EARTH SCIENCE

NASA Revises EOS, Adds Small Craft

This week the National Aeronautics and Space Administration (NASA) will unveil its latest plan for the controversial Earth Observing System (EOS), including a radical change in the way data will be distributed to researchers. The space agency is also seeking industry support for a series of smaller, cheaper satellites to complement the three large spacecraft that now make up EOS.

These changes are the agency's response to criticism from Congress and earth scientists of its multibillion-dollar effort to make comprehensive measurements of the Earth's land, seas, and skies. The plans were to be discussed this week at a hearing of the House Science Committee and at a meeting with the National Research Council (NRC) panel that reviewed the EOS program last year (*Science*, 22 September 1995, p. 1665). "We've had a lot thrown at us," says William Townshend, NASA's deputy chief of the Mission to Planet Earth (MTPE) office that oversees the effort. "But we feel we've addressed most of the concerns."

So far, reaction from researchers has been cautiously positive. Berrien Moore, the University of New Hampshire mathematician who chaired the NRC panel, says he is generally upbeat about NASA's new approach, but he will push for additional changes.

EOS has been controversial ever since its conception in the 1980s. Researchers initially argued that NASA was spending too much on hardware and not enough on the actual research. They have also complained that the original EOS data system is outdated and that one of the planned EOS spacecraft should be redesigned as a more focused mission. And lawmakers like Representative Robert Walker (R–PA), who chairs the science committee, have balked at the cost and urged NASA to save money by involving the private sector.

Taking some of Walker's advice to heart, NASA has decided to seek industrial support for small satellites, costing less than $100 million apiece. This new program, to be called Earth System Science Pathfinder, would provide opportunities for scientists not involved in designing the fleet of instruments for the EOS platforms. "EOS has had such a long gestation period," says NASA's Granville Paules. "This is a chance to bring in really new science." Paules is leading the effort in the agency's MTPE office to win financial help from private companies interested in using data for commercial purposes such as weather forecasting.

Each Pathfinder satellite would be overseen by a principal investigator who would be responsible for the overall mission and who would be obligated to release received data immediately to the scientific community, according to a letter to the community from Charles Kennel, NASA's MTPE director. An announcement of opportunity will go out this summer. Townshend says the program's goal is to augment EOS, not compete with it. The first launch could occur by 1998, the same year that the first large EOS spacecraft is slated to go into orbit.

NASA is also paying heed to the NRC's advice in restructuring the EOS data system. The agency's initial plan for a handful of large, government-owned data-processing centers came under fire from scientists who feared they would have little control over how and when satellite data are processed. The NRC group instead proposed a more decentralized system that would allow teams of scientists to compete for the more advanced processing work.

Moore says he supports the NASA move to restructure the data system along the lines proposed by the NRC. "We all have more computer power on our desks now; the Internet and World Wide Web have overtaken the old concept" of centralized data stations, he says.

Another concern of both Congress and the NRC panel is the Chem spacecraft, the third EOS platform, which would examine atmospheric chemicals. Walker has sought to kill funding for the satellite, slated for launch in 2002, while the NRC report warned that the mission was too complicated and should be refocused on measuring ozone in the troposphere. After months of wrangling, NASA officials decided against any dramatic changes. Townshend adds, however, that a team at Goddard Space Flight Center is looking for ways to use advanced technology to slim down the satellite and its instruments.

Townshend says NASA's new plan is open for discussion among politicians and scientists alike. "We may have to go back and do some work," he says. "But we've got some good stuff to show them."

–Andrew Lawler

NUCLEAR WEAPONS

Los Alamos Takes Step Back to Its Roots

It has been 42 years since the last batch of components for the U.S. nuclear arsenal rolled off a rudimentary assembly line at Los Alamos, New Mexico. Since then, the U.S. Department of Energy (DOE) has kept the prosaic task of manufacturing separate from the more rarefied realm of weapons research. But last week, Secretary of Energy Hazel O'Leary unveiled a plan that would end that separation—at least in part—and bring the Los Alamos National Laboratory (LANL) closer to its roots as a maker of nuclear weapons.

DOE

The pits. Plutonium pitmaking at now-defunct Rocky Flats plant *(above)* will be moved to Los Alamos.

The plan, a blueprint for reorganizing nuclear weapons production for the 21st century, would shrink DOE's sprawling nuclear weapons complex—now spread over eight facilities across the United States—without closing any existing plants. Overall, up to 3600 jobs would be eliminated and budgets would drop from $1.5 billion to $1 billion by 2005; as recently as 4 years ago, the complex's annual budget stood at $2.5 billion. The outlook for the weapons research laboratories is brighter. Gone are earlier notions of shifting research from the Lawrence Livermore National Laboratory in Livermore, California, to LANL; instead, all three laboratories—LLNL, LANL, and Sandia National Laboratories—would see modest growth in their defense sectors. For Los Alamos, there's a bonus: inheriting the responsibility for manufacturing plutonium "pits," or fission triggers that are at the heart of hydrogen bombs.

LANL officials downplayed the lab's reentry into weapons manufacturing as relatively insignificant, even hailing it as synergistic with the research and development mission. "There's a feeling among materials scientists that these two missions can coexist," says Earle Marie Hanson, deputy program director for nuclear materials and reconfiguration technology. But critics outside the laboratory see it as a step away from research by a cash-strapped institution. "It's part and parcel of decline of the lab as scientific institution," says Greg Mello, director of the Los Alamos Study Group, a citizens' watchdog group in northern New Mexico.

The last plutonium pit produced at Los Alamos for the weapons arsenal was completed in 1954, when production was shifted

entirely to the Rocky Flats plant, 16 miles northwest of Denver. In 1992, however, DOE shut Rocky Flats down after the Federal Bureau of Investigation found a scandal-riddled plant dangerously contaminated with hazardous and radioactive waste. That left the United States with no industrial-level capacity to manufacture replacement pits for the nation's aging nuclear stockpile.

LANL's TA-55 facility was the logical place to transfer that function. It was already producing a dozen pits a year, mainly for underground nuclear tests in Nevada. But at first LANL Director Sig Hecker blanched at the proposal, worrying that a weapons production role would crowd out research and scare away talented scientists. That was before the painful downsizing last year, when 1000 LANL employees lost their jobs. Retooling TA-55 for pit manufacturing would bring $100 million to LANL. Another $200 million would be used for previously planned refurbishment of TA-55. DOE estimates the task will create 138 jobs during construction and 260 jobs during operation. Now LANL officials sound far less concerned.

"We have no problem whatsoever with stepping up to 20 to 50 [pits] a year," says Hanson. "But we want to make sure it's synergistic with R&D and it doesn't swamp R&D." Any more than 50 would begin to impact on research by appropriating floor space and personnel, said Joe Martz, a plutonium chemist and group leader for weapon component technology.

The laboratory plans to make changes in Rocky Flats' pit manufacturing process, says Tim Neal, LANL's program manager for materials and process technology. In the past, pits were made through a process called "wrought-ing," in which workers stretched, flattened, and rolled plutonium into hollow spheres, like bakers kneading dough. LANL wants to move toward pouring molten plutonium into molds, a process that would cut down on plutonium shavings and machine contact.

But this kind of production work has never been a great draw for top researchers, warns Ray Kidder, a retired LLNL physicist. If it remains small, it will do no harm, Kidder says, but if it squeezes real research funds out of a constrained budget, it will prove counterproductive. And, with a wary eye on the mess at Rocky Flats, citizens groups are openly cringing at a return to LANL's roots. "I think it's bad news for the people of Los Alamos," said LeRoy Moore, a longtime Rocky Flats watchdog and consultant for the Rocky Mountain Peace Center in Boulder, Colorado.

–Jonathan Weisman

Jonathan Weisman is a science writer for the Oakland Tribune.

SCIENCE AND THE PUBLIC

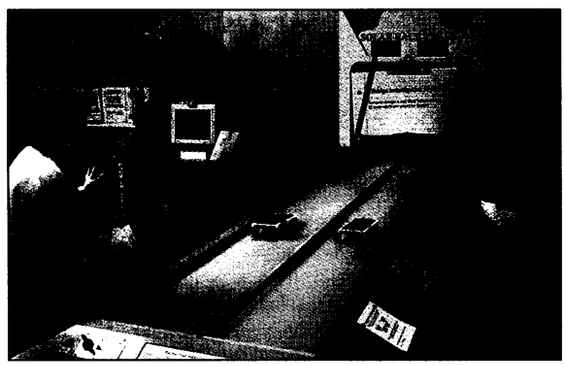
Putting Museumgoers in Scientists' Shoes

BOSTON—Walk the halls of this city's Museum of Science today and you'll be bombarded by questions: Can a thin, disk-shaped clownfish maneuver more nimbly than a long, torpedo-shaped shark? Do bricks fall any faster than basketballs? Do styrofoam cups really keep coffee hot longer than paper ones?

"Investigate!" an interactive exhibit opening today at the museum, is long on such questions—but short on answers. That's because it's trying to put museumgoers in scientists' shoes. Visitors will "do the kinds of things scientists and engineers do when they are carrying out research," explains Lawrence Bell, the museum's vice president of exhibits, "as opposed to simply referring to science's authoritative answers." So visitors will formulate hypotheses, then test them and compare their own conclusions with those left behind by previous visitors. They'll emerge, museum officials hope, with a better understanding of how scientific habits of mind can be of use in their everyday lives—knowledge many educators believe is at the core of "scientific literacy."

The new attraction, developed by exhibit planners Mary Dussault and Susan Sunbury and funded largely by a $1.6 million grant from the National Science Foundation (NSF), boasts a solar car workshop and racetrack, a mock archaeological dig, and a high-tech re-creation of Galileo's legendary Tower-of-Pisa gravity experiment. One kitchenlike area simply presents visitors with a selection of cups, fans, hot and cold water, and computerized thermometers, leaving them to think up their own ways of plumbing the basics of heat and conduction.

While the exhibit isn't the first to give museumgoers hands-on access to the events, artifacts, and apparatus that are the stuff of science, many museum professionals say it goes farther than any comparable exhibit toward simulating, and hence demystifying, the scientific process. "It combines more experiences into one and involves visitors in a very rich way," says J. Shipley Newlin Jr., director of physical sciences and technology at the Science Museum of Minnesota in St. Paul.



BOSTON MUSEUM OF SCIENCE

Racing hypotheses. On this solar car track, visitors to Boston's Museum of Science can change light levels and wheel sizes to see the effects on car speed.

The project's roots, Bell explains, are in the science literacy movement of the late 1980s, which argued that critical thought and the ability to explore questions are more important than learning answers by rote. And while museums such as the Ontario Science Center and San Francisco's Exploratorium have long featured hands-on exhibits that allow visitors to probe physical phenomena such as waves and electricity, "the emphasis was more on understanding those concepts than on understanding the variables you are manipulating in the process," says Robert Russell of Informal Science Inc., a Washington, D.C., consulting firm, and a former officer in NSF's Informal Science Education Program.

Now in Boston, visitors get to manipulate those variables. In one area, museumgoers can study the hydrodynamics of fish physique by making variously shaped rubber fishes race through tanks of water. By comparing the fishes' performance in the 100-centimeter dash or their cornering ability in a maze, budding biomechanicists can gain some idea of the specialized talents evolved by real fishes with these body shapes. More advanced users can make quantitative comparisons, attaching the fishes to electronic strain gauges in a special laminar-flow tank to measure the water resistance they create.

How does the exhibit's picture of the scientific process stack up against the real thing? To David Barrett, an ocean engineer at the Massachusetts Institute of Technology who advised the museum on the construction of the fish tanks, "it's an accurate depiction of what we do. We just do it with more precise equipment."

Planners at other science centers say they'll be watching the Boston effort closely. "It's difficult to communicate process using an exhibit, but Boston is a museum that has approached this topic very seriously and systematically, and I'm hoping that they'll be successful," says Patty McNamara, director of project development at Chicago's Adler Planetarium and Science Center. "That's experience we want to draw on." And if they do, says Barrett, it's also experience that can be widely shared: "Science and engineering are the world's biggest sandbox. It would be a shame if only scientists and engineers got to play in it."

–Wade Roush