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Modernization and New Technologies: Coping with the Information Explosion

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Introduction

Science and technology have advanced more rapidly in the last 50 years than in the previous 50,000 years. Innovation has moved us forward, from airplanes, rockets, missiles, jets, and supersonic transport systems to today's space shuttle operations. Through research and development, we have achieved the ideas found only in fiction a few short years ago. We are in the midst of an unprecedented technological explosion, one that encompasses a tremendous expansion of scientific and technological effort. The result is a fantastic increase in the accumulation of technical knowledge -- and paradoxically -- in the need and search for even more knowledge.

Along with this technological explosion, we find ourselves living in a different environment -- a new information environment. The convergence of computer technologies, the dramatic increase in the availability of information, the increase in demand for information products, the rise of the information industry, and the appearance of information professionals are some of the signposts of this environment.

A strong science and technology base is a national necessity in a competitive world, and adequate communication is a prerequisite for it. An individual, be it a policy maker, program manager, a bench scientist, or engineer, resorts to the information system if he or she believes it will save him or her time to first consult the written record rather than to undertake a repetitious experiment or investigation.

Scientific and technical information (STI) is a valuable resource that directly affects the cost of performing a technical task, the quality of one's work and results, and productivity. The problems of identifying, collecting, and supplying STI to those who need it, when they need it, is of vital and increasing concern; these problems concern information specialists and others who work to establish systems and operations to fulfill the needs of the information user.

The basic requirement for a successful STI program is to fulfill the needs of the people it serves. To fulfill these needs, we must determine who needs the information, what information do they need, how do they want the information, and when do they want or need it?

Ideally, all of the information we provide to a user should be available from one central source. The user should not be required to identify and canvass four or five or more different sources to get a complete picture of what he or she is seeking. This is not to say that the source of

information must be in one repository, but a query to one center should produce a reply containing a comprehensive and complete reply of all the documents pertaining to a subject and where they may be located.

Herein lies one basic principle that we as information specialists must never ignore; that is, an information service is not an end in itself, but rather, is a device through which its users obtain information. As is true with most services, the user does not want to think about the mechanics or details of the service's operation. The user only wants service of the type and degree that he or she wants, when he or she wants it, and at a reasonable price. We who are responsible for operating an information service must be cognizant of this principle, and, in general, operate accordingly.

The expanding use of information technology, the growth of interdisciplinary research, and an increase in international collaboration and development of international standards is having a significant impact on the conduct of science and the corollary information management activities.

The internationalization of science is of utmost significance in providing scientific and technical information support. STI is being produced, enhanced, and stored around the globe. While single countries in some cases are acknowledged leaders in select scientific and technical disciplines, many of the major research efforts involve world-wide data collection.

Many of the significant research challenges today are interdisciplinary in nature, which requires expanding the circle of collaborators and the range of information sources. Not only are a variety of disciplines involved, but scientists from around the world are participating in these efforts. The users in these projects are distant geographically as well.

All of these factors are changing traditional data management techniques and are creating pressures to change accepted information practices. Although we now have vast and large databases, the different methodologies, vocabularies, and cultures of individual disciplines create obstacles to efficient information exchange. Merging existing data collections from different fields to perform analyses creates new problems. It becomes extremely difficult to compare data that were derived using different techniques or approaches. Contributing to this problem is the lack of standards for data exchange formats which hamper the building of multidisciplinary and interdisciplinary databases.

Providing information in support of the aerospace, or any other global community would appear to be a formidable and overwhelming task. This is especially true when the provision of information must take into account the vast array of multidisciplinary databases, the requirement to provide both observation data and graphic representations of observation data, the availability of information through personal contacts, and the ability to supply complete reports of research on demand. The end users are a diverse group with many diverse needs. They require different types of data, different products, different services, and different user interfaces.

The NASA Scientific and Technical Information Program

The NASA Scientific and Technical Information (STI) Program is a combination of systems, functions, products, services, and information professionals, with the common mission of providing for the widest practicable and appropriate dissemination of information concerning NASA activities and research results. The Program is geographically and organizationally dispersed across NASA Headquarters, each of the 13 NASA Research and Flight Centers, and service centers such as the NASA Center for AeroSpace Information (CASI). The Program provides interfaces to and from other U.S. government agencies engaged in the collection and dissemination of scientific and technical information and to and from international aerospace agencies such as the European Space Agency (ESA).

The Program's user community includes NASA scientists, engineers, and managers; NASA contractors; other U.S. government agencies and their contractors; US industry and the academic community; and the international aerospace community. In total, over 7,000 entities are registered with the Program, but since many of these are actually registered at the intermediary and organizational level, the number of end users reached by the Program is much greater. For example, the number of registered international users in January 1992 was 700, with an associated end user population of some 40,000 users.

The NASA STI Program recently completed an in-depth analysis of the technology it uses for acquisition, management, and distribution of the recorded results of NASA and worldwide research and development aerospace information. We concluded that the current technology infrastructure was considerably out of date and inadequate to support the increasingly sophisticated requirements of information users within the NASA community. A series of program reviews,

evaluations, user requirements studies and feedback solicitations validated the need for modernization.

The modernization project will create an environment that will expand database coverage to include more comprehensive subject coverage, new data types and sources (such as multimedia), and improved quality and timeliness. It will also provide for full text search and document retrieval at the desktop in addition to providing enhanced and increased database searchability.

The focus of the modernization program is the technology upgrades required to develop a state-of-the-art system: network upgrades, full text/image retrieval software, electronic document interchange/dissemination, machine translation, video/multimedia support equipment, a graphical user interface (GUI)/gateway front end, an optical imaging system, management information software, expert search software, and data manipulation tools.

Our approach to modernization is characterized as one of evolutionary development, designed to reduce the risk and cost of new system acquisition through the cautious, incremental building of system components. Our approach emphasizes the use of already proven commercially available technology and other government developed or public domain products. We are also emphasizing the use of standards to ensure the lowest cost migration path for future enhancements and to support the greatest potential for interoperability among and between system components.

In our strategic plan for modernization, one important fact that we have taken into consideration is that **no one information center can hope to collect all the relevant data in support of their aerospace community participants.** Our goal at NASA is to meet the requirements of our customers and to establish as comprehensive and complete a database as possible. This goal is inherent in any organized information program. But how best to attain this goal? The most practical way to achieve this it to work with all the other organizations worldwide who share this goal, and to develop cooperative strategies to realize it.

One strategy is to form an international coalition to collect and provide access to disparate, multidisciplinary sources of information, and to develop standardized tools for documenting and manipulating this data and information. Mobilizing international resources to plan and strategize in a coordinated manner will move us towards this goal.

Recent advances in information retrieval systems have focused on developing and applying interface technology to create an environment where networking and interoperability strategies are possible on a global basis. One of these technologies is the development of gateways. Gateways allow users to interconnect with multiple, diverse information systems. In essence, gateways act as intelligent switches. Gateways are being designed and developed to operate in environments ranging from single-user microcomputers to multi-user, central processing mainframes. These gateways allow simple interconnections, registration into multiple systems. They provide telecommunication paths and protocols, and logon and logout procedures. More sophisticated gateway systems incorporate menus, common command language, data analysis routines, artificial intelligence, and related technology.

To date, we have found that access to online information sources of scientific and engineering data has been limited to a large extent by factors such as inadequate telecommunication systems, non-standard query language syntax, lack of standardization in the information, and lack of adequate tools to assist in searching.

The NASA Access Mechanism Prototype Gateway System

The NASA STI Program has recently began testing a prototype gateway system, the NASA Access Mechanism (NAM), which offers a solution to these problems by providing the user with a set of tools that provide a graphical interface to remote, heterogeneous, and distributed information in a manner adaptable to both casual and expert users. The NAM will provide access to many Internet-based services such as electronic mail, the Wide Area Information Servers (WAIS) system, peer locating tools, and electronic bulletin boards.

One requirement of the future NAM is that the user interface be easily customized for specific user communities. Another requirement for the future is to provide for two- and three-dimensional visualization and rendering of datasets, both for user input and results output.

Using gateway technology, we can determine which relevant databases exist to solve an information query; from there we can learn how to access them, how to retrieve information from them, and how to manipulate the retrieved information. The NAM can provide a single, easy-to-use interface for identifying, accessing, interrogating, and post-processing information from numerous databases relevant to global change information needs.

In terms of peer locator databases, or "people bases," the NAM can be designed to answer questions such as what expertise is available on the network, how to communicate with the experts, and how to share information with colleagues. The system acts as an integrated information system that allows human experts, information users, and information resources to communicate more efficiently and cost effectively.

In short, the NAM or any other gateway will help us ensure that the proper sources are used, and that relevant information is retrieved. Such systems can also help us avoid leaving out important sources of information and retrieving volumes of irrelevant data. Gateway technology will help us to:

- Maintain a constant alert for new databases/services.
- Register for, and maintain accounts with each of the services.
- Select the right service(s) for the query.
- Learn the diverse command structures associated within each of the services.
- Become knowledgeable regarding the terminology used in each database.
- Merge and analyze results from multiple sources.

The basic components of the NAM include a directory of subject-searchable resources, a common method for accessing and searching diverse databases, tools for downloading and post-processing data, and tools for communicating with a network of experts and colleagues. **The NAM is still in its infancy, but it has the potential for extraordinary growth.**

Strategies for Cooperation

There are two strategies that can be implemented quickly to improve the availability of information to the worldwide aerospace communities.

One strategy is to build gateway connections between the existing databases of our worldwide aerospace partners. This will increase the availability of the existing databases, and create a base for establishing

and promoting a global scientific and technical information network (STINET).

The second strategy would build upon the first, as a next step in this international cooperative effort. This strategy is to organize and establish an advisory group of representatives composed of from the world-wide aerospace community. The first action this advisory group might undertake would be the development of a comprehensive list of issues to be addressed, such as how can current existing exchange relationships form the basis for more cooperative international efforts. Other tasking for this group could include:

- Determining the types of agreements and relationships that will encourage involvement.

- Determining whether a formal group should be established to set policy and establish procedures for the sharing of existing international databases.

- Determining how to make the bibliographic database more comprehensive and timely, by identifying how information producers can be motivated to provide input, and how coverage of those parts of the world not participating in the effort might be accomplished.

- Addressing the issue of database availability. Who would be eligible for access, what should the pricing strategies be, and what is an appropriate network architecture?

- Identifying what strategies will be necessary to go beyond bibliographic cooperation into sharing of other kinds of data and information, including improvements in systems and technology for delivery and management of information, by determining how to reconcile the need on the part of participants in the international cooperative effort national for proprietary information.

- Providing oversight of a global STINET. This would require intellectual maintenance, in addition to the maintenance requirements associated with hardware and software. Some of the challenges for the advisory group would involve tracking changes instituted at remote resources to initiate appropriate modifications to preclude network disruption. Maintenance would also involve adding new resources to the network, and an appropriate task for the advisory group would be to determine what resources should be added to the network and

in what priority order. Most importantly, the advisory group would be called upon to attest to the validity and reliability of data sources, ensuring that resources are credible.

- Developing policies concerning how nationally generated information will be controlled and validated. The use of incorrect information for decision making and planning could prove disastrous to an individual or to an organization.

- Examining strategies for an automatic translation facility. This would be useful in cases where pertinent information is stored in a language that is not native to the user. Automatic translation could make the information rapidly available in a useful format, and help eliminate the language barrier among users on the network. It could be used in conjunction with the "people bases."

- Addressing when to distribute resources on optical media for local use rather than making the resources available through telecommunications. Optical and video technology introduce us to the era of hypermedia, where conventional definitions of information systems and the data they contain must be redefined.

Summary

The job of establishing an international program to deal with the burgeoning sources of information is a tremendous task, but with the proper planning, resources, and both fiscal and personnel support, it can be accomplished. The effort is important, in its potential for providing invaluable services to the worldwide aerospace user community.

The task is not an easy one. Other issues and problems that will need to be addressed as the international program evolves include the following:

- Information technology issues to address technology advances, next-generation information system problems and issues, the pace of technology development, development of computer networks, standards, military applications, and other technology issues.

- Policy, structural and institutional issues to address changes in science, information policy issues, public/private sector roles and relationships, and relationships among text, numeric, and image providers.

- Legal and ethical issues to address intellectual property rights and other ethical issues.

- Economic/marketing/financial issues to deal with issues such as the increasing volume of information, storage and archiving, quality/comprehensiveness/currency of information content, access and dissemination, and security.

- Attitudinal and behavioral issues that concern the user community and the relationships with the information programs.

- Education and training issues are self evident; education and training will be vital to maintaining a strong STI program.

- International issues for information access that encompass items such as trans-border data flow, privacy/security, political/economic/social considerations, acquisitions and mergers of information companies, pricing/currencies, information to be exchanged/transferred/sold, language and translation, telecommunications, communicability, compatibility, standards and copyright and data rights.

The challenge of building a global scientific and technical information network will stretch far into the future. Network services will be added and deleted based on changes in technology and user requirements. The unchanging factor in successful development of the global network will be the partnership among end users, information specialists, and network developers. As long as this cooperative relationship continues, the STINET will continue to grow and expand.

Bibliography

1. Blados, Walter R. "Quo Vadimus? Coming to Grips With the Information World," NASA Technical Memorandum 105138, May 1991.

2. Blados, W. and G. Cotter, "An International Aerospace Information System: A Cooperative Opportunity," NASA Technical Memorandum 108171, October 1992.

3. Blados, W. and G. Cotter, "Global Change Information Support: A North-South Coalition," NASA Technical Memorandum 108983, January 1993.

4. Blados, W. and G. Cotter, "Modernization and Unification: Strategic Goals for NASA STI Program," NASA Technical Memorandum 109186, April 1993.

5. Cotter, Gladys A., "The Scientific and Technical Information Network (STINET): Foundation for Evolution," Defense Technical Information Center (DTIC) Technical Report DTIC/TR-88/5, September 1987.

6. Cotter, Gladys A., "Global Scientific and Technical Information Network," Defense Applied Information Technology Center Technical Report DAITC/TR-88/007 (DTIC/TR-89/2), December 1988.

7. Cotter, G. and K. Kaye, "NASA STI Program Multimedia Initiative," paper presented at the 31st Aerospace Sciences Meeting and Exhibit, January 11-14, 1993, and published by the American Institute of Aeronautics and Astronautics, Washington, DC.

8. Cotter, G. and T. Lahr, "Unification: An International Aerospace Issue," paper presented at the 30th Aerospace Sciences Meeting and Exhibit, January 6-9, 1991, and published by the American Institute of Aeronautics and Astronautics, Washington, DC, 1991.

9. Cotter, G., T. Lahr, and B. Cooper, "Unification: An International Aerospace Information Opportunity," paper presented at the Strasbourg Conference of Management and Information: From Information Evaluation to Decision, January 15 - 17, 1992 and published as NASA Technical Memorandum TM-107767, January 1992.

10. Hunter, J., D. Duncan, and C. Generous, "NASA Access Mechanism -Graphical User Interface Information Retrieval System," paper presented at the 31st Aerospace Sciences Meeting and Exhibit, January 11-14, 1993, and published by the American Institute of Aeronautics and Astronautics, Washington, DC.

11. "A Strategic Direction: The NASA Scientific and Technical Information Program," published by the NASA STI Program Office, Washington, DC, 1991.

12. "International Aerospace Information: The NASA Scientific and Technical Information (STI) Program," published by the NASA STI Program Office, Washington, DC, 1991.

13. "NASA STI Program: Prologue to the Future," published by the NASA STI Program Office, Washington, DC, 1992.

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13. ABSTRACT (maximum 200 words)

Information has become a valuable and strategic resource in all societies and economies. Scientific and technical information is especially important in developing and maintaining a strong national science and technology base. The expanding use of information technology, the growth of interdisciplinary research, and an increase in international collaboration are changing characteristics of information. This modernization effort applies new technology to current processes to provide near-term benefits to the user. At the same time, we are developing a long-term modernization strategy designed to transition the Program to a multimedia, global "library without walls." Notwithstanding this modernization program, it is recognized that no one information center can hope to collect all the relevant data. We see information and information systems changing and becoming more international in scope. We are finding that many nations are expending resources on national systems which duplicate each other. At the same time that this duplication exists, many useful sources of aerospace information are not being collected to cover expanded sources of information. This paper reviews the NASA modernization program and raises for consideration new possibilities for unification of the various aerospace database efforts toward a cooperative international aerospace database initiative, one that can optimize the cost/benefit equation for all participants.

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