

between \$9 billion and \$11 billion. Now the estimated cost of developing a partly expendable, less sophisticated shuttle is pegged at \$5.5 billion.

It should be noted, however, that this figure reflects what the auto dealers call the cost of the vehicle "stripped." Essential extras include a \$1 billion contingency fund for cost overruns and another \$300 million for each of three operational shuttles (the rock-bottom price buys only two test vehicles) which NASA and the Air Force would like. Another extra is a launch and recovery base for the shuttles—two if the Air Force gets its own to avoid an embarrassing mixture of civilian and military traffic at a single site. Cost of base facilities: around \$300 million each. Thus the entire bill, not including the manned shuttle booster which space officials still hope to build in the 1980's, might easily approach \$9 billion.

Another issue raised by the shuttle's critics centers on how often it will have to fly, and how much, and what, it will have to carry to pay for its own development. Space agency spokesmen say the currently proposed system would be cost-effective—that is, it would bring a 10 percent return on investment—by making 514 flights over a 12-year period. This implies an average of 43 military and civilian flights a year, about the same pace as in the 1960's. But this level of activity assumes that on each trip the shuttles will carry an average of 60 percent of their maximum load, or about 39,000 pounds. At 43 flights a year this implies a total annual payload of about 1000 tons, or four times what the United States has ever before launched in a single year, even at the peak of the Apollo program.

Congressional critics take this to mean that the space program, unmanned or otherwise, will have to be vastly expanded to take full advantage of the shuttle's economies of scale. NASA officials, however, say that much of extra weight will be accounted for by heavier (though cheaper) payloads and by final rocket stages for far-ranging probes and satellites not previously counted as payload.

The critics may have scored some valid points, but fine details of economy are not the stuff from which great public debates are often made. The shuttle's opponents in Congress are all too well aware that their attack on the SST drew its strength from a vast and vocal public constituency aroused by alarms—rightly or wrongly—of environmental damage and organized by major con-

servation organizations. In the end, of course, it was the SST's shaky economic grounding that did it in, not the threat of doom and boom from the stratosphere. But a good case can be made that the economic arguments would not have carried the weight that they did in the absence of issues more easily grasped and pursued by the public.

As things stand, no such catalytic issue seems in the offing in the coming debate over NASA's ferryboat to the future. There is no visible ground swell of public support for the shuttle's congressional critics. The major conservation groups haven't the time, money, or inclination to carry a battle that has little to do with their direct interests. And Mondale and his allies have so far found only a handful of scientists with more than a faint dislike of the shuttle and with some competence to assess its merits. "Unless we can pull together the kind of public campaign that brought down the SST," one Senate aide laments, "the shuttle is going to get by this year without a thorough examination, and without an adversary hearing in Congress."—ROBERT GILLETTE

## RECENT DEATHS

**John W. Ashton**, 71; former dean, College of Arts and Sciences and the Graduate School, former vice president, Indiana University; 8 November.

**Henry A. Blair**, 71; chairman emeritus, radiation biology and biophysics department, University of Rochester Medical Center; 4 November.

**LeRoy Bowman**, 83; professor emeritus of sociology, Brooklyn College; 30 September.

**Lucy J. Hayner**, 73; professor emeritus of physics, Columbia University; 21 September.

**Thomas A. Hippaka**, 76; professor of education, Iowa State University; 5 September.

**S. Russell Keim**, 43; executive director, marine board, National Academy of Engineering; 8 November.

**Ken-Ichi Kojima**, 41; professor of zoology, University of Texas; 14 November.

**William H. Johnston**, 51; president, Scientific Research Instruments Corp., Maryland; 9 November.

**Eliot Jones**, 84; former professor of economics, Stanford University; 17 October.

**Sophia J. Kleegman**, 70; clinical pro-

fessor of obstetrics and gynecology, New York University School of Medicine; 26 September.

**Samuel Laycock**, 80; dean emeritus of education, University of Saskatchewan, Canada; 5 September.

**Edgar MacNaughton**, 84; former professor of mechanical engineering, Tufts University; 21 October.

**Raymond D. Magus**, 33; instructor in pharmacology, University of North Carolina; 13 May.

**John P. Maurer**, 56; president, Southeastern University; 14 November.

**Robert A. Moore**, 70; retired president, Downstate Medical Center, State University of New York; 24 September.

**Alonzo G. Moron**, 62; former president, Hampton Institute; 31 October.

**Bradley M. Patten**, 82; professor emeritus of anatomy, University of Michigan; 8 November.

**C. Richard Purdy**, 62; professor of mathematics, California State College, Hayward; 21 October.

**L. Corsan Reid**, 77; retired professor of research surgery, New York University Graduate Medical School; 1 October.

**John A. Ross, Jr.**, 92; former president, Clarkson College of Technology; 17 September.

**Truman G. Schnabel, Sr.**, 85; professor emeritus of medicine, University of Pennsylvania; 27 August.

**J. Hervey Shutts**, 63; former professor of biological sciences and science education, Mankato State College; 7 September.

**E. Russell Stabler**, 65; retired professor of mathematics, Hofstra University; 26 September.

**Robert L. Strider**, 49; dean of graduate and undergraduate programs, arts and sciences division, Johns Hopkins University; 4 September.

**Joel H. Swartz**, 78; retired geophysicist, U.S. Geological Survey; 28 September.

**Gerald Tannenbaum**, 44; associate professor of psychiatry, New York Medical College; 23 September.

**Marian M. Torrey**, 77; former chairman, mathematics department, Goucher College; 16 September.

**Henry Tucker**, 48; professor of systems engineering, University of Arizona; 13 September.

**Dmitri A. Zhdanov**, 63; Soviet anatomist and president, World Association of Anatomists; 26 September.

**Erratum:** Warren F. Goodell, vice president for Administration at Columbia University, was mistakenly referred to as Charles Goodell (14 Jan., p. 153).