The laboratory has demonstrated a flexibility that would have been impossible at the national level, he says.

And the major barrier to future growth? "We do not have a good spirit of European collaboration, in the sense that the creation of a strong and aggressive approach to establishing a European effort in molecular biology, as opposed to a collection of national efforts, does not appear to be of enormous importance to member countries." ■ DAVID DICKSON

Defense Research: Promises, Promises

The pressures for cooperation on defense R&D are growing stronger, but so far competition has been the order of the day

NOWHERE are the pressures both for and against closer European collaboration felt more intensely than in defense research.

On the one hand—as the United States frequently points out to its European allies within the North Atlantic Treaty Organization (NATO)—increased collaboration would go far toward raising the overall effectiveness of European defense spending. Duplication of research would be reduced and the weapons procurement policies of NATO member states would be better coordinated.

Set against this, however, is the fierce competition among European weapons manufacturers, particularly for foreign markets in the United States and the Third World. This fuels a desire to protect sales, and thus reduce international cooperation, in domestic markets as a springboard for exports. There is also the political argument that an adequate "defense industrial base" should be preserved for security reasons.

Competition, rather than cooperation, has so far ruled European defense research efforts. Recently, however, there have been various signs that this may be changing. Economic pressures on defense budgets, combined with a growing awareness of the need for a convergence in defense policies, are providing European politicians with a greater incentive for requiring their defense industries to collaborate on R&D projects.

Last spring, for example, when Britain's defense minister, George Younger, announced that he was planning a long-term reduction in the proportion of the nation's R&D budget devoted to military research, he made it clear that part of the saving was to be achieved through increased international collaboration.

Similarly, André Giraud, his French counterpart, has surprised the nation's armaments manufacturers with the enthusiasm with which he has been pushing proposals for greater collaboration with European neighbors—including an agreement to exchange "background information" with the United Kingdom on the two countries' nuclear deterrents.

The most vocal case for greater research collaboration has come from the 13-nation Independent European Program Group (IEPG), which is made up of the European members of NATO, and was established to help ensure a genuine "two-way street" in military technology between the United States and other members of the alliance.

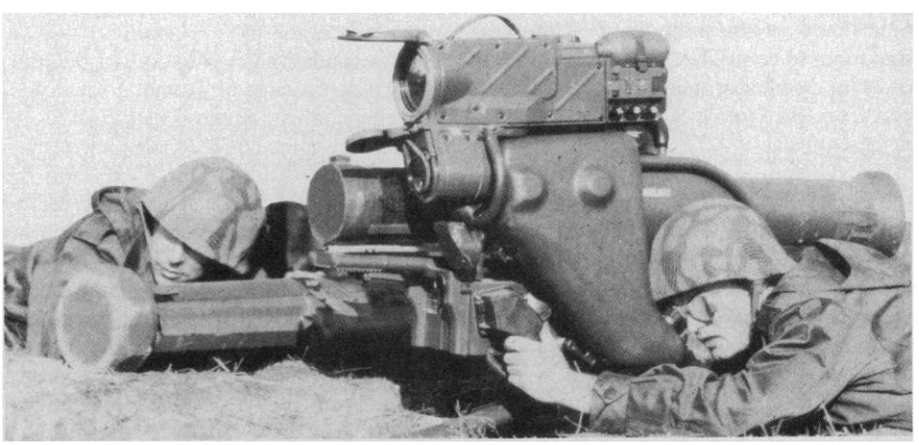
Earlier this year, for example, IEPG published a report prepared by a group under Henk Vredeling, a former Dutch minister of defense, proposing the creation of a joint military R&D fund starting at $100 million a year and eventually rising to $500 million.

Lord Carrington, NATO's current secretary general, has suggested going even further, with the creation of a "European agency for military research," which could coordinate initial work on all new weapons systems. According to Carrington, French President François Mitterrand has said he would be prepared to support the idea if Carrington can win approval from other NATO countries.

Pressures for closer collaboration continue to run up against the opposition of national armaments manufacturers, however. They worry that any attempt to rationalize military research on a European basis would reduce the amount of money they receive from the public purse, and they have warned that the result would be a rise in unemployment.

"We have achieved a lot of cooperation for civilian purposes, but are far behind when it comes to cooperation in military developments," says a member of the science advisory board to France's Ministry of Defense. "Perhaps we need a little more modesty from the industries working for defense; if you come to meetings saying that you have the best ideas, the best materials, and so on, then it can be difficult to persuade others to accept your point of view."

The problems were recently highlighted by tense negotiations over R&D plans for a new European Fighter Aircraft. After the French company Dassault-Bréguet made it clear that it was only prepared to cooperate with other European companies if it were



Franco-German missile. *The Milan 2 antitank missile is a product of a joint venture between French and German companies.*

given the lead role in technical design and construction, a consortium was established by companies from Britain, West Germany, Italy, and Spain—but excluding France.

French Prime Minister Jacques Chirac has subsequently given the go-ahead for substantial government support for Dassault to develop unilaterally its own fighter aircraft, Rafale. But Defense Minister Giraud has made known publicly his reservations about the cost-effectiveness of the deal. "The European Fighter Aircraft is a good example of both the potential and the problems of European collaboration in military technology," says Dennis Brennan of the International Institute for Strategic Studies in London.

In the long term, a full-blooded commitment to collaborate on military research is only likely to result from a political consensus on the need for a common defense policy; or, as one observer puts it, on "the political harmonization of the concept of European defense."

The U.S. invitation to European nations to participate in the Strategic Defense Initiative research program has been one stimulus at the technical level, encouraging discussion of Europe's possible role in the development of those technologies which could contribute to its own space-based defense. Politically, a comparable result was achieved by the agreement on the "zero-option" principle at Reykjavik last fall, which many European leaders felt left them standing powerless on the sidelines.

Within this broader context, groups such as IEPG are already taking steps to encourage greater cooperation in research as a move toward closer European integration in defense policy more generally. A major step in this direction was taken by IEPG last year with the organization of the first meeting of the directors of all Western European military research laboratories.

Many now argue that closer European cooperation is needed to enable Europe to participate in a dialogue with the United States over defense technologies. "It is very important to coordinate European efforts in order to enable Europe to become an equal partner to the United States," says a French defense official.

The United States, while supportive of the logistical advantages of closer cooperation among its European allies, remains wary of such arguments. For example, one of the main reasons Congress decided last year to allocate $200 million to collaborative R&D projects between U.S. and European companies—the so-called Nunn-Warner-Roth amendment—was the fear that a strong and united European voice might weaken U.S. influence over NATO decision-making. ■ **DAVID DICKSON**

Space: It Is Expensive in the Major Leagues

A meeting this fall will determine whether Europe believes playing a leading role in space is worth $30 billion

Paris

EUROPE'S space program is facing a crisis. Space officials and aerospace companies claim that a package of collaborative programs carrying a price tag of at least $30 billion over the next 15 years is essential if Europe is to sustain a major role in space activities into the next century. But European governments are far from united over whether they are prepared to pick up the bill.

A symptom of the crisis is the fact that the ministers responsible for space in the 13 member states of the European Space Agency (ESA) have postponed from June to November a top-level meeting designed to approve a strategy for the agency up to the year 2000. A recent decision by British Prime Minister Margaret Thatcher not to increase the United Kingdom's space budget in the near future (*Science*, 7 August, p. 597, and 14 August, p. 719) has only made the negotiations over the agency's long-term plans more difficult.

But although the immediate cause of the crisis is money, this has merely triggered deeper tensions. As with most major European technological ventures, the space program requires a delicate equilibrium between the political, technical, and economic interests of the various partners. Furthermore a desire for Europe to develop its own independent (and expensive) space capabilities must be balanced against pressures—both internal and external—to participate more fully in the U.S. program.

All was relatively harmonious at the ministers' last meeting in Rome 2 years ago. Complimenting themselves on the success of the package agreed on a decade previously—which included the Ariane rocket and the shuttle-launched Spacelab—they agreed to preliminary design studies of an ambitious set of new projects.

These included a new, more powerful version of Ariane, known as Ariane V, and—as a successor to Spacelab—various hardware contributions to the U.S. space station, known collectively as Columbus. The hardware will include a laboratory module permanently attached to the space station, a polar orbiting platform and, later, a separate free-flying platform that would be tended periodically by astronauts.

Since the Rome meeting, however, the estimated costs of each element in the proposed package have grown significantly, some say almost doubled. And the likely overall costs have been further inflated by the insistence of France's space engineers that a third element be added, the spaceplane Hermes (whose own cost estimates have themselves been escalating rapidly over the past 2 years).

At the same time, the governments of Britain, West Germany, and even France—three of the four largest contributors to the European space budget—have each been increasingly reluctant to provide public funds for large-scale technology projects in a time of economic constraint, arguing that a greater share of such commitments should come from the private sector.

The November meeting could therefore be a key test for the future viability of ESA itself. The agency was set up in 1975 as an amalgam of the (successful) European Space Research Organization and the (less successful) European Launcher Development Organization. It currently has a budget of about $1.1 billion a year and a staff of 1400 scientists, engineers, and technicians.

ESA director general Reimar Lüst points proudly to a string of ESA achievements. These include, in addition to Ariane and Spacelab, last summer's encounter of the spacecraft Giotto with Halley's Comet. "We have shown that we can work together in Europe, not only in basic science, but also in fields of advanced technology where we have a high level of industrial competence," he says.

The problem now is whether this achievement can be repeated in the new political climate of the late 1980s. Or rather, whether European governments, which together spend on space less than one-sixth the amount spent by the United States and an even smaller proportion of that spent by Soviet Union, can be persuaded that this difference in funding is a major weakness requiring a significantly increased injection of public funds.

As far as the technology is concerned,