the air, as required for certification by the Air Ministry.

In Germany, Hitler, kept abreast of von Ohain's test runs with the engine, objected to producing jet-powered fighters, believing the war would be won with heavy bombers and with his "ultimate weapon," the V-1 and V-2 rockets. In Britain, jet engines were considered too unreliable and unsafe for fighters and bombers, though after observing several flights of Whittle's engine, US General H. A. P. Arnold sent Whittle's plans to General Electric for further development. By April 1942 the engine was part of the twin-jet P-59A Bell Aircomet.

Progress in Germany and Britain was slowed by wartime shortages of materials and bureaucratic opposition to new aircraft developments. Even so, by 1944 Messerschmitt 262 twin-jet fighter planes were in action, and soon afterward Gloster twin-jet Meteors became operational.

After the war Whittle became an RAF technical adviser to the Ministry of Supply. In 1948, on his retirement from the RAF with the rank of air commodore, he was knighted by King George VI. He emigrated to the US in 1976, and the next year he joined the faculty of the US Naval Academy in Annapolis, where he is currently an adjunct research professor. Von Ohain came to the US in 1947 and worked at the Wright–Patterson Air Force Base in Ohio, where he became chief scientist, responsible for maintaining the quality of all Air Force R&D on turbojets. In 1979 he retired from the Air Force and joined the University of Dayton Research Institute, where he is a senior researcher.

At a news conference at the academy after the award was announced, Whittle said that throughout World War II he knew nothing of von Ohain's efforts, "though it was often rumored that a German four-engine jet-powered bomber would pummel New York City one day soon." He thought the most practical application of jet aircraft would be to fly mail from Europe to the US the same day.

Asked how the US could stimulate the development of more creative talent like theirs, both jet-age pioneers stressed the need for simplicity. "Things are getting so complicated that individuals don't have the chance to do big things," Whittle observed. Von Ohain added that while improvements in existing inventions require complex technology and teamwork, "breakthrough ideas are not from teams. . . . Radical innovations are usually created by solitary figures." —IRWIN GOODWIN

WASHINGTON INS & OUTS

MUSICAL CHAIRS AT OSTP, DOE AND PENTAGON LEAVE TECHNOLOGY POLICY A TRIVIAL PURSUIT

Some call it musical chairs. To the more cynical it's something like the Mad Tea Party in *Alice in Wonderland*, at which the participants changed seats at the direction of the Hatter. In *Alice*, the shuffling of seats had little effect on individuals or on events. By contrast, the moves in Washington over the past few months are intended to make a difference at the White House Office of Science and Technology Policy and the Departments of Energy and Defense.

At OSTP the changes were set off on 25 September when **William D. Phillips**, the agency's very first associate director for industrial technology, unexpectedly announced that he was resigning. Phillips said he was leaving for personal health reasons. He had been coaxed to Washington early in 1989 from St. Louis, where he was a professor of chemistry at Washington University. In addition, as president of the Missouri Advanced Technology Institute and as science adviser to Missouri's Republican Governor John Ashcroft, he was active in strengthening regional government–industry collaboration on commercially promising technologies. It wasn't surprising, then, that he was brought to OSTP to lead the charge to coordinate government–industrial technologies in Federal policy-making circles.

Announcing the departure, D. Allan Bromley, the President's science adviser and director of OSTP, declared that Phillips had "built new bridges between the Administration and the private sector." In fact, after introducing OSTP's only major policy statements to Congress—the first on US technology policy (PHYSICS TODAY, December 1990, page 54) and the second on national critical technologies—Phillips decided there was little more he could do in Washington to promote the policies enunciated in the two papers. Sources in Congress say the purpose of both papers clashed with the Bush Administration's abhorrence of "industrial policy." Representative George E. Brown Jr, a California Democrat and chairman of the House Committee on Science, Space and Technology, claims there are obvious distinctions between technology policy, which deals with R&D in the precompetitive stage, before products are designed and perfected, and industrial policy, which usually involves the market stage. The White House argues that government backing of advanced commercial technologies means choosing "winners" and "losers" and that the business of government is to stand aside and allow the "invisible hand" of the market to make those decisions.

For a time at OSTP, Phillips was responsible for setting up the Critical Technologies Institute. The institute was conceived by Senator Jeff Bingaman, a New Mexico Democrat, to reinvigorate America's declining technological fortunes. Bingaman, chairman of the Senate Armed Services subcommittee on defense industry and technology, claims that the Reagan and Bush Administrations have shown "a vacuum of leadership" in advancing joint government–industrial research on technologies that are likely to yield high payoffs in military and civilian products. Persuaded by Bingaman's fervor for increasing the government push behind dual-use R&D, his colleagues in Congress gave OSTP $5 million (to be spent over two years, if necessary) from the 1991 Defense Appropriations Act to set up the institute. The act designated the director of OSTP to head the new institute's board, which would number 10 senior government officials plus 10 members from industry and other sectors of society. Lawmakers say they voted for the institute as a way of improving US competitiveness in the international marketplace. If American companies are to succeed in outperforming the government–industrial juggernauts in other countries, they need to have, among other things, access to the R&D their tax dollars make possible.

A 55-page report issued on 12 September by the august Carnegie Commission on Science, Technology and Government concludes that the Energy, Commerce and Defense De-

partments, along with NASA and the National Institutes of Health, should support high-risk generic and precompetitive R&D and should diffuse to industrial firms any technologies that emerge from such collaborations. To further this goal, the commission calls for transforming the Defense Advanced Research Projects Agency into an agency it labels NARPA, which stands for National Advanced Research Projects Agency, "to provide stronger linkages between modern military technology and high-technology commercial industry." The Carnegie Commission contends that the new agency should retain its basic responsibility to the military services but also take on long-range, dual-use generic technologies "with potentially high payoff" in commercial products—an idea that was strangled almost as soon as it was conceived in Reagan's second term. The commission also urges OSTP to pull the levers in merging the nation's two technological enterprises—one commercial, the other military—into a single globally preeminent industry. Sources at both ends of Pennsylvania Avenue say the idea is unsuited for the little agency, with its small staff and modest ambitions.

While successive Administrations in the 1950s and 1960s endorsed the policy that DARPA and its predecessor agency could back commercial developments for, say, aircraft or computers, the Bush White House has stymied virtually all attempts to continue the practice or to venture into other activities for promoting government–industry linkages.

The concept of a civilian DARPA, advanced last year by Senator John Glenn, a Democrat from Ohio, has been derided as "son of MITI"—that is, possessing many characteristics of Japan's Ministry of International Trade and Industry. The most influential figures around the President—namely, White House chief of staff John H. Sununu, budget director Richard G. Darman and Council of Economic Advisers chairman Michael Boskin—used the same analogy to oppose the Critical Technologies Institute. In July they advised Bromley to thank Congress for its interest in funding the institute and to ask Congress to simply take back the money.

It was about this time that Phillips, practical to a fault, decided he had learned some lessons about how Washington works, and, anyway, he had just about completed his self-imposed two-year limit on getting things done. For his last appearance with OSTP, on 5 September, Phillips spoke at a symposium in Washington sponsored by the National Center for Advanced Technology and the American Institute of Aeronautics and Astronautics and urged government policy makers not to "downplay the role of appropriate Federal technology policy"—a position that doesn't quite hew to the current White House line. He also said that in view of America's loss of market share in consumer electronics and commercial airplanes to foreign companies that receive financial assistance and political succor from their governments, the US must now "increasingly question the assumptions that have been the underpinnings of the way we have done business for the past 50 years."

It so happens that Senator Bingaman's persistence paid off on the Critical Technologies Institute. With the backing of Senators Sam Nunn of Georgia, Ernest Hollings of South Carolina and Albert Gore Jr of Tennessee and the endorsement of the Council on Competitiveness and the Aerospace Industries Association, among others, Bingaman was able to push a series of technology and manufacturing initiatives, including the institute, into the 1992 Defense Appropriations Act. Bingaman believes the legislation is essential "to define and implement a coherent Federal technology policy."

Among the provisions is $100 million for DARPA to fund the development of dual-use technologies by industrial partnerships. Though 1992 is the second year that DARPA would sponsor such work, the Administration had not requested any money to continue the activity beyond 1991. Bingaman says Congress was impressed by the choices DARPA made in the first year of the program, supporting consortiums in optoelectronics, advanced static random-access memory chips, superconducting electronics and ceramic fibers. The defense spending law for 1992 also enables DARPA to fund Sematech another $100 million for the fifth straight year and to lay out $75 million for high-resolution display technology and $70 million for advanced lithography technologies—none of which was in the President's 1992 budget request.

With Phillips's departure, Bromley shifted **Eugene Wong**, who has served since April 1990 as OSTP's associate director for physical sciences and engineering, into the technology chair. Into Wong's vacant seat, Bromley moved **Karl A. Erb**, detailed to OSTP in December 1989 from the National Science Foundation. Before joining OSTP Wong had a 28-year career as a professor of electrical engineering and computer sciences at the University of California at Berkeley. Born in Nanking, China, and the recipient of a PhD in electrical engineering from Princeton, Wong is best known as a founder of INGRES Corp, which pioneered database management systems in 1980. During his 10 years with the computer software company, he watched it expand to 1400 employees and to annual sales of about $170 million.

Erb carried the title of assistant director for physical sciences and engineering under Wong in OSTP's table of organization. But he was always more than that: Having worked with Bromley at Yale's tandem van de Graaff accelerator for 10 years, Erb commanded his confidence as well as his ear. Erb often functions as Bromley's surrogate at meetings of Federal advisory committees and at many conferences where science and technology issues are debated.

At the time Energy Secretary James D. Watkins appointed William Happer director of DOE's Office of Energy Research (see PHYSICS TODAY, September, page 65), he also announced a reorganization of the office that would give Happer additional advice and oversight throughout the system—a technique Watkins learned during his 37 years of Navy experience, the last four as Chief of Naval Operations. As part of the reorganization, Watkins brought aboard some new and old hands:

Robert M. Simon leaves his post as executive director of the Secretary of Energy Advisory Board and becomes Happer's deputy director—the first time anyone has held that title. It puts Simon higher in the DOE pecking order than **James M. Decker**, who has been acting director on two occasions—the first, for more than a year after Alvin Trivelpiece left in 1986, and the second, for almost two years after the sudden departure of Robert O. Hunter Jr in October 1989.

Simon received a PhD in inorganic chemistry from MIT in 1982 and almost immediately joined the National Academy of Sciences as a postdoctoral fellow in science policy. He later became a staffer on the National Research Council's Board on Chemical Sciences and Technology and in 1989 took on the additional positions of acting associate executive director of the Commission on Physical Sciences, Mathematics and Resources and secretary of the US National Committee for the International Union of Pure and Applied Chemistry. Later that year Simon joined DOE as Watkins's personal aide, with unrivaled access to his boss. Simon is

credited with reorganizing several advisory groups; among other things, he transformed the Energy Research Advisory Board into the Secretary of Energy Advisory Board with a much more impressive membership, including three Nobel laureates. While Decker retains his title of deputy director, insiders at DOE suggest he will soon leave for another post.

Antoinette Grayson (Toni) Josephs, associate director of the Office of Field Operations Management, which oversees the running of nondefense DOE labs, as well as their science education and technology transfer programs, takes on the additional function of deputy science and technology adviser. She came to the department's headquarters in 1979 from her post as executive director of DOE's San Francisco Operations Office. Actually, she joined the old Atomic Energy Commission as an intern in 1964. In the period of transition from the AEC to the Energy Research and Development Administration she was executive director of laboratory and field coordination, a post in which she developed procedures for managing R&D operations at the labs. When ERDA metamorphosed into DOE, she became chief of operations and facilities in the Office of the Assistant Administrator for Field Operations. In 1971 she received an MBA from Harvard's Kennedy School of Government.

Warren Chernock is deputy science and technology adviser for defense programs. After getting an MS in metallurgy from New York University in 1955, Chernock joined Combustion Engineering Inc, where he directed the development of high-temperature gas-cooled reactors and the commercialization of fuel cells. He was vice president for nuclear power systems at Combustion Engineering in the 1970s and 1980s and vice president for advanced systems for two years before joining DOE.

Still vacant is the chair reserved for Happer's deputy science and technology adviser for nondefense R&D programs. But a new position as Watkins's own adviser on DOE nondefense legislative matters goes to **F. Paul Gilman**, a top aide to New Mexico's Senator Pete V. Domenici, senior Republican on the Senate Committee on Energy and Natural Resources. Gilman served on the committee staff for six years before moving to Domenici's office. He earned a master's degree from The Johns Hopkins University in 1975 in Earth and planetary sciences and a PhD from Hopkins in 1979 in ecology and evolutionary biology. That year he became a Congressional science fellow in the American Association for the Advancement of Science program and found himself on Domenici's staff.

Watkins also designated the heads of three new DOE units:

Richard E. Stephens, who was director of the Division of University and Industry Programs, is now associate director for University and Science Education Programs. In this post Stephens is responsible for oversight and evaluation of the department's entire science education operation and for several specialized precollege and university programs making use of the unique capabilities of the national labs. After he acquired an MA in public administration from the University of California at Berkeley in 1964, Stephens joined NASA as a management intern at the Manned Spacecraft Center in Houston. He was shifted later to NASA's Washington headquarters, where he was chief of administration and management research in the Office of University Affairs. He worked at the National Science Foundation from 1970 to 1975, then joined the newly organized ERDA, which became DOE.

Cherri J. Langenfeld becomes director of technology utilization and Happer's adviser on technology transfer practices. With a BS in civil engineering from Georgia Tech, obtained in 1976, and an MBA from the Harvard Graduate School of Business Administration, in 1984, Langenfeld worked for Exxon in New Orleans in a number of hands-on engineering and supervisory positions and later for General Motors, first as an assembly plant foreman and then in marketing and product planning. After a stint with Scientific Systems Services Inc in the 1980s as director of consulting services, she joined DOE.

Fenton Carey, a longtime Navy civilian who once served on the Secretary of Defense's Competitive Strategies Initiative and on the Chief of Naval Operations executive staff, where he was Admiral Watkins's expert on space-related policies, is now Watkins's key assistant for space programs, as well as head of the department's newly organized Office of Space. The office runs all DOE lab activities to develop sensors, robotics and space propulsion systems, including nuclear-powered ones, to further the Administration's promise to initiate a Moon–Mars voyage by 2019, the 50th anniversary of the first landing by man on the Moon. Carey received a PhD in aeronautical engineering from the Naval Postgraduate School in 1976. He is regarded by Watkins as one of the best and brightest at DOE.

On 14 April, Watkins appointed **N. Anne Davies** associate director for fusion energy. She had been serving as acting head of DOE's fusion program since January 1989, when **John F. Clarke** left the post to join Battelle Memorial Institute's Pacific Northwest Laboratory, where he is associate director for global studies. Davies received her PhD in engineering and applied physics from Yale in 1972 and worked in the tokamak program at the University of Texas at Austin before she joined the AEC as a plasma physicist. From 1980 to 1985 she was director of DOE's toroidal confinement systems division in the Office of Fusion Energy. From 1985 to 1989 she was deputy associate director for fusion energy.

On the morning of 7 May, **Charles Herzfeld**, the Pentagon's highest ranking scientist, appeared before the Senate Armed Services subcommittee on defense industry and technology, where he laid out the latest plan for advancing militarily critical technologies and pledged his commitment to its implementation. That afternoon, Herzfeld observed his final hour as director of defense research and engineering at a party with several staffers in his third-floor office on the Pentagon's outer ring. A few days later, still on the DOD payroll, he joined OSTP as a consultant on matters of national security and advanced technologies.

Herzfeld left the DDR&E post 14 months after he was sworn into office. Pentagon insiders claim Herzfeld is technically brilliant and certainly capable of running the program, but he was hobbled by the often acrimonious rivalry between Donald Atwood, deputy secretary of Defense, and John A. Betti, undersecretary for acquisition. Even after Betti left DOD, Herzfeld found himself virtually powerless to run his operation, which includes DARPA and many of DOD's leading research and technology programs. In moving to OSTP, Herzfeld had expected to take charge of the Critical Technologies Institute, but soon after he joined the agency the decision was made to ask Congress for a recision of the institute.

Born in Vienna, Austria, Herzfeld received a PhD in physics from the University of Chicago in 1951, then worked at the National Bureau of Standards and DARPA. He held defense research positions in industrial firms during the 1980s before returning to DOD.

Replacing Herzfeld as DDR&E is **Victor H. Reis**, who had been director of DARPA since last November

(PHYSICS TODAY, March 1991, page 54). Reis succeeded **Craig I. Fields**, who left last year after a donnybrook with Atwood and Betti. They agreed, perhaps for the first time, say onlookers in the Pentagon, to object to any efforts to select winners for a commercial technology (PHYSICS TODAY, November 1990, page 70). In his time at DARPA, Fields, now president and CEO of Microelectronics and Computer Technology Corp, had done the unthinkable: In exchange for a share of the profits and royalties, he had invested $4 million of the agency's relatively insignificant $1.1 billion annual budget in a tiny California startup firm making gallium arsenide computer chips. Reis, politically cautious as well as technically clever, made no missteps at the little agency.

Key leadership changes also have occurred at DOD's Strategic Defense Initiative Office. President Bush appointed **Henry F. Cooper** the third director and first civilian head of SDIO on 10 July 1990. Cooper's predecessors were both Air Force lieutenant generals—James Abrahamson and George Monahan. Despite their prestigious Air Force backgrounds, they were never given the full support of other officers at the Pentagon who viewed "Star Wars" as an unfair competitor for missions and money because it was a Presidential initiative. But on Capitol Hill, SDIO was cut back every year since it was formally launched as a budget item in 1985. Even so, DOD expenditures for Star Wars have reached a total of $22.9 billion from its inception through fiscal 1991. In the same period, the Energy Department has spent another $1.6 billion for R&D on nuclear directed-energy weapons, such as the x-ray laser that was "zeroed out" in fiscal 1991, and for nuclear space propulsion systems.

SDI fared better in fiscal 1992 than it has in the past. The 1992 Defense Appropriations Act provides $4.15 billion, some $1 billion less than the President had asked for but substantially more than the $2.9 billion available to Star Wars in 1991. The increase is said by both Democrats and Republicans in Congress to support the scaled-back, ground-based version that could prove effective against an unauthorized or accidental nuclear missile attack from a breakaway group in a Soviet republic or a purposeful launching by a "rogue" country such as Iraq. The legislation's final language calls for placing SDI interceptors around a single site at Grand Forks, South Dakota, by 1996—a concept similar to the deployment of missile interceptors around Moscow, which is allowed under the 1972 Anti-Ballistic Missile Treaty. At the same time, the lawmakers expressed support for DOD to develop a range of ground-based interceptors and urged the President to renegotiate amendments to the ABM treaty to allow deployment of such options, while maintaining the spirit of the original treaty.

Cooper, the new chief Star Warrior, is a true believer in the revised anti-ballistic missile defense, known as GPALS, which stands for Global Protection Against Limited Strikes. He has told Congress that the system could be deployed by 1996 at an estimated total cost of $46 billion, not taking inflation into account.

While working for a PhD in mechanical engineering at New York University in the early 1960s, Cooper was also a member of the technical staff of Bell Telephone Laboratories. After receiving his PhD in 1964 he joined the Air Force and later became a scientific adviser to the Air Force Weapons Laboratory at the Kirtland Air Force Base in New Mexico. It was there that he met William R. Graham, who later became President Reagan's science adviser (PHYSICS TODAY, July 1986, page 45). From 1972 to 1980 Cooper was at R&D Associates, a high-tech research company and science think tank located in Marina Del Ray, California, that was organized by Graham and some 25 Rand Corp staff members, most of them physicists. In 1980 Cooper was named deputy to the assistant secretary of the Air Force with oversight responsibilities for all strategic and space programs. In 1982 he returned to R&D Associates as deputy director of the nuclear effects division.

During 1984 and part of 1985 Cooper was assistant director of the Arms Control and Disarmament Agency, while Graham served as chairman of the President's General Advisory Committee on Arms Control and Disarmament. It was during this period that Reagan's vision of SDI was under scrutiny in Washington and in Moscow. Cooper gained prominence in the White House for backstopping the bilateral negotiations on strategic nuclear matters with the Soviet Union and for heading interagency planning on SDI. To do this effectively he was appointed chief US negotiator for defense and space talks with the USSR, with the rank of ambassador. At the end of 1989 Cooper became senior vice president for planning at Jaycor Inc, a military technology firm that Graham then headed.

SDIO's deputy director is Major General **Malcolm R. O'Neill**, a former commander of the Army Laboratory Command and the first director of the Army Acquisition Corps, which was formed to train a civilian and military cadre for high-tech project management functions. O'Neill was previously SDIO's deputy project director for programs and systems and director of kinetic energy weapons development. He received a PhD in physics from Rice University.

Though the title of chief scientist for the SDI program was abolished when O'Dean Judd returned to Los Alamos last year, the post has been subsumed and somewhat expanded under the name of systems architect. This position is now held by **Edward T. Gerry**, who worked during the 1960s at Avco–Everett Research Laboratory, where he was among the first to demonstrate CO_2 laser action in gas-dynamic flow. At DARPA in the early 1970s he was chief of laser technology and later assistant director for technology. From 1975 to 1990 Gerry was president of W. J. Schafer Associates, a DOD contractor for space surveillance optics and sensors. In the summer of 1983 he served on the Defensive Technologies Study Team, under the chairmanship of James C. Fletcher. This was the group that made the first examination of Reagan's early vision of Star Wars. Subsequently, Gerry participated in SDI architectural studies, including an evaluation of the "Brilliant Pebbles" concept.

One of the new seats at SDIO went to Colonel **Simon P. (Pete) Worden**, who most recently was director for advanced concepts at the National Space Council, headed by Vice President Quayle. Worden is SDIO's deputy for technology, a job that enables him to manage the development of prototype kinetic and directed-energy weapons and the demonstration of target acquisition, tracking and identification systems. He, too, was a participant in Fletcher's Defensive Technologies Study in 1983. For the next three years, Worden served as special assistant to Abrahamson, the agency's first director. In 1986 Worden became a senior policy analyst at OSTP, and in 1987 he went on to be chief of the special operations branch at the US Space Command in Colorado Springs. When the Bush Administration reinstituted the National Space Council for the first time since Lyndon Johnson's Administration, Worden returned to Washington. In 1975 he got a PhD in astronomy at the University of Arizona.

—IRWIN GOODWIN ■