cism of the programs, but regret that great numbers of minority students have no opportunity to participate in them. The point made by keynote speaker Herman R. Branson, president emeritus of Lincoln University and now director of the precollege science and mathematics research program at Howard University in Washington, D.C., was that it is necessary to interest minority students in science at an earlier age and provide them with basic mathematics and science training. Otherwise the choice of research careers is effectively foreclosed. He called the two programs "an oasis in a desert of defeat and despair."

The congressionally founded Institute of Science, Space, and Technology is designed to address broader questions of minority access to science. Prime mover in the effort to establish the institute was Representative Mervyn M. Dymally (D–CA). The institute is intended to provide a national focus for efforts to promote minority competence and involvement in technical areas. One early aim is the creation of forums in congressional districts to foster discussion of successful models in science education for minorities. Still very much in its formative stage, the institute is headquartered at Howard.

NSF's initiative extends its expansion of specialized research centers to minority institutions. NSF's first two minority research centers will be established at Howard and at Meharry Medical College in Nashville. The centers will offer research support for science faculty members and seek to attract minority students to science careers through scholarships and a variety of outreach efforts to other higher education institutions and to schools. Howard and Meharry will each receive $5 million for the centers over 5 years. NSF plans a total of six minority research centers.

Other specifically labeled minority programs in the foundation provide a total of about $10.5 million for graduate fellowships for minority students, funds for improving research facilities in institutions with substantial minority enrollments, and grants to permit minority scientists to make a start as NSF investigators. NSF staff says that the support minority institutions and individuals receive under regular foundation programs usually exceeds that provided under the special minority programs.

Drawing conclusions on what the flurry of conferences, reports, and program initiatives signifies requires caution. Concern about minority underrepresentation in science has been cyclical. This time may be different, however, since the concern is driven not only by considerations of equity, but also by an emerging consensus on manpower needs. ■ JOHN WALSH

Reinventing the Space Truck

NASA and the Air Force are off on a race into the past, ransacking technologies from the 1970s and 1960s to create a new space cargo vehicle to launch heavy loads

ENERGIA, a 198-foot pile of Soviet rocketry, took off from a launch pad near Tyuratam on the evening of 15 May carrying a test cargo of 220,000 pounds. The news gave a jolt to U.S. rocket designers, who have been engaged since early this year in a campaign to build a cargo vehicle for the United States. Working in competing teams for the Air Force and the National Aeronautics and Space Administration (NASA), they hope to develop a new, unmanned space truck.

Energia, in comparison, might be called a space barge. The weight of its payload was more than the entire U.S. shuttle fleet could carry if all four orbiters (including the one not yet built) were launched at once.

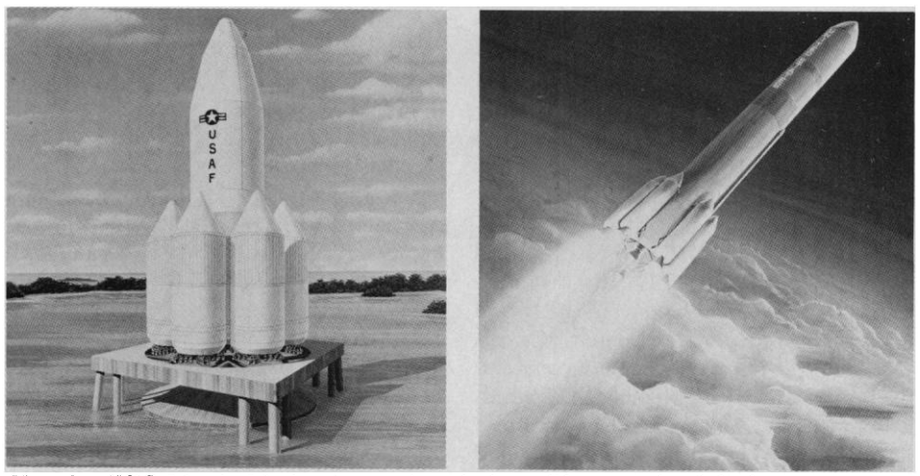
Experts were dazzled not only by Energia's muscle, but by its use of high-thrust, supercooled fuels. These had not been seen before on a Soviet launcher, even though the shuttle and other U.S. systems have used liquid oxygen and hydrogen for 20 years. It also was a surprise to hear the Soviets announce the test in advance—a sign of confidence.

Meanwhile, the U.S. shuttle is in the doldrums. Several reviewers, including a NASA advisory group headed by retired Air Force General Jasper Welch and a National Research Council panel headed by Robert Seamans, Jr., have urged that the shuttle not be used for cargo but treated as a rare and fragile tool. It should be held in reserve for unusual missions that must involve humans. "It just doesn't make sense to use this precious resource for a truck," one panel staffer says.

For cargo missions, both the Air Force and NASA want to build a new, heavy-duty rocket. The Air Force may need one to carry millions of pounds of weapons hardware to orbit each year for the Strategic Defense Initiative (SDI), and NASA needs one to orbit large components of the space station in the mid 1990s and to send planetary exploration craft into deep space.

In July, the two agencies were asked by Congress to begin working together on a joint R&D project, but so far they have hardly been able to sit at the same table. They agree that the new launcher must be able to carry twice the payload of the shuttle, but apart from that, their specifications do not merge. Since Energia's launch, the rivalry between the two has grown intense, and at times they seem to be competing more with one another than with the Soviets.

This summer, NASA's Marshall Space Flight Center in Huntsville, Alabama, and the Air Force's Space Division in Denver, Colorado, began a kind of world series of



Need a lift? *Martin Marietta's entry into the heavy lift sweepstakes (left) features a cryogenic core stage and multiple strap-on boosters. Hughes Aircraft's rocket (right) would have 32 or more Centaur engines packed together in bundles of 8.*

rocket design. The big aerospace companies are taking part, and some have joined on both the Air Force's and NASA's side. Preliminary contracts have been awarded and if the program receives full funding, the first test flight is expected in 1993 or 1994. No hearings have been held as yet, and according to congressional aides, the first important funding decision is 6 months off.

As the competition gets under way, however, some policy issues have come to the fore that may need review. One is the question of who will actually control the final design. If the Air Force and NASA cannot agree, as seems likely, which is to be eased out of the game, and how? There are some hints as to how this might happen, but no clear decision. There is also a question about size: is it necessary or wise to have both the large payload capacity and the frequent flight capability that has been mandated? Perhaps it would make sense to allow a smaller capacity, lowering operational costs and creating a vehicle that could later be used commercially by private space launch companies. Entangled with these issues are questions of haste and quality. As one aerospace executive asks: "Do we just want to kluge up something and fly it?" Or would it be better to allow longer time for development to guarantee a better system?

At present the government's approach is to go for everything. Both the Air Force and NASA are being allowed to fund conceptual studies. Both say they can meet a quick deadline of 1993–1994 for building a preliminary rocket. Both say the vehicle will carry a large load, which is sometimes set at 100,000 pounds and sometimes at 150,000 pounds. (This lack of specificity is "schizophrenic," says one aerospace consultant.) By 1998, the Air Force aims for an incredible ten-fold reduction in the cost of trucking hardware to orbit (from $4000 a pound to $400 a pound), and both agencies promise that their rocket will outdo the shuttle in efficiency, reliability, automation, and so on. It seems as though the sponsors are promising all things to all people—as the shuttle program did when it began.

This race really began last Christmas, according to an executive at a large aerospace firm. Lieutenant General James Abrahamson, head of the Strategic Defense Initiative Office (SDIO), caused a lot of excitement when he said a heavy lift vehicle would have to be developed quickly in order to carry out an "early deployment" of the SDI missile defense scheme. The SDIO asked Congress to finance the project with a supplemental appropriation. As the aerospace executive describes it, NASA and the Air Force saw this as a rare opportunity to get a new rocket, and each one thought, "We better step out and make this ours." Since 1985, both agencies have been engaged in a "space transportation architecture study" whose chief finding is the need to produce larger and more varied types of space vehicles. Here is an agenda on which both NASA and the Air Force can agree. What they cannot do is agree to produce just one vehicle.

NASA began to draw up plans for a shuttle-derived system, while the Air Force wanted to get as far from the shuttle as possible. The military views the shuttle as hopelessly expensive and unreliable. The Air Force has been frustrated in the 1980s by a policy that forced all of its spacecraft onto NASA's transport system, a policy inspired by NASA's wish to boost the shuttle's economic profile. Unmanned military rockets—now being resurrected at great cost—were phased out on the grounds that they were obsolete. The Air Force also was persuaded to spend $1 billion on a California launch pad for the shuttle (Vandenberg) that may never be used. At present, according to Lieutenant General Aloysius Casey, quoted in *Air Force* magazine last month, the shuttle does not have enough power to put big military payloads into polar orbit from Vandenberg. It will only be able to do so, he said, if the power of the propulsion system can be increased by 40%. For these reasons, the military carries a grudge.

"The argument over the advanced launch system boils down to an argument about whether or not you are going to have SDI," says a congressional aide.

As word of the new funding opportunity spread last winter, NASA began to package concepts for two versions of a heavy lift rocket. Both were based on the shuttle: one being a cargo pod aligned in a straight configuration with liquid-fueled engines beneath, and the second, a cargo pod sitting piggyback on the engines as the shuttle orbiter now sits on the fuel tank. In both designs, the engines are the same as those on the shuttle, helped during the launch by the familiar side-mounted booster rockets. NASA also began studying the possibilities for converting the boosters from solid to liquid fuels, which would add thrust.

When the Air Force got wind of this, according to one observer, it raced ahead with its own plans. The Space Division talked about setting aside all shuttle technology, starting from a "clean sheet," avoiding NASA's "legacy of labor-intensive hardware production and operational procedures," and aiming for a ten-fold reduction in launch costs. The emphasis was to be on simple, easily produced parts, automated flight, and quick mechanical servicing on the ground.

A solicitation for studies was prepared, but before it was published NASA intervened, objecting that too much emphasis was being put on cost and not enough on the immediate needs of scientific missions and the space station. NASA needs a heavy lift vehicle soon, not 10 years from now. According to *Aviation Week and Space Technology*, NASA's deputy administrator, Dale Myers, wrote to the Air Force on 20 March that it was NASA's "intent . . . to be a strong participant in defining and implementing an early HLLV [heavy lift launch vehicle] and longer-range capabilities."

At about the same time, NASA and the Air Force began jousting over the military's role on the space station. The Japanese and European partners became nervous about supporting a venture that might be used as a weapons base. Defense Secretary Caspar Weinberger increased the tension when he sent a letter on 7 April to the State Department insisting that the military have free rein to conduct "national security activities" on the station, even if it meant excluding the allies. Myers of NASA suggested in a speech that perhaps the military should go out and build its own station.

The spat came to a head in a meeting at the White House in April. Afterwards, the Defense Department backed off a bit, agreeing that its work on the station would be limited to research, not weapons deployment, and that it would tolerate foreigners aboard.

Meanwhile, the Air Force went ahead with plans for its version of a heavy lift vehicle, renaming it the "advanced launch system" (ALS). Congress, in a vote on the 1987 supplemental appropriation on 1 July, prohibited early deployment of any SDI hardware and reduced the Administration's request for funds. But it empowered the Air Force to go on with the ALS program and provided $75 million in R&D money, specifying that $38 million of it be spent at NASA propulsion facilities. The Air Force was allowed to use $12 million from an earlier budget to start ALS research. Simultaneously, NASA was allowed to spend $5 million of its own funds on cargo vehicle studies. NASA and the Air Force were ordered to find a way to cooperate on ALS and report back to Congress before spend-

ing the $75 million. Although the Air Force has begun making commitments to spend the $75 million, it has not agreed on an R&D plan with NASA, and no report has been filed.

On 10 July the Air Force awarded contracts worth $5 million apiece to seven big aerospace firms, each of which must come back in a year with a design for a system that could fly at the rate of about 30 times a year, have a large cargo capacity, and reduce operational costs in 1998 by a factor of 10. The Air Force also asked bidders to prepare an "interim ALS" that would be not quite as efficient but would be able to lift huge payloads—presumably for deployment of SDI—by 1994.

One month later, NASA invited bidders to prepare designs for a large "shuttle-C" cargo vehicle that would carry the same size payload and be ready for the first flight at roughly the same time as the interim ALS, or perhaps a year earlier. Secretary of the Air Force Edward Aldridge, Jr., asked NASA to submit its plans to the joint R&D program. NASA declined.

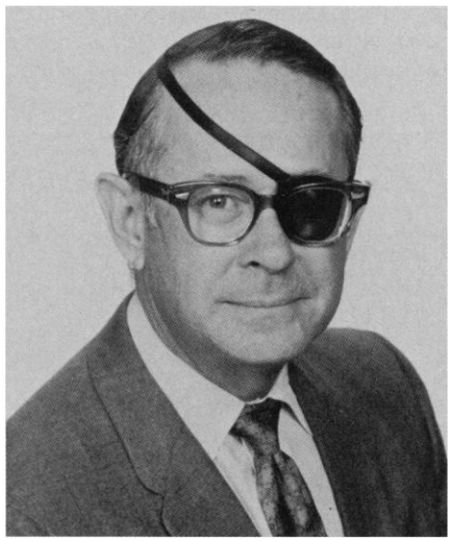
As explained by Thomas J. Lee, deputy director of the Marshall Space Flight Center, the objectives of shuttle-C are quite different from those of ALS. Safety and reliability are most important, with operational cost a lesser concern. The main goal is to keep the purchase price (R&D cost) low and the production time short. Lee thinks the price for shuttle-C would be $1 billion or $1.5 billion, although others say it may cost more than $2 billion.

NASA wants a system in a hurry, and by taking advantage of the existing shuttle launch pads and servicing facilities, its pieced-together shuttle-C serves the purpose well. In fact, NASA may have no alternative but to fight for continued use of shuttle technology, says Byron P. Leonard, a consultant in El Segundo, California, formerly with the Aerospace Corporation. He argues that if an Air Force cargo vehicle is brought on-line and shuttle flights are curtailed, NASA's cost per launch for the shuttle would escalate so rapidly that its economics would turn "not even marginal, but unacceptable." This might kill the system. However, if the shuttle-C is chosen as the new cargo vehicle and deployed as part of the old shuttle system, NASA's high manpower costs would be averaged over the combined flight rate, giving it a new lease on life. The manned shuttle could be phased out gradually as the shuttle-C is deployed, masking the increased cost per launch.

From NASA's point of view, there are some valid, objective reasons to build shuttle-C. Whatever the shuttle's weaknesses may be, they are at least understood. The ALS, by contrast, is an undeveloped system whose price tag, according to one educated guess, will be in the tens of billions of dollars. Sometime in the future it may prove to be tremendously efficient. But then, it may not.

In the short term, it will be virtually impossible for the Air Force to put together an interim ALS by 1994 without using the most powerful rocket technology now available—shuttle engines—or older technology such as that developed for the Saturn rockets in the 1960s. Rocket designers acknowledge this fact. The companies involved in the ALS project have been asked by the Air Force to say little about their work, but it is clear that most will be borrowing parts of the shuttle.

However, Hughes Aircraft's concept for ALS illustrates what can happen when a drastic effort is made to avoid shuttle technology. In an iconoclastic scheme, Hughes would manufacture hundreds of copies of the small and relatively simple RL-10 engine from the 1960s-vintage Centaur rocket. These would be bound in bundles of eight and packed in modules that could be harnessed together. This approach would tap into the economies of mass production and steer away from the shuttle, but skeptics say there are many unexplored risks in joining together so many engines, including the "nightmarish plumbing" required and the chance of a catastrophe. Every designer faces the same problem: simple technology stops being simple if it is radically increased in size or repackaged in brute multiples.



Dale Myers. *NASA's deputy administrator made clear his agency would be involved.*

There is another fundamental problem that plagues ALS—the question of what will happen to SDI when President Reagan leaves office in 1989. An aerospace executive says that everyone realizes that "SDI is on the wish list" and may never be approved. A Democratic aide on Capitol Hill sees this as a killer issue for the Air Force.

The huge capital investment required to build an entirely new, large launch system is "justifiable only if you're going to have a very high launch rate," such as four times a week or four times a month, the aide says. "If you're only going to fly this thing four times a year, it's a waste of money; current technology is adequate." No program on the national agenda would require the ALS's flight rate to be four times a month except SDI. "So the argument over the advanced launch system boils down to an argument about whether or not you are going to have SDI."

The shuttle-C is not vulnerable to this controversy. Even without SDI, shuttle-C can be justified as a support vehicle for the space station and large scientific payloads. These would not require more than half a dozen launches per year at most.

Many in the aerospace industry argue that it would be prudent to invest in a new launch system of the ALS type just to have redundancy in the space fleet. If the shuttle develops a problem again, they say, the stand-down for repairs would cripple not only the manned space program but the shuttle-derived cargo vehicle. Leonard has been making this argument for some time, and it is endorsed by A. Dwight Abbott of the Aerospace Corporation and James W. McCown, vice president for advanced systems of Martin Marietta Aerospace.

They argue that if an independent technology is used in a new cargo vehicle, it would continue flying regardless of what happens to the shuttle. In this view, it is imperative that new technology be developed, preferably based on a brand new rocket engine with more power than the shuttle's main engines and easier manufacturing requirements. McCown believes that such an engine could be developed in 5 or 6 years if the funds were available. When it comes to choosing between a new engine or the shuttle-C, says McCown, "We really need both." This prudent but costly advice has not yet made an impression on Capitol Hill.

Many congressmen may be inclined, as a congressional aide with responsibility in this area says he would be, to put off a decision on futuristic vehicles for a while. He argues that there will be time enough to develop a radically new cargo system if and when a space weapons program is approved. Until that decision is made, budget-conscious leaders may limit the new rockets to a paper-and-VuGraph technology. ■

ELIOT MARSHALL