earthquake-resistant? What predisposing factors govern cellular differentiation and function in plants and animals?

I began with many questions and I am concluding with many still to be answered. I have covered only some of the many activities in which I and my office have been involved—such issues as human nutrition, dam safety, earthquake hazards, mineral policy, space policy, and many other important matters. We are hard at work on what we feel are some of the major issues of our times. It is essential that all work in the basic scientific disciplines advances and provides a sounder basis for our science policy decisions. The work of the scientist must continue to merit and earn the esteem with which the public holds science and scientists.

We owe those who support us and place their hopes in us a very frank and honest appraisal of what we realistically can and cannot be expected to do, what costs and burdens must be borne to fulfill those expectations, and the uncertainties and risks that lie ahead for all of us. "The business of the future is dangerous," Whitehead warned us.

We must throw back certain challenges to them. Nature holds tightly to her deepest secrets and reveals them grudgingly. Patience and endurance are necessary. As John F. Kennedy once questioned, "I don't understand why we're suddenly so fatigued. The struggle won't be over in this century." There will always be uncertainties and unknowns. The quality of our science will reflect our pursuit of excellence throughout our entire society—our education, our public concerns and interests, and our institutions. Our technology will never be foolproof or fail-safe, but always dependent on the human factor—the quality, dedication, and responsibility of our workforce. There is perhaps a moral lesson in all this—we will get, in the long run, the society and civilization we deserve. And, as I recall someone once saying, "Why not the best?"

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NEWS AND COMMENT

Addiction to Technology Is One Cause of Navy's Shipbuilding Crisis

The Soviet Navy's recent dramatic increase in its oceangoing capabilities has made the U.S. Navy—whose fleet is aging and shrinking—anxious to construct more ships. But one of the chief obstacles is the Navy's own shipbuilding program, which has been plagued by delays, high costs, and acrimonious disputes. Shipbuilders' claims against the Navy have reached an all time high of $2.7 billion and some ships are being built only because courts have so ordered. The problem is so serious as to threaten the Navy's ability to fulfill its strategic role at a time when that very role is the subject of widespread debate.

The Carter Administration has begun to urge general reforms on the Navy by using the shipbuilding claims as a lever. An Administration budget official recently warned a group of Navy admirals and others that the problems with the claims were the "single most influential reason" why President Carter had chosen not to accelerate any major shipbuilding programs in the fiscal 1979 budget. If the Navy didn't make substantial progress on the claims within 1 year, Edward C. Jayne III told a shocked audience, the President would continue to favor Army and Air Force budget requests at the expense of new Navy shipbuilding proposals. In short, the Navy leadership of carrier admirals who dominate Navy policy and feel the most urgent desire for more ships to meet the Soviet threat, are being told that the less glamorous, procurement side of the Navy will determine whether these wishes are granted.

But to ex-Navy man Carter, and many others, such as John Stennis (D.–Miss.), the powerful chairman of the Senate Armed Services Committee, plus the House Appropriations Committee and the General Accounting Office (GAO), the Navy claims are only the tip of the iceberg. The larger problem has been called a "breakdown" in Navy shipbuilding, an "all time low" in relations between the Navy and the private shipyards, and just plain "sick."

The cumulative message of several examinations of the more fundamental aspects of Navy shipbuilding seems to be that the Navy is addicted to buying the most technologically advanced ships, even if this means that initial plans are vague, even if constant changes must be made during construction, and even if costs escalate and production is delayed. Many have contrasted this approach with that the Navy followed in World War II when Liberty-type ships were stamped out very efficiently, for a few million dollars apiece.

A destroyer, which cost $5 million during World War II, now costs some $132 million, but the Navy argues that without the advanced electronics, communications, sensors, and weapons which the extra money buys, its ships would be little more than "million dollar floating targets."

Yet even the Secretary of the Navy, W. Graham Claytor, echoed a popular view when he said "there is enough blame for everyone" in the shipbuilding mess. One charge that has been made is that the biggest problem in the program is Admiral Hyman G. Rickover, the 78-year-old father of naval nuclear propul-

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Guided missile cruiser Virginia. *The three ships in her class are now the subject of $159 million in claims.*

sion, whose iron control over all aspects of design and construction of nuclear naval ships is legendary. Rickover's most vocal critic has been a former Navy procurement chief, Gordon W. Rule, who, in a series of speeches has called for Rickover to be disciplined—a charge which brings a taut "no comment" from the Navy. It is noteworthy that claims on nuclear vessels, for which Rickover is responsible, totaled only 17 percent of all claims in 1972, 26 percent in 1975, and has grown to 47 percent of all claims today (Table 1). However, most people do not think Rickover alone is to blame.

Still another whipping boy are the shipbuilding companies themselves. Rickover and other Navy officers have alleged that the yards are inefficient and mismanaged, and that the companies are exploiting the situation to make money. They note that companies often underbid on initial contracts to get Navy business, and then rely on the claims mechanism to make up the difference. They also note that the companies can carry the claims on their books as profit for years—showing a favorable corporate financial picture to shareholders in years when they are actually losing money. The companies retort that carrying some portion of a claim on one's books is required by the securities laws.

Finally, everyone agrees that in the early 1970's the economy played a number of tricks on the shipbuilding industry. The Navy contracts signed during this period did not do justice to the cost burdens of schedule delays when inflation is rising rapidly. The yards took on new work, assuming that the skilled labor could be found, and learned too late that much of their prospective labor force preferred the wages and working conditions of the conventional building trades. A merchant marine shipbuilding boom came and went in the same period. Says Navy Information Chief, Rear Admiral David M. Cooney, "Everybody is blaming everybody else, but the real culprit has been our intractable national economic problems."

Since the claims are only symptomatic of other problems, it is useful to look at how Navy ships are built. *Science* did this by tracing the appropriations histories of some of the programs under dispute and by viewing Navy and commercial ships under construction at one of the major yards at Newport News, Virginia.

The Navy buys ships differently from the way the government procures aircraft, computers, and other items of advanced equipment. This is partly because ships take far longer to build and partly a function of their complexity, which is manifestly greater than it was 15, 20, or 30 years ago.

The process begins, as everyone knows, when Congress awards funds for a new ship. The Navy says it requests a ship only when there exists a military requirement for it. But, in fact, the dramatic decline in the size of the American fleet and concurrent rise of a Soviet global fleet has meant that nearly every year, for some years, the Navy has wanted to start construction of major new ships.

Ship procurement is a fairly political matter. Different administrations have had varying views of the Navy's "wish list" of new ships. During the Vietnam period, for example, money was mainly allowed for building the Poseidon strategic submarines. The Nixon Administration concurred with the Navy's wish to replenish its supply of aircraft carriers and destroyers, and to start building new nuclear attack submarines. The Carter Administration, as Jayne's Newport speech made clear, is trying to hold requests for new ships to the minimum, and in fact cut the Navy's 5-year request for new ships by half.

But even more than the Army and the Air Force, the Navy has close, deeply rooted links to Congress, and is quite capable of sending it the message that it wants new ships anyway, regardless of what any particular administration thinks. Admiral Rickover's congressional ties are among the strongest: his congressional testimony often starts with a long list of the many Secretaries of Defense and Secretaries of the Navy whom he has outlasted, and then proceeds to blast current official policy. And Congress, which properly regards Rickover as a source of tremendous expertise and a key architect of the Navy, often is sympathetic to his requests.

An examination of the history of the ships now under dispute shows the effect of these political considerations. Most were ordered in a hurry (a House Committee report described them as ordered "on a crash basis") around 1970, when the Vietnam war was winding down and the Nixon Administration was sympathetic to the need for more ships. Most were also ordered in bunches, several at a time—despite the Navy's stated philosophy of building a "lead ship" first, and getting it well along to iron out the bugs, before building supposedly identical "follow-on ships" of a new class. Once authorized, ships seem to become locked into a treadmill of intertwined problems, starting from the fact that initial design and costs are vague, and therefore

Table 1. Shipbuilder's claims against the Navy.

Company	Vessels under dispute (propulsion)			Amount claimed (millions of dollars)	Contract year (number contracted)
	Type	Number	Class		
Ingalls-Litton*	Amphibious assault ships (nonnuclear)	5	LHA	1,076	1969 (5)
Electric Boat, General Dynamics†	Attack submarines (nuclear)	18	688	544	1971 (7) 1973 (11)
Lockheed	Destroyer escort (nonnuclear)	1	DE LPD's	165	1960's
Newport News, Tenneco‡	Attack submarines (nuclear)	7	688	359	1969 (2) 1970 (1) 1971 (4)
	Aircraft carriers (nuclear)	2	CVN 68, 69	221	1970 (2)
	Guided missile cruisers (nuclear)	2	CGN 38-40	$ 159	1970 (3)
Total				2693	

*Pascagoula, Miss. †Groton, Conn. and Quincy, Mass. ‡Newport News, Va.

change as construction proceeds. A related problem arises from the Navy's preference for putting state of the art technology, particularly in electronics and weapons systems, aboard every ship, regardless of whether it is the lead ship in a class or one of the supposedly identical follow-on ships. One shipbuilder has even charged that every single ship in a class ordered by the Navy is a separate research and development project of its own.

Navy information chief Cooney counters that some shipbuilders have exaggerated the lack of standardization among ships. Ships of a single class have to be "substantially identical" so that crewmen trained aboard one can serve on board another, and literally "find their way around in the dark." Nonetheless, a number of critics of the shipbuilding program say the number of differences are too large.

For example, one of the big issues in the claims dispute is how much it costs the company when government-furnished equipment is late or defective. But the General Accounting Office, investigating claims in a 1972 study, said:

> One of the major reasons for the Navy's being unable to deliver equipment on time is that the equipment to be supplied is developed concurrently with ship construction.
>
> Some of the features of this equipment exceed the state of the art to such an extent that the equipment manufacturers cannot complete production within the time parameters of the contract. . . .
>
> Whenever the Navy attempts to obtain the latest developments in its new ships, there is a certain degree of risk that there will be a lag in the development of a new weapon system, which, in turn, could cause delay and disruption at shipyards and to the Navy.

Another bone of contention is the number of change orders issued by the Navy while a ship is under construction. One company has charged that, for one vessel, the number of orders totaled 35,000. Even President Carter believes that this is partly caused by poor Navy management, as he told a group of newspaper editors in January:

> I think part of the problem is that we've given the order for submarines, airplanes and other equipment quite early, and then continued with the advanced design during the same period that construction was already initiated, which means that excessive change orders are required.

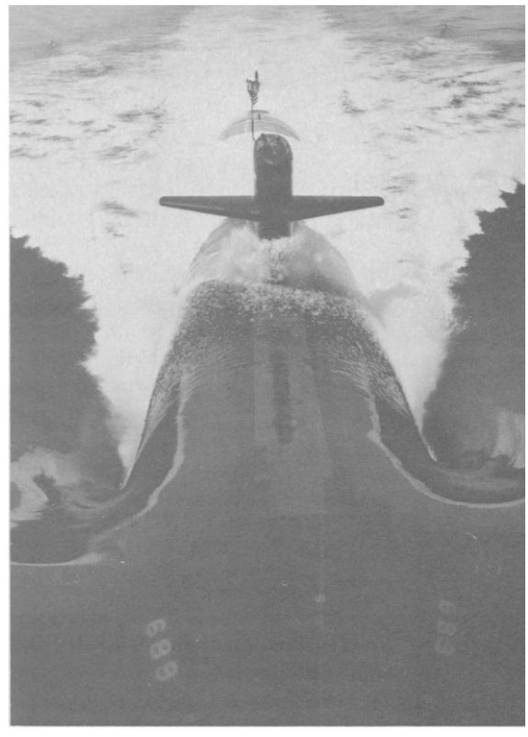
Navy spokesman Cooney notes that it takes so long to build a class of ships that technology cannot be frozen during the entire period without the resulting ship becoming obsolete. But a former Litton official recalls how the Navy used to solve that problem in the 1930's, 1940's, and 1950's, when relations between the Navy and the shipyards were much better and cost and schedule targets usually were met.

> It used to be that the Navy would design a new class of ships, let the contract to the shipyard that would then build about three ships a year for a few years. After a while, they'd know pretty much how to build those ships.
>
> The philosophy used to be that you changed one thing at a time and hold everything else constant. So for one class of ships you'd change the steam plant and nothing else, and then, after you'd built that class you'd start building a new class that changed only the weaponry.
>
> Now I gather they're changing everything, all the time.

The House Appropriations Committee also wrote that the Navy should be able to get its research and development over with before launching into production. It said, "If this country can spend nearly three billion dollars and several years developing the B-1 before entering production, certainly there is a need for more research and development in the acquisition of ships."

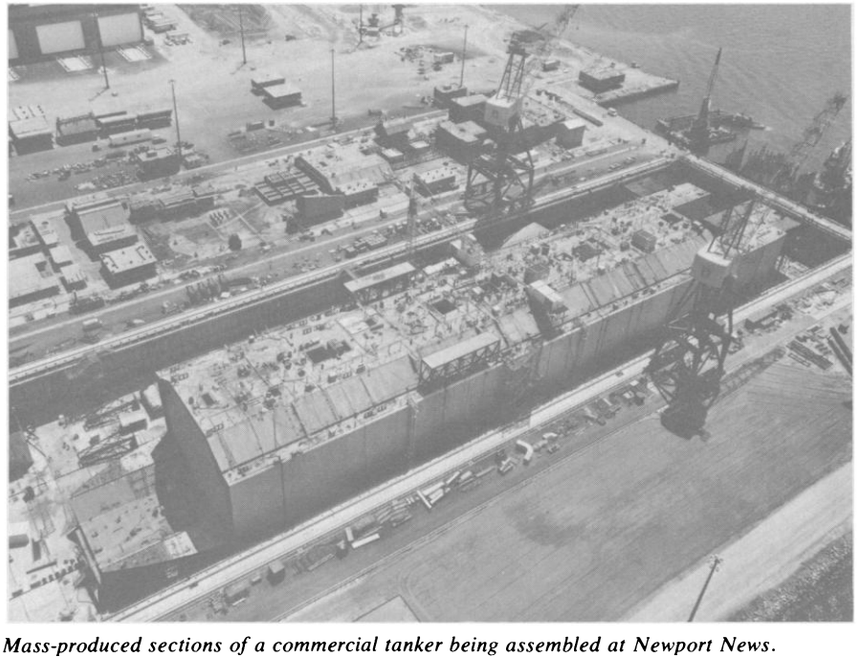
A visitor touring the yard of the Newport News Shipbuilding and Drydock Co., at Newport News, Virginia, gets some sense of the Navy's style of building ships. On one such tour, three 688 nuclear powered attack submarines, like oily, black cigars, were lying in the water alongside outfitting piers. The guide explained that there they will sit for approximately 18 months while electricians, welders, and technicians outfit every inch of their narrow interiors—each of which is about a city block long and only 33 feet wide.

Along other piers sit the nuclear guided missile cruisers, whose gray



Congress approved 22 more nuclear attack submarines of this type before the first was delivered; claims now total $900 million

crowns of antennas, radar lobes, and other sensors hint of the mass of classified electronics crammed within. In one drydock one of the strategic Polaris submarines is being overhauled. It is concealed by tarpaulins from visitors to the yard and from Soviet reconnaissance satellites overhead. Deep down in one drydock there are the stories of steel that will be, by about 1981, the aircraft carrier CVN 70 *Carl Vinson* the yard is building for the Navy even though they have not agreed on a contract for it.



Mass-produced sections of a commercial tanker being assembled at Newport News.

Nearby is the partly finished CGN 41 *Arkansas*, swarming with yellow-hatted workmen even though the court test of the contract options under which the yard must work is not scheduled until February 1979.

Looming up behind these ships are the vast orange and black hulls of the liquified natural gas tankers that the yard is mass-producing for the El Paso Natural Gas Company. Those giant, bulbous ships are as different from the delicate, hand-crafted Navy vessels as a basketball is from a Fabergé egg. Newport News, like other yards, invested in mass production techniques in the early 1970's to be ready for a merchant marine tanker boom that never came; but the potential of the tools remains impressive. The yard has an 11-acre building, where automatic tools suspended from the ceiling slice and weld steel according to preset computer plans. Inside, a workman, with a shoe box–sized portable set of controls, manipulates a giant crane that lifts a 10-ton section like a piece of butter. The identical sections, each of which is large enough to hold a five-story office building, are hauled to drydocks so long that two of the liquified gas tankers can be assembled in a single "graving" dock.

Ideally, Newport News officials say, the shipbuilding industry would like to stop building Navy ships "stick by stick like the Vikings" as they say they do now. After all, a subsidiary yard of the company stamped out 243 Liberty-style ships in World War II, or an average production rate of four a month. If the Navy decided what it wanted was quantities of ships, they say, it would be no trick to turn them out; what hampers efficient production, they say, is the hand crafting, constantly changing, "stick by stick" approach the Navy insists upon.

Round Another Helix in the Legislative Helter-Skelter

The latest twist in Congress's current attempts to draw up a recombinant DNA bill is a move which means that there may be no bill at all. According to his staff aides, Senator Edward Kennedy has now decided that no bill is necessary, a sentiment which is the polar opposite of his position last year but identical to that of the year before.

No one is predicting where Kennedy, or at least his staff aides, will be next week; but on present showing there may perhaps—but not definitely—be no Senate action this session and therefore no legislation at all.

The prospect is welcomed by scientists who oppose government regulation of research in principle, but is causing concern to those who hoped through legislation to preempt state and local authorities from writing rules more restrictive than the existing National Institutes of Health guidelines.

Meanwhile at a meeting last month the NIH committee that wrote the guidelines approved several important changes, including a proposal to delegate authority for initial approval of recombinant DNA experiments from the NIH to institutional committees. Experiments would still be reviewed by NIH, but could begin as soon as local approval was obtained, cutting bureaucratic delay by some 3 to 4 months. The NIH committee also proposed reducing experiments with viruses to much lower containment levels.

If Congress fails to pass a bill, the Administration will then have to choose between continuing the present approach of voluntary adherence to the NIH guidelines, and invoking existing legal authority to give the guidelines the force of legislation. Each choice has its own advantages and difficulties.

It is far too early, however, to rule out the possibility of a Senate bill. The latest move by Kennedy's staff aides is not as inconsistent as it may seem. Although it is ascribed by aides to a change in Kennedy's perception of the hazards over the last 10 months, Kennedy has always seemed to be less interested in the possible risks of the research than in the principle of allowing the public and local authorities a voice in decisions about research. The bill pending in the House, which also has strong general support from certain senators, would preempt that role. Probably not having the votes to defeat preemption in the Senate, Kennedy's staff may hope to obtain the same end by inaction.

Those who favor preemption, such as the NIH and the American Society of Microbiologists, may therefore press for a Senate bill to be passed. Other interested parties, such as Senator Adlai Stevenson, may also favor a Senate bill if the Administration declines to use existing powers.

Where matters now stand is that, at a meeting of staff aides of the Senate human resources committee on 1 May, it was decided that Kennedy would write to HEW Secretary Joseph Califano to the effect that legislation seemed unnecessary if the Administration were prepared to use already existing powers.

Califano's response is hard to predict because the thought of no legislation at all is too new for people to have decided what they would like to do instead. Nor is the Administration all of one mind. The NIH favors strong preemption, believing that a law without preemption would be the worst of both worlds. For this, among other reasons, the agency is lukewarm toward invoking existing authorities, such as Section 361 of the Public Health Service Act, which gives the Secretary of HEW sweeping powers to control communicable diseases but not to preempt state governments.

Other parts of the Administration, however, such as the White House staff, are not so hot for preemption and could live with Section 361. As the result of an internal compromise, NIH director Donald Fredrickson recently testified in support of a weaker form of preemption than that stipulated in the House bill.

"It is our judgment that many aspects we desire could be achieved under Section 361," says Gilbert Omenn, a staff member of the President's science adviser's office. But he also notes that voluntary compliance has worked well.

Kennedy's letter to Califano will probably ask, among other things, if Section 361 is an appropriate vehicle for regulating recombinant DNA. "Our response will be that simple legislation is required, and that 361 is not an appropriate statute," says an NIH official. In the NIH view, the section does not explicitly offer preemption (although some legal opinion holds that it would do so in practice), use of the statute might imply that recombinant DNA could give rise to communicable disease, and in any case Congress should carefully frame a special new law if it wishes to take the step of regulating biological research.

The problem of how to govern recombinant DNA research is as far from certain solution as ever, but the present range of likely outcomes is generally much less restrictive than those prevailing last year.—N.W.

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Newport News officials, as well as most close students of Naval shipbuilding, say that Rickover is part of the program's problem but not all of it. The charge against Rickover is that in the three yards qualified to work on nuclear powered ships, Rickover constantly interferes with the work, requiring work to be redone or changed, regardless of the impact on schedules or costs. His most severe critic has been former Navy procurement chief Gordon Rule, who has said that there are really two navies—one made up of people accountable to Congress and the public and the Secretary, and the other accountable only to Rickover. Rule has gone so far as to name various admirals on the procurement side, whose titular responsibilities have little to do with nuclear power, but who nonetheless conduct the Navy's business the way Rickover wants. He says, "Rickover is constantly injecting himself into the contractural or business side of the Navy, an area in which he has no assigned duties. . . ." As a specific example, Rule has charged that one of Rickover's deputies succeeded in overturning a settlement Rule negotiated with Newport News on behalf of the Navy over the contract options to build the nuclear cruiser *Arkansas*. A second court test of the question is scheduled for next February.

Rule's charges were echoed in a recent article called "The breakdown in naval shipbuilding"* by John Newell, a former executive of Bath Iron Works in Maine. Newell wrote that Rickover "continually redefined the scope of the work and interfered on a grand scale with normal shipbuilding procedures. . . . There will be no improvement until Congress . . . retires every officer in accordance with the statutes."

On the other hand, even his critics say that Rickover's retirement would not change the Navy's method of procuring ships. The habits that have developed in the procurement bureaucracy, they say, will not be eradicated so easily.

The Navy's response to all this has not been limited to trying to settle the claims. "We recognize that we have management problems too," says Rear Admiral Cooney. These, he says, are being studied jointly with the companies' participation by the Assistant Secretary for Manpower, Reserve Affairs, and Logistics Edward Hidalgo. The Hildalgo interim report, issued in 1977, is a listing of charges and countercharges between the Navy and the companies, listing the problems of late government furnished equipment, change orders, and the like.

**United States Naval Institute Proceedings*, January 1978, "The breakdown in naval shipbuilding," p. 25 ff.

It also seems typical of the rest of the Navy's delicate approach to the Rickover issue; the interim document which is 294 pages long, nowhere mentions Rickover by name or singles out the nuclear ship program for separate treatment.

The Navy is also using a new kind of contract that will allow lead ships of a class to be bought on a cost, instead of a fixed price, basis. The new escalation clauses that allow more realistically for double digit inflation, according to Navy officials, are also less likely to get the yards into the sort of economic aggravation that can lead to claims. Finally, Navy leaders boast that at least one new ship, the FFG 7 nonnuclear frigate, recently built at Bath, Maine, is following the lead-ship, follow-ship philosophy and the first ship, the *Oliver Hazard Perry*, was recently delivered on schedule and on cost.

But one ship built on time and below cost does not an entire fleet make; it does not assure that the more complex nuclear powered ships that the Navy is building can also be built on time and below cost. In short, it is not yet clear to the Navy's critics that the service has realized that to go on building state of the art ships means, in the long run, a constantly dwindling fleet.

—DEBORAH SHAPLEY

Science in Europe/Professors' Pay Strike May Lead to Free Degrees

London. Five years of tight budgets and declining real income have left British universities in a delicate financial situation. Academic salaries lag behind inflation and university teachers are threatening, for the first time, to refuse to mark final examination papers if the government does not meet their demands for more pay. In addition, support for research has fallen so far as to threaten an "irreversible decline" in academic standards, according to the University Grants Committee, the body responsible for channeling government funds to the universities.

How serious the situation appears depends on who you talk to. Lord Vaizey, professor of economics at Brunel University in Surrey and an observer of the British educational scene over many years, talks of a "growing demoralisation" in the universities caused by disappointed expectations and the fact that education is no longer held in high esteem. " 'Hold on to your jobs' was once a principle that applied only to politicians," he told a meeting of the NATO Science Committee in Brussels in April. "Today it applies to professors as well. There are so few jobs going that everybody stays where they are."

Laurie Sapper, general secretary of the Association of University Teachers (AUT), also believes the situation is serious. He is leading the AUT into its first experience of industrial action, a baptism not wholly to the taste of some of his more conservative members. But he says that the patience of university teachers has snapped: "even the most conservative of institutions is showing anger that would not have seemed possible 5 or 6 months ago."

Others are more phlegmatic. Sir Sam Edwards, a professor of physics at Cambridge and until recently chairman of the Science Research Council, believes that the situation is difficult but not desperate. Universities could do more to help themselves, he says, if they managed their affairs more efficiently. "The real trouble is that universities are well-adapted to an expanding budget, but don't have a mechanism for managing contraction," he says. "When difficulties do come they respond by spreading the suffering around equally to all the departments, instead of being more decisive and using the money to best advantage."

There are two problems, distinct but interrelated, which have brought about the present malaise in the universities. The first is a dispute over academic salaries which has been festering quietly since 1975 when the introduction of the government's pay policy prevented aca-

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