

**Best Practices in Electronic Government: Comprehensive Electronic Information
Dissemination for Science and Technology**

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Abstract

The Department of Energy's (DOE) Scientific and Technical Information Program (STIP) has successfully reinvented the way in which DOE's scientific and technical information is collected, organized, archived, disseminated, and used in the performance of research and development (R&D). Through a suite of innovative Web-based products conceived and developed by the Office of Scientific and Technical Information (OSTI), the scientific and technical information and resources resulting from the Department's R&D activities as well as worldwide information needed by the research community are readily available to all users in a fully integrated E-Government environment. This suite of products is publicly accessible at <http://www.osti.gov>.

Introduction: E-Government In Action

E-Government has been defined as “implementing cost-effective models for citizens, industry, federal employees, and other stakeholders to conduct business transactions online. The concept integrates strategy, process, organization, and technology.”¹ This statement is consistent with OSTI's concept of E-Government as applied to scientific and technical information transactions.

The transition of scientific and technical information dissemination to an E-Government

environment represents a fundamental change in the way DOE transacts business and reflects a new milestone in the Information Age as the world recognizes the value of applied information as the gateway to the future. As a result of DOE's efforts in applying E-Government concepts and practices, users have easy access to a far greater body of information and resources than previously existed, and information is readily available to all who need it via the Internet. The electronic environment allows for locating, assimilating, and using retrospective and current information from a wide variety of sources to create new knowledge; and it provides the tools to facilitate the use of scientific knowledge in real-world settings, all at no charge to the user and greatly reduced Federal costs per user served.

The Literature: Information Dissemination Milestones in Science and Technology

In 1944, Vannevar Bush, then Director of the Office of Scientific Research and Development, authored a report at the request of President Roosevelt entitled Science The Endless Frontier: A Report to the President. It outlined a policy framework to “get this scientific material to scientists everywhere with great promptness and at as low a price as is consistent with suitable format.”² Further, the U.S. “should formulate a national policy for the Government toward science, [and] should sponsor the interchange of scientific information among scientists and laboratories both in this country and abroad.”³

Later, scientific information dissemination dialogue coalesced with opportunities presented by new technologies through the efforts of groups such as the Task Force on Electronic Information Systems formed by American Physical Society President Val Fitch in 1988. The charge to the Task Force begins, “The American Physical Society recognizes that the new information technology offers the Society an unprecedented challenge and opportunity to further

the mission of advancing and diffusing the knowledge of physics.”⁴

In January 1993, a Task Force on a National Strategy for Managing Scientific and Technological Information, under the auspices of the Association of American Universities (AAU) Research Libraries, was charged to “examine new options for the collection and dissemination of scientific and technical information that could break an extraordinary information cost spiral while at the same time support innovative applications of information technology.”⁵ Grassroots efforts such as the Chicago Conference on the Future of Federal Government Information reiterated a commitment “to the assumption that no-fee public access to government produced information is fundamental to a democratic society ... and is a cornerstone in the building of the national information infrastructure.”⁶

More recently, the President’s Information Technology Advisory Committee Report to the President (PITAC) Information Technology Research: Investing in Our Future highlighted the possibilities of electronic information “transforming the way that we learn.”⁷ The report puts forth the notion of a National Digital Library, having a “strong and positive impact on scientific and engineering research and development and on education by providing users with more up-to-date information, reducing effort and cost, and preserving this body of knowledge for future generations.”⁸ The U.S. National Commission on Libraries and Information Science (NCLIS), a permanent, independent agency of the Federal government was charged by Section 5 of Public Law 91-345 to advise the President and Congress on national and international policies and plans concerning library and information services, has recognized government information resources as a “strategic national asset.”⁹

Thus, the need for scientists to have a comprehensive body of information and resources in

scientific disciplines to facilitate the use of information in research endeavors has long been recognized. This need has taken on a new urgency as the amount of worldwide information grows exponentially. It is currently estimated that between 1 and 2 exabytes, or 1 to 2 billion gigabytes, of unique information is created annually.¹⁰ For DOE the importance and value of widely disseminating the results of R&D and related information is documented in the mandates of DOE's enabling legislation requiring dissemination of research results to the broadest possible audience.¹¹

Background: OSTI's Unique Position

The primary output of DOE's multibillion-dollar R&D programs is scientific and technical information. This information, when supplemented by worldwide research results, represents a vast national resource that provides the basis for technology application and future research. It serves a vital role in sustaining U.S. competitiveness and promoting public well being. Through OSTI, the Department collects both DOE-sponsored and worldwide scientific and technical information and disseminates it to the broadest possible audience. OSTI has been in the business of information dissemination for over 50 years, and has long been recognized as an innovator and leader in the global information industry. It is OSTI's unique responsibility to make DOE's vast store of research information, as well as the results of current and future DOE-sponsored research, available to the widest possible audience in the most economical, easy-to-find, and useable forms and formats. This information is supplemented through exchange and acquisition to include worldwide research results in scientific disciplines of interest to the Department.¹² Today, OSTI's information holdings include 1.5 million full-text reports, over 80,000 of which have been digitized to date. This extensive resource, along with 5 million abstracts and citations

announcing the availability of worldwide energy research results, combined with networked links to over 500 external Web sites with distributed searching mechanisms, enabled DOE to service 3.4 million customer transactions in FY 2000.¹³

Known throughout the world as a central source of information about energy science and technology, OSTI has developed state-of-the-art methods to improve access to the Department's vast information holdings to scientists, engineers, educators and other interested parties in government, business, academia, and the general public. In the past, research results were catalogued, and text was distilled into short summaries, or abstracts. As information access and dissemination has transitioned from a paper-based to an electronically-based paradigm, new ways of achieving OSTI's mission and meeting DOE's mandates have been developed. Through an innovative suite of products designed to provide information directly to the user's desktop, OSTI has successfully transitioned the collection, organization, retention, dissemination and use of DOE's scientific and technical information into a fully-functional E-Government environment. All products in the suite are available via the Internet and are offered at no charge to users. In the interest of meeting DOE's statutory mandate for broadly disseminating information, OSTI uses its appropriated funds to build, populate, and maintain its products, capitalizing on emerging technologies and innovative applications to provide information in the most useful and useable means possible.

Implementation: Building the E-Government Infrastructure

OSTI, an organization of fewer than 100 federal employees, has created an extensive infrastructure that serves the scientific and technical information needs of scientists, engineers,

program and project managers, and others, both within DOE and among other government agencies, academia, U.S. industry, and the interested public, as well as the international information community (via U.S.-sanctioned international and multinational exchange agreements).^{14 15} OSTI's suite of almost 60 electronic Web-based products accommodated 3.4 million customer transactions in FY 2000, more than a ten-fold increase over the 300,000 electronic transactions recorded in 1995.¹⁶ Customer transactions continue to increase as advances in information technology make traditional access limitations such as physical location irrelevant through the virtual environment of the World Wide Web.

A case in point is *EnergyFiles Virtual Library Collections of Energy, Science and Technology* (<http://www.osti.gov/energyfiles>). Visiting a comprehensive library used to mean traveling, sometimes quite a distance, to a library facility. The Internet-based *EnergyFiles* provides access to a portal of over 500 Web sites and databases containing scientific and technical information and resources in a variety of science disciplines. An innovative search engine called *EnergyPortal* (<http://www.osti.gov/energyportal>) enables users, with a single query, to search across these sites in a seamless manner and locate and assimilate information from multiple sources. This unique tool is thought to be the first of its kind in government, and provides a model for the next generation of tools and technologies designed to accomplish the convergence of content, technology, and service into an integrated electronic environment.¹⁷

In designing the E-Government environment to accommodate DOE information transactions, OSTI assessed the needs of scientists and engineers to determine how information could be better integrated into the scientific process. Respondents from the scientific and technical community indicated the need for a virtual library of science information that could be

used in context with other tools and resources to facilitate research.¹⁸ OSTI has determined that the three main ways in which scientists share, acquire, and communicate information are through technical reports; peer-reviewed scientific journals; and preprints, or informal articles or other documents that have not been peer reviewed and published and are often working papers.¹⁹ OSTI set out to conquer these three main conduits for communicating information by developing electronic systems that would provide easy and effective access to each. These three systems, comprising the information trilogy, are the *DOE Information Bridge*, *PubSCIENCE*, and the *PrePRINT Network*.

Prior to 1997, full-text of the scientific and technical reports, resulting from DOE's R&D had to be ordered in print copy by mail or located at a library. This process created a significant user investment in both time and money. Realizing early that the future lies in electronic information, OSTI moved quickly into uncharted territory by developing a system called the *DOE Information Bridge* (<http://www.osti.gov/bridge>) to put full-text reports on the World Wide Web and make them fully searchable and immediately accessible at no cost to users. This system continues to grow, and over 60,000 full-text documents representing over 5 million searchable text pages are now publicly available via the *DOE Information Bridge*.²⁰ Recently, permanent URLs (PURLS) have been added to all full-text documents to allow for bookmarking and accessing individual reports.

In October 1999, OSTI's *PubSCIENCE* product (<http://www.osti.gov/pubscience>) was officially launched by the Secretary of Energy in a ribbon-cutting ceremony at DOE Headquarters in Washington, DC.²¹ The second component of the trilogy, this Web-based application provides the means to search and access hundreds of peer-reviewed journals at one

time without having to search individually through multiple Web sites, publications, and references. To accomplish this, OSTI has brokered an extensive partnership of 38 scientific journal publishers to provide a unique resource, free of charge to the user, for locating journal information on the physical sciences and other energy-related disciplines. *PubSCIENCE* currently is comprised of over 1,260 scientific and technical journals with 2 million multi-source journal citations, including those dating back over 25 years from DOE's prestigious *Energy Science and Technology Database*.²²

In January 2000, the *Preprint Network* (<http://www.osti.gov/preprint>) was introduced. Harnessing this third component represents a major breakthrough in making previously difficult-to-find scientific information available in a more timely and comprehensive manner. This Web-based tool provides free access to yet-to-be-published papers, draft journal articles, and other electronic documents and communications produced by researchers. Interested users can browse or cross-search one specific preprint site, a selected set of sites, or all of the listed sites. Over 1,500 sites have been indexed to date, providing access to 340,000 scientific documents.²³

In addition to *EnergyFiles* and the three products that make up the Information Trilogy, OSTI developed and hosts over 50 additional Web sites.^{24 25} Together these products comprise an extensive product portfolio that provides the basis for OSTI's ability to meet its DOE-mandated responsibilities and deliver a comprehensive range of useful and useable science and technology to the user's desktop in a fully electronic environment.

Two recently-developed products are the *GrayLIT Network* and *Federal R&D Project Summaries*. These products, formally introduced in August 2000, focus on the need of users to access government information without having to first find the originating agency, then

individually searching Web sites of each agency. Developed by OSTI in collaboration with other Federal agencies, these products provide the capability to search for documents with a single query across databases of participating agencies to find and combine information regardless of where it happens to reside.

GrayLIT Network (<http://www.osti.gov/graylit>) provides a portal to over 100,000 full-text technical reports, electronically housed at DOE, Department of Defense, Environmental Protection Agency, and National Aeronautics and Space Administration.

Federal R&D Project Summaries (<http://www.osti.gov/fedrnd>) includes more than 240,000 research summaries and awards of three major sponsors of research in the Federal government - DOE, National Institutes of Health, and National Science Foundation.²⁶ *GrayLIT Network* and *Federal R&D Project Summaries* are early successes of a proposed new information infrastructure for the physical sciences.

Future Direction: Physical Sciences Information Infrastructure

Primarily as a result of DOE's efforts in transitioning scientific and technical information to an electronic environment, a workshop was held at the National Academy of Sciences in May 2000, to address the concept of a comprehensive information infrastructure for the physical sciences to increase the productivity of the scientific enterprise in the United States and benefit both the scientific community and the national good. A panel of experts in science policy, information science, and scientific publishing convened to discuss the concept of a Physical Sciences Information Infrastructure, which has been recognized and advocated for over 50 years, but has only recently become technologically possible.²⁷

"The time is now, the need is now" was the conclusion of the workshop, the results of which

have been issued in the “Workshop Report on a Future Information Infrastructure for the Physical Sciences,” (<http://www.osti.gov/physicalsciences>). The workshop findings support the need for a common knowledge base that provides comprehensive access and facilitates the reuse of worldwide sources of physical sciences information as well as a point of convergence for ensuring awareness, availability, use and development of information, technologies, and tools. The workshop report notes that the Department of Energy’s Office of Scientific and Technical Information could well serve as this point of convergence and lead an initiative through a collaborative effort that encompasses government, industry, academia, and professional associations.²⁸

The information revolution is upon us. With the successful transition of scientific and technical information dissemination to a fully-integrated electronic environment, the next step is to capitalize on that major accomplishment to develop a broad-based physical science infrastructure that will serve scientists and the public in ways that have heretofore only been envisioned.

Customers and Partners: Leveraging for Success

The decision to develop a comprehensive, fully integrated electronic means of delivering scientific and technical information carried many implications regarding customer base. “Information at the desktop” became the rallying cry for OSTI as the organization focused on providing direct service to end users in the public sector, academia, industry, and the public, in addition to its traditional redistributor customers. Anyone with a need for scientific and technical information and resources is now able to come to a central location on the World Wide Web to find what he/she needs wherever it happens to reside, work with it to gain or create knowledge,

and apply it to specific situations. This powerful capability embodies the concepts of both one-stop shopping and distributed searching across disparate databases and Web sites, as well as expanded service to a broad public constituency.

From the first stages, it was understood that such a massive undertaking would require extensive collaboration with partners within DOE and among the national and international scientific and technical information community. OSTI has extensive experience in partnerships and collaborative efforts with other entities to accomplish information acquisition and dissemination goals, and those relationships were brought to bear in the planning and development of the electronic environment.

The DOE Scientific and Technical Information Program (STIP), coordinated by OSTI, consists of Technical Information Representatives from DOE Headquarters' programs, Technical Information Officers from the DOE Field Offices, laboratory information managers, and others throughout the DOE complex. This broad-based group developed a STIP Strategic Plan to transition the Department's dissemination of scientific and technical information from paper/microfiche to electronic media, including electronic submittal of full-text technical reports via a system called E-Link. That plan called for the input and not just the output to operate in the electronic environment, creating the basis for a totally digitized system throughout the information life cycle.²⁹

In addition, OSTI used its position in CENDI, an interagency Working Group composed of senior scientific and technical information managers from the Departments of Commerce, Energy, Defense, and Interior, the Environmental Protection Agency, the National Aeronautics and Space Administration, and the National Libraries of Agriculture, Education, and Medicine, as a sounding board for the assessment and evaluation of new ideas and concepts that would

support the development of a true E-Government environment for science and technology. The idea for a comprehensive infrastructure for science and technology was presented to CENDI in 1998, and a study group reported agreement with the initial concept and offered suggestions for further development.³⁰

DOE and the U.S. Government Printing Office (GPO) have partnered closely for many years to provide improved service to the public. Many electronic products of OSTI, including the *DOE Information Bridge*, *PubSCIENCE* and *GrayLIT Network*, are being sponsored by the GPO as a means of providing access to scientific and technical information to the public through the Depository Library Program, and *GPO Access*.

Other partners in the transition to an electronic environment include multinational organizations (International Atomic Energy Agency's International Nuclear Information System and the Atomic Energy Agency's Energy Technology Data Exchange) and publishers of scientific journals. International Partners exchange worldwide scientific and technical information with the United States through reciprocal agreements implemented by OSTI. Scientific journal publishers contribute access to 2 million citations from over 1,260 journals by participating in *PubSCIENCE*. These two sources significantly increase the amount of information available for dissemination in electronic form and effectively supplement the DOE-generated scientific and technical information.

OSTI also utilizes the services of commercial partners in developing and implementing the tools and technology needed for a fully-functional E-Government environment. A major contributor is Innovative Web Applications (<http://www.iwapps.com>), whose founder Abe Lederman developed Distributed Explorer, the ground-breaking search and retrieval technology that provides distributed searching for many of OSTI's products, including *EnergyPortal Search*,

the *PrePRINT Network*, *Federal R&D Project Summaries*, and the *GrayLIT Network*. This distributed search capability represents an essential next step in information technology -- the integration of parallel searching and retrieving of information from disparate and geographically dispersed databases and Web sites.

Costs and Returns: An Investment in the Future

OSTI's investment in transitioning DOE's dissemination of scientific and technical information to an E-Government environment came in the form of redirected resources and refocused priorities. The transition was driven by the potential of the Internet as a means of disseminating information and the emphasis placed on Federal agencies finding effective ways to improve the productivity of government.³¹ In 1995, OSTI staffing consisted of scientists, information experts and computer systems specialists who were involved in automating and streamlining traditional means of disseminating information. Therefore, the expertise was already in place to achieve the transition to electronic dissemination. Those resources were redirected to the design and development of new Web-based systems and tools that would provide for much broader dissemination of a much larger body of information in ways that it could be easily located, compiled, assimilated and used in a fully integrated electronic environment to create new knowledge in the advancement of scientific endeavor and public well being.

In 1995, OSTI had 154 Federal employees, all involved in acquiring, managing, organizing, announcing, disseminating, and preserving scientific and technical information. Currently, OSTI has 84 Federal employees to support its extensive E-Government activities.³² As traditional hands-on, document-by-document processing gave way to fully electronic applications, OSTI has been able to accommodate staffing reductions while providing greatly improved service to

customers.

Costs of transitioning to an E-Government environment were also absorbed by redirecting resources to focus on the new way of doing business. OSTI's appropriations budget to support DOE's scientific and technical information activities was \$15M in 1995. In FY-2000, OSTI's budget is \$8.6M, and is fully allocated to the development, maintenance, and administration of collaborative ventures, networks, systems and tools that support the collection, organization, and delivery of useful and useable electronic information.³³

Data from 1995 indicates that 808,500 customer transactions were served as the transition to electronic dissemination got underway. With an investment of \$15 million, the cost per customer transaction was \$18.55. In 2000, 3.4 million customer transactions were accommodated electronically at a cost of \$8.6 million, for a cost per customer transaction of \$2.59.³⁴

In the past, transactions in scientific and technical information dissemination were measured by the number of documents provided to customers and the number of accesses to OSTI-maintained Web sites. Currently OSTI uses customer transactions to measure the success of its products. In theory, we are providing units of information for customers to use. In the electronic environment, that unit is a Web page. Each time a customer goes to a page, it is recorded as a transaction in OSTI's computer log files. Unlike "hits" which are not necessarily a reflection of customer activity and can be easily manipulated to provide inflated numbers, customer transactions provide a relatively accurate reflection of activity, and the same data gathering mechanisms are consistently applied to all OSTI Web products.

Benefits: More Service, Lower Cost

Beneficiaries of the transition of the Department's dissemination program to E-Government and the vast electronic resource it provides include end users, contributors, DOE and OSTI, and

the Nation and its taxpaying public.

End users including scientists, engineers, researchers, academicians, and the interested public now have a comprehensive suite of products providing information and resources available at their desktops. In addition, there are electronic tools in place to provide for easy identification, retrieval, assimilation, integration, and use in real-world settings. Since the information is sorted and organized by discipline, subject, type, and/or function, navigating through the vast amount of information and misinformation on the Internet is minimized by a common framework and boundaries. The fact that the products are integrated and can be cross-searched saves time and makes the information more useable and useful. Because the information is organized not by agency or organization, but by the type of service or information, it is now much simpler for users to find it. According to Dr. John Gibbons, formerly of the White House Office of Science and Technology Policy, “agencies expend 2 to 4 percent of their R&D budgets on the STI enterprise.”³⁵ With 30,000 scientists and engineers in DOE alone, and science and technology jobs in the U.S. projected at 4.4M by 2006,³⁶ it is easy to see the significance of the transition of scientific and technical information dissemination to an E-Government environment for the scientific and technical community.

Information is now free to the user to a much greater extent, whereas most documents previously had to be purchased, often at significant cost. For example, users of DOE’s full-text reports previously had to locate and read them on microfiche at a regional library or purchase them from a redistributor at a representative cost of \$33 per printed copy plus shipping and handling.³⁷ In FY 2000, users downloaded over 150,000 full-text reports using OSTI’s E-Government information access tools. That represents a potential savings over purchase of at least \$5M for this year alone.³⁸

In addition, redistributors and intermediaries who have been long-term partners with OSTI in information dissemination have realized significant benefits from electronic access to science and technology. Prior to 1997, DOE-sponsored or acquired full-text research reports were distributed in microfiche format to about 225 GPO Depository Libraries, whose employees cataloged, stored, and made this information available to the public. Today, all GPO Depository Libraries can easily access this same information electronically, and incremental costs to GPO and the Depository Libraries to maintain the infrastructure necessary to serve the public have been significantly reduced, while service has improved by making electronic information available to all 1,400 libraries.

Contributors of DOE-sponsored research results can now submit, track, and revise or update their scientific and technical information easier and faster than ever before as a result of the electronic collection mechanisms OSTI has made available to them. Significant cost savings are a result of the improved submittal and maintenance mechanisms.

Contributors also see their scientific and technical information announced sooner than ever and more broadly announced in easier-to-find and retrieve electronic output systems such as the DOE Information Bridge. Over the years, OSTI has seen cycle time to process reports decrease dramatically. For example, in FY95, it took 6 weeks to process and announce scientific and technical reports. In FY2000, that process time was reduced to 2 days.³⁹

As noted throughout, the across-the-board cost savings to users, contributors and DOE/OSTI result in a greater return on taxpayer investment. Greater accountability is provided and productivity of energy R&D is increased by making full-text research information available through state-of-the-art electronic collections with improved public access. The envisioned Physical Science Information Infrastructure will lead to greatly increased productivity in the

scientific research community, resulting in sustained U.S. economic competitiveness as well as advancement in public health and well-being.

Awards and Recognition: What Others Think

Awards and recognition have accrued as OSTI has moved aggressively into the electronic information environment. In 1996, the first of five prestigious Hammer Awards was presented to OSTI by Vice President Gore's National Partnership For Reinventing Government (NPR), awarded for streamlining burdensome directives associated with the processing of scientific and technical information. Since that time, OSTI has received four additional Hammer Awards - for the *DOE Information Bridge*; *Energy Files Virtual Library Collections of Energy Science and Technology*; *DOE's R&D Project Summaries*; and for OSTI leadership in the Scientific and Technical Information Program (STIP) Community of DOE.

In 1997 OSTI received the Tennessee Quality Commitment Award, presented by Governor Don Sundquist, the 1997 DOE Information Management Quality Award for Management and Administrative Excellence for R&D Project Summaries and the 1997 Energy Quality Commendation given to those organizations displaying exemplary achievements in demonstrating the quality ethic. Recognition came again as OSTI won the 1998 Information Management Quality Award for Technical Excellence for the *DOE Information Bridge*. In addition, a special commendation was awarded by the Federal Depository Library Council in recognition of the no-fee public access for the *DOE Information Bridge*. By invitation, OSTI has been represented at each of the East Tennessee Technology Corridor Summits.

Conclusion: The Future of E-Government Is Now!

In January 1997, Walter L. Warnick was named Director of the Office of Scientific and Technical Information. As Dr. Warnick put it shortly thereafter, "I found an organization poised

for the challenges of the Information Age. Together with our partners across the DOE complex, we envision and will implement a new digital environment for scientific and technical information.”⁴⁰

With that statement, OSTI embarked on a new era in information dissemination, one which would not only make the information easy to find, but easy to access, assimilate, and apply in meeting real-world needs. As a result, the Department of Energy now transacts its scientific and technical information business in a fully-integrated environment consisting of a suite of electronic products that collectively represent a highly-successful example of E-Government as it is applied to an entire business element.

Unlike the development of a system to meet a specific need for a limited audience, OSTI has conceived, designed, developed and implemented a visionary scheme to bring dissemination of scientific and technical information into the 21st century. At OSTI, E-Government is already in place, and transactions with customers now occur in a fully electronic environment. The enterprise will continue to grow and evolve into the future, but the basic framework has been developed and is successfully functioning to the benefit of everyone who produces, manages, or needs scientific and technical information.

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