheen of Princeton University. Other members were President William C. Friday of the University of North Carolina, President Fred H. Harrington of the University of Wisconsin, Chancellor G. Alexander Heard of Vanderbilt University, and President Nathan M. Pusey of Harvard University. The Association president is David D. Henry, University of Illinois president.

of a vehicle as a desirable feature for which they are willing to pay very much."

Authors of several government reports on the pollution problem support these views. A panel headed by Richard S. Morse of M.I.T., in a study written last year for the Department of Commerce,* recommended that the government support research and development of steam cars. Another report, recently sent to Congress by HEW's National Center for Air Pollution Control, also saw a need for federal support of steam cars and other low-pollutant vehicles. Irwin Auerbach, chief of the legislative section of the Air Pollution Center, told *Science* that "it's pretty clear that some government effort is necessary at least to supplement the activities of industry." He said that his office was examining two studies—one on electric cars and one on steam cars—that it had contracted for, and would then try to determine what role the government should play in steam car research and development. The Center's report to Congress acknowledged that steam cars still faced "significant cost and engineering problems," but said that they "may hold the greatest promise for achieving the low-pollutant levels that will be necessary" in this country in the near future.

At least one congressman—Representative Richard L. Ottinger (D–N.Y.)—plans to push hard for federal subsidies of steam car research and development. He also plans to introduce a bill that would have the government purchase steam vehicles for use by federal agencies.

In the past, Congress has generously provided money for projects considered necessary to the defense of the country. This is why the government took such an active role in the development of the aircraft industry. Congress has been much more wary of supporting projects that are not defense oriented. There have been exceptions, prominent among them being agriculture and health-related activities. But, in most nondefense cases, the government has not been in direct competition with corporations conducting research along similar lines, as it would be if it supported steam car research and development.

—ANDREW JAMISON

* "The Automobile and Air Pollution: A Program for Progress," a report by the Panel on Electrically Powered Vehicles, chaired by Richard S. Morse, of M.I.T.'s Sloan School of Management. In two parts, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Part 1, 60¢; part 2, $1.

AAAS Names Environmental Group

A chairman and eight new members have been named to the AAAS Committee on Environmental Alteration, after months of difficulty in setting up the group. The committee will study a broad range of environmental problems.

Jack P. Ruina, vice president for special laboratories at M.I.T., is chairman of the committee. Other new members include Theodore C. Byerly, U.S. Department of Agriculture; John E. Cantlon, Michigan State University; William M. Capron, Brookings Institution; H. Jack Geiger, Tufts University School of Medicine; Jacob E. Goldman, Ford Motor Company Scientific Laboratory; Oscar Harkavy, Ford Foundation; Walter Modell, Cornell University College of Medicine; and Arthur M. Squires, City College of the City University of New York.

Barry Commoner, of Washington University, and Rene Dubos, of Rockefeller University, had been named to the committee earlier.

The origins of the new committee date back to the December 1966 AAAS annual meeting, when a resolution was offered calling for the AAAS to investigate the military use of chemical and biological agents in Vietnam. Substantial opposition to the resolution resulted in broadening it to include a study of all uses of such agents to modify the environment, whether peaceful or military. To implement this resolution, the AAAS, at its December 1967 annual meeting, established the Committee on Environmental Alteration.

The initial task of the committee was directed toward the Vietnam defoliation issue. The committee was to review a study of herbicide literature that was carried out by the Midwest Research Institute under contract with the Defense Department, as well as a review of that study by a National Academy of Sciences group. However, the AAAS review was delayed when two of four original appointees to the new committee resigned (*Science*, 23 Feb. 1968). Subsequently, the AAAS board decided to conduct the review itself with the help of specialists. The board expects to release a report on its review shortly. Meanwhile, the Committee on Environmental Alteration, divested of its responsibility for reviewing Vietnam defoliation, will set its own tasks at an initial meeting which has not yet been scheduled.—PHILIP M. BOFFEY

House Authorizes Study of Metric Conversion

Last week, nearly two centuries after Thomas Jefferson first tried to get the United States to adopt the metric system, the House passed a bill calling for a study of the problems and advantages of working on a metric measure. The House action, on a bill which has been stalled for years, was accompanied by a decision to eliminate the $500,000-appropriation that the House Science and Astronautics Committee had recommended for financing the first year of the study. As things now stand, the Commerce Department will finance the study out of general appropriations and it will be conducted by the National Bureau of Standards. Since the Senate passed a metric study bill last year, it is expected that the House bill will face no difficulty in that chamber.

The first of several metric-system-study bills was referred to the House Science and Astronautics Committee in 1959. Since that date, Great Britain has announced the beginning of a 10-year metric-system-conversion program, and 14 other countries have made similar decisions. India has completed its conversion and the Union of South Africa has announced similar intentions. New Zealand, Australia, and Canada—the only major countries in the world besides the United States that have not adopted the metric system—are all moving toward it.—M.M.