The Winds of Change?

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Abstract

In this issue, we bring you coverage of recent events in the US that may have an impact on database funding, especially at NSF. We also announce two upcoming NSF Small Business Innovative Research Conferences and requests for proposals from the Air Force, the Army, and the folks at the Strategic Defense Initiative. A new database/knowledge-base BAA and other bits of news from DARPA round out the funding news for this issue.

1 The Winds of Change

The past few months have seen a flurry of news that indicates possible major changes ahead for US government funding of research, leaving academic corridors abuzz with speculation. In this section we provide an overview of the recent developments.

First came the publication of *Computing the Future*, a 200-page tome produced by a blue-ribbon panel of scientists assembled by the National Research Council[1]. An excellent summary of *Computing the Future* appears on the front page of the September issue of *Computing Research News*, under the attention-grabbing headline, "CSTB report: CS&E research funding may not be easy to come by in future". Said the summary, "[The report] urges computer scientists and engineers to embrace computer challenges that arise in many areas outside the computer science and engineering (CS&E) discipline[: ...] 'New applications of computing will also lead to new CS&E research problems.' [... D]ifferences between CS&E basic and applied research are artificial because both require the same judgment, creativity, skill and talent. [...] Researchers need to focus on problem domains that derive from non-routine computer applications in other fields or from technology-transfer activities. [...] They should not worry whether the activity [...] falls into traditional categories of basic research, applied research or development." *Computing the Future* says that "academic CS&E must broaden its self-concept or risk becoming increasingly irrelevant to computing practice." Thus, the priorities outlined in *Computing the Future* are, first, to sustain the core activities in computer science and engineering; second, to broaden the field; and third, to improve undergraduate education in computer science and engineering.

Computing the Future notes that research funding has become much tighter in recent years, as more and more researchers compete for a share of the pie. If the report's recommendations are translated into policies at the national funding agencies, one might expect to see increased support for interdisciplinary research that attacks well-known problems from outside CS, through a collaboration between domain experts and computer scientists and engineers. *Computing the Future* lists "information storage and management" as "central" or "very important" for each of four representative applications: global change research, computational biology, commercial computing, and electronic libraries.

Computing the Future also notes that the image of computers in society has become tarnished recently, as the negative side of computerization has become better known to individuals. At the same time, the image of academia has lost its luster, with financial scandals at research universities, concern over quality of education and skyrocketing costs, publicity over cases of academic fraud, and public concern over the fraction of professorial time devoted to teaching. Said Fred Weingarten at the 1992 Snowbird Conference of CS Department heads, "The government and the public have lost interest in the bargain [that tax dollars are handed over to scientists, who decide what work to fund]. [...] We can assume that Congress and the administration would not be engaged in [...] aggressive political and legal attacks on the integrity of higher education and science if the public still strongly [...] supported those institutions." In the *Computing Research News*, Weingarten concluded that future research programs "will be tied to explicit social objectives", as is the current HPCC program. In addition, "industry will be incorporated more explicitly in a three-way partnership." Pressure will build between advocates of short-term and long-term research, Weingarten went on to say, and protectionist tendencies will complicate international exchange on scientific matters. Weingarten concluded that "the debate is just starting."

Peter Likins struck a similar note in his keynote address to the Snowbird Conference, reprinted in *Computing Research News*. Likins began by explaining the origins of current government policy toward support for scientific research, tracing their origin to a 1945 report by Vannevar Bush. Likins summarizes the report's "social contract" in an imagined conversation with then-president Truman: "Look, Harry. Here's the deal. The

[1] For information on ordering a copy of *Computing the Future*, call (800) 624-6242.

US government promises to finance all legitimate research required to satisfy the curiosity of America's scientists, and they in turn promise to deliver military security, public health and economic prosperity to the American people."

Likins comments on the lack of an explicit role for industry in Vannevar Bush's proposal, and goes on to say that "[w]e designed a two-legged stool in 1945, and it served us well as long as a healthy private sector was there to prop up the system. But our nation's industrial leadership in the global economy has been challenged, and on some fronts displaced by other countries. We can no longer assume that our economy will be so dominant that scientific success will automatically be transformed into social benefit. We must recognize the advantages of a well-designed, three-legged stool. [... W]e must be explicit in our expectations of industry, and recognize the critical roles to be played by engineering technology and the system that delivers the benefits to the people. [...] We are entering a new era, and the rules have not been written yet."

These are all strong words, bound to rouse a storm of debate and strike fear into the hearts of many academics. In response, a group of well-respected computer scientists announced a petition calling for the retraction of *Computing the Future*, which many readers will have seen circulated on the Internet[2]. The petition begins, "We are asking you to join us in asking the Computer Science and Telecommunications Board of the National Research Council to withdraw for revision its report entitled 'Computing the Future: A Broader Agenda for Computer Science and Engineering', because we consider it misleading and even harmful as an agenda for future research. Our objections include its defining computer science in terms of a narrow set of applied objectives, and its implication that the tone of computer science is to be set by government agencies, university administrators and industrialists and that computer scientists are just the 'soldiers on the ground'." The authors of *Computing the Future* published a response to the petition, and the report will not be withdrawn.

Meanwhile, the National Science Foundation (NSF) announced its plans for soul-searching, with the formation of the Special Commission on the Future of the NSF[3]. The announcement we received said that the commission "will examine how NSF can maintain and enhance America's strength in science and engineering research and education in ways that adequately prepare the nation for the 21st century." The announcement went on to solicit email input on two questions: how NSF can "maintain and enhance" the health of the "academic system", and whether and how NSF should "build on its traditional mission by pursuing a broader array of research and education objectives and doing more to link academia and industry." Our mailing included an essay by the director of NSF, Walter Massey. His paper began with a quote from Vannevar Bush, then cited major recent world changes such as the advent of a global economy and the end of the cold war, and went on to list three possible options for NSF in the new age. First, NSF could revert to its earlier mission of support of small groups at universities, discontinuing its support for NSF Centers. Second, NSF could continue as it now is. Third, NSF could expand its programs, linking them to industry and to other government agencies as well as to academia, while expanding support for education. The director favored the latter course.

The commission was to have three meetings, all open to the public, on September 17, October 16, and November 7. The announcement we received was sent to NSF PYIs on September 8; the commission itself was announced on August 14; the final report for the commission was expected in November, and so will probably be available by the time this column is published.

[2]Copies of the petition can be obtained by anonymous ftp to sail.stanford.edu, in the directory /pub/jmc.

[3]For more information on the Special Commission, send email to stisinfo@nsf.gov.

2 US Air Force Support for Knowledge-Based Design and Development of Software and Systems

Rome Laboratory is requesting proposals in support of their Knowledge-Based Software Assistant Program under BAA 92-08-PKRD. The announcement includes thirteen areas of interest; one of them is directly in the database area ("support for massive and distributed knowledge/data and communication requirements"), and the remaining twelve cover many of the major problem areas in software engineering, both formal and practical, and thus may be relevant to database researchers: expansion, generalization and refinement of design process theories and formalisms; support for better user/computer interaction; techniques for creating, organizing, and reusing abstract components; formal theory unifying evolutionary and meaning-preserving transformations; theories and techniques for system architecture design and system-level optimization; formal techniques for recovery or re-engineering of designs and specifications from existing software components; techniques for assisting in group coordination and collaboration; techniques for negotiating resolution to conflicting requirements in collaborative tasks; techniques for reasoning about software process modeling and management; techniques for addressing realtime and distributed requirements of embedded systems; techniques for capturing, integrating and supporting legacy software systems; and transition of technology into practice. The deliverables for this BAA are technical reports and demos. Short white papers from prospective proposers will be accepted through September 30, 1993, with proposals due by December 31, 1993. The funding available under this announcement is US$1,600,000, with three to five awards expected, and ten percent of the funds reserved for historically Black colleges, universities and minority institutions.

For more information, contact the program manager for this announcement, Douglas White (phone (315) 330-

3564, US mail Rome Laboratory/PKRD, 26 Electronic Parkway, Griffiss AFB NY 13441-4514).

3 US Army Advanced Computing and Software

In October the US Army Research Laboratory issued BAA SOL DAAL02-93-4000, covering a wide variety of research areas in engineering. The portions of the announcement relevant to database researchers are for research in advanced computing and software, 'which includes the plans, designs, management, and operation of global computing, communication, and information systems assets'; and for technology to enable the collection, fusing, and assimilation of battlefield weather data. For more information about these topic areas, including points of contact within the Research Laboratory, fax a request to Henry Mehler at (617) 923-5328, or send US mail to the same individual at Contracts Branch/ AMSRL-OP-PR-WT/ Watertown, MA 02172-0001. Proposals will be accepted until February 1, 1993.

4 US 'Star Wars' Program

Proposals will be accepted by the Innovative Science and Technology Directorate of the US Strategic Defense Initiative Organization (SDIO) through June, 1993, for areas of research relevant to SDI. The listed topics of interest to database researchers are (#4) distributive [sic] computing and simulation, (#8) fault-tolerant computing, and (#13) computer security; topic #39 is '[o]ther proposer-identified science and technology areas that may be shown to be of immediate high level importance to the overall SDIO effort.'

For more information, contact Carol Williams at (703) 693-1671 regarding SDIO 92-29. If you wish to obtain the full text of the announcement, including the points of contact for specific topic areas, you must write to (not call) her at the Office of the Secretary of Defense/ SDIO/ ATTN: TNI-C/ Washington, DC 20301-7100, and mention the topic numbers given above in your request.

5 US Small Business Innovative Research Conferences

The US National Science Foundation (NSF) recently announced three National Conferences on the Small Business Innovation Research (SBIR) program, which awards funds to small businesses engaged in innovative product research and development. (For an overview of the SBIR program, see this column in the December 1991 issue of the *Record*.) The first conference was held October 27-29, 1992 in Arlington, VA. The other two conferences will be held in Phoenix, AZ on November 17– 19, 1992 and in Minneapolis, MN on April 27–29, 1993. NSF's overview of the first of the conferences is reproduced below. For more information on the upcoming conferences, contact Foresight Science & Technology, Inc., contractor to NSF and the Department of Defense, at (407) 791-0720.

"The 2 1/2 day conference will (1) describe research opportunities for small technology-based firms in the SBIR program and (2) feature special sessions on how to convert R&D into commercial applications.

"More than 100 government and private sector specialists will be available to meet with attendees. These include all SBIR program managers in the 11 participating departments and agencies, specialists from 20-30 Fortune 500 firms, experts in 20 separate seminar areas, and keynote speakers including Dr. Joseph Bordogna, Assistant Director for Engineering of NSF, Ambassador Henry Cooper, Director of the Defense Strategic Defense Initiatives Organization, Esther Smith, Founder and President of Washington Technology newspaper and Merrill Buckley, President of IEEE.

"Special sessions will include Starting and Financing a Small High Tech Firm, Commercializing SBIR R&D for Private Sector Markets, U.S. and Foreign Licensing, Finding Strategic Alliances and Partners, Seeking Venture Capital and 16 others."

6 The DARPA I3 Program

The US Defense Advanced Projects Research Agency (DARPA) is planning a new program on Intelligent Integration of Information (I3), under program manager Gio Wiederhold (wiederhold@darpa.mil; (703) 696-2218; Program Manager for Knowledge-based Systems/ DARPA/ 3701 North Fairfax Drive, room 739/ Arlington, VA 22203-1714). The I3 program is still subject to FY93 congressional directives, but funding looks likely. We quote here from a draft description of the new program.

"*Purpose and description*: The Intelligent Integration of Information Program (I3) is intended to establish a technology and support the science needed to present information in a form and at a level of abstraction needed for high-level applications. Modules in an I3 system gather data from a variety of sources, and transform and process such data to yield relevant information. Information sources include databases, knowledge bases, sensor-based subsystems, and simulations. To achieve their goal I3 modules also obtain and manage meta-data describing the content, format, location, and meaning of base data. Complementary meta-data can model the information needs of the application types being served. The total of such meta-data is used to manage consistency of data being processed, determine its processing, and present the best possible information to the user's applications."

"*Scientific foundation*: Critical to the success of the I3 program is the matching of resources to the user's needs. The role of an I3 module is that of a trustworthy asssistant. A responsive assistant has the competence to access and distill data resources, select and reduce the data to the essentials, assess the reliability of the result, and report the result in a timely manner. Automation of these tasks requires having models of the resources and the users, and interpreting the models to carry out processing. Since these models cover multiple domain,

their maintenance is a major issue.

"The actual processing include[s] summarization of detail data to the right level of abstraction for the user, or for intermediate tasks. A frequent intermediate task is fusion, bringing together data from autonomous sources. To have valid merging of information the sources must have an intersection, i.e., a shared ontology. Where the matching is not perfect uncertainty is created. Models of uncertainty can consider the reliability of the resources, the reliability of the match, and the appropriateness of the result to the user's needs. Since data sources may not retain historical data a module may have to keep past data to resolve temporal mismatches.

"A handcrafted I3 module uses knowledge of the programmer. Automation requires that this knowledge be encoded for interpretation. Having declarative knowledge allows many processing paths, so that optimization becomes an integral part of the processing paradigm. Variables to be included in the optimization include the location of I3 processing, in order to minimize delays due to remote access and dissemination and the use of parallel resources.

"There are many current research efforts that can contribute to integration of information, but their focus and integration is envsioned to give rise to an integration science."

"*Technology impact*: The Intelligent Integration of Information program will provide the essential conceptual integration of the rapidly increasing flow of data. Effective services must be alterable to a variety of needs, and permit autonomy of the resources, so that rigidity of systems is avoided. Distribution of data and information is not only a physical aspect, but pervades system use as well. Users will be distributed and will rely on shared information for collaboration. Information users and data contributors share the same resources. Some users need the data for close operational control, others will use it to monitor long-range trends. This mean that an effective I3 system has to satisfy many objectives within a common infrastructure. An I3 system enables collaborative work, and in that sense is essential to exploit the diverse and distributed strength of U.S. industry and the many small businesses that comprise it.

"The I3 concepts exploit advances in High Performance Computing and Communication, and in turn provide much of the justification for the investment made into this technology. It depends on the evolving standards in high-speed communication. As consensus is achieved among participants in specific information domains it must consider, evaluate, and support the development of standards for the representation of data and the knowledge used to describe them. To understand the complexity of the data resources and the users requirements it must be able to model that world, and represent the modeling knowledge effectively.

"To manage the models that describe the needs of the applications and the available resources, artificial intelligence (AI) technologies are essential. The AI tasks have a clear scope since knowledge-based systems deal with symbols and numbers in defined scopes, rather than with the complexity of a real world, as must be faced by a robot. At the same time the volume of data is immense, and careful structuring is required to attain stability, consistency, and longevity. Modules of an I3 system take on the task of technical maintenance, relieving application programmers of work which is not related to the essential function of the applications, [such] as modifications caused by changes in database, communication, or simulation subsystems. Providers of such subsystems, on the other hand, can concentrate on the integrity and improvements of their systems, and introduce changes that permits them to reflect more precisely the real world and changes occurring in it. The I3 model is predicated on a linear cost of maintenance.

"Getting relevant information to the military decision maker, whether he is in the front-line or managing resources in peace time is critical. Rapid improvements in database storage, sensor bandwidth, and simulation capability, combined with reliable and high bandwidth global communication, create data overload on the decision maker. While such an overload is sometimes refered to as information overload, the mass of data impose the implicit responsibility on the user to consider all possible detailed facts, since any item of data may contain some sliver of useful information. With good models of application needs, based on meaningful structural primitives that can be imposed on the data sources, the tedium can be greatly relieved, and human capability can be focused on the tasks that humans do well: seeing patterns in well-presented data, diagnosing causes of aberrations, selecting appropriate actions, and motivating colleagues to collaborate.

"Automation of Intelligent Integration of Information systems will relieve the user of tedium and permit better performance at less effort. An effective architecture can also support continuous improvement of the systems, both by being responsive to new rules for data selection and reduction, and by automatic learning from changes in data or the user's applications access patterns."

"*Technology transfer*: Distributed Information Services are required in most DoD programs, and by extension, in all thrust areas as well. Especially obvious here are:

"1. Global Grid: Selecting and delivering information rapidly over the world-wide network supporting multiple, distributed command-and-control centers requires modern and effective techniques for distributed data management.

"2. Affordability. Producing, acquiring, and shipping the right materiel for the appropriate use is an essential part of making strength affordable. Tracking requirements, capabilities, and logistics usage is inherently a Distributed Information Service.

Since Intelligent Integration of Information services are a processing infrastructure, in many senses similar to the communication infrastructure provided by prior DARPA initiatives as the ARPAnet, it is equally hard to assess what the full scope of global Intelligent Integration of Information services will be. An early task of the I3 program will be to develop meaasures of effectiveness."

"*Business and acquisition strategy*: To fully realize the benefits of I3 technology the concepts must, in time, be adopted by the vendors who provide the bulk of DoD computer systems hardware and software. Three layers of effort are foreseen in the transition strategy for the I3 program: (1) Support and focusing of the underlying science and technology base (2) Collaborative projects providing demonstrations of the effectiveness of I3 technology (3) Insertion of I3 technology into major demonstrations, [such] as the F-22 IWSDB and other DARPA ATDs."

7 Other DARPA News

What is the reaction at DARPA to the self-examination taking place at NSF? A usually reliable source says that DARPA probably will not be much affected by the NSF computing report. Big issues at DARPA nowadays are, first, the role of commercial off-the-shelf software in DoD applications, as opposed to software written to order; and second, on the best means of ensuring that new software engineering principles and tools are used in DoD software generation and maintenance.

DARPA is considering a program to bring together the object-oriented database management system vendors in a "harmonization effort." That sounds like fun!

A new Broad Agency Announcement (BAA) is expected soon from DARPA in the software area. Due dates for proposals may well fall before the publication of the next issue of the *Record*, so keep your eye on the *Commerce Business Daily* for the official announcement if you are interested in submitting a proposal.

The US Department of Defense has announced this year's Augemenation Awards for Science and Engineering Research Training (AASERT) program, which supports students whose work is associated with a current DoD research award. (See this column in the March 1992 *Record* for more details on the AASERT program.) The supported students must be US citizens, and proposals are due December 15, 1992. Contact the agency sponsoring your current DoD award for more information on the program requirements. You may also retrieve the program brochure via modem by dialing the Federal Information Exchange at (301) 258-0953, or by contacting the Army Research Office at (919) 549-4206. DARPA expects to have substantially more funds for AASERT this year (over US$5 million, versus US$4 million last year).

DARPA's new BAA 93-01, from the Autonomous Systems Technology Program, focuses on the problems of image understanding and of planning for unmanned air and ground vehicles. While this BAA is not directly in the database area, a database component might logically be part of a larger proposal that addressed one of the image understanding or planning problems. DARPA expects to award ten three-year contracts, for a total of US$7,5000,000, and the due date for proposals is December 18, 1992. Areas of interest are natural scene understanding, model-based object recognition, motion compensation, target detection, multi-sensor fusion, image understanding, multi-agent planning and control, and hybrid image understanding and neural network systems. For more information, contact Oscar Firschein, fax (703) 522-2668; email to baa9301@darpa.mil; or send US mail to BAA 93-01/ DARPA SISTO/ 3701 N. Fairfax Drive/ Arlington, VA 22203-1714.