and Congress not to undermine the system through pork barrel politics.

Others worry that, by participating in pork barrel politics, universities could undermine efforts to head off further political control over research decisions—such as legislation proposed by Representative Henry Waxman (D–Calif.) to increase Congress's influence over the National Institutes of Health (NIH). "It bothered me when AAU institutions started doing this—institutions that have benefited enormously from the peer review system," says Albert Bowker, dean of the school of public affairs at the University of Maryland.

Schlossberg and Cassidy respond by pointing out that decisions on funding for science have never been free of politics, citing in particular the recent scrap between a coalition of southern universities and the Argonne National Laboratory over the siting of an accelerator (*Science*, 27 May, p. 929), and the Administration's decision to seek funds for NCAM without first bothering to consult the research community on the need for such a facility. Moreover, they note that many universities already maintain large government relations staffs to influence political decisions.

Schlossberg also says he believes there is some "confusion" about what his firm has been doing, pointing out that it has been helping universities acquire funding for buildings, not for research grants or major facilities that should be put through a peer review process. The distinction between buildings and research is not always clear, however. The Catholic and Columbia buildings, for example, will require another $24 million before they are completed, and the funds presumably will have to come from DOE's research budget. The Tufts toxic waste center, which could eventually be a $10-million-a-year operation, will also take a bite out of EPA's research budget. The Tufts funds "will not be part of a competitive peer-reviewed process, and in my view that sets a poor example," says Courtney Riordan, EPA's research chief.

Finally, Schlossberg and Cassidy argue that the AAU, which represents 50 of the largest research universities in the country, reflects the views of those that are already comparatively well off. "It is somewhat hypocritical for universities like Stanford, Harvard, and Yale, to be advising the rest of the university community . . . not to seek support where they can find it, including from the U.S. Congress," says Schlossberg.

One reason why so many universities have sought special interest amendments in Congress is that the approach evidently works. But a deeper reason is that there are no longer any programs to which they can apply for building funds. The Department of Education and the National Science Foundation both ran out of funds for facilities in the early 1970's, and an NIH program for construction of biomedical facilities expired in the late 1960's.

The AAU earlier this year drafted a bill that would provide funds for construction, equipment, and graduate fellowships. It was introduced into the Senate by John Danforth (R–Mo.) and Thomas Eagleton (D–Mo.) but did not get very far. The AAU intends to push it harder next year.

Schlossberg, however, accuses the AAU of "standing still or being very ineffective in whatever efforts they have made to increase funding for facilities." He adds: "If the AAU would like to hire my firm's resources and use our professional expertise to obtain general funding [for facilities] we would be absolutely delighted." Robert Rosenzweig, AAU's president, responds that "we would welcome their help on that, but we don't welcome their shooting for individual universities. . . . They risk undermining the whole basis of decision-making in research funding."—**COLIN NORMAN**

The Pentagon's Ambitious Computer Plan

It wants to spend $600 million on artificial intelligence for smarter weapons systems

The Defense Department's main agency for basic research is proposing to embark on an ambitious $600-million program to develop artificial intelligence systems and computer technology. If successful, it could fundamentally change the way in which battles are planned and fought. The long-term proposal would create a whole new generation of computers with capabilities including vision, comprehension of speech, and reasoning, and diverse applications including the development of unmanned armored tanks for reconnaissance, an automated copilot that could understand a human voice, and an elaborate computer system to assist in strategic planning.

In a report called "Strategic Computing," which was made available to *Science*, the Defense Advanced Research Projects Agency (DARPA) describes the plan and says that the new technology "will have unprecedented capabilities." It adds, however, that the development of these new computers will "severely challenge the [current] technology and the technical community."

The report, completed in late October, comes none too soon for many members of industry and academia, who have been pressing for more money in artificial intelligence research. The United States presently is the world leader in this type of computer research, but the Japanese government in 1982 launched a $500-million 10-year program to develop "fifth-generation computers," which would incorporate artificial intelligence. Japanese industry has apparently committed a matching sum, bringing the national effort to a total of $1 billion, according to Michael Dertouzos, head of the Laboratory for Computer Science at Massachusetts Institute of Technology. DARPA's plan covers a 10-year period in which $600 million would be spent during the first 5 years, starting in fiscal year 1984. DARPA has already succeeded in securing from Congress $50 million for its FY 1984 appropriations.

According to an agency official, the $600 million represents support for current DARPA computer research and a request for new money as well. The exact figures on "old" and new money are unclear, but the official said that the plan would at least double DARPA's present expenditures in artificial intelligence research. Dertouzos estimates that industry, universities, and the federal government now spend about $150 million to $200 million a year on long-range research in computer science, including artificial intelligence.

The U.S. military already widely uses computers in guided missiles, munitions, aviation, and command-control-communications intelligence. But DARPA envi-

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To help repair the trouble-prone M1 tank, the Army wants to develop an elaborate computer diagnostic system to replace the technical manual. The manual totals 61,000 pages.

sions much broader and more sophisticated applications in the handling and evaluation of information, given the creation of weapons that can move faster and more accurately than ever before.

DARPA plans to take on the challenge by tackling several areas of research simultaneously. The comprehensive research program would include the development of so-called expert systems, which would play a vital role in the evaluation of complex problems and high-level planning; machines with the ability to see and to understand speech; faster computing power; ways to run several computers concurrently or in parallel; and better microelectronic technology.

These are DARPA's broad, long-range goals, but it has specific ideas how this technology should be put to use. In 10 years, the agency plans to have a robotic tank that could navigate 80 miles from one destination to another. On a reconnaissance mission, it would be able to recognize roads, identify man-made and natural landmarks, devise strategies to avoid unanticipated obstacles, map the terrain, identify enemy targets, and interpret and transmit the information back to headquarters, all while moving at about 40 miles per hour.

DARPA's idea of an automated copilot would be a crucial helpmate to a combat pilot. The human pilot would be able to train the computer to respond in certain ways and perform particular functions. The computer would be knowledgeable about the aircraft and the environment, be able to distinguish between friendly and enemy forces, and be able to understand speech commands even if a pilot's voice is distorted by heavy noise during combat.

The third use of fifth-generation computers planned by DARPA conjures up visions from the recent movie, "War Games." Like the "WOPR" computer in the film, the military's real version would alert commanders of impending problems during a battle, lay out options in war strategy while factoring in uncertainties, carry out the preferred option, and monitor the results. The DARPA plan proposes to incorporate this elaborate system on the aircraft carrier USS *Carl Vinson*, enabling commanders to monitor a detailed picture of enemy attack from aircraft, submarines, and ships. The report says the system would be able to describe the enemy's possible intentions, generate various courses of action, explain the advantages and disadvantages, and then disseminate a selected option.

While DARPA has set out a long-range plan, the Army has more immediate and modest goals to begin incorporating artificial intelligence and robots into its arsenal. The Army has conducted several studies over the past 2 years to analyze what short-term projects it should undertake in computer technology. Then it requested the National Research Council to offer an opinion. A council committee recently completed a $150,000 study that basically agreed with the Army's assessments. The 16-member committee, of which nine were representatives of companies involved in some aspect of computer research, were brought together to provide a realistic picture of what can be achieved in the next few years.

Its chairman, Walter Abel, said that it is time for the Army to stop studying the problem. Abel remarked, "We wanted to say, 'Look fellas, it's a new field and a large one. Pick a project and get going.' " Abel, a designer of robots, recently retired from the Emhart Corporation where he was a senior fellow for technology. Emhart manufactures machines and uses robots in production.

In its report, "Applications of Robotics and Artificial Intelligence to Reduce Risk and Improve Effectiveness," the committee outlined three specific projects that the Army should undertake: a robot to load ammunition in a tank, a robot to act as a sentry, and a system to diagnose repair problems in sophisticated Army equipment such as the trouble-prone M1 tank. The committee said that simple demonstrations of each project could be achieved in 2 to 3 years. "We're saying to the Army, 'Don't try to do everything all at once, but get enough computer power into a demonstrator to do something,' " Abel said. "Simplicity and reliability are the key." The committee estimated that the three projects would cost about $22 million.

Current Army tanks require a four-soldier crew—a commander, a gunner, a driver, and an ammunition loader. In battle, a loader must select the correct ammunition, load it, and then inform the commander. The work is quick and strenuous. The soldier must be able to heave a 105-millimeter round that weighs 45 pounds into the breech. The average loader can handle six rounds per minute.

The committee suggests that a robot capable of seeing could eliminate the need for the loader and also increase the loading rate. More importantly, according to Frank Verderame, assistant director for the Army's research programs, the robot, if made lighter and smaller than the average soldier, could lead to the development of a faster and smaller tank. Some development is already under way. Last week, the Army announced that it is designing a robot to load howitzers. By the 1990's, the Army wants a device that can load shells weighing more than 100 pounds into M-109 howitzers.

The committee's plan for a sentry robot may represent the first step toward DARPA's dream of a fully automated reconnaissance tank. The committee recommended that an elementary robot would be laden with sensors to detect intrusion via seismic, infrared, audio, magnetic, or visual disturbances. The robot would at first be stationary and later be made mobile. This is the only suggestion with which the Army took some issue. Verderame says the Army

wants the robot demonstrator to be able to move. Although the committee warned that the development of this ability is too ambitious for a short-term project, Verderame says, "We will have a vehicle."

The development of expert systems would help train soldiers to handle and repair sophisticated equipment. For example, to analyze the numerous ills of the M1 tank with its new turbine engine, the committee recommends the creation of an elaborate diagnostic system. The technical manual for the tank totals 61,000 pages. The report notes, "An individual working inside the turret of an M1 tank . . . cannot at present easily flip through the pages of the repair manual." With the computer system, a person could use a transmitter, receiver, floppy disk, and a computer that can understand verbal commands to fix the tank more efficiently. But the report cautions, "Any Army diagnostic system should be easily understood by any operator. . . ." Choosing alternatives offered by the software "is not necessarily easy for a semiliterate person."

The committee also recommended a few other projects but assigned them a lower priority. It urged the creation of a "dog tag chip," in which a soldier's medical history could be encoded. The dogtag would be used to speed up the treatment of injured soldiers. Such research is already under way at Purdue University. To eliminate the need for soldiers in the loading and unloading of supplies (especially ammunition) near the front lines, the equivalent of an automated forklift truck should be built, the committee said. And, as in the DARPA plan, an expert system to evaluate information during a battle should be created.

The Army already spends about $11 million on artificial intelligence research. Last year, it asked Congress for an additional $15 million to develop a sentry robot, but was turned down. Verderame believes that the National Research Council's report will lend considerable weight to the Army's request the next time around.

Given the goals of DARPA and the Army, does all this planning mean that future wars will be fought and planned by robots and fifth-generation computers? Verderame says, "I can't imagine that a war will be fought and won by robots. Robots will be an assistant to man, not a substitute." The DARPA report doesn't explicitly address this question, but if its proposal is approved, the multimillion dollar program would go a long way in changing the present nature of battle.—**MARJORIE SUN**

Historians Deplore Classification Rules

New restrictions on classification and declassification of documents are hampering historical research

Scholars of diplomatic and military history have never been happy with what they have to go through to obtain copies of historial documents from the government. They have to wait for years for material to be reviewed and declassified, and are sometimes rewarded with a pile of nearly blank pages reflecting the deletion of sensitive material.

But some recent actions of the Reagan Administration are making an unsatisfactory situation worse, and historians, perhaps belatedly, are "finally pulling themselves together" to look for new ways to address the problems, says Anna Nelson of George Washington University.

A major focus of concern is Executive Order 12356, issued by President Reagan in August 1982, which governs the classification and declassification of government documents. In essence, the order eliminates automatic declassification of any documents, puts low priority on the systematic review of documents that would ordinarily be declassified after 30 years, and permits reclassification of some material.

The Reagan directive constitutes a reversal of a trend dating from the end of World War II—or, as one government document says, it is "taking the bold step of bucking the trend of prior Orders." This trend moved toward putting greater weight on the public interest when balancing it against national security interests, and toward putting the burden of proof on the government that disclosure of a given document would damage the national security.* As critics see it, the new policy may be summed up as "When in doubt, classify."

At this point it is not clear how severely the new order will hamper historical research because the lag time between a request for material and its delivery is so great that few requests made since the order have been processed. But policy is not the only problem.

- Delays in declassification have been greatly exacerbated by drastic budget and personnel cuts at the National Archives and Records Service, which has been assigned by the Administration to do the bulk of the reviewing. According to Edwin Thompson of the Archives declassification division, the old goal of reviewing all material by the time it is 20 years old has given way to a 30-year goal. But to realize even this would be impossible without a doubling of staff, which now stands at around 40. Under Reagan, staff and budget have been cut by 60 percent. The bulk of material reviewed has decreased from tens of millions of pages to about 3 million pages a year, according to Steven Garfinkel of the General Services Administration's Information Security Oversight Office. Priority is being put on reviewing material in anticipation of user needs rather than on systematic declassification. But historians rely heavily on information that can only be gained through access to complete records in a given area.

- Historians have also been alarmed by recent actions of the National Security Agency (NSA), which took the unusual step of closing some public files at the George C. Marshall Library in Lexington, Va. The library contains the papers of two former NSA employees, including William F. Friedman, a renowned cryptographer whose career extended from World War I to the 1950's. Last May a book, *The Puzzle Palace*, by James Bamford, was published which drew from unclassified papers in the Friedman collection. Afterward, NSA operatives appeared at the library and ordered some

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*The shift in emphasis away from what the government calls the "negative tone" of the old Carter directive is shown in these excerpts: the Carter order said eligible material "may not be classified unless . . . its unauthorized disclosure reasonably could be expected to cause at least identifiable damage to the national security." This section has been changed to read that information "shall be classified when . . . its unauthorized disclosure, either by itself or in the context of other information, reasonably could be expected to cause damage to the national security."