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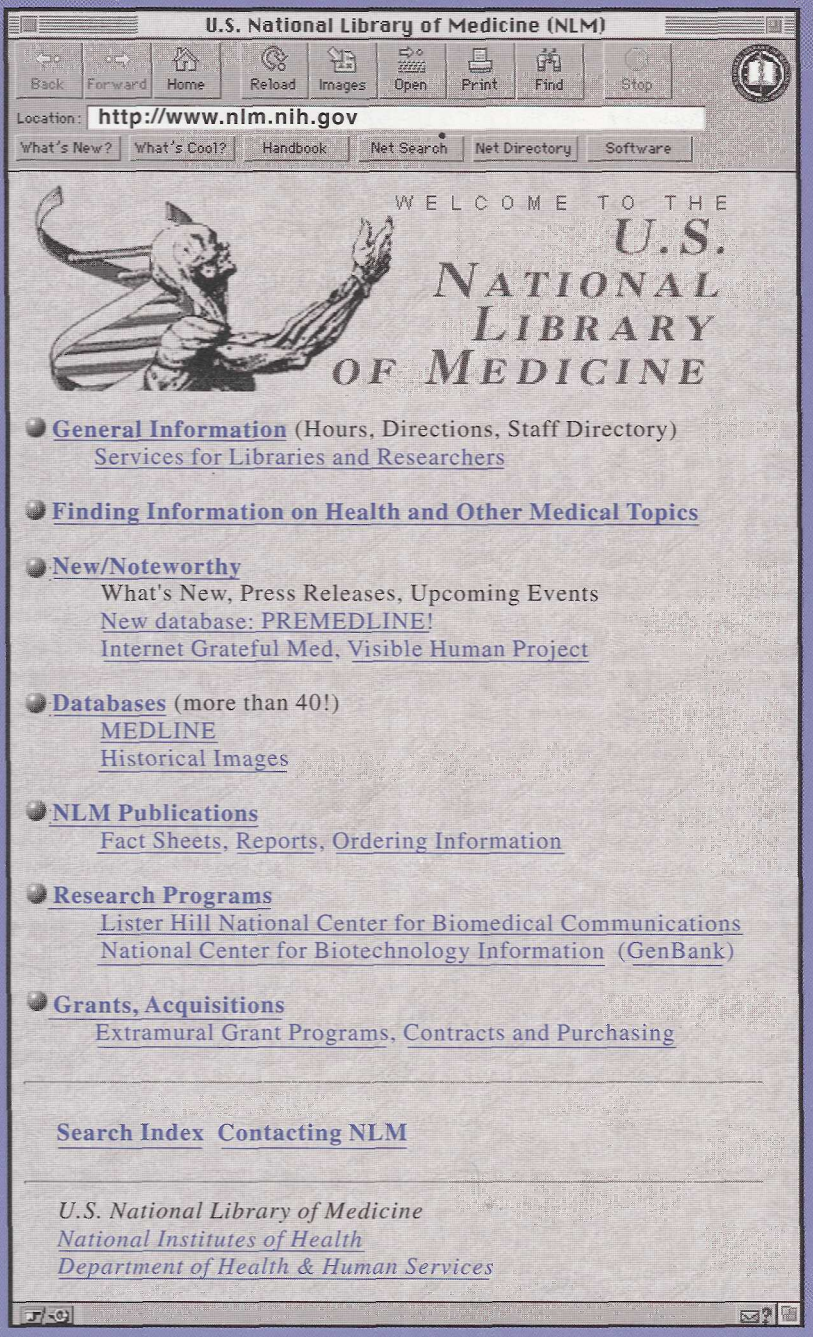

DEPARTMENT OF HEALTH AND HUMAN SERVICES

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Preface

Fiscal Year 1995 saw not only a steady growth in the collections and services of the National Library of Medicine, but a number of remarkable special developments:

- In October 1994, hundreds of colleagues and well-wishers turned out to honor Thelma Charen, indexer *extraordinaire*, for her many achievements during 50 years of service at the NLM.

- Early in the Fiscal Year, the Library put up on HyperDOC, its World Wide Web site, "Images from the History of Medicine." Almost 60,000 pictures relating to the history of the health sciences are now available for searching and viewing via the Web.

- In November, the Library introduce the "Visible Man," a 15-gigabyte image dataset representing the three-dimensional computer-generated "cadaver" of a human male.

- The number of user codes for NLM's national online network hit 100,000 sometime in January 1995.

- In February, the Library announced HSRProj, a new database providing access to grants and contracts in health services research.

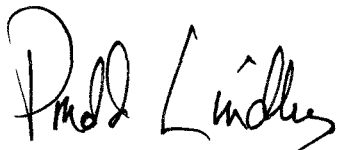
- The *NLM Long Range Plan on the Education and Training of Health Science Librarians* was published in the spring of 1995. It was prepared by a distinguished panel of outside health professionals, librarians, library school faculty, and medical informaticians.

- In May, NLM was host to hundreds of visitors during the 7th International Congress on Medical Librarianship, held in Washington, D.C.

- In August, NLM announced a second round of 16 awards to community-based organizations and libraries to help them develop HIV/AIDS-related information services.

- Two new Regents were appointed by the HHS Secretary in 1995: Tenley E. Albright, M.D., and Sherrilynne Fuller, Ph.D.

The strength of this institution is its staff of dedicated and hard-working employees. This resource, in combination with thousands of talented collaborators in the National Network of Libraries of Medicine, has resulted in an unprecedented level of health information services available to American health professionals. Thanks also go to the many advisors to the Library who serve on committees and boards and whose wisdom contributes greatly to the success of our programs.



Donald A. B. Lindberg, M.D.
Director

HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS PROGRAM

The High Performance Computing and Communications initiative is the rubric under which the Library engages in several important technology-related programs. Up until January 1995, NLM director Donald A. B. Lindberg, M.D., headed the coordinating office for the HPCC multiagency initiative. He had assumed that post in 1992 and held it concurrently with his directorship of the NLM.

Awards for HPCC Applications

As reported last year, the NLM made a number of contract awards to fund research applications in the area of advanced computing and networking capabilities. These 3-year projects are for telemedicine, imaging, testbed network projects and similar technology-related projects. Additional awards were made in areas related to multimedia electronic medical records.

Visible Human

On November 28, 1994, at the annual meeting of the Radiological Society of North America, NLM unveiled the Visible Human Male, a 3-dimensional, computer-generated "cadaver" representing an incredibly detailed atlas of human anatomy. The dataset, created from thousands of images of a human body collected with state-of-the-art radiographic and photographic techniques, takes up some 15 gigabytes of computer storage. The images include digital representations derived from cross sectional photographic images from cryosectioning, computerized tomography CT), and magnetic resonance imaging (MRI) of a human male cadaver.

The Visible Human Project has its roots in the Library's Long Range Plan, which recommended that the NLM should "thoroughly and systematically investigate the technical requirements for and feasibility of instituting a biomedical images library." An ad hoc planning panel subsequently recommended that the Library should "undertake a first project building a digital image library of volumetric data representing a complete, normal adult male and female.

The Human Male was done under contract with the University of Colorado Health Sciences Center in Denver. The principal investigators are Victor Spitzer, Ph.D., and David Whitlock, M.D., Ph.D. The Visible Human Female is now being prepared and will be released next year.

Unified Medical Language System

The UMLS is an ambitious program sponsored by the NLM in collaboration with other research groups around the country the goal of which is to help health professionals and researchers to retrieve and integrate biomedical information emanating from a variety of electronic sources. To do this, it must overcome obstacles of language (various information sources use various vocabularies), disparate search procedures, and wide distribution of computer-based information across the electronic landscape. The UMLS seeks to build "knowledge sources" that may be used to develop interfaces by those creating medical information systems. These knowledge sources map concepts and terms from many different biomedical vocabularies and classifications and also provide machine-processable descriptions of the contents of health-related databases.

UMLS applications are now being developed and tested in a variety of environments, including linking automated patient records to related information, such as clinical practice guidelines. NLM itself is using the UMLS Knowledge Sources in developing the Internet Grateful Med interface to the MEDLARS databases. Other interfaces that make use of the UMLS Knowledge Sources are being developed by other institutions and private companies.

See also the description of the UMLS Metathesaurus in the Lister Hill Center chapter, page 24.

OFFICE OF HEALTH INFORMATION PROGRAMS DEVELOPMENT

Elliot R Siegel, Ph D
Associate Director

NLM Long Range Plan

NLM has a very successful Long Range Planning process In January 1985, NLM's Board of Regents undertook to develop a Long Range Plan to guide the Library in using its human, physical, and financial resources to fulfill its mission This culminated in the adoption of a report by the Board of Regents containing goals, recommendations, and resource requirements, published in 1987 NLM continually expands and updates the Plan, recent planning reports prepared as supplements to the 1987 Plan contain recommendations on outreach to health professionals (1989), electronic imaging (1990), information services for toxicology and environmental health (1992), and the education and training of health science librarians (1995) The next planning effort will focus on NLM's international programs

NLM's Long Range Plan is prepared under the direct supervision of its Board of Regents Planning panels are advisory to the Planning Subcommittee of the Board The Board reviews the progress of each planning panel at regular intervals, and usually sends a representative to panel meetings to inform other Board members of the panel's deliberations The supplements are published as part of the Long Range Plan of the Board of Regents

The original Plan involved the participation of librarians and information scientists, physicians, nurses, and other health professionals, biomedical scientists, computer scientists, and others—some 130 distinguished persons in all Each subsequent planning panel has been heterogeneous, drawing in a broad range of members from many relevant constituency groups

The Long Range Plan is integral to the day to day management of the Library Over the past 10 years, NLM has successfully integrated its budget and planning processes, so that the budget is "driven" by the Long Range Plan New initiatives are presented in terms of the Plan, and progress toward achievement of recommendations is tracked This gives NLM a rational process for setting goals and objectives and measuring program performance that is built into the fabric of its management processes

Training Panel Report

In 1995, *The NLM Long Range Plan on the Education and Training of Health Sciences Librarians* was made available on request from NLM's Public Information Office and via the Internet (see below) The report was prepared by a distinguished panel chaired by Dr Thomas Detre of the University of Pittsburgh, and is the result of a year-long effort by a multidisciplinary team of health professionals, librarians, library school faculty, medical informaticians, and NLM staff Staff of the Office of Health Information Programs Development coordinated the work of the panel

In accepting the report, Dr H Kenneth Walker, chair of the Board of Regents, underscored that the report " lays out a number of opportunities for health sciences librarians, schools of library and information science, professional associations, and the National Library of Medicine to work together to assure that society benefits from the considerable skills and contributions of health sciences librarianship " The report's goals and recommendations address the need to

- Prepare for the new forms of information, new users, and new practice patterns that may be required for health sciences librarianship,
- Match the capabilities of health sciences librarians to the needs of employers,
- Update and enhance the curricula of schools of library and information science,
- Foster educational programs enabling health sciences librarians already in the workplace to update and extend their professional education and training,
- Experiment with alternative methods and courses of study for adult learning,
- Attract the best and brightest candidates the current mar ket can provide, and
- Achieve greater cultural and ethnic diversity in the profession

NLM's Extramural Programs Division is providing support for a limited number of "challenge grants" to support planning for the implementation of specific report recommendations deemed to be of exceptionally high priority and that require further study The objective of these awards is to identify groups and institutions prepared to take responsibility for a portion of the problem, to form alliances and to work collaboratively toward achievement of our common goals (see Extramural Programs chapter)

International Panel

The NLM's International Programs are integral to the Library's responsibilities in biomedical information transfer The U S health community depends on NLM's information retrieval system to identify the relevant information from the world's biomedical literature and, in turn, the world health community shares the benefits of NLM's advanced information systems in meeting its own requirements for information

The 1986 NLM Long Range Plan included among its more than 50 recommendations that NLM provide assistance to other countries in identifying and gaining access to biomedical information in the U S , and also assist U S health-care professionals in accessing information developed outside this

country While serving in principle as a positive affirmation of current practice, no guidance was offered regarding the need to re-examine the Library's information policies and programs internationally As these have their roots in the conditions and circumstances of past decades, a review at this time would seem highly advisable in light of fundamental changes in

- Global relationships, including the formation of new countries,
- Availability of market-priced high-speed telecommunications networks,
- Distribution of where and how science is done, and
- Movement towards English as the language of science

The Board of Regents approved the formation of a Long Range Planning Panel for NLM's international programs The purpose of the panel is to advise NLM on the relative priority of its international activities and responsibilities, and to assist in the development of appropriate strategies consistent with the Library's statutory mission and availability of resources It is expected that the panel will meet approximately three times in 1996, and will present its final report to the Board for approval and inclusion in the NLM Long Range Plan

Dr Donald S Fredrickson, former NIH Director, has accepted the chairmanship of this panel Dr Fredrickson is a distinguished physician and scientist who has been President of the Institute of Medicine and President and Chief Executive Officer of the Howard Hughes Institute, among many other accomplishments and honors

Outreach

Outreach Management and Evaluation

NLM's outreach program marked its fifth anniversary in 1995 Since FY 1990, Congress has appropriated outreach funds to NLM to support efforts to bring the benefits of its information systems to health professionals across the country Over the 5-year period, NLM and the more than 4,500 member institutions of the National Network of Libraries of Medicine have undertaken a long-term, wide-reaching program to make health professionals more aware of the medical information resources that NLM provides, to facilitate their access to these resources, and whenever possible to link health professionals to local library services Close to 300 outreach projects, involving more than 500 institutions, have taken place since NLM's outreach program began

In the fall of 1994, in the report accompanying the Senate Appropriations Committee's FY 1995 Appropriations Bill, NLM was requested to provide a status report on outreach funding and activities A status report was prepared for the Senate Appropriations Committee and also presented to the NLM Board of Regents at its January 1995 meeting At the same time that the status report was being prepared for the Senate Appropriations Committee, a team of NLM staff was working to prepare a comprehensive and detailed assessment of NLM's numerous outreach projects undertaken since the publication in 1989 of the long range plan for "Improving Health Professionals' Access to Information "

The result of the intensive team effort is a 100-page "Report on Outreach Activities of the National Library of Medicine A Five Year Review" that brings together information on the outreach strategies and approaches that have been used in reaching out to thousands of U S health professionals The report provides a detailed look at the many types of outreach projects NLM has supported, from those focusing on Grateful Med training, to special efforts to reach rural and minority populations, to improving hospital access to information resources, to Internet connections, and to more recent efforts that focus on toxicology/environmental health and HIV/AIDS information Building on earlier efforts, NLM staff see the need for

- More targeted outreach efforts (e g , focusing on identified populations or involving specific areas, such as HIV/AIDS),
- Working with the public library community—perhaps as part of an expanding NLM consumer health agenda,
- Developing benchmarks and further expertise in evaluation methodology,
- Greater emphasis on strengthening hospital access to national information sources, especially involving Internet connectivity,
- Continued support of training in health science information management, and
- Increased efforts to develop new products and services

A summary of the report was presented to the Board of Regents at the May 1995 meeting Responses from the Board members were highly supportive of the outreach program

Concurrently, staff have been working to develop an outreach database to serve as a searchable repository for information related to each of the outreach efforts An ongoing effort is under way to develop descriptive and statistical information on all of the outreach efforts that have been supported to date

HIV/AIDS

NLM's HIV/AIDS information services continue to grow and mature using the recommendations from the 1993 NLM/NIH HIV/AIDS Information Services Conference as the guide for this development NLM's two collaborative projects with other PHS agencies, the AIDS Clinical Trials Information Service (ACTIS) and the HIV/AIDS Treatment Information Service (ATIS) continue to be very successful While direct online use of the AIDSTRIALS and AIDSDRUGS databases has stabilized, many other information providers are downloading the data and adding it to their services A number of bulletin boards and gophers are providing the data to their users and the data have also been distributed internationally

through this mechanism NLM has added a number of AIDS-related treatment recommendations to HSTAT as part of the ATIS project

NLM initiated a second round of AIDS Outreach Purchase Orders in FY 1995 and made awards to 16 community-based organizations and libraries This brings the total number of awards to 35 for two years As with the previous awards, many of these projects involve the efforts of a number of organizations and libraries The awards are primarily intended to promote improved access to HIV/AIDS information to patients, the affected community and their care givers as well as the general public Implementation of this goal may include providing access to electronic resources, training in their use, expanding collections, Internet connections, development of local information materials, and opening access to collections and document delivery services

As an example of an AIDS outreach project, NLM has supported the Detroit Community AIDS Library (DCAL), a multi-organization partnership The goal of DCAL is to enable access to local and world-wide HIV/AIDS information resources and make them available to persons in the greater Detroit community NLM funding for this project is being used to strengthen participating library collections with AIDS and HIV materials, educate librarians to better meet the HIV/AIDS information needs of patrons, and to provide a computer-based networked resource of HIV and AIDS information

In addition to these smaller awards, NLM awarded a contract to the Montgomery County (Md) Department of Public Libraries for a collaborative project between NLM and the Wheaton Regional Library's Health Information Center in the areas of AIDS and toxicology/environmental health information This project will provide NLM with an opportunity to learn about use of the Library's databases by the general public The Health Information Center is providing free access to information databases such as AIDSLINE, AIDSDRUGS, AIDSTRIALS, ALERT, CHEMID, TOXLINE, and DIRLINE, free access to the TOXNET computerized system of databases (HSDB, TRI, RTECS, etc) free access to Internet sites that focus on environmental health and HIV/AIDS topics as well as other medical subjects available through the Health Information Center World Wide Web home page, materials such as books, periodicals, newsletters, videos, and pamphlets, special programs including speaking engagements with community groups and programs in the library, and faster document delivery

International Programs

In FY 1995, NLM marked another year of activities with individual countries, international government organizations such as the World Health Organization (WHO) and the Pan American Health Organization (PAHO), and international nongovernmental organizations such as the International Council for Scientific and Technical Information (ICSTI) NLM international activities also included training for colleagues from abroad, the NLM publication exchange program with 132 institutions in 53 countries, and receiving numerous professional visitors from abroad

Country-to-Country Activities and Bilateral Agreements

Israel

The Israel MEDLARS Center at the Berman National Medical Library at the Hebrew University-Hadassah Medical Center in Jerusalem is presently the only foreign center to access NLM's databases exclusively over the Internet using the Grateful Med software The experience of the Center staff in successfully implementing a variety of means for establishing Internet connectivity using different hardware configurations, and local area network arrangements found in health science libraries located throughout Israel, remains a valuable example to NLM as a prototype for other candidate centers wishing to establish comparable service arrangements The Israel Center and its staff continue as leaders in advancing the use of high-speed computers and telecommunications networks as a means for obtaining access to health information resources in Israel NLM and the Israel Center are also pursuing steps to support Palestinian health institutions' efforts to access NLM's databases over the Internet

Newly Independent States

Since 1994 he NLM has been providing help to several newly independent states of the former Soviet Union with the assistance of State Department funding Scientists in these countries have been increasingly interested in having access to western scientific information and in developing contacts with colleagues in the West The dissolution of the USSR and the depletion of foreign currency resulted in the cancellation of many scientific journal subscriptions in libraries, and a poor telecommunications infrastructure has exacerbated the sense of isolation The goal of this project is to improve access to U S biomedical information in Belarus, Ukraine, central Asia, and the Baltics through their national medical libraries

To achieve this objective, the medical libraries of Belarus, Ukraine, Kazakhstan, Krgygstan, Uzbekistan, Lithuania, Latvia, and Estonia were each provided with a microcomputer, modem, printer, communication and search software, and e mail access to Internet E-mail can be used to search MEDLARS databases, exchange correspondence with American scientists, and obtain information from other libraries The equipment was installed and on-site workshops were conducted in 1994 To remedy the journal shortfall, arrangements were made with the medical libraries of the University of Kansas Medical Center, the University of Maryland Medical Center at Baltimore, the University of Massachusetts Medical Center, and the University of Pennsylvania Medical Center to provide interlibrary loans In addition, an agreement was made with the American Association for the Advancement of Science to include the medical libraries of Kazakhstan, Krgygstan, and Uzbekistan in a journal project that has resulted in their now

receiving selected medical and environmental health journals from the U S

The directors of the participating Newly Independent States' libraries were brought to the U S to attend the annual meeting of the Medical Library Association and the Seventh International Congress on Medical Librarianship in May of 1995 They subsequently attended a one-week seminar at the NLM on medical librarianship and informatics, MEDLARS databases and retrieval tools, and using Internet During that time they also visited local medical libraries and the Library of Congress and met with the directors of U S medical libraries that were providing interlibrary loans and with representatives from the AAAS which was providing journals In 1995, all libraries were able to search NLM databases and to communicate with colleagues at NLM and other participating libraries via e-mail Additional codes for MEDLARS access have been given directly to certain researchers in these countries receiving U S support for collaborative research projects, especially in the area of environmental health Further, an experiment in upgrading telecommunications infrastructure was completed successfully using Lithuania as a testbed Both the Vilnius University Medical Faculty and the Lithuanian National Medical Library were fully connected to the Internet

Hong Kong

The Chinese University of Hong Kong (CUHK) has been nominated by the Hong Kong Secretary for Health and Welfare, to serve as the International MEDLARS Center of the country Once established, the Hong Kong Center will access NLM's databases exclusively over the Internet using Grateful Med software The CUHK has already demonstrated successfully from many hospitals, doctor's offices, and libraries how to use Grateful Med and the Internet to search NLM MEDLARS databases

Activities with International Organizations

PAHO

The Pan American Health Organization has been an important collaborator with the NLM In 1988, Dr Carlos Gamboa, working with colleagues at the University of Chile's School of Medicine, successfully devised BITNIS as a means to conduct MEDLINE searches over high-speed computer networks using Grateful Med BITNIS is a gateway system that imbeds a MEDLINE search within an e-mail packet envelope, thereby providing an inexpensive and fast search service in regions of the world where the cost of access by traditional communications systems would be prohibitive for most health professionals During 1995, searches were performed from more than 40 countries and the quality and variety of BITNIS services were improved The goal is to enhance this capability with full Internet access

WHO

The National Library of Medicine and the World Health Organization continue their cooperative effort to publish the *Quarterly Bibliography of Major Tropical Diseases* and the *Bibliography of Acute Diarrhoeal Diseases.* NLM prepares camera-ready copy from the MEDLINE system, and WHO prints and distributes these to thousands of institutions in the developing countries

International Meetings and Visitors

Working in collaboration with the International Council for Scientific and Technical Information, NLM is leading the development of a new pilot demonstration project intended to reduce existing technological and tariff barriers to the flow of scientific and health-related information over the Internet to developing regions of the world Focused initially in the eastern Caribbean, the NLM/ICSTI effort will be carried out in conjunction with a number of other international organizations, including UNESCO, PAHO, the International Telecommunications Union, and the United Nations Development Programmes

The Library continues to be a focal point for visitors of the international community from a variety of disciplines Many of these visitors are responsible for medical, scientific or technical information in their own countries Several large groups of visiting foreign dignitaries, such as the Traveling Seminar on Medical Informatics from the Americas, and the Russian Federation Health Delegation, observed a demonstration of the Visible Human Project, and Internet Grateful Med Other visitors are officially received and briefed on relevant aspects of NLM operations and research Among the visitors in 1995 were representatives from the following countries

Argentina, Bangladesh, Barbados, Belarus, Brazil, Bolivia, Chile, China Columbia, Costa Rica, Dominican Republic, Ecuador, Estonia, Ethiopia, France, Georgia, Ghana, Guatemala, India, Israel, Jamaica, Japan, Kenya, Korea Latvia, Lithuania, Maldovia, Mexico, Netherlands, Nigeria, Norway, Panama, Peru, Rumania, Russia, Singapore, South Africa, Spain, Syria, Thailand, Ukraine, United Kingdom, Uruguay

Table 1
International MEDLARS Centers

Tapes	Tapes/Software	Online NLM
France	China	Australia
Germany	Sweden	PAHO*
Japan		Canada
India*		Egypt
PAHO (BIREME)*		France*
Switzerland		India
		Israel
		Italy
		Korea
		Kuwait
		Mexico
		South Africa
		Switzerland*
		Taiwan
		United Kingdom

*Combined online/tapes

LIBRARY OPERATIONS

Lois Ann Colaianni
Associate Director

The largest of NLM's Divisions, Library Operations (LO) is responsible for the basic NLM services that support effective dissemination of biomedical knowledge to health professionals and researchers throughout the United States and the world LO's multidisciplinary staff acquires and preserves NLM's comprehensive collection of biomedical literature, develops basic tools for organizing biomedical information, including a biomedical thesaurus and a classification, applies these tools in indexing and cataloging the literature acquired by the Library, disseminates NLM's authoritative indexing and cataloging records online, in machine readable products, and in publications, provides document delivery, reference, and re search assistance as a back-up to services available from the other U S health sciences libraries, and coordinates the Na tional Network of Libraries of Medicine (NN/LM) LO also maintains a research program in the history of medicine, conducts research and evaluation related to LO programs and services, and directs or participates actively in many NLM-wide initiatives LO's basic services form an essential foundation for NLM's Outreach Program and for other special pro grams including those in biotechnology, AIDS, and health services research information

Planning and Management

In FY 1995, LO re-examined its operations in light of the combination of Government-wide staffing reductions, flat or decreasing budgets, and continuing increases in the demand for NLM services As part of the NLM's streamlining effort (see section on Special Initiatives), LO consolidated some organizational units, increased its employee to supervisor ratio by reducing the number of individuals who spend more than 25 percent of their time performing supervisory functions, and eliminated some internal reporting and review requirements that did not contribute directly to the quality of user services Early in the fiscal year, LO issued a new strategic plan for 1995-97 This plan identified the re-engineering of LO customer service activities related to reference services, NLM's electronic databases, and information dissemination as a high priority An NLM-wide team was subsequently appointed to review customer service in these areas As a result of this effort, NLM will pilot test new approaches to handling some categories of customer service requests and new procedures for analyzing user feedback to determine how the Library might improve its products and services

NLM's ability to cope with resource constraints and increasing demand for services depends in part on the efficiency and effectiveness of its automated systems In FY 1995, LO staff members were actively engaged in all parts of the NLM System Reinvention effort (see section on Special Initiatives), contributing to the evaluation of potential software platforms and to the design and testing of new user interfaces Specific system reinvention projects are described elsewhere in this chapter

Collection Development

To build and maintain a comprehensive collection of scholarly biomedical literature, LO establishes and updates literature selection policy, acquires and processes relevant literature in all formats and languages, and preserves the materials acquired As of September 30, 1995, the Library owned 2,144,230 printed books, journal volumes, theses, and pamphlets and 2,964,725 nonprint items, including audiovisuals, computer software, microforms, prints, photographs, and manuscripts (Table 2)

Selection

Literature of all types is selected for the Library's collection according to guidelines published in the *Collection Development Manual of the National Library of Medicine* NLM conducts periodic collection assessment studies to determine how successfully it is applying its collection guidelines and to identify areas in which the guidelines may need revision or clarification In FY 1995, several collection development projects focused on the serials collection, with a goal of reducing the acquisition and retention of titles that do not meet current collection development criteria To this end, LO drafted and tested more explicit criteria for serials selection Special efforts were made to review journals in the field of psychology and in Japanese As a result, some titles that did not match current collecting guidelines were discontinued The Library also initiated a project to ensure that all Nobel Prize winners in medicine are represented in its picture collection, portraits of those not already in the collection have been identified and are being acquired

Acquisitions

In FY 1995, the library received and processed 177,085 modern books, serial issues, audiovisuals, and software packages (Table 3) The net increase in the Library's collection was 41,007 volumes and 39,372 other items (e g , audiovisuals, microforms, software, pictures, manuscripts) Important additions to NLM's rare book and early manuscript collections included an incunabulum, *De Insomnii* (Rome, 1481), Mondino de' Luzzi's *Anothomia cum Postillis* (1501), a compendium for teaching anatomy, a Galenic text on pulses (in Greek but with a Latin title), *Liber de Pulsibus Introductorius* (Paris, 1529), Gerhard Dorn's *Fasciculus Paracelsicae Medicinae Veteris et Non Novae* (1581), a digest of Paracelsian medicine, *L'Opera Cirurgiche* (Padua, 1672) by Fabricius ab Aquapendente, who was one of William Harvey's teachers, *Remedio, y Curacion de los Ahogados* (1690), the gift of Dr Sheldon Cohen, and a broadside issued by General George Washington in 1777 entitled *Instructions for Soldiers in the Service of the United*

States, Concerning the Means of Preserving Health The Library also acquired the papers of Christian B Anfinsen (1916-1995), an NIH laboratory chief and later professor at Johns Hopkins University, who won the Nobel Prize in chemistry in 1972, and the papers of Luther L Terry, the United States Surgeon General (1961-1965) who issued the famous report on the hazards of smoking NLM's collections of historical pictures and films were enriched by the acquisition of 1500 photographs of World War II medical facilities and field hospitals in Europe, Asia, North Africa, and Australia, many public health posters, and films donated by the Western Psychiatric Institute and Clinic, the American Dental Association, and the National Institute on Drug Abuse

In FY 1995, staff expended considerable effort to ensure a smooth transition to the use of contracts for serials subscriptions As is inevitable when large numbers of subscriptions are canceled and reordered through other vendors, there were many more serial subscription problems than usual In addition to monitoring receipt of current subscriptions, NLM also attempts to ensure that it holds complete sets of retrospective biomedical journals Often other libraries contact NLM when they plan to discard older issues of biomedical journals to determine if any are needed to fill in gaps in the NLM collection In FY 1995, NLM received substantial numbers of missing issues from Rutgers University, the Pennsylvania State Medical Center, the Medical and Chirurgical College of Maryland, the Health Sciences Library of the University of Washington, Northwestern University Health Sciences Library, and the Library of Congress

To improve its acquisition of books from Eastern European countries and the newly independent states of the former Soviet Union, LO located and entered into acquisitions arrangements with new book vendors for these areas The project was prompted by a 1994 collection evaluation study that found deficiencies in NLM's acquisitions of books from these countries

Improvements to the current automated systems that support acquisitions and receipt processing were held to a minimum this year while staff throughout LO and the Office of Computer and Communications Systems evaluated commercial integrated library system (ILS) products NLM hopes to use a modern ILS as a platform for replacing internal processing systems that rely on a combination of software developed in-house and older commercial database management software This effort is a major part of NLM's System Reinvention project An interim PC-based acquisitions/in process tracking system was implemented for historical pictures to reduce the potential for duplicate acquisitions of such materials

Collection Preservation and Maintenance

To preserve and maintain the NLM collection, LO binds incoming journal issues, microfilms brittle volumes, provides conservation treatment for rare and unique items, maintains storage facilities and conditions for all types of library materials, and responds to emergencies that threaten materials in the collection The Library also explores the use of new technology to preserve library materials and promotes the use of permanent paper in new biomedical publications A survey of paper in U S *Index Medicus* (IM) titles conducted this year revealed that use of acid-free paper is becoming the norm for U S biomedical journals Ninety-one percent of U S IM titles are now printed on acid-free paper, up from 82 percent in 1991

In FY 1995, NLM bound 24,101 volumes, microfilmed 3 58 million brittle pages, and gave conservation treatment to 192 items in the special historical collections An analysis of long-term collection space needs and storage options was produced The Library completed a project to review and, if necessary, refilm older microfilm for brittle U S *Index Medicus* titles A similar project for non-U S *Index Medicus* titles will be completed in 1996 These projects were initiated when examination of samples of microfilm produced or purchased for NLM prior to 1986 revealed that some titles had been filmed incomplete or were of poor technical quality The Library conducted a survey of the collection to determine book repair needs and has made progress toward establishing a small onsite book repair facility In response to a major flooding incident last year, NLM is revising its disaster recovery plan and providing disaster recovery training for NLM staff Disaster recovery equipment and supplies have been upgraded and reorganized As a result, the Library staff was able to respond even more effectively to new incidents in which water leaked into the NLM collection Roof repairs will eliminate one cause of these emergencies

Bibliographic Control

To help health professionals and researchers find relevant information in the world's biomedical literature, NLM builds the Medical Subject Headings (MeSH®) thesaurus for use in indexing, cataloging, and online searching, maintains the NLM Classification for subject arrangement of books on library shelves, and produces authoritative cataloging and indexing records for newly published or acquired items

Thesaurus

MeSH, the NLM subject thesaurus, now contains 18,239 subject headings Its supplementary chemical file includes about 85,000 additional records for substances In FY 1995, the LO staff added 242 new MeSH headings and 1,825 new entry terms, updated the terminology for 81 existing headings, and added more than 1,200 scope notes Eighty-six percent of MeSH headings now have scope notes For 1996, terminology was enhanced in the fields of immunology, molecular biology, health services research, and alternative medicine NLM also revised the way that pharmacologic action information is represented in MeSH to allow for more specific indexing and searching MeSH headings for specific drugs have been deleted from the pharmacological action hierarchies or "trees" in the chemical portion of MeSH Each MeSH heading for a drug

now carries a pharmacologic action field that includes the MeSH headings for its various pharmacologic actions The pharmacologic action field will be updated as drugs are used for new purposes In addition to indexing an article with the MeSH heading for the drug in question, indexers will now assign a pharmacologic action heading for the specific action discussed in the article Prospectively this approach will provide searchers with increased precision in retrieval of articles dealing with specific pharmacological actions

LO plays a leading role in the expansion of the UMLS® Metathesaurus®, of which MeSH is a major component In FY 1995, the MeSH staff began to use contract support for some Metathesaurus editing and MeSH development tasks Additions to the 1995 edition of the Metathesaurus included the topography and function axes of the *Systematized Nomenclature of Human and Veterinary Medicine SNOMED International*, a large percentage of the *Thesaurus of Psychological Index Terms* that is used in *Psychological Abstracts* and the *PsychINFO* database, the remainder of the disease and finding terminology from the *DXplain* expert knowledge base, the Omaha System visiting nurses terminology, and the Portuguese and Spanish translations of MeSH Effective with 1996, new editions of the Metathesaurus will be issued in January or February rather than in the summer As a result of this schedule change, much of the editing for the 1996 edition of the Metathesaurus was also completed during FY 1995 Major enhancements for the 1996 edition will include the disease axis of the *Systematized Nomenclature of Human and Veterinary Medicine SNOMED International* and additional terminology from the National Cancer Institute's *PDQ* vocabulary

Cataloging

NLM's authoritative cataloging and name authority records describe what is available in the Library's comprehensive collection Records produced by NLM also are used by other libraries, thus reducing the level of effort required to organize their local collections Many health sciences libraries arrange their collections according to the *National Library of Medicine Classification* The fifth edition of the NLM Classification was published in February 1995, replacing an edition published in 1981 By the end of the year more than 6,000 copies had been distributed by the Government Printing Office Catalogers at NLM began using the new classification on December 2, 1994, the start of the 1995 cataloging production year

In FY 1995, the Library cataloged 22,232 modern books, serials, nonprint items, and cataloging-in-publication (CIP) galleys, using a combination of in-house staff, contracts, an interagency agreement with the Library of Congress, and assistance from the International MEDLARS Center in China The working inventory of uncataloged books was reduced by 2,183 items A total of 2,451 rare books and pre-1601 manuscripts was cataloged, reflecting the completion of special projects to create online catalog records for all of NLM's Persian and Arabic manuscripts and for the rest of the Library's incunabula collection The project to catalog the Persian and Arabic manuscripts identified many works not previously known to be in the NLM collection and about 20 works unknown to scholarship Earlier attempts to list items in this collection had failed to detect all the individual manuscripts bound together in single volumes

As part of its continuing efforts to streamline the cataloging process and provide access to new materials more quickly, the Library began to provide an "NLM Core" level of cataloging for nonprint materials and to assign shelf-list numbers to serials prior to cataloging Existing contracts for cataloging modern literature were extended to cover some historical materials NLM's internal cataloging system was upgraded to allow electronic importation of MARC records from OCLC and Z39 50 records from the Library of Congress

Indexing

NLM indexes more than 3,800 biomedical journals to assist health professionals and researchers in identifying articles on specific topics The Library also updates and annotates its indexed citations when indexed articles are retracted, corrected, or challenged in subsequently published commentaries LO staff members index gene sequences and edit author sequence submissions for incorporation in the National Center for Biotechnology Information's databases (see NCBI chapter) In 1995, the National Federation of Abstracting and Information Services issued the findings of its Benchmarking Project MEDLINE, NLM's flagship database, was named best in the biomedical field and one of five products that set the qualitative standard for the information industry due to its indexing excellence

The Literature Selection Technical Review Committee (LSTRC— see Appendix 6 for list of members), an NIH chartered committee, advises NLM on the journals that should be indexed in MEDLINE, *Index Medicus*, and other NLM databases and publications In FY 1995, the LSTRC reviewed 354 journal titles and rated 47 sufficiently highly for NLM to begin indexing them The LSTRC considered recommendations prepared by professional societies in the fields of orthopedics, endocrinology, and diabetes and advised NLM to index 14 additional titles and to discontinue indexing 18 titles in these subject areas

A combination of LO staff members, commercial contractors, International MEDLARS Centers, and cooperating organizations such as the American Hospital Association, the American Journal of Nursing Co , and the American Dental Association index journal articles for MEDLARS databases To increase the number of contract indexers, the Library held four indexing classes this year In FY 1995, NLM added 392,000 indexed citations to MEDLINE, 7 percent more than in the previous year Seventy-five percent of the citations added to MEDLINE contained English-language abstracts NLM updated previously indexed citations to reflect 15 retractions, 3,215 published errata, and 32,734 substantive commentaries Early in the fiscal year, more than 15,000 retrospective MEDLINE citations were enhanced with either the "Random-

ized Controlled Trial" or "Controlled Clinical Trial" publication types based on data provided by the Baltimore Cochrane Center

NLM continues to explore ways to improve the cost-effectiveness of its indexing operation All NLM staff indexers and indexing contractors now use the online indexing system, and Internet access to the system is being gradually extended to International MEDLARS Centers During FY 1995, NLM indexers received access to a hypertext version of the Indexing Manual and Technical Memoranda and began testing a hypertext version of MeSH The Library plans to extend access to these tools to contract indexers and International MEDLARS Centers

NLM is also experimenting with integrating electronic SGML-encoded header data supplied by a single publisher into its indexing system, as an alternative to keyboarding citation and abstract data for articles to be indexed The Library hopes to use this avenue to obtain data for its indexing process on a regular basis and to expand this procedure to many more publishers and titles To explore the possibilities offered by increased access to electronic versions of the journals it indexes, by progress in the development of natural language processing tools, and by the expansion of the UMLS Metathesaurus, NLM has initiated a 3 to 5 year "Next Generation" Indexing project This joint Lister Hill Center/LO project will determine the extent to which alternative approaches to building and indexing NLM databases can produce comparable retrieval performance and reduce the time and human resources needed to index articles

Network Services

To make current biomedical information more readily available, NLM disseminates its indexing and cataloging data online, in machine-readable formats, and in publications, responds to requests for reference and research assistance from onsite and remote users, supplies documents from the NLM collection to supplement the resources available from other libraries, and coordinates the National Network of Libraries of Medicine (NN/LM) The primary purpose of NLM's Outreach Program is to link more U S health professionals to these services

Online Services

Twenty-three years after launching MEDLINE, NLM issued its 100,000th online code By the end of the fiscal year, more than 114,000 individuals and institutions had codes for searching the 40 online databases available on NLM's systems The net gain in code holders in FY 1995 was 19,714 Many of the new codes were issued under flat-rate per code arrangements with professional associations or fixed fee arrangements with hospitals and medical schools NLM's online users conducted about 7 3 million searches (table 7) This figure does not include searches performed on the computer systems or CD-ROM products of the many organizations that lease data from NLM and probably represents less than 50 percent of the total online use of NLM's databases

Most of NLM's online users now search via the PC or Macintosh versions of Grateful Med, a user-friendly microcomputer-based software package Since Grateful Med first appeared in 1986, the National Technical Information Service has distributed 89,662 copies (74,018 PC, 15,644 Macintosh) Purchasers receive new versions of the software at no extra charge Two new versions of Grateful Med received extensive testing in FY 1995 Windows Grateful Med and Internet Grateful Med Both contribute to NLM's System Reinvention strategy and are expected to be released to the public in the coming year

NLM issued three NIH clinical alerts to all online users and members of the National Network of Libraries of Medicine Alerts are issued when the results of NIH-sponsored clinical trials provide compelling evidence that should be considered in determining appropriate treatment for patients with the conditions under study in the trials

In FY 1995, LO worked with other NLM program areas to expand the types of information available in several MEDLARS databases The AIDSLINE database was augmented with indexing for selected AIDS-related newsletters These titles were added to the database based on input received from the representatives of community-based AIDS organizations who participated in the NIH HIV/AIDS Information Services Conference in 1993 Several new types of documents were added to HSTAT (Health Services and Technology Assessment Text) AIDS-related guidelines issued by the Public Health Services AIDS Treatment Information Service, NIH Clinical Center Protocols, and Treatment Improvement Protocols identified by the Substance Abuse and Mental Health Services Administration Procedures for adding new guidelines sponsored by the Agency for Health Care Policy and Research were improved so that the guidelines are now available in HSTAT simultaneously or even before the release of the printed versions HISTLINE, NLM's History of Medicine database, was modified and expanded to include nearly all history of medicine and science records in MEDLINE, HEALTH, CATLINE, and AVLINE HISTLINE is now searchable through MeSH terms and a separate controlled historical keyword vocabulary Work was completed on the development of the joint NLM/National Aeronautics and Space Administration database on space medicine and life sciences, SPACELINE, to be publicly released early in FY 1996

NLM is interested in providing online access to pre-1966 *Index Medicus* records Based on a number of tests involving pages from a range of pre-1966 volumes, the Library has determined that use of scanning technology is not cost-effective for this purpose Data from the Name Index of the 1965 *Cumulated Index Medicus* has been keyboarded into a test database

In addition to expanding the range of information it provides online, NLM also improved methods of access to its data ELHILL, NLM's basic retrieval software, was upgraded to provide proximity searching and other enhanced features to command language searchers A growing number of NLM users are using file transfer protocol (ftp), in preference to having printouts mailed, to obtain the results of automatic selective

dissemination of information (SDI) searches Use of ftp speeds receipt of information by users and reduces workload at NLM The Library developed and tested a Z39 50 protocol server to allow outside systems that have Z39 50 compliant client software to search MEDLINE more efficiently NLM itself has no current plans to develop Z39 50 client software As part of NLM's System Reinvention effort, LO worked with OCCS and SIS staff on a test of the use of the Inquery retrieval software for integrated retrieval from NLM's three AIDS databases

As it provides access to new types of information and improves access mechanisms, the Library also reviews existing databases to identify those that can be eliminated or merged to simplify access for users and to reduce administrative overhead In FY 1995, the Name Authority File was removed from the MEDLARS system Use of the file was minimal because external health sciences librarians access NLM's name and series authority records in bibliographic utilities such as OCLC and RLIN, and NLM staff use the data as it appears in the internal cataloging system BIOTECHSEEK was merged into MEDLINE, and the separate database was eliminated Background work was completed to merge the HSTAR and HEALTH databases effective in January 1996

In preparation for the 1996-2001 NN/LM contracts, NLM has developed a revised approach to providing online training The number of Regional Medical Libraries providing online training will be reduced from three to one, and the "Fundamentals of MEDLARS Searching" training course will be restructured The redesigned, more cost-effective course will use computer-based practice exercises, computer-driven and analyzed class evaluation and student assessments, and computer-generated CE certificates The class will include a section on Grateful Med Many of the specialized training modules will no longer be given, due to steadily declining attendance over the past five years In FY 1995, the last full year of the current online training approach, NLM and the three RML online training centers taught 68 classes attended by 845 search intermediaries and other students

Machine readable databases

To provide the widest possible access to its authoritative information, NLM leases MEDLARS databases in machine-readable form to commercial database vendors, international MEDLARS centers, universities, and other organizations The licensees then make the data available online or in CD-ROM products In FY 1995, NLM distributed data from one or more of its databases to 100 different organizations At the end of the year, 9 licensees were producing CD-ROM products containing data from 6 different NLM databases

NLM now uses ftp to distribute MeSH in USMARC format and the MeSH tree structures and to provide CIP (cataloging in publication) data to the Library of Congress The Library has done some initial experiments with ftp distribution of weekly MEDLINE updates

NLM is modifying the programs that produce USMARC formatted records from its internal cataloging system to conform to USMARC Bibliographic Format Integration The first set of changes was implemented effective in late April 1995 The remaining changes will be implemented in the spring of 1996 to coincide with the time that the major bibliographic utilities will be able to process records in the new format

Publications

NLM continues to publish some of its authoritative data in printed publications, of which *Index Medicus* is the most comprehensive and well-known As the electronic options for access to NLM's authoritative bibliographic data increase, the Library reviews its publication program to modify or eliminate those that have outlived their usefulness and to identify additional publications that should be distributed via the Library's Internet servers Materials now accessible via the Internet include updated chapters of NLM's *Online Services Reference Manual* and introductory sections of the *NLM Classification* In FY 1995, Internet users obtained more than 536,000 copies of NLM publications—from fact sheets to extensive bibliographies—using ftp or gopher

One series available both in print and electronically is *Current Bibliographies in Medicine*, which addresses topics of significant current interest that may be difficult to search in NLM's databases and other sources The bibliographies cover topics relevant to specific programs of NLM, NIH, or other Public Health Service agencies and are often produced in conjunction with NIH Consensus Development Conferences or other special meetings NLM staff members collaborate with outside experts to produce each issue FY 1995 additions to the series included *Telemedicine Past, Present and Future,* which provided background for a current Institute of Medicine study of criteria for evaluating telemedicine projects, *Whole-Body Irradiation*, which was part of NLM's extensive support of the Administration's initiative to identify and review Federally supported research projects that involved radiation of human subjects, *Asian/Pacific Islander American Health*, and *Cochlear Implants*

Reference Services

NLM provides reference service and assistance to onsite users and to remote requesters as a backup to services available from other U S health sciences libraries In FY 1995, NLM's Reference Section responded to 68,267 requests for reference assistance from onsite and remote requesters (table 9) The number of inquiries received via the Internet continues to increase sharply Use of the Internet has been fully incorporated into the reference services NLM provides

The Library continues to expand the databases available to Reading Room patrons Onsite users can now search the Library of Congress and NIH Library Catalogs The latter catalog is particularly helpful to the many NIH employees who use both the NIH Library and NLM's Reading Room Access to onsite services was improved for people with disabilities software was installed for screen enlargement and voice synthe-

sis of computer-based services and workstations for enlarging or synthesized reading of print materials from the NLM collection The Library also provides large print handouts for users of the Main Reading Room

In FY 1995, the Reference staff was instrumental is planning and providing special seminars for 12 students and 5 faculty members from the District of Columbia's Coolidge High School during their summer work-study program at NLM The training sessions were designed to equip the students and faculty to train others in the Coolidge high school community to become more effective users of the Internet Information Center, which NLM has established at the school Staff members from other NLM program areas also participated as instructors in the seminar series

Document Delivery

NLM provides document delivery from its comprehensive collection as a back-up resource for other health sciences libraries in the NN/LM The Library also retrieves documents from its closed stacks for use by onsite patrons (table 6) In FY 1995, the Library received a total of 573,541 requests for post-1913 documents and 10,358 requests for items from the historical and special collections

NLM filled 71 percent of 345,428 interlibrary loan requests for post-1913 materials If requests for which the requester was unwilling to pay are excluded, the fill rate was 76 percent Eighty-seven percent of filled requests were processed within one day of receipt The Library received 12,995 requests via the Internet using the Ariel software NLM discontinued use of SAIL (System for Automated Interlibrary Loan), a system developed by NLM's Lister Hill Center to fill selected interlibrary loan requests with little or no human intervention Although technically successful, SAIL was not cost-effective due to the widely scattered pattern of document requests received by NLM The Library is exploring other approaches to improving automated support for remote document delivery including scanning individual documents at the time requests are received, but not retaining the scanned images after the delivery transaction is completed NLM is also testing different services for shipping books and audiovisuals to remote requesters in an effort to speed delivery of materials while reducing administrative overhead

In FY 1995, NLM received 89 percent of its interlibrary loan requests via DOCLINE, its automated document request and routing system Special efforts were made to contact libraries submitting requests to NLM via other mechanisms and to encourage them to switch to DOCLINE DOCLINE was enhanced to accommodate rush requests for clinical emergencies that were previously received via fax and telephone DOCLINE depends on SERHOLD, a database of 1 35 million holdings statements for 3,155 health sciences libraries in the United States and Canada In FY 1995, NLM began work on streamlined procedures for updating SERHOLD, including use of ftp, that will allow more frequent and less labor-intensive updates

A total of 2,789 libraries now use DOCLINE, including libraries throughout Canada Twenty-nine percent of DOCLINE users access the system via the Internet This year DOCLINE participants entered 2 9 million document requests of which 94 percent were filled Individual Grateful Med users may employ the Loansome Doc feature to route requests for documents identified in MEDLINE searches to a network library that has agreed to serve them These requests are referred on by DOCLINE if that library is unable to fill them In FY 1995, Grateful Med users initiated 273,210 Loansome Doc requests, up 39 percent from the previous year Some institutions with fixed-fee arrangements for use of NLM's online system encourage their users to use the Loansome Doc feature to route document requests to the institution's library

Onsite users requested 228,113 documents from NLM's closed stacks, of which 79 percent were supplied Due to the onsite circulation system implemented in mid-1994, the Library now can produce summary statistics characterizing the items onsite patrons request from NLM's closed stacks Like interlibrary loan requesters, onsite patrons are primarily interested in journal articles, and they request articles from many different journals For example, articles from 13,151 different journal titles were requested in the six months ending with December 1994 In FY 1995, NLM also conducted a study of the use of titles that are shelved in its Main Reading Room As a result of this study, 15 titles were removed from and 8 titles will be added

National Network of Libraries of Medicine

The purpose of the NN/LM is to equalize access to current biomedical information throughout the United States The goal is to reduce the extent to which geographic location and institutional affiliation affect the level of information service available to U S health care practitioners and researchers There are 4,500 Network members, including health sciences libraries of every size and type located in all parts of the country NLM's NN/LM Office oversees and coordinates Network programs, which are administered by eight Regional Medical Libraries The NN/LM Office and the RMLs communicate regularly via e-mail and audio-teleconference to ensure that new and enhanced programs and services are introduced smoothly throughout the country The competition for the eight new RML contracts for 1996-2001 began in FY 1995 Three review teams, each consisting of outside experts and NLM staff, completed initial evaluations of all proposals Contract awards will be made in FY 1996

The NN/LM program is a critical component of NLM's outreach initiative The RMLs, as well as many individual network members, carry out specific outreach projects to underserved rural and inner city health professionals Special outreach projects undertaken in FY 1995 included eight projects with an HIV/AIDS focus, four projects that targeted nurses, and one that targeted pharmacists, there were other projects to connect libraries in small hospitals to the National Information Infrastructure

As part of its health services research information program, NLM engaged a consultant to assess the training needs of health sciences librarians in the field of health services research, to identify existing courses and materials that met some of these needs, and to advise NLM on additional training courses that should be developed Staff at the RMLs and in other network libraries provided important input to this study The Library will use the consultant's report in designing an expanded health services research information training program An initial module of this program was pilot tested as a continuing education course given at the 1995 annual meeting of the Medical Library Association in Washington, D C

The RMLs conduct most exhibits and demonstrations of NLM's products and services at health professional meetings around the country NLM staffs the exhibits at the meetings in the Washington, D C area and some remote meetings that relate particularly to health services research In FY 1995, NLM and NN/LM services were highlighted at 158 exhibits at national, regional, and state association meetings throughout the country

Another focus of the NN/LM program is technology transfer All of the RMLs collect and disseminate information about regional Internet service providers and sources of funding for start-up costs for Internet connections RMLs also arrange special sessions on new information technologies either as free standing programs or in conjunction with other professional meetings Some of these conferences have been co sponsored by the Friends of the National Library of Medicine as well as other organizations In FY 1995, some of these sessions focused on telemedicine, health resources on the Internet, and the "Virtual Hospital "

Special Onsite Programs

In addition to reference and document delivery services, NLM offers a variety of special programs and services to those who visit the Library in Bethesda, including guided tours, briefings on NLM's operations and services, and historical exhibits and symposia NLM also has a one-year post master's training program for librarians with potential for substantial contributions to health sciences information services

Public Tours and Briefings

NLM is a popular attraction for domestic and international visitors with an interest in biomedical communication, health sciences librarianship, and information technology In FY 1995, LO staff members conducted 153 regular daily tours for a total of 519 visitors The Office of Public Information (Office of the Director) arranged 108 special group tours and orientation programs for 1127 visitors In conjunction with the annual meeting of the Medical Library Association and the 7th International Congress of Medical Librarianship, held back to back in Washington, D C , NLM was pleased to provide special tours and demonstrations for more than 200 health sciences librarians from around the world NLM staff members also arranged special briefings on library programs and services for many individual visitors

Historical Programs

As part of NLM's celebration of African American History Month, Keith Wailoo, Assistant Professor of Social Medicine at the University of North Carolina, presented a public lecture (February 8, 1995) on "Genetics and Segregation Sickle Cell Disease and American Society in the Early 20th Century " Several historians who make use of NLM's collections also presented seminars for History of Medicine Division staff members

NLM installed three major historical exhibits in FY 1995 "The Birth of Clinical Medicine, Paris, 1794-1848," with assistance from consultant, Caroline Hannaway, Ph D , "Here Today, HERE Tomorrow Varieties of Medical Ephemera," featuring material from William Helfand's private collection as well as many items he has donated to NLM, and "Allopaths, Maharajas, & Vaidyas Nizams, Jams, & Hakims Medical Pluralism in the Princely States of India "

NLM published the fifth edition of the *Directory of History of Medicine Collections*, produced from an updated and expanded group of DIRLINE records The American Medical Informatics Association published Dr Morris Collen's *A History of Medical Informatics in the United States, 1950 to 1990* Dr Collen's research was partially supported by NLM, and members of the NLM staff reviewed early drafts of the book The source material he collected from members of the American College of Medical Informatics has been incorporated into the NLM collection

NLM Associate Program

The NLM Associate Program is a one year competitive program that allows library school graduates to become familiar with NLM's operations, to gain an understanding of key issues facing health sciences libraries, to use new information technologies, and to develop their skills by conducting special projects FY 1995 Associates developed strategies for outreach to Hispanic health professionals, reviewed MeSH coverage in the field of dentistry, and developed a prototype multi-media, Internet-based catalog for selected historical films, among other project assignments Associates also have an opportunity to visit other national libraries and various types of health sciences libraries and information centers and to attend professional meetings Three associates completed the 1994/95 program Three new Associates began the program in September 1995, including an international Associate from the National Medical Library in Prague, Czech Republic

Table 2
Growth of Collections

Collection	*Previous Total (9/30/94)*	*FY 1995*	*New Total (9/30/95)*
Book Materials			
Monographs:			
Before 1500	576	0	576
1501-1600	5,780	7	5,787
1601-1700	10,100	20	10,120
1701-1800	24,422	19	24,441
1801-1870	40,002	1,104	41,106
Americana	2,341	0	2,341
1870-Present	596,639	17,138	613,777
Theses (historical)	281,794	0	281,794
Pamphlets	172,021	0	172,021
Bound serial volumes	1,025,504	24,460	1,049,964
Volumes withdrawn	(55,956)	(1,741)	(57,697)
Total volumes	2,103,223	41,007	2,144,230
Nonbook Materials			
Microforms:			
Total microforms	356,322	37,762	394,084
Reels of microfilm	68,682	10,957	79,639
Number of microfiche	287,640	26,805	314,445
Audiovisuals	57,226	1,496	58,722
Computer software	662	114	776
Pictures	56,601	0	56,601
Manuscripts	2,454,542	0	2,454,542
Total nonbook	2,925,353	39,372	2,964,725
Total book and nonbook	5,028,576	80,379	5,108,955

Table 3
Acquisition Statistics

Acquisitions	*FY 1993*	*FY 1994*	*FY 1995*
Serial titles received	22,397	23,250	22,600
Publications processed:			
Serial pieces	154,069	154,076	154,342
Other	23,682	22,569	22,743
Total	177,751	176,645	177,085
Obligations for:			
Publications	$4,129,478	$4,456,480	$4,788,181
Included for rare books	($149,829)	($207,575)	($189,527)

Table 4
Cataloging Statistics

	FY 1993	*FY 1994*	*FY 1995*
Completed Cataloging*	20,176	19,556	22,232

*Revised figures. Records released to CATLINE and AVLINE.

Table 5
Bibliographic Services

Services	*FY 1993*	*FY 1994*	*FY 1995*
Citations published in MEDLINE	376,312	367,877	392,354
For *Index Medicus*	358,993	351,958	374,907
Recurring bibliographies	22	12	6
Journals indexed for *Index Medicus*	3,058	3,127	3,093
Abstracts entered	280,599	274,514	293,724

Table 6
Circulation Statistics

Activity	*FY 1993*	*FY 1994*	*FY 1995*
Requests Received	522,472	539,988	573,541
Interlibrary Loan	307,481	324,670	345,428
Onsite	214,991	215,318	228,113
Requests Filled:	401,162	410,453	424,169
Interlibrary Loan	220,464	229,949	245,078
Photocopy	207,442	217,627	231,993
Original	11,493	10,864	11,384
Audiovisual	1,529	1,458	1,701
Onsite	180,698	180,504	179,091

Table 7

Online Searches*

DATABASES	*FY 1993*	FY 1994	FY 1995
AIDSDRUGS	582	1,288	1,453
AIDSLINE	38,485	54,596	66,200
AIDSTRIALS	1,377	2,319	3,148
ALERT	1,923	2,027	3,062
AVLINE	22,298	27,269	27,543
BIOETHICS	15,450	15,075	15,248
BIOTECHSEEK	781	725	.....
CANCERLIT	83,805	88,077	91,324
CATLINE	279,474	363,805	390,067
CCRIS	4,763	4,048	3,168
CHEMID	10,782	10,608	9,970
CHEMLINE	18,784	16,588	13,075
DART	3,338	3,061	3,861
DBIR	115	.....	.....
DENTALPROJ	120	146	142
DIRLINE	11,036	17,064	33,427
DOCUSER	13,082	14,353	17,699
EMIC	1,082	3,577	3,787
EMICBACK	4,473	2,995	2,039
ETICBACK	1,076	896	1,046
GENETOX	1,496	1,808	1,913
HEALTH	192,083	186,701	178,295
HISTLINE	4,658	4,374	6,806
HSDB	33,239	35,767	30,296
HSRPROJ	.....	93	1,266
HSTAR	3,301	27,789	41,670
IRIS	23,244	21,453	17,593
LOANSTATUS	7,475	14,495	19,939
MEDLINE	4,421,825	4,989,911	5,262,329
MeSH VOCABULARY FILE	38,355	37,221	38,058
NAME AUTHORITY FILE	2,585	1,760	.....
PDQ	24,342	23,794	20,303
POPLINE	17,328	24,610	22,864
REFLINE	43,301	42,518	39,984
RTECS	15,122	14,685	13,808
SDILINE	51,733	44,259	218,654
SERLINE	178,945	418,162	633,615
SPACELINE	.....	.....	1,507
STORED SEARCH	248	336	108
TOXLINE	69,271	69,944	71,631
TOXLIT	12,924	11,766	11,074
TRI	25,519	21,320	12,793
TRIFACTS	663	577	511
USERS	4,581	3,912	3,701
YEAR86	3	2	4
Total	**5,685,067**	**6,625,774**	**7,334,981**

*Beginning in FY 1995, figures include off-line searches.

Table 8
Off-line Searches*

DATABASES	*FY 1993*	*FY 1994*
AIDSLINE	1,971	1,710
AVLINE	82	75
BIOETHICS	3	5
CANCERLIT	3,967	3,177
CATLINE	526	504
CHEMLINE	0	0
DENTALPROJ	1	0
HEALTH	10,509	9,943
HISTLINE	4	6
MEDLINE	6,376	3,733
MeSH VOCABULARY FILE	1	0
POPLINE	4,684	4,692
SDILINE	243,713	210,612
SERLINE	1	3
TOXLINE	4,334	3,557
TOXLIT	2,887	2,234
Total	**279,059**	**240,251**

*Off-line searches are no longer being counted separately.

Table 9
Reference Services

Activity	*FY 1993*	*FY 1994*	*FY 1995*
Reference Section:			
Offsite requests	24,015	22,706	25,135
Onsite requests	47,901	42,482	43,132
Total	**71,916**	**65,188**	**68,267**

Table 10
History of Medicine Activities

Activity	*FY 1993*	*FY 1994*	*FY 1995*
Acquisitions			
Books	115	126	154
Modern manuscripts	56,475	193,725	184,000
Prints and photographs	0	313	2,046
Historical audiovisuals	38	61	147
Processing			
Books cataloged	297	340	2,451
Modern manuscripts processed	31,940	0	0
Pictures cataloged	0	1	0
Citations indexed	4,801	3,697	2,510
Public Services			
Reference questions answered	12,352	13,516	13,434
Onsite requests filled	5,751	7,866	7,273

SPECIALIZED INFORMATION SERVICES

Melvin Spann, Ph D
Associate Director

Twenty-nine years have passed since the Division of Specialized Information Services (SIS) first established the Toxicology Information Program, now known as the Toxicology and Environmental Health Information Program (TEHIP) TEHIP's evolution has kept pace with the spread of, and demand for, toxicological and environmental health information, by taking advantage of new computer and communication technologies Such mechanisms have enabled us to provide more rapid access to a wider audience Our development of novel search capabilities means that users require less prerequisite search knowledge and thus allow data to be delayed to them more efficiently Finally, we are moving beyond the bounds of the physical National Library of Medicine, and exploring ways to point and link users to relevant sources of toxicological and environmental health information wherever these sources may reside This will be accomplished through the TEHIP and AIDS gophers recently made public by SIS, and by a new World Wide Web server currently under development

In FY 1995 SIS reexamined the scope and coverage of current SIS programs, proposed new opportunities to enhance SIS information services, and investigated emerging areas, including the application of new multimedia technology in the delivery of information services This examination was initiated using the mechanism of an Institute of Medicine (IOM) evaluation of the TEHIP Program

TOXNET

Enhancements were made to two major modules of the Toxicology Data Network (TOXNET), the Library's networked microprocessor system the Remote Data Entry File Building module and the Search/Retrieval module All file building contractors and Scientific Review Panel members now have high-speed modems to access TOXNET A feasibility study to investigate mounting NCI's voluminous PHS-149 data (i e , chemical carcinogenicity studies) as an online TOXNET database was started Work continued on the further enhancement and implementation of the Windows workstation for building and updating Hazardous Substances Data Bank records A major enhancement to the Search/Retrieval module is the addition of proximity operators that allow users to specify word order and location of their search terms

The experimental Mosaic Boolean search interface and a "Mosaic Graphical Map" concept search interface to TOXNET have been moved to an experimental WWW server in SIS More work is needed to implement a fully associative graphical user interface, using the Forms Software imbedded in the experimental SIS server This will facilitate literature searches by users who also need to search ELHILL databases, such as MEDLINE and TOXLINE

Databases under TOXNET

The **Hazardous Substances Data Bank** (HSDB) continues to be the most highly used data bank on TOXNET, averaging more than 10,000 searches each month Increased emphasis was placed on providing more data on human toxicology and clinical medicine within HSDB, in keeping with the recommendations of the Board of Regents' Subcommittee on TEHIP Additional recommendations are anticipated from the Institute of Medicine Evaluation Study Changes to the composition of the Scientific Review Panel may be necessary in the future to accommodate the shift in content emphasis Newer sources of relevant data are being examined for incorporation into new and existing data fields within the current 4,500 HSDB records More records are being processed through special enhancements, including source updates from various peer-reviewed files These enhancements are made possible by a customized WINDOWS-based PC workstation with enhanced file-building features

The **Toxic Chemical Release Inventory** (TRI) series of files now includes seven online files, TRI87 through TRI93 These files remain an important resource of environmental release data and continue to attract new users Mandated by the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986), these databases, sponsored by the Environmental Protection Agency (EPA) contain environmental release data to air, water, and soil for almost 400 EPA-specified chemicals Starting with the TRI91 file, the reporting facilities were required to report source reduction and recycling activities, in addition to environmental releases These additional reporting requirements, mandated by the Pollution Prevention Act of 1990, have considerably increased the size and complexity of the databases

In spite of the additional data, the TRI93 file was released in March 1995, the earliest date yet, and TRI94 is scheduled to be completed by February 1996 The early release dates have been made possible by increased TOXNET system efficiencies and improvements in data handling at the Environmental Protection Agency EPA is planning to include more than 300 additional chemicals in 1996, as well as required submissions from federal facilities and military installations Another major change in TRI95 will be two versions of the reporting form, a long and a short, requiring unit record changes TRIFACTS, a companion file to the TRI series, supplies users with information related to health and ecological effects and the safety and handling of the TRI chemicals These records are supplied by EPA, which also funds the management and maintenance of the TRI files

The **Chemical Carcinogenesis Research Information System** (CCRIS) continues to be built, maintained, and made publicly accessible by NLM This data bank is supported by the National Cancer Institute and has grown to 6,203 records The chemical-specific data covers the areas of carcinogenesis, mutagenesis, tumor production and tumor inhibition

The **Integrated Risk Information System** (IRIS), EPA's official health risk assessment file, continues to experience high usage on TOXNET and be very popular with the user community Beginning with version 6 5, Grateful Med contains new form screens to facilitate the searching of IRIS by inexperienced users Creating a search mechanism with the TOXNET Concept Menus is also under consideration IRIS now contains 666 chemicals

The **GENE-TOX** file continues to be built and updated directly on TOXNET by EPA scientific staff This file contains peer-reviewed genetic toxicology (mutagenicity) studies for about 3,000 chemicals GENE-TOX receives a high level of interest among users in other countries

The **Registry of Toxic Effects of Chemical Substances** (RTECS) is a data bank based upon a National Institute of Occupational Safety and Health (NIOSH) file by the same name which NLM has restructured and made available for online searching SIS continues to add new data to this file as NIOSH makes them available NIOSH has announced that the full RTECS will no longer be available as a printed or microfiche product, so online access via NLM is now even more important

The **Developmental and Reproductive Toxicology** (DART) database now contains more than 26,000 citations from literature published since 1989 on agents that may cause birth defects This year, a significant effort was made to add relevant technical reports to DART Records from DART are also added to TOXLINE on a quarterly basis DART is a continuation of the Environmental Teratology Information Center backfile (ETICBACK) database, which contains almost 50,000 citations to literature published from 1950-1989 ETICBACK citations are also found in TOXLINE DART is funded by the EPA, the National Institute of Environmental Health Sciences (NIEHS) and the FDA's National Center for Toxicological Research and is managed by NLM

The **Environmental Mutagen Information Center** (EMIC) database contains citations to literature on agents that have been tested for genotoxic activity A backfile for EMIC (EMICBACK) contains over 70,000 citations to the literature published from 1950-1991 Records from EMICBACK are included in TOXLINE Plans are under way to add the records from the new EMIC database to TOXLINE as well EMIC is funded by the EPA and the NIEHS and managed by NLM

Databases under ELHILL

CHEMID (Chemical Identification File) is an NLM online chemical dictionary which contains over 267,000 records, primarily describing chemicals of biomedical and regulatory importance It also contains an important set of regulatory data, collectively known as SUPERLIST Over 9,000 records are augmented with the name and an indication of source for chemicals mentioned in one or more of 19 lists, e g , the Department of Transportation Hazardous Materials List, and the Priority List of the Agency for Toxic Substances and Disease Registry (ATSDR) These data allow users to determine if a chemical is mentioned on a given list and under what name, as well as to search for chemical classes on these lists In FY 1995, the file regeneration programs were completely rewritten to allow more frequent file updates Enhancements to the quality of the data were also made During FY 1996, the number of lists in SUPERLIST will increase to more than 30 and the file size of ChemID will grow to approximately 300,000 records

CHEMLINE (Chemical Dictionary Online) is an online chemical dictionary and directory file that allows users to identify chemical substances via nomenclature and other identifiers, and to formulate optimum search strategies for other NLM files CHEMLINE is updated every two months and regenerated annually The basic foundation of CHEMLINE's data is supplied by the Chemical Abstracts Service from its Registry System, and this is augmented extensively by NLM with nonproprietary data from a variety of sources CHEMLINE now contains more than 1,400,000 records on chemical substances An online file maintenance capability for this file will be put in place in 1996

TOXLINE (Toxicology Information Online) is an NLM online bibliographic retrieval service produced by merging "toxicology" subsets from some 17 secondary sources TOXLINE and its backfile, **TOXLINE65**, contain data from sources that do not require royalty charges based on usage The Chemical Abstracts Service requires usage royalties, therefore, information from this source is used to create two separate online bibliographic files, **TOXLIT** and **TOXLIT65.** The four databases in the TOXLINE family of services now contain nearly four million records Approximately 20,000 records are added with each monthly update

During FY 1996, SIS plans to add a new subfile from the Swedish National Chemical Inspectorate's file, RISKLINE Changes are also expected in the indexing vocabulary used by Biological Abstracts, producers of the BIOSIS subfile We are also exploring ways that the Unified Medical Language System can be utilized to accommodate vocabulary changes in TOXLINE subfiles

DIRLINE (Directory of Information Resources Online) is NLM's online directory of resources including

organizations, databases, bulletin boards, as well as projects and programs with special biomedical subject focus These resources provide information to users which may not be available from one of the other NLM's bibliographic or factual databases The availability of DIRLINE via the Internet through NLM's Locator has led to substantially expanded use of the database and a higher level of recognition of its utility by biomedical librarians, health professionals, and the public Increased funding for database maintenance has made it possible to improve the quality and timeliness of the content of the database maintenance and improve collaboration with other subfile producers

AIDS Services

NLM's HIV/AIDS information services continue to grow and mature using the recommendations from the 1993 NIH HIV/AIDS Information Services Conference as a guide NLM's two collaborative projects with other PHS agencies, the AIDS Clinical Trials Information Service (ACTIS) and the HIV/AIDS Treatment Information Service (ATIS) continue to be very successful While direct online use of the AIDSTRIALS and AIDSDRUGS databases has stabilized, many other information providers are downloading the data and adding it to their services A number of bulletin boards and gophers are providing the data to their users in a number of formats and the data have also been distributed internationally through this mechanism NLM has added a number of AIDS-related treatment recommendations to HSTAT as part of the ATIS project

NLM initiated a second round of AIDS Outreach Purchase Orders in FY 95 and made awards to 16 community-based organizations and libraries This brings the total number of awards to 35 for two years In addition to these smaller awards, NLM awarded a contract to the Montgomery County (Maryland) Department of Public Libraries for a collaborative project between NLM and the Health Information Center, Wheaton Regional Library, in the areas of AIDS and toxicology/environmental health information This project will provide NLM with an opportunity to learn about use of the Library's databases by the general public

Other Programs

Internet

The scope of the prototype SIS World Wide Web server was expanded to cover all programs in SIS A SUN Sparc-20 was ordered to serve as the public server, and will use Netscape server software It will be made public early in FY 1996 New TEHIP and AIDS Gophers were made public during FY 1995, and have enabled SIS to bring specialized types of information in toxicology, environmental health, and HIV/AIDS to a new Internet audience

Outreach

SIS continues its support of the Toxicology Information Outreach Project The objective of this initiative is to strengthen the capacity of Historically Black Colleges and Universities (HBCUs) to train medical and other health professionals in the use of NLM's toxicological, environmental, occupational health and hazardous wastes information resources In addition to providing workstations, training and free online access to nine HBCUs participating in a pilot training development project, NLM has collaborated with the Agency for Toxic Substances and Disease Registry (ATSDR) to train representatives from 50 additional schools in the use of NLM's valuable online resources During the past year, one of the training classes was hosted by Howard University and it included HBCUs from the Lower Mississippi Delta This class was jointly sponsored by ATSDR, NLM, and the EPA's Environmental Justice Office in support of the Mississippi Delta Project

User Support Computer-Based Activities

The main focus of SIS's computer-based training activities has been to develop an introductory level toxicology course for use in various university health science curricula The course was developed under TOOLBOOK for a Windows environment It takes advantage of Windows' graphical user interface incorporating color graphics, photography, animation, and audio A beta version covering the basics of toxicology was distributed to more than 20 sites for testing at the end of FY 1995 It is anticipated that an intermediate module will be added to the course this year before its release to the public

Over the past three years, as part of a collaborative project with NCI's International Center for Cancer Information, SIS consulted on the development of microcomputer based tutorials for the CANCERLIT and PDQ databases Completed tutorials for CANCERLIT and PDQ, developed in QUEST for delivery in a DOS environment, were delivered to NCI at the end the fiscal year Additionally, a Windows95 prototype that was developed in Multimedia Toolbook for the CANCERLIT database was delivered

SIS made DOS versions of TOXLEARN, MEDTUTOR, and ELHILL LEARN that were developed under QUEST using the CANCERLIT LEARN as a model available on INTERNET Windows 3 1 versions developed under TOOLBOOK complete with mini-databases and an ELHILL simulator for practice searching as well as an optional audio component are ready for release on INTERNET

Alternatives to Animal Testing

SIS continued to compile and publish references from the MEDLARS files that were identified as relevant to methods or procedures which could be used to reduce, refine, or replace animals in biomedical research and toxicological testing Requests for these quarterly bibliographies have in-

creased, as has the number of articles deemed relevant to the field. Bibliographies issued during the past three years are available in the Internet through the SIS Gopher and WWW servers.

LISTER HILL NATIONAL CENTER FOR BIOMEDICAL COMMUNICATIONS

Harold M Schoolman, M D
Acting Director

The Lister Hill National Center for Biomedical Communications (LHNCBC) was established by a joint resolution of Congress in 1968 An intramural research and development division of the NLM, LHNCBC research programs apply state-of-the-art computer and communications technologies to the management of biomedical knowledge Such knowledge can take the form of images, electronic signals, sounds, and standard information LHNCBC programs create innovative methods for acquiring, storing, retrieving, analyzing, communicating, and presenting the knowledge of the life sciences

A Board of Scientific Counselors meets to review the quality and contents of the intramural research programs within the Lister Hill Center The Board is composed of scientific and technical experts (see Appendix 3 for a list of members) who are prominent leaders in the fields of medicine, computer science, engineering, and health professions education

The Center is organized in five component branches

- Computer Science Branch
- Information Technology Branch
- Communications Engineering Branch
- Cognitive Science Branch (formerly the Educational Technology Branch)
- Audiovisual Program Development Branch

The research and development programs of the LHNCBC fall into three categories

- Computer and information science as applied to the problems of the Library, of Biomedical research, and health care delivery,
- Biomedical image engineering, including image acquisition, processing, storage, retrieval, and communications, and
- Use of computer and image technologies for health professions education

Computer Science Branch

Research projects of the Computer Science Branch (CSB) concentrate on the application of artificial intelligence techniques to problems in the representation, retrieval, and manipulation of biomedical knowledge CSB projects involve both basic and applied research in such areas as expert systems, intelligent database systems, multimedia hypertext information delivery, machine learning, and machine-assisted indexing for information classification and retrieval The research addresses issues in knowledge representation, knowledge base structure, knowledge acquisition, the validation of automated consultant systems, and the human-machine interface for complex systems Important components of the research include embedded intelligence systems which combine local reasoning with access to large-scale mainframe databanks, and multimedia knowledge-based systems with interactive video capability

Branch staff members participate in individual and team research projects Several are principals in the Access Model project of NLM's System Reinvention program and in the development of the Metathesaurus and the Information Sources Map of NLM's Unified Medical Language System (UMLS) initiative They are active in the medical informatics and information science research communities and professional specialty societies Finally, recognizing the importance of addressing the future of medical informatics by helping to train new researchers, Branch Chief Dr Lawrence Kingsland directs the 8-week NIH elective in Medical Informatics for third year and fourth-year medical students each spring

Access Project

The Access Model project applies techniques of computer science, information science, artificial intelligence and networked distributed computing to the problems of helping users gain access to the information in NLM's multi-million record databases It began during FY 1994 and received full project status in FY 1995 Though the Access Project draws on expertise from several divisions of the Library, its core group of four researchers including the project leader are members of the Computer Science Branch The Access Model design group is developing an intelligent gateway system for searching a broad range of databases Major elements of the gateway include software called the Request Manager, a Library of Intelligent Search Aids which builds on work done by the Coach team in earlier Expert Systems Program research, and a series of Database Interfaces to existing legacy systems and to new systems not yet online Prominent in the Library of Intelligent Search Aids is a comprehensive browser module to help users find appropriate concepts in the huge UMLS Metathesaurus

The working name of the Access Project searching software is NetCoach, though it is likely that a name related to the Grateful Med family of programs will be chosen before the system's production release The system was alpha tested with users inside NLM during the spring of 1995 A revised version incorporating feedback and lessons learned from the alpha testing was beta tested beginning in the summer of 1995 A formal call for beta testers was issued, testers were deliberately chosen from among experienced and relatively inexperienced searchers, former Grateful Med and non-Grateful Med

users, and practicing clinicians, medical librarians, biomedical researchers and others An early beta version of the system was demonstrated at the Annual Meeting of the Medical Library Association in May, 1995 to intense interest and favorable response by the attendees The beta testing was enormously useful, resulting in additional feedback which helped significantly improve the NetCoach system

The goal of the Access Project development team is to complete the beta testing of the new system in the first half of FY 1996, add refinements as indicated by the testing, and deliver an initial production release during FY 1996

Expert Systems Program

CTX Shell—The Expert Systems Program has built a complete multimedia expert system shell called CTX, for Criteria Table Expert A Microsoft Windows version of CTX and a CTX engine which runs on Unix and DOS machines were completed in FY 1995 In April 1995 a prototype was successfully implemented to deliver public health information over the Internet using World Wide Web graphical browser software accessing a CTX engine running on a Unix workstation

Testing and refinement of the CTX software will continue in FY 1996 Documentation will be written and the shell prepared for dissemination to potential system developers Dr Balu Athreya of the University of Pennsylvania is exploring the feasibility of creating a general pediatrics system using CTX in collaboration with NLM and the American Academy of Pediatrics Intended users of the system would be general practice and emergency room physicians and nurse practitioners As the NLM Internet Grateful Med system becomes more complex, CTX reasoning modules may be incorporated into that system to suggest searching in alternative databases through the UMLS Information Sources Map Further development of the CTX software will focus on its use over the Internet Collaborations will be sought with members of the biomedical community who have information dissemination needs which could benefit from the capabilities of Internet CTX

AI/RHEUM Diagnostic System—AI/RHEUM is a knowledge-based consultant system for diagnosis of rheumatologic diseases This research project originated at the University of Missouri-Columbia and was brought to NLM with Director Dr Donald Lindberg and Dr Lawrence Kingsland in 1984 Expert Systems staff with research contract support from Dr H James Williams of the University of Utah and Dr Balu Athreya of the University of Pennsylvania have updated the AI/RHEUM knowledge base Work included updating and testing of the disease criteria tables and updating and writing of new Tell-Me-More definitions of patient findings used in the system Work was done on a new More About-Conclusion component which offers Tell-Me-More, Show-Me-More, and Search-For-More information to the user at the point when the system has reached its differential diagnosis

A new capability was added to provide alerts for drug toxicity in patients with rheumatic problems A triage capability to help the physician decide whether a patient has a rheumatic problem and would benefit from using the program was explored The pediatric aspects of the system were strengthened and the system tested with pediatric cases from the University of Pennsylvania The system and results of the testing were presented at the annual meeting of the American Academy of Pediatrics in October 1995

The AI/RHEUM system is undergoing final updating and testing to bring it to a distributable form NLM, with the expert rheumatologists, will complete the updating of the disease criteria tables by testing the tables with stored benchmark cases and fine-tuning the disease definitions Work on updating and including new Tell-Me-More definitions, Show Me-More images, and Search-For-More searches of MEDLINE for the findings and disease conclusions in the knowledge base will be completed One or more manuscripts describing the testing of AI/RHEUM in clinical settings, now in draft form, will be completed and submitted for publication The NLM will sponsor a workshop on "Evaluation of Knowledge-Based Systems" to assemble members of the knowledge-based systems and evaluation research communities to report on their experiences, discuss opportunities and challenges, and produce a white paper on the state of the art of expert systems evaluation

Unified Medical Language System Metathesaurus

The 1995 edition of the Unified Medical Language System (UMLS) Metathesaurus was released in June 1995 and shipped to 620 registered users It was named "Meta95" rather than by a version number, to encourage use of the most current annual version and to encourage evaluators to specify which edition is referenced in their work

Meta95 contains approximately 223,000 biomedical concepts called by 478,000 names from 31 source vocabularies This is an increase of 32,000 concepts from last year The increase, while comparable to last year's record, required a great deal more editing because of much greater content overlap as new portions of vocabularies were added New content in Meta95 includes the Snomed International Topography Axis and the nonchemical concepts in the Function Axis, all DXplain diseases and findings, WHOART, the Psycinfo Thesaurus, DSM-IV, and the Omaha System for Nursing For the first time this year, lexical classes were formed using the SPECIALIST lexical tools created by the Natural Language Systems group in the Cognitive Science Branch Also this year, all MEDLINE data from 1967 on has been processed to provide co-occurrence data for the Access Model project and other NLM uses

Planning, design, and implementation of a revised Metathesaurus production system is well under way, with the goal of creating an integrated NLM vocabulary development system Work on the 1996 Metathesaurus has already begun, starting with the Disease Axis of Snomed International An ambitious goal of releasing Meta96 early in 1996 has been set, to coincide more closely with the release of 1996 MeSH and

of MEDLINE searching under Elhill with 1996 MeSH An editing support contractor is working on mapping Metathesaurus concepts to MeSH and on reviewing additional definitions from Dorland's Medical Dictionary for release with Metathesaurus concepts NLM has begun meeting with members of the National Center for Health Statistics to discuss coordination of the maintenance of the ICD9-CM vocabulary and of ICD-10 with the Metathesaurus

Unified Medical Language System Information Sources Map—Considerable progress was made during FY 1995 in developing an application to help locate network-based information resources to answer specific biomedical information requests Using the Information Sources Map (ISM) database and other components of the Unified Medical Language System, a prototype application known as Sourcerer was created The Sourcerer prototype, employing a graphical user interface based on World Wide Web (WWW) technology, accepts query terms from a user and returns a list of potentially useful information sources, with embedded hypertext links for access A paper describing the prototype was presented at the Second International World Wide Web Conference in Chicago A new version of the ISM was released on CD-ROM in June 1995 with the other UMLS Knowledge Sources

Z39 50 Standard and World-Wide Web Activities

ISM Project leader Dr R P C Rodgers and his team continued to participate in and monitor activities of the Z39 50 Implementors Group (ZIG) and its Advanced Query subgroup and to work with visitor Dr John Kunze as he completed implementation of a Z39 50 server for NLM's MEDLINE database Dr Rodgers and Dr Kunze authored a brief introductory overview of this complex standard and made the overview available via NLM's World Wide Web (WWW) server, HyperDOC They also jointly explored various alternative means of providing platform-independent information access

Web-related projects under way at NLM became increasingly recognized as leading edge efforts during this fiscal year Dr Rodgers made a number of invited presentations on Web related subjects, for example at the annual meeting of the Internet Society, the Federal Webmasters Conference, and the Symposium on Computer Applications in Medical Care He was invited to serve as chair of the NSF/NCSA (National Center for Supercomputing Applications) World Wide Web Federal Consortium in its founding year, helping to establish the Consortium's charter and Web site and to guide review of NCSA's comprehensive project plan for post-Mosaic developments This interagency grouping sponsored a 2-day seminar on WWW and security, as well as the highly successful 3-day Federal Webmasters Conference held at NIH in July 1995 As a founding member of the International World Wide Web Conference Committee (IW3C2), he served on the program committee or the editorial review committee (or both) for the Second, Third, and Fourth International World Wide Web Conferences (held in Chicago, Darmstadt, Germany, and Boston, respectively)

Dr Rodgers worked with colleagues in the Office of Computers and Communications Systems (OCCS) and Library Operations (LO) to migrate the operational running of NLM's WWW server, HyperDOC, from the Lister Hill Center to OCCS and to develop and improve NLM's WWW services He supervised two very productive summer students, who helped to evaluate and install numerous software packages related to system administration, software development, and the creation and management of distributed World Wide Web servers, as well as the expansion of HyperDOC's multimedia content He worked closely with colleagues in the History of Medicine Division of LO to help train their personnel in online exhibit preparation Dr Rodgers was active in teaching the 1994-95 NLM Library Associates about UNIX, the Internet, NLM's WWW services, and the UMLS/ISM project, and he helped guide several of their projects One Associate created a forms-based entry tool for the ISM project, the other built a Web-based multimedia system for accessing motion pictures related to mental health

Finally, continuing his quest for practical higher-bandwidth means of multimedia Internet access for homes and small offices, Dr Rodgers and several CSB colleagues participated in Bell Atlantic's experimental residential ISDN program This experience led directly to subsequent work with remote Metathesaurus editing using ISDN connections

Machine Learning Project

Since 1989, the Lister Hill Center has been exploring the application of machine learning technology to biomedical problems Machine learning encompasses a wide variety of mechanisms for creating computer programs that improve their performance with use The objective of this project is to develop and apply methods by which programs can automatically acquire knowledge and put it to work

The underlying motivation for this work arises from the explosion of available biomedical information and the less well acknowledged explosion of the analytical tools and techniques applied to that information The NLM has long recognized the need for automated assistance to help researchers and clinicians gain access to this extremely valuable corpus of knowledge and has supplied the community with a wide variety of databases However, to take full advantage of the anticipated exponential growth of biomedical data and of the increasingly evident interrelationships among previously disparate information sources, dramatic improvements in automated knowledge manipulation, analysis, and inference will be necessary

Programs like expert systems have already moved from the manipulation of information toward the manipulation of knowledge The Machine Learning Project creates computer programs that not only manipulate knowledge, but also can acquire it themselves Ideally, a researcher or clinician

with a question should be able to have a machine learning program identify where to find relevant information, retrieve that information (possibly from multiple data sources), and analyze and assemble the information into a complete, accurate and comprehensible representation of the desired knowledge

These visions are the driving force behind the LHNCBC Machine Learning Project Currently, machine learning technologies focus primarily on inducing concept definitions from externally specified datasets To pursue the vision, the project endeavors to advance the state of the art in machine learning, creating a computationally tractable theory of how to use diverse sources of knowledge and deploy diverse (and complex) analytical tools in pursuit of explicitly stated goals

Machine Learning Project staff have developed a state-of-the-art multistrategy machine learning system, capable of matching or exceeding the performance of all current supervised learning systems This approach, called "Coevolution Learning," has been under intensive development in FY 1995 and is now beginning extensive testing and application The system combines genetic algorithms, neural networks, statistical inference, and other learning methods in a unified framework capable of handling many inferential tasks that were previously not amenable to automatic processing

The Coevolution Learning approach involves managing a population of machine learning programs, each using a different set of compound features and a different set of learning parameters, to try to solve a problem Both the parameters and the representation features evolve The parameters evolve using a standard genetic algorithm The features evolve on the basis of an analogy with cultural evolution Each learner in the population does constructive induction that is, it looks for new features combinations that are more useful in making the desired discrimination than any individual feature The constructed features are then given a "fitness" based on the success of the learner using them At the next iteration, all learners in the population select features to use as primitives with a probability proportional to the features' fitness

An implementation of this approach, called COEV, has been written in the object oriented programming system CLOS It is being tested on a variety of difficult inference problems, including applications in areas as diverse as biochemical structure function relationships and biomedical information retrieval Preliminary results have been very promising, and we look forward to further exploring biomedical applications of the system in FY 1996

MedIndEx Project

The MedIndEx Project develops and tests interactive knowledge-based systems for computer assisted indexing of medical literature currently indexed in the MEDLINE database using terms from the Medical Subject Headings (MeSH) thesaurus The main objective of MedIndEx is to facilitate expert indexing that goes into the MEDLINE product Another focus of this research has been developing intelligent retrieval systems utilizing the same representations and environment of the indexing system

The MedIndEx (Medical Indexing Expert) System is written in a frame language, a type of object-oriented language where objects, known as frames, are used for representing concepts Frames are subdivided by slots which relate the current frame to other frames, thereby forming factual knowledge in a domain The frame language includes an inheritance relation, whereby lower-level frames automatically assume descriptions of higher-level frames to which they are linked by this relation Slots may also contain executable code, which serves as the procedural knowledge component of the knowledge base (KB) for assisting indexers interactively

Indexers, with system guidance and help coming from the KB, create for each document indexed a set of indexing frames patterned after KB frames In addition to assisting indexers in completing the indexing frames according to relations inherited from KB frames, the KB also contains rules for generating in the background conventional MeSH indexing terms at the level of expert indexing This output can be used to compare the system to conventional indexing, and would provide actual MEDLINE indexing for current retrieval systems In addition to the Indexer Interface, the MedIndEx System includes KB Manager software designed to assist knowledge engineers in ensuring a consistent, compact, and syntactically correct KB

The prototype is written in Lucid Common Lisp/ SPARC Solaris Development Environment Version 4 1 1 and runs on SPARCstation 5 workstations under the Solaris 2 operating system Domain-independent project software includes a Lisp based experimental frame language The interface uses public-domain window system software X Windows (X11 Release 5), CLX, and CLUE (Common Lisp User Interface Environment) MedIndEx is designed to run similar indexing and KB Manager applications in other domains The KB contains about 6000 frames (MeSH concepts)

During FY 1995 a contract for conducting the MedIndEx evaluation, "Evaluation of a Knowledge-Based Expert System for Subject Indexing," (N01-LM-5-3516) was awarded to Herner and Company, Arlington, Virginia This contract was funded by the NIH 1% Set-Aside, Section 513, Public Health Services Act (Evaluation Project NIH/NLM 94-305) The methodology is based on "Design for a Study to Evaluate the MedIndEx Approach to Subject Indexing," (NTIS PB93-236016), which also received support from the NIH 1% Set-Aside (NIH/NLM 92-308)

Information Technology Branch

The Information Technology Branch (ITB) pursues applied R&D in computer and information science with an emphasis on electronic information generation, storage, and retrieval Major program areas at present target the development of object- oriented full-text and fielded data retrieval systems for both online and CD-ROM applications Specific programs include developing generalized windowing inter-

faces across multiple platforms, object-oriented retrieval systems encompassing fielded data, full text and graphics objects, editing workstations for manuscript preparation, com puter based publication, and CD-ROM technology Within these activities, many areas of applied computer science must be addressed such as portability, object-oriented programming, multiprocessing, client/server distributed processing models, and advanced memory management

Full Text Retrieval

The Full Text Retrieval Program in ITB is targeted specifically to address the needs of searching, retrieving from, and updating online medical reference works A medical reference work, in general, may contain voluminous amounts of text, structure (chapters, sections, sub sections, etc), and a variety of objects in addition to standard text such as table of contents, figures, tables, and footnotes The initial ITB-developed full-text retrieval system, IRx (Information Retrieval Experiment 1), allowed full text retrieval and maintenance of linear, nonstructured, text IRx has been extensively employed to deliver online full-text medical reference material to an international biomedical community by Johns Hopkins University Medical School, the NLM National Center for Biomedical Information (NCBI), and others

Present R&D efforts are targeted toward the evolution and further development of an object-oriented full-text retrieval system (FTRS) designed to address the needs of more general medical reference works Version 1 of FTRS became operational in 1993 It provided a client/server architecture and many advanced features including Table of Contents browsing and Natural Language Query searching FTRS 1 employed an object-oriented encapsulation of the IRx search engine FTRS 2 0 became operational in 1994 and provides a complete object oriented programming structure for modular development Major user oriented enhancements in both the FTRS server and clients were achieved including phrase searching, an improved ranking algorithm, online comments and annotations, and Internet as well as dial-up access In addition, two new prototype FTRS clients were completed a full windows based client (FtWin) and a World Wide Web based client (FtWeb)

In May 1994, NLM announced public online access to the Health Services/Technology Assessment Text databases (or, simply, HSTAT) HSTAT initially included full text from three sources 1) AHCPR Guidelines, 2) NIH Consensus Development Conference and Technology Assessment Reports, and 3) the PHS monograph, *Guide to Clinical Preventive Services* Since that time, full text from the Aids Treatment Information Service (ATIS), NIH Clinical Center Research Studies, and Treatment Improvement Protocols from SAMHSA, have been added The next edition of the *Guide to Clinical Preventive Services* is expected to be included shortly after its publication (originally scheduled for Summer 1995, but not yet available) As of October 1995, the following full text collections are being supported in HSTAT

- 17 AHCPR Guideline topics in four versions Clinical Practice Guideline, Quick Reference Guideline, and Consumer Guideline (both English and Spanish),
- 12 Morbidity and Mortality Weekly Reports, 1 State of the Art Conference Report, and 1 set of Guidelines in the ATIS collection,
- 950 NIH Clinical Center Research Studies—updated nightly,
- 100 NIH Consensus Development Conference Reports,
- 17 NIH Technology Assessment Workshop Reports,
- 1 Treatment Information Protocol from SAMHSA (the full collection is expected by December 1995), and
- 1 monograph, *Guide to Clinical Preventive Services*

Online access to HSTAT is available via standard mo dem dialup and Internet Internet access is available in 4 different modes FTRS, WWW Clients, Gopher, and FTP Through its support of HSTAT, ITB is gaining invaluable, iterative feedback from the biomedical community regarding needs and shortcomings of online full text delivery from the user perspective

During 1995, the FTRS server software has been upgraded to run under the Solaris operating system The character-based client supporting dial-in access, FTCH, has been enhanced to include a download feature and the "Help" system has been improved FTWIN has undergone a major rewrite to resolve communication problems and take advantage of major changes in the development software, delaying its Beta release FTWIN has also been ported to Motif (the window system available on Sun/Unix workstations) It is now being ported to the Macintosh window system The FtWeb client was released in October 1995 This client is accessible by most of the major WWW browsers and is currently the only WWW entry to the data FtWeb fully supports the search and retrieval capabilities of FTRS and has quickly become the major access to HSTAT In 1995, the number of accesses to HSTAT through the WWW has approximately doubled every three months In October 1994, the total connections numbered 7,200, in October 1995, the total connections were 266,891

Programming and development efforts are focused on improving FtWeb and enhancing the searching features through the use of pull-down menus and other WWW supported tools Investigation of the use of new tools and languages, particularly Java, to improve performance for such FTRS features as dynamic term expansion—the display of the database vocabu lary as the user types—is also part of the FtWeb development Improving communication between window-based clients and the server is another major effort that is continuing The text processing procedures supporting the variety of access mechanisms are also part of the current development path as several new data collections are expected in the near future

The development of tools and methodologies for prepar ing text for online delivery has, of necessity, proceeded in concert with the development of FTRS The area of text preparation is much broader than just preparation for use by

FTRS The general problem is one of preparing and maintaining text in a form from which both traditional hardcopy and online publications can be derived without highly redundant manual labor and/or processing The problem is compounded by the fact that different online access methods most often require different formats and/or tagging for the same full text In 1995, the tagging efforts were primarily done under contract with outside sources Data providers also began submitting text in tagged format as defined by an appropriate Document Type Definition (DTD) The DTDs were developed by ITB in accordance with the provisions of the Standard Generalized Markup Language (SGML) Efforts are being made to reduce the number of formats or versions of the text required to support all access to HSTAT and a variety of publication types

CD ROM Program

The research activities of the CD-ROM laboratory have been temporarily set aside due to staffing and budgetary constraints The laboratory, however, continues to function in support of NLM activities such as the Unified Medical Language System

Communications Engineering Branch

Image engineering R&D is the main focus of projects in the Communications Engineering Branch Included are the capture, storage, processing, online retrieval, transmission, and display of both biomedical documents and medical imagery Data types of interest include bitmapped bitonal document images, digitized color documents, digitized xrays, color cryosection images from NLM's Visible Human collection, and motion video Areas of active investigation center on image compression, image enhancement, image understanding, pseudo grayscale rendition, image transmission and networks, omnifont text recognition, and man-machine interface design This applied R&D is motivated by NLM's mission-critical tasks such as document delivery, archiving, and preservation, as well as wide Internet access to mixed text/xray image databases, and future imaging applications in support of medical educational packages employing digitized radiographic, dermatological, and other imagery Information on Branch projects appear in our Web server at *http // archive nlm nih gov*

DocView

The goal of the DocView program, reviewed by the Board of Scientific Counselors in May 1994, is to investigate the role of advanced client software that provides access to, and facilitates delivery of, bitmapped images of biomedical documents over the Internet The documents in bitmapped image form, may reside in servers (Web, Gopher, or FTP), or scanned and sent over the Internet by Ariel systems Ariel, a product of the Research Libraries Group, has become a popular way for libraries to send document images over the Internet to each other DocView extends this capability to end users

The DocView client software running under Microsoft Windows 3 1 for widest possible applicability, allows a user to select a server located anywhere on the Internet, the current options being a Sun 690MP in the lab, a 3 processor C3830 Convex supercomputer on the NIH campus, and a Sparcstation across the country at the University of Arizona After connecting to any one of these servers, the user receives information on the number of documents available and document citations The user may key on a citation to retrieve a document, and choose to preview just the first page of the desired document on the screen before deciding to download the entire document If after previewing, the document is not of interest, the user may delete it by selecting a *trashcan* icon The user may navigate through a document selecting pages of interest by invoking an *electronic bookmark* feature, rotate pages to view those in landscape mode more conveniently, zoom in for better legibility, copy sections of interest into a *personal notebook* and add text from a word processing program, and either print or store electronically items of interest The user has the option of printing just the pages needed On an experimental basis, servers holding electronic documents are becoming increasingly available While DocView is a complete client with communications capability, it could also serve as a TIFF viewer for compressed images received through a Web browser such as Mosaic or Netscape

DocView is currently being beta tested to establish the technical feasibility of easy and intuitive document delivery over the Internet Investigations focus on performance of rapid delivery of document images to users over the Internet, design issues related to the selection of communication protocols and archiving techniques, and the performance of user functions at the receiving workstation Broadly, the project aims to evaluate the role of such software, specifically with regard to performance and cost issues, to serve the NLM's mission in document delivery to its biomedical constituency

The first version of DocView relied on commercial hardware and software for certain functions, such as image compression, decompression, scaling and display, requiring expensive hardware boards in the user machine By implementing these functions by inhouse-developed software, this dependency was recently eliminated with no loss of performance This paves the way for wide distribution of the software to the biomedical community in the future

DocView communications and imaging subsystems were redesigned to make the DocView image format and communications protocol compatible with the new Windows-based Ariel software distributed by the Research Libraries Group With hundreds of libraries worldwide now using Ariel for document delivery over the Internet, this new feature in DocView makes it possible for Ariel documents to be sent to any DocView user

Beta testing of DocView was initiated at three sites the NIH Library, the medical libraries at Hahnemann University in

Philadelphia, and the University of Washington at Seattle Each site sends documents by Ariel to end users equipped with DocView Initially, the beta test sites will mainly report bugs After users gain some experience with DocView, they will be sent user satisfaction questionnaires to elicit feedback on usage of the software

A comments function allows users to send comments and bug reports while in DocView to the design team at NLM This also allows the design team to easily remain in touch with beta testers User comments are received by a Comments Server running continuously in the developmental lab

A messaging function allows DocView users to compose and send a message to an Ariel system or another DocView user It provides a rapid and convenient method for DocView users to directly request documents from their libraries eliminating the delay associated with the Loansome Doc/DOCLINE document ordering system It also provides a means for DocView users to communicate among themselves in a manner similar to E-mail

A fact sheet describing DocView was developed and widely accessed from the Branch's Web site In addition, two papers describing DocView were presented at the 1994 and 1995 Integrated Online Library Systems (IOLS) meetings, and published in the proceedings The most recent paper Walker FL, Thoma GR DocView Providing access to printed literature through the Internet *Proc 10th IOLS Meeting* New York Learned Information, Inc, May 1995, pp 165-73

DocView's communications subsystem is being modified to provide users the ability to send documents in addition to receiving them This development relies on Multipurpose Internet Mail Extensions, or MIME E-mail This new technique available to the DocView user will be in addition to Ariel protocol One advantage of MIME E-mail over Ariel protocol is that document format is not restricted to Group 4 compressed black and white images With MIME E-mail, any document format may be used A second advantage of MIME is that E-mail is more universal than Ariel E-mail is used by millions of people worldwide, whereas Ariel is limited mostly to libraries

Beta testing will be extended to additional sites to get feedback from a wider audience To facilitate user feedback on important issues such as user interface design, an electronic questionnaire will be developed for DocView

DocView software will be modified to make it into a 32-bit application compliant with the Windows95 operating system Object linking and embedding will let DocView users take advantage of other software available for Windows95, such as Optical Character Recognition (OCR) With OCR, users will be able to index and search the text in the document images received by DocView

Other image formats will be investigated as candidates for inclusion into DocView Possible image formats include gray scale and color images The addition of these image formats would allow DocView users to view color documents, digitized photographs, x-rays and other biomedical imagery, in addition to two tone document images

System for Automated Interlibrary Loan (SAIL)

The SAIL Program addresses automated document delivery mediated by the interlibrary loan (ILL) process involving the request routing DOCLINE system in the NLM mainframe computer The program evolved into two projects

(1) *The pilot SAIL system* After 4 1/2 years of successful operation, the pilot SAIL system was discontinued in September 1995 The system, designed and built by the CEB research engineering team, included both a document input process and an output process The document input process included capture, quality control, tagging, and archiving of biomedical journals About 200,000 pages from 64 biomedical titles, selected according to criteria that predicted high demand, were stored on optical disks The output process involved the automated retrieval of ILL requests from the DOCLINE request routing software package in the NLM mainframe computer, the linking up with document images, and the automated faxing or onsite printing (for mail requests) of these images The prototype system served as a testbed for experiments to evaluate the role of such systems, specifically with regard to performance and cost issues, to serve the NLM's mission in interlibrary loan During its operation, SAIL handled 35,360 DOCLINE requests

(2) *Workstation for Interlibrary Loan (WILL)* While the pilot SAIL system addressed the issue of delivering preselected journal articles in response to ILL requests, a significant part of the requests will be for documents not preselected The pilot operation revealed that the 64 titles preselected for this pilot project delivered 5% of the total ILL requests to the NLM, proportionately a high figure considering the size of the journal collection at the Library, but of the articles stored only one-third were accessed to serve the ILL service This finding motivated a second look at the way articles are entered into the system, prompting an investigation of a point of-request or delivery-on-demand system The design of such a system is based on a 486 platform running under Microsoft Windows 3 1 The idea is that the only human operation involved should be one that cannot readily be automated, viz , scanning the requested document All other operations, e g , faxing, printing, transmitting over Internet, retrieving ILL requests from DOCLINE, extracting information from the ILL requests, and updating DOCLINE as to status, are to occur automatically in the multitasking environment of Windows

WILL is designed to meet this requirement It is a multi functional integrated workstation that delivers documents on demand The only activity WILL requires of an operator is to scan requested documents It eliminates other operator decisions concerning recipient and delivery mode WILL automatically retrieves ILL requests from DOCLINE, parses the request into data fields, provides a GUI for the operator to scan requested documents, and automatically delivers document images by all three delivery modes (print for mail, fax and

Internet), and updates DOCLINE with status The only process that cannot be automated is the physical handling and scanning of the documents

WILL is seen as a contribution to the nationwide interlibrary loan service by helping the U S medical libraries meet their document delivery responsibilities, since increasing labor costs and new delivery modes are placing an increasing burden on the traditional photocopying/mailing method coupled with manual activities in request retrieval, status updating and statistics gathering

Current activities

- Performance analyses on a single WILL unit to estimate cost of document input, cost of document delivery, input and delivery throughput
- Beta test a single WILL unit to determine performance levels, improvements possible in delivery speed, image quality, system reliability, GUI layout and design, data base functions, operator procedures
- Investigate techniques for higher performance (a) Dual page scan and automated segmenting and page rotation, (b) input devices such as speech recognition, touch screen, foot pedal, (c) PDAs to eliminate paper records, (d) automated QC and correction
- Investigate methods for identifying titles, issues, or articles that are likely to be heavily requested, and develop subsystems to temporarily store these images for automatically delivering succeeding requests
- Conduct network analyses and simulation studies to define migration path to a larger scale, higher performance, and multiple unit system

Document Image Analysis

As part of research into automated document imaging, an algorithm was developed to detect the orientation (portrait vs landscape) of a binary page image Detecting page orientation is a necessary preprocessing stage for optical character recognition, skew detection or skew correction In addition, page orientation is crucial for automated document entry in which the contents of a printed document is segmented into such regions as headlines, text columns, graphics or footnotes

The algorithm developed is based on an analysis of projection profiles, vertical and horizontal variances on a page, and a technique to reduce the impact of nontextual data (blanks, graphics, forms, line art, large fonts and dithered images) Using a sample of several thousand images of medical journal pages, the algorithm was found capable of detecting page orientation at an accuracy rate of 99 92% Orientation detection is useful as a preliminary step in skew detection, described below

Skew in a scanned image often requires rescanning the document, a time-consuming and costly step, but often necessary in document conversion A multistage technique was designed to automatically detect page skew The principal elements of this algorithm are component labeling, a procedure to reduce the amount of data to be processed, a technique to minimize the effect of nontextual data (graphics, forms, line art, large fonts and dithered images), and the Hough transform The algorithm is characterized by the following (1) it uses the bottom part ("feet") of the objects (characters), (2) the data to be processed is reduced by a factor of 15 for a typical page of text, and more than 80 for a compound page, (3) the detection process can be running while a page is scanned, and (4) it is independent of text dominance The algorithm was tested with several hundred images of medical journal pages, and found to detect skew with an accuracy of about 0 5 degrees

These projects are described in the literature, most recently in (1) Le DX, Thoma GR, Wechsler H Document image analysis using integrated image and neural processing *Proc 3rd ICDAR'95* Vol I Montreal, Canada, August 1995, pp 327-30 (2) Le DX, Thoma GR, Wechsler H Document classification using connectionist models *Proc 1994 IEEE International Conference on Neural Networks* Orlando FL June 1994, vol 5 pp 3009-14

Digital X-ray Prototype Network (DXPNET)

This project deals with digitized x rays It aims to address fundamental questions that arise in the handling, organization, storage, access and transmission of very large electronic files in general and digitized x rays in particular The approach adopted is to address these questions by the design, development and evaluation of prototype systems which serve as testbeds to investigate (1) image compression techniques, especially high yield lossy methods, and tools to interactively select compression parameters, (2) techniques to organize images and associated textual data for ready retrieval and use, (3) procedures and algorithms to implement transparent hierarchical storage using heterogeneous storage systems and media to match usage patterns, and (4) multi socket transmission methods to segment large images and to send the pieces concurrently over multiple socket pairs to overcome the inefficiencies of conventional transmission protocols

DXPNET serves as a vehicle to address these engineering goals while creating an archive of digitized radiographic images accessible over the Internet In this project, a joint collaboration with the National Center for Health Statistics (NCHS) and the National Institute of Arthritis, Musculoskeletal and Skin Diseases (NIAMS), the NLM takes on the role of technical manager and developer The x-rays, consisting of about 17,000 cervical and lumbar spine films, were collected during the second National Health and Nutrition Examination Survey (NHANES II), one of a series of nationwide surveys conducted by NCHS designed to provide a snapshot of the nation's health As films they are relatively inaccessible, a

major motivation for digitizing them All 17,000 films were digitized with a Lumisys laser scanner resulting in images of size 5 MB (cervical) and 10 MB (lumbar) These are currently being quality controlled and archived

A goal of the project is to determine the essential design characteristics required in systems that provide remote access to such a medical image collection, and to design and develop systems that satisfy these requirements The systems developed include (1) a Standardized Readings Workstation (SRW), the tool for radiologists to retrieve the images over the Internet and to enter their readings, (2) an Electronic X-ray Archive (EXA) consisting of an optical disk jukebox controlled by a Sun 670MP server and interfaced to the Internet, and (3) Quality Control Workstations (QCW) to enable NCHS technicians and radiologists to perform quality checks at different levels of the scanned x-rays

A prototype Standardized Reading Workstation was developed on a Sun 4/260 platform, with image display on both the standard Sun monitor (1K x 1K) and a high resolution Megascan monitor (2K x 2 5K) An evaluation by NIAMS staff radiologists and rheumatologists yielded design information used to refine the software Based on this data an SRW is being developed that would be suitable for remote deployment over the Internet This system has a Sparcstation 20 as the platform, S-bus connected high resolution monitor (2K x 2 5K), and a finalized design of user interface under Motif, X-Windows, TAE Plus GUI development tool, client software incorporating custom-designed Berkeley sockets, and image enhancement functions This SRW will be deployed at sites identified by NIAMS and NCHS collaborators

For a comprehensive quality control of the x-rays, a 3-stage procedure was developed, the first two stages by technicians and the final stage by a radiologist For the second and third stages, Unix-based QC workstations were developed on a Sparcstation 10 platform, and are being routinely used by technicians at NCHS and a radiologist at NLM under contract to NCHS The QC of the x-rays is currently well under way and will conclude in Fall 1995

To increase effective image access and delivery speed, the storage system, originally an optical jukebox, was expanded to include a Sun Sparcarray RAID system, controlled by a Sun Sparc 20 This design incorporated file management and readings data acquisition software, and included Internet communications capability using a multisocket method This new method has shown faster image transmission over the Internet compared to conventional single socket techniques like FTP Prototype multisocket software was developed, and performance tests were done to determine optimum number of sockets Tests were done both over the Internet and via a T1 satellite link through the Advanced Communications Technology Satellite (ACTS) recently made available by NASA The satellite link offers a contention-free T1 link allowing tests to be done without contamination from other traffic This was reported in the literature Long LR, Thoma GR Medical image database access via satellite *Proc ACTS Results Conference* Cleveland NASA Lewis Research Center, Sept 1995, VSAT section

Image compression studies were conducted in collaboration with investigators at Stanford, Monash University (Australia), IBM Almaden Research Center, NASA Ames Research Center, and NIH/BEIP The JPEG Evaluation Tool (JET) developed earlier inhouse was used to select the appropriate quantization table for image compression using JPEG

Motivated by the potentially widespread use of the heretofore inaccessible x-rays from NHANES, a prototype system named MIRS (*Medical Information Retrieval System*) is being designed to enable general access to the mixed text/image database consisting of NHANES II collateral data and the x-ray images over the Internet MIRS is developed on a Sun Sparc 10 platform and uses X-Windows and TAE Plus for interface development Access to the data is by SQL query, and the data is organized in an Illustra DBMS An anticipated beta test of MIRS will demonstrate access to the integrated database consisting of the images, the standardized readings, and the corresponding NHANES collateral data (demographic, blood chemistry lab data, medical questionnaire data, etc) Beta testing of MIRS will be done over the Internet as well as over the ACTS satellite link offering contention-free T1 data rate

Since the May 1995 Board meeting, seven papers related to this project have been presented, published, or accepted for publication Recent papers on this topic (1) Long LR, Berman LE, Thoma GR Client/server design for fast retrieval of large images on the Internet *Proc 8th IEEE Symposium of Computer-Based Medical Systems (CBMS'95)* Lubbock TX, June 1995, pp 284-91 (2) Thoma GR, Berman LE, Long LR Digitized medical x-rays on the information superhighway *Proc 48th Annual IS&T Conference* Springfield, VA Society for Imaging Science and Technology May 1995, pp 111-3

Machine Readable Archives in Biomedicine (MRAB)

Machine-readable text coupled with graphics has a role in several NLM missions such as indexing, cataloging, as well as in efficient document delivery The first step in the generation of such text from paper documents is bitmap scanning The subsequent conversion of the bitmapped document images to machine-readable ASCII characters involves optical character recognition (OCR) whose reliability is compromised by noise in the image and the presence of unwanted page edge effects

This problem has motivated research into techniques to enhance bitmapped images to a quality level commensurate with OCR requirements by reducing noise in the bitmapped images and to automatically remove unwanted borders (page edge effects) The long-term goal is to develop a prototype system that will implement the conversion from paper scanned by a bitmapping engine to a database of segmented text/image files

The approach adopted is morphological image process-

ing and artificial neural network (ANN) techniques for automated border removal Morphologic operations such as erosion, dilation, opening and closing were combined to remove noise, i e , small bitonal spots on the image and to reduce the image to relatively large blocks This processed image was divided into rectangles whose projection profiles were calculated The projection profiles and the xy coordinates of the rectangles were used as the input vector to an ANN of the back error propagation type Each input was paired with the correct classification of each rectangle, i e , (unwanted) border, margin, or (desired) image, and this data was used to train the ANN The trained network was tested with samples of bitmapped images from the lab and reliability data was taken The next step is to experiment with different rectangle sizes and positions, and to combine the ANN output with other known information, to reliably classify border regions in the bitmapped image

Biomedical Digital Image Processing (BDIP)

Biomedical images include monochrome and color still images as well as motion video The information content of these images is a key to understanding the disease conditions in many medical disciplines A prerequisite for "understanding" this content, or its extraction or analysis, is a set of image processing activities, including image capture, segmentation, compression, image manipulation, image file format conversion and related areas This requires the digital capture of images at full 24 bits/pixel color and the subsequent processing to pare the portions of the image down to 8 bits/pixel and 1 bit/pixel in those areas where there is gray material and two-tone text respectively It also requires the digitization of video and providing access to selected sequences through textual databases The fundamental goal of this program is to further the existing inhouse capability to acquire, compress, retrieve, manipulate, segment, analyze, display and transmit digitized biomedical images, both still and moving image sequences

The main activity in this area this year was continued research in automated extraction and classification of features in digital x-ray images This work is motivated by the possibility of using features (e g , texture, shapes, edges) as descriptive elements in images for image retrieval The principal tool used is mathematical morphology The approach is to determine if texture or shape can be used to discriminate between, say vertebrae, and other areas of the image Morphological operations (e g , erosion, dilation, etc) and kernels as structuring elements to identify the vertebrae were investigated Future work will build on existing results to define the optimum structuring elements and morphologic operations to automatically extract and classify image features

In addition, a prototype digital video-on-demand system was developed for video sequences such as medical ultrasound and educational video from the NLM audiovisual collection A perl script was written to link AVLINE textual records and digitized video sequences The system used a Sun Sparc 10 platform, off-the-shelf board hardware, and inhouse client and server software Both MPEG and motion JPEG compression techniques were incorporated into client and server software, and comparative performance was evaluated

Engineering Laboratories

The R&D conducted in the branch rely on laboratories which are designed, equipped and maintained by the Communications Engineering Branch. These are described below

Document Imaging Laboratory This laboratory supports the DocView, SAIL, WILL, and Document Image Analysis projects Housed in this laboratory are advanced systems to electro-optically capture the digital images of documents, both in bound volume form and as loose sheets Subsystems are available to perform image enhancement, segmentation, compression, OCR and storage on digital optical disk media The laboratory also includes workstations, based on Microsoft Windows, DOS, and Novell Netware-based networks, for performing quality control and tagging for the captured documents These bitmapped images may be retrieved in conjunction with a search of NLM's bibliographic databases or the DOCLINE document request system that serves the interlibrary loan function at NLM

Specific equipment developed inhouse includes document capture workstations, for both loose-leaf and bound volume documents Other systems have integrated optical disk drives and high resolution softcopy display devices for documents These are configured into systems that serve as laboratory testbeds to support research into automated document delivery, document preservation and document archiving, and techniques for image enhancement, manipulation, segmentation, compression for high density storage and high speed transmission, omnifont text recognition, and related areas

Networks include both Ethernet and Token Ring at backbone rates of 10 Mbps connected to other local area networks throughout the building and to the Internet

Image Processing Laboratory This laboratory supports the investigation of image processing techniques for both grayscale and color biomedical imagery at high resolution It consists of computer and communications resources and image processing equipment to capture, process, transmit and display such high-resolution digital images The machines include a Sun 690MP SPARCserver with magnetic disk storage capacity of 11 Gigabytes and 224 Megabytes of RAM This machine operates as a file server for all Unix machines in the branch and as an interdepartmental resource for commercial and public domain packages The branch also has several SPARC 10's for development, a SPARC 20 for hosting the branch's Web server, RAID system performance research, color scanning and video experiments A Sun 670MP hosts an optical jukebox and enables point-to-point connections over a satellite link Two Sun 4/260's are currently being used for medical imaging, although the medical imaging system is in

transition and will be hosted on a SPARC 20 with a high resolution DOME SBUS video card and a high resolution Megascan monitor Two similarly equipped SPARC 20's will be deployed in the field

Large-volume storage is provided by a jukebox containing 144 5-1/4 inch rewriteable magneto-optical platters, each formatted to contain files in the format required by the Unix file system Each platter has a storage capacity of 586 megabytes, for a total jukebox storage capacity of 81 5 gigabytes The host computer for the jukebox is the Sun 670MP In addition to the jukebox, mass storage is also provided by a Sun SPARCstorage unit, a RAID system, consisting of 18 1 2 Gigabyte hard drives, 6 independent fast buffered SCSI-2 buses, and connected to an SBUS card in a SPARC 20 via a 25 Megabytes/s fiber channel connector

The SPARC 20, two SPARC 10's, the 690MP and a SPARCcenter 2000 machine used for the Visible Human project, are linked via 100 Megabits/s multimode fiber in a FDDI ring which is fiber-connected to other workstations in the Lister Hill Center

The 690MP and 670MP machines are equipped with dual Ethernet ports which allow, in addition to standard networking capabilities on the local Ethernet, the capability of alternate physical communications channels (Ethernet-compatible) with these machines This capability has been used to experiment with point-to-point satellite channels connecting these machines to remote sites

Cognitive Science Branch

The Cognitive Science Branch conducts research and development in learning and information technologies, disseminates information about these technologies to NLM's various constituencies, and supports their application in health professions education CgSB staff participate in the national and international health professions education, computer and information sciences, and medical informatics communities Program staff have published several research papers during FY 1995 Branch Chief, Dr Alexa McCray, has been co-editor of the International Medical Informatics Association Yearbook of Medical Informatics since its first volume was published in 1992

Research in Learning Technologies

The Learning Center for Interactive Technology

More than 9,000 individuals, including physicians, nurses, scientists, health administrators, librarians, and other health care professionals have visited the Learning Center since its inception in 1984 Visitors have had hands on experience with a wide range of computer-based information and education technologies representing stand-alone, local area networked and wide area networked applications in the health professions In the past year Center staff and visitors have concentrated their activities on client-server technologies and the array of services that they enable over the Internet and the World Wide Web

Individuals and groups of health professionals have used the Learning Center technologies to learn about networked technologies and to practice searching and retrieving biomedical and educational resources Center staff have assisted them in a variety of ways Staff have provided demonstrations of new and emerging technologies and have assembled, organized and made available on the Branch World Wide Web server a variety of learning resources and tools In addition, staff have conducted research on the effective utilization of computer-mediated communications technologies in the health professions and are currently conducting a collaborative investigation and evaluation of models for the effective utilization of distributed learning environments for graduate and continuing health professional education The Learning Center remains the central focus for these distance learning activities and will continue to be a venue for demonstrating successful technology applications

A major outreach activity continued this year as Center staff completed their sixth year of participation in the Radiological Society of North America (RSNA) Annual Meeting in Chicago, immediately following the Thanksgiving holiday This year the Center staff, with assistance from other NLM staff, conducted 12 tutorials at RSNA in which more than 720 health professionals received training on National Library of Medicine online resources, basic Internet services, and distance learning opportunities in medicine

The Learning Center also has involved several outreach activities for local high school students (Coolidge High School, School Without Walls Senior High School, and Walter Johnson High School) Participation in Learning Center activities enabled the students to complete requirements for their respective internships The internships afforded the students many opportunities to learn about computer-based technologies and information systems in the health professions while also requiring them to make contributions to ongoing staff projects

Digital Microscopy System

The Digital Microscopy System (DMS) project was initiated in 1994 Project goals are to (1) define the parameters that govern the production and indexing of a library of photomicrographic images, (2) determine whether the large (8000+) library of analog images produced by the Human Light Microscopy and Basic Medical Pathology projects can be digitized to produce a high quality digital image library, and (3) produce front-end software that will permit online indexing of medical images Project plans were to first explore indexing of the library of analog images while experimenting with digitization of a small subset of those images The first expert panel (David Bostwick, M D (Mayo), Jonathan Epstein, M D (Hopkins), and Gary Miller, M D , Ph D (Colorado) for image indexing was appointed late in FY 1994 and convened at NLM at the end of August The task assigned the panel was

to describe and assign indexing terms to a series of prostate photomicrographs ("videomicrographs") that exist on optical videodisc as results from two previous LHNCBC projects (Human Light Microscopy (HLM) and Basic Medical Pathol ogy (BMP) While at NLM the panel, working as a group, described and indexed ten slides (frames) from the collection During the next four months the experts then independently indexed an additional 41 images from the same (videodisc) database The results indicate that while working independently the experts always agreed on a diagnosis for a particular slide but frequently used different terms to describe it Due to absence from the country by one of the experts, attempts to reconcile the differing descriptions are progressing slowly

One-hundred forty-one images from the HLM and BMP projects were digitized in December 1994 and are ready for use as soon as the indexing system is ready

Dr Miller returned to NLM in August of 1995 to record a series of prostate images that depict the five Gleason patterns of prostate images The images were recorded digitally on the Abacus machine and on 35mm film The film has been developed and the images placed on a Photo-CD Comparison of the two sets of images is in progress at this time

As a parallel effort, DMS has engaged the services of Michael Becich, M D , Ph D and his co-workers at the University of Pittsburgh to provide a larger number of slides from their files that depict the Gleason patterns These digital images (there will be approximately 200 eventually) have been loaded on a WWW server that has a link to the UMLS Thesaurus Becich, et al , will produce a CGI script that will permit online indexers to view a slide, call the UMLS Metathesaurus and select index terms to be recorded in a database

Distributed Learning Environments

Time, distance and resource scarcity always have con strained teaching and learning Emerging telecommunications and computer-mediated technologies can expand and enhance the learning experiences and opportunities that are made available anyplace, anytime During FY 1995 a new project, Distributed Learning Environments, was initiated to investigate the potential of these technologies to provide enriched, distributed learning experiences The project focuses on iden tifying and developing alternative applications and designs that can be realized with the technologies, especially those relevant to the Internet Research will result in knowledge resources that support the design, development, management, and assessment of innovative learning systems

In May, Branch staff conducted a collaborative work shop, Designing and Integrating Internet Resources In the Medical Curriculum, for 18 health professions faculty from the University of Missouri Faculty utilized basic Internet tools to identify and explore medical resources available on the World Wide Web and completed small group exercises in which five separate teams converted a problem-based medical case text into a Hypertext Markup Language (HTML) document integrating local and networked multimedia files and resources This workshop initiated an ongoing research collaboration on distributed learning environments between the Cognitive Science Branch and the University of Missouri

Research in Information Technologies

Natural Language Systems Program

Retrieving information from computerized databases is a complex process whose success depends heavily on the user's knowledge of the structure and logic of the particular database being searched A significant aspect of this interaction between computers and humans involves questions of language The Natural Language Systems (NLS) research team is concerned with investigating the contributions that natural language processing techniques can make to the complex task of mediating between the language of users and the language of the databases they attempt to access The successful integration of these techniques with other sophisticated retrieval strategies has the potential of contributing to the resolution of some of the most difficult problems faced by health professionals as they attempt to access biomedical information in computerized form

The focus of NLS work is the development of SPECIALIST, an experimental natural language processing system for the biomedical domain The research questions lie at the intersection of the fields of computer and information science, linguistics, and medical informatics, and involve methods and approaches used by each of these fields The SPECIALIST system includes several modules which are based on the major components of natural language—lexicon, morphology, syntax, and semantics The morphological component is concerned with the structure of words and the rules of word formation The syntactic component treats the constituent structure of phrases and sentences The semantic component is concerned with the meaning of words, sentences, and dis courses All three rely heavily on the lexical component which encodes the information specific to the lexical items in the language

The SPECIALIST lexicon is an English language lexicon containing many biomedical terms The lexicon entry for each word or term records syntactic, morphological, and orthographic information Currently the lexicon contains some 80,000 records, with approximately 160,000 forms Lexical entries may be single or multi-word terms Lexical information includes syntactic category, inflectional variation (e g , singular and plural for nouns, the conjugations of verbs, the positive, comparative, and superlative for adjectives and adverbs), and allowable complementation patterns (i e , the objects and other arguments that verbs, nouns, and adjectives can take) The SPECIALIST lexicon is regularly released as one of the four UMLS Knowledge Sources

The morphology module uses data from the SPECIALIST lexicon as it computes the different forms of lexical items The morphology module is regularly released with the UMLS

Knowledge Sources as a set of lexical programs written in the C programming language The programs allow for a good deal of flexibility in matching one term to another

The NLS group has designed and implemented the UMLS Knowledge Source Server for accessing information stored in the UMLS Knowledge Sources The Server was released to the UMLS community in the summer of 1995 It provides flexible access to the UMLS data over the Internet The system has three client interfaces, a World Wide Web interface, an application programming interface, and a command-line interface The clients run on all three platforms, Unix systems, PC's, and Macintoshes

The Knowledge Source Server allows the user to request information about particular concepts in the Metathesaurus, including, for example, attributes such as the concept's definition, its semantic types, and the concepts that are related to it It also allows the user to request information about the attributes themselves, for example by asking for all the concepts that have been assigned to a particular semantic type, or by asking for all the terms that have a particular lexical tag

The implementation of the Semantic Network module in the server computes the relationships between semantic types using the inheritance property of the network type hierarchy Information in the network can be queried in terms of two semantic types and the relationship between them Individual queries are specified by providing the known types or relations and leaving out the unknowns The system then retrieves the corresponding values for the unknowns

Information in the other two Knowledge Sources, the SPECIALIST lexicon and the Information Sources Map, can also be accessed through the Server The SPECIALIST lexicon forms the basis for the lexical routines and the normalized indexes that provide flexible access to the data in the Metathesaurus

An ongoing and fundamental aspect of NLS research is the evaluation of the effectiveness of natural language processing in the context of information retrieval NLS staff regularly conduct experiments using the SPECIALIST system and UMLS knowledge to assess incremental improvements in retrieval effectiveness It is a testable hypothesis that methods such as those under development by the NLS group, which depend on extensive linguistic and domain knowledge, provide an advantage over methods which do not have access to such knowledge

Text Analysis Project

The volume of text available in electronic form is increasing exponentially Electronic texts are widely disseminated via the Internet, primarily on the World Wide Web but also on Gopher and FTP sites There is active research in methods for creating, maintaining, and accessing digital libraries Many publishers provide abstracts and tables of contents for their journals on the World Wide Web, and some are making the full electronic text of their articles available to subscribers Text in electronic form ranges from highly structured, for example, with SGML tags, to the error-prone output of optical character recognition

The Text Analysis project, begun in September 1995, conducts experiments in automated indexing and retrieval for a variety of text types The project team will develop text processing algorithms for both structured and unstructured text Word-based retrieval algorithms will be compared with concept-based algorithms The research products of the Natural Language Systems and UMLS projects will be extended for use in these experiments The project will test the proposed methods using recognized evaluation metrics

CgSB World Wide Web Server

The Cognitive Science Branch World Wide Web server provides information relevant to health professions education and information technologies The URL for the server is

http //wwwcgsb nlm nih gov

The server features information about CgSB research projects, resources, and monographs and provides links to closely related Web and Gopher servers

Access to several databases maintained by CgSB is provided on the server The Learning Center courseware database provides brief descriptions, system requirements, and contact information for the Center's courseware The courseware collection includes state-of-the-art microcomputer and optical disc hardware and educational software, high quality working prototypes, and commercially available products for health science education Branch staff have developed a variety of tutorials on Internet resources and distance learning These have also been made available on the server The CgSB Web server is updated regularly and new features continue to be added by project staff

Audiovisual Program Development Branch

The Audiovisual Program Development Branch (APDB) conducts media development activities with three specific objectives As its most significant effort, the branch supports the LHNCBC's research, development, and demonstration projects with high quality video, audio, and graphic materials From initial project conceptual images, through actual project implementation with image preservation, transfer and display, to project evaluation and reporting, all forms and formats of imaging are produced

Creative consultation and materials development are also provided by the branch for the NLM's educational and information programs With the mission requirement of the Library to have effective outreach activities, the support that the branch provides to these type of programs continues to increase From optical media technologies to teleconference support, the graphic, video, and audio materials requirement has increased in quantity and diversified in format

The third area that the branch concentrates on is technical development issues such as image resolution, color fidelity, media transportability, media storage and image communica-

tion In addition to technique development by the staff, the facilities and hardware systems must reflect state-of-the-art standards in a very rapidly changing field High resolution video is a development area being explored that represents the future for improved electronic image quality Multimedia systems techniques, visualization and networked media are being pursued for the educational and cost advantages that they offer Three dimensional computer graphics, animation techniques, and photo realistic rendering methods have changed the tools and products of the graphic artists in the branch Digital video and image compression techniques are central to projects being pursued to improve image storage and communication With all of the technologies which are being brought together in the development and support projects of the branch, the central core expertise remains the creative, artistic, communication skills of the staff

Cervical Cancer Project

An instructional project on the detection of cervical cancer, originally designed as an interactive videodisc program, was redesigned as a CD-i project The CD-i version has been completed and is being distributed by the National Cancer Institute APDB has also developed a menu option on the CD-i program which allows the viewer to use a CD-i modem to dial up the NCI's PDQ cancer information database, and to download the "Screening" and "Treatment" files for cervical cancer into the CD-i unit for display on an attached TV monitor This project is now being converted to a format that will allow access on the World Wide Web The text, graphics, and motion elements of the Cervical Cancer project were converted to an HTML format, and a portion of the Cervical Cancer program was placed onto an internal World Wide Web server The program is currently being tested using the Netscape browser on Silicon Graphics, PC Windows, Mac, and Sun platforms Eventually, this document will be made available as part of the NLM HyperDoc site When the entire Cervical Cancer program is converted for the Web, NCI's International Cancer Information Center will make it available on its server for access by the biomedical community

The Making of a Medical Illustrator

Beginning with the 1993-1994 academic year, APDB began videotaping selected learning experiences of beginning Medical Illustration students in the Johns Hopkins University School of Medicine's two-year master's degree program Portions of these tapes were edited into a highlights program which was presented to attendees at the 1994 World Congress on Biomedical Communications These students are featured, along with their instructors and other medical illustration experts, in a documentary program covering the entire two-year medical illustrator program Videotaping of all source material for the documentary including student interviews, thesis preparation, advisor consultations, surgical and ophthalmological illustrations, faculty interviews, and finished student artwork has been completed A final script has been prepared and editing is in progress

Visible Human Project

Major visualization and illustration support has been provided by APDB to the Visible Human project Hardware and software modification were completed on the Kodak custom scanner system This included updated film reference tables and color look-up tables Increased resolution, dynamic range, and color fidelity were observed after these changes Duplicate 70mm film copies of selected test frames were received from the contractor holding the original film so that final scanning procedures could be developed 24-bit 3-D renderings of Visible Human data, using Analyze have been accomplished although image registration continues to be a major question and tests are being conducted on that problem

Educational and Information Program Support

A 20-minute program was designed, produced and edited by the Branch on "Islamic Calligraphy " The finished videotape was shown during an all-day "Islamic Culture and the Medical Arts" symposium at NLM The same day, a DRAW disc version was kiosk-mounted as a key part of another HMD-coordinated NLM Lobby exhibit

APDB provided technical and production advice and coordination to the MEDLARS Management Section in preparation for the Library's first use of digital compressed video teleconferencing This full five-location "multipoint" video teleconference took place in November and consisted of "MEDLARS Training " A National Institute on Aging conference room equipped for such teleconferencing was checked out and modified to integrate a computer and a video cassette recorder A successful two-way test transmission was conducted, linking the NIH site with an Army Corps of Engineers location in Omaha, Neb Staff members from the University of Nebraska Regional Medical Library participated in this initial test, during which a successful computer connection and transmission was completed Additional two-way test transmissions were conducted with staffs of the Regional Medical Libraries at the University of Washington and the New York Academy of Medicine

APDB produced a presentation videotape on the Visible Human project, drawing on a variety of informational materials This videotape was used to accompany additional entry materials for *Discover Magazine*'s "scientific achievement of 1994" award competition

Following remote productions at High Techplanations in Rockville, Greenfield High School anatomy class in Greenfield, IN , Duke University Medical Center in Durham, NC, and the Mayo Clinic in Rochester, NY, a "Visible Human Data Applications" videotape was edited and a limited number of review copies distributed Also included in the videotape was a LHC developed segment on hip joint replacement

Video editing of the "DocView" videotape was completed, including the addition of a short scene created on the Branch's graphics animation system and enhanced by electronic image special effects Following final narration and music mix, viewing copies were supplied to the Communications Engineering Branch

After the final script for "HPCC 96" was approved and subsequent video editing was completed, videotape copies were turned over to the High Performance Computing and Communications Office Initial response was highly favorable and a revised version titled "Foundation for America's Information Future" was edited, duplicated, and distributed An NLM version of this videotape was then edited and copies made available

Audiovisual Support Activities

The branch continues to upgrade the equipment used to support meetings held in the Lister Hill Center Auditorium and the NLM Board of Regents Room APDB also provides preventive maintenance for audiovisual recording, playback, and projection equipment used in other meeting rooms throughout the Library

NATIONAL CENTER FOR BIOTECHNOLOGY INFORMATION

David Lipman, M D
Director

The National Center for Biotechnology Information (NCBI) was established by Public Law 100-607 in November, 1988, as a division of the National Library of Medicine The establishment of the NCBI reflects the importance of information science and computer technology in the understanding of the molecular processes that control health and disease The Center has been given the responsibility to

- Create automated systems for storing and analyzing knowledge about molecular biology, biochemistry, and genetics,
- Perform research into advanced methods of computer-based information processing for analyzing the structure and function of biologically important molecules and compounds,
- Facilitate the use of databases and software by biotechnology researchers and medical care personnel, and,
- Coordinate efforts to gather biotechnology information worldwide

There are presently 54 senior scientists, postdoctoral fellows, and support staff working at the NCBI These scientists have backgrounds in medicine, molecular biology biochemistry, genetics, biophysics, structural biology, computer and information science, and mathematics

NCBI programs are divided into three areas (1) creation and distribution of sequence databases, primarily GenBank, (2) basic research in computational molecular biology, and, (3) dissemination and support of molecular biology databases, software, and services Within each of these areas, NCBI has established a network of national and international collaborations and also closely coordinates its activities with other NLM divisions NCBI integrates data from NLM databases such as MEDLINE into specialized data resources for the molecular biology community

Database Building

GenBank—The NIH Sequence Database

NCBI is responsible for all phases of GenBank production, support, and distribution GenBank is the NIH genetic sequence database, an international database that collects all known DNA sequences, and a critical research tool in the analysis and discovery of gene function

The database contains nearly 556,000 sequences, 314,000 of which are human Over 341,000 sequences were added during the year, a 61% increase in the size of the database, with the number of human sequences representing an 82% increase, largely due to large-scale human cDNA sequencing projects Growth is projected to continue at a rapid rate, especially in the large numbers of human sequences resulting from newly funded human genome research This growth is reflected in the design of two new GenBank divisions, Genome Survey Sequence (GSS) and High Throughput Genome (HRT), which are planned for inclusion in future GenBank releases The GSS division will contain random single pass read genome survey sequences and other types of sequence that will be used as a framework for the mapping and sequencing of complete genomes The HRT division will be used for genomic sequences that are produced by high-throughput sequencing projects The records are expected to be primarily human and to contain long sequences and computer-generated annotation

NCBI produces GenBank from thousands of sequence records submitted directly from authors prior to publication and, to a lesser degree, from extracting sequences from publications Indexers with specialty training in molecular biology create these records and apply rigorous quality control procedures on the data As a final step, senior NCBI scientists review the records for accuracy of biological information Improving the biological accuracy of submitted data and correcting existing entries are high priorities for the GenBank team New releases of GenBank are made every two months, daily updates are made available via the Internet and the WWW

Comprehensive coverage of all sequence data, protein as well as DNA, is provided by GenBank along with the corresponding MEDLINE bibliographic information, including abstracts NLM has expanded its journal coverage to include all journals that regularly contain sequence data even if they are in nonmedical domains, e g , applied biotechnology A particularly useful feature of the database is the inclusion of abstracts and indexing terms from the MEDLINE records of sequence-containing articles

GenBank is a key component in an integrated sequence database system that NCBI has developed in order to serve as a single, comprehensive source of all known DNA and protein sequence information The integrated database offers researchers the capability to perform seamless searching across all available data including the MEDLINE abstracts linked to the sequence data

An international collaboration with the EMBL Data Library at Hinxton Hall, UK, and the DNA Database of Japan in Mishima facilitates the exchange of data worldwide through a shared automated system of daily updates Cooperative arrangements are used to augment the in-house data capture operation Other cooperative arrangements, such as with the U S Patent & Trademark Office for sequences from issued patents, augment the data collection efforts and ensure the comprehensiveness of the database

Other Specialized Databases

NCBI staff also are active in creating special-purpose databases The Expressed Sequence Tags database (dbEST) collects the growing number of gene fragments obtained through cDNA sequencing and now contains over 328,000 entries, about 80% of which are human Participants submit data electronically to NCBI and are provided with access to the BLAST network service, plus software tools to assist in their cDNA analyses The Sequence Tagged Sites database (dbSTS) holds over 21,000 sequences submitted during the first 18 months of existence Both dbEST and dbSTS are available for public queries via the Internet

The NCBI taxonomy group, expanded from one to three scientists, completed a comprehensive review and phylogenetic revision of the merged taxonomy produced by NCBI The impetus for the project was the need for a consistent and comprehensive sequence-based taxonomy to process and query the sequence databases built at NCBI

TAXON, a SyBase relational database version of the taxonomy database, was also developed, along with a tool to aid the group in simultaneous editing of the database, called Taxedit The taxonomy database was integrated with submission and database tools, and a taxonomy search tool was added to Web Entrez Some 30 international molecular biologists and taxonomists serve as curators and provide expert review and consultation for the task of building and maintaining a current and consistent phylogenetic classification and nomenclature for the source organisms in the sequence databases The second taxonomy curators workshop was held in summer, 1995

Database Access

Software Toolkit

Equally important as building databases for molecular sequence information is the ability to access and retrieve the information using automated systems The NCBI software toolkit concept addresses this need by creating software modules that provide a set of high-level functions to assist developers in building application software Among these tools are a Portable Core Library of functions in the C language that facilitate writing software for different hardware platforms and operating systems, and AsnLib, a collection of routines for handling ASN 1 data and developing ASN 1 applications The ASN 1 (Abstract Syntax Notation) tool is an International Standards Organization data description language that provides a mechanism for defining and structuring data as well as a set of program definitions that can interact with databases structured in ASN 1

NCBI's adoption of ASN 1 for database output has several advantages for users as well as developers The data definitions in ASN 1 for biological objects enable the representation and structuring of complex biological data in data files without the need for a specific database management system Manipulation of the complex objects is performed through the ASN 1 software tools that are freely distributed to the biology community Thus, complicated analysis programs can be readily constructed from pre-existing sets of modular tools, saving considerable time and programming effort In order to disseminate information about NCBI software and database projects, and provide technical support, NCBI has organized a Professional Software Developers Forum This forum is intended for professional software developers in the biotechnology and pharmaceutical industries

Entrez Retrieval Software

A major application based upon the toolkit approach is a retrieval tool called Entrez that searches nucleotide and protein sequence databases and related MEDLINE citations With Entrez and the integrated database on a CD-ROM or a local network, a user can search several hundred megabytes of sequence and literature data using techniques that are fast and easy to use A key feature of the system is the concept of "neighboring," which permits a user to locate related references or sequences by asking for all papers or sequences that resemble a given paper or sequence The ability to traverse the literature and molecular sequences via neighbors and links provides a very powerful yet intuitive way of accessing the data New releases of the database are produced every two months

Entrez's design permits incorporating additional linked databases without changes in the user interface Links to a taxonomy database and to a collection of 3-D protein structures were recently added Over the past year, queries to Entrez have doubled with over 6,000 queries processed per day CD-ROM and server/client versions are available but the greatest growth has been with WWW Entrez

Other Network Services

A major improvement to the GenBank submission process was made in February 1995 when NCBI introduced BankIt, a World Wide Web submission tool Adoption of this new tool by scientists was rapid, and BankIt submissions represented a significant proportion of direct submissions within a few months By the close of FY 1995, two-thirds of submissions were entering the processing stream via BankIt An option to update an existing GenBank record was added and also proved popular with the molecular biology community

The BLAST sequence searching server is one of NCBI's most heavily used services and its usage continues to grow at a fast pace BLAST compares a user's unknown sequence against the database of all known sequences to determine likely matches Sequence similarities found by BLAST have been critical in several gene discoveries Hundreds of major sequencing centers and research institutions around the country use this software to transmit a query sequence from their local computer over the Internet network

to a BLAST server running on a computer at the NCBI In a few seconds, the BLAST server compares the user's sequence to several hundred thousand known sequences and determines the closest matches

Each day more than 8,000 sequence searches are performed, with users submitting their requests through e-mail, server/client programs, and the World Wide Web The e-mail service has a public key encryption option to guarantee the confidentiality of user data as it traverses the public networks Through distributing the BLAST processing among three multiprocessor computers and through incremental upgrades of their processors, NCBI has been able to accommodate the increased user population as well as the near-doubling in the size of the database over the past year The BLAST server is internationally recognized as an essential laboratory tool in the exploration of genome data

NCBI's electronic mail server, RETRIEVE, is also widely used by the scientific community RETRIEVE is used to retrieve records from several sequence databases, including GenBank, EMBL, Swiss-Prot, and PIR, by sending a mail message containing a text query to the server Any user in the world with e-mail access can submit a query to the servers and have an answer returned within minutes More than 1,300 queries are handled daily by the Retrieve server

Usage of NCBI's World Wide Web (WWW) services, first introduced in December 1993, has expanded nearly ten-fold during the year Information about NCBI, its databases and services, data submission and update, and individual scientists research projects is readily available, as well as an ever-increasing number of search tools The WWW server provides capabilities for Entrez and BLAST searches and submission by BankIt Many other WWW servers have links to the NCBI server to conduct searches and obtain the latest GenBank records At the end of FY 1995, NCBI's site was averaging over 150,000 accesses daily

GenBank is also distributed over the Internet through the standard File Transfer Protocol (FTP) program Many large commercial and academic sites maintain a local copy of GenBank Every two months, nearly 500 sites download new full releases of GenBank, and daily, 160 sites download the update files Fifty-five additional databases of molecular biology data are distributed as part of the NCBI Data Repository to over 1,000 sites daily NCBI uses a cluster of Unix-based symmetric multiprocessor servers to provide Internet-based public search services such as BLAST and Entrez

During FY 1995 the NCBI added an eight-processor Silicon Graphics system dedicated to BLAST services A six-processor Sun server was acquired to support the basic research needs of the NCBI's Computational Biology Branch The servers are supplemented by Unix workstations, PCs and Apple desktop systems that are used for database and software development, research applications and data analysis, user service support, as well as conventional office and administrative applications The NCBI's servers and workstations are connected internally via an FDDI- and Ethernet-based network and connected to the Internet via a router and a T-1 connection The router was upgraded to allow the NCBI FDDI ring to be connected to the NLM backbone FDDI ring and thus gain high-speed access to the NLM's new T-3 Internet connection

Basic Research

Basic research is at the core of NCBI's mission The Computational Biology and Information Engineering Branches at the NCBI are comprised of a multidisciplinary group of scientists who carry out research on fundamental biomedical questions at the molecular level by developing and utilizing mathematical, statistical and other computational methods The approach is both theoretical and applied These two lines of research are mutually reinforcing and complementary The basic research has led to new practical methods and the application of these methods has opened new areas of research

There has been continued development and improvement of algorithms and statistics for the analysis of biologically important molecules These include methods for searching protein and DNA databases for significant sequence similarities, detecting motifs in collections of related molecules, predicting protein structure through sequence-structure threading, and analyzing genomic rearrangements Biopolymer sequence pattern detection methods have been applied to investigate such proteins or protein families as the HIV1 envelope protein, the HMG-1 box proteins, ammonia-producing enzymes, the cytidylyltransferase family, chaperonins, hedgehog family proteins, heat-shock proteins, helicases, and peptidyl-prolyl isomerases, among others

Biomolecular structural investigations include the structural modeling of a neural cell adhesion protein, the prediction that the obese gene product is a helical cytokine, the modeling of RNA 3-D structures, and analysis of the energy statistics of native states for random peptides Genomic studies have led to the construction of a reference database of yeast genes, the determination of the complete sequence of *S cerevisiae* chromosome and the *Citrus tristeza* virus RNA genome, and the analyses of several viral and bacterial genomes Other Computational Biology Branch projects have focused on phylogenetic analysis, and text categorization and retrieval

The intramural group is engaged in more than 40 projects, many of which involve collaborations with NIH and other research laboratories The work is reviewed by a Board of Scientific Counselors of distinguished extramural scientists (see Appendix 4 for list of members) The high caliber of the work has been evidenced by the number of peer-reviewed publications, some 60 in FY 1995, and the requests for outside collaborations and invitations for talks at international meetings

The Visitors Program continues to be successful in bringing members of the scientific community to the NCBI to engage in collaborative research with the Computational Biology Branch as well as joint activities in database design

and implementation with the Information Engineering Branch This program, administered in conjunction with Oak Ridge Associated Universities, facilitated over 50 visits by 44 individual senior researchers this past year

Support and Outreach

As part of its mandate to facilitate the use of databases and software by the biology community, NCBI maintains a user support group with broad experience in handling biology and medical information The primary focus of this group is to support the particular services that NCBI offers by phone, fax, and e-mail NCBI has extended its outreach to the library science community by invited presentations and workshops on biotechnology information topics

As the number of database services and number of users has increased, user support services have expanded Additional contract staff have been added to complement existing NCBI and contract staff in the Information Resources Branch who provide responses to queries for information and assistance The three main areas of user support include information about GenBank services and data submission, technical assistance for submission of new GenBank data and revision of existing records, and technical assistance with Entrez and other data retrieval services Most responses are immediate and nearly all answers or information are provided within 24 hours of receipt of a message Likewise, authors who submit their sequences to GenBank are furnished with accession numbers for publication within 24 hours

To increase awareness of NCBI and its programs, NCBI staff participate in exhibits, seminars, workshops, and courses, both nationally and internationally In FY 1995 NCBI staffed exhibits at scientific society meetings, including the American Society for Biochemistry & Molecular Biology, American Society for Cell Biology, Genome Sequencing & Analysis Conferences VI and VII, American Society of Human Genetics, the Medical Library Association, and, the National Association of Biology Teachers

In addition, senior NCBI members participated as faculty at courses sponsored by the American Association for Cancer Research, the World Health Organization, Johns Hopkins School of Medicine, The Jackson Laboratory, NLM/ Marine Biological Laboratory, and, the International Center for Genetic Engineering & Biotechnology (Trieste, Italy)

Three issues of a newsletter were distributed to a mailing list of 25,000 biologists and institutions, and new Fact Sheets on programs and services were distributed at all public forums where NCBI was represented More than 200 NIH scientists, plus 150 guest accounts at Cold Spring Harbor Laboratory and Washington University, are supported through online access to 20 databases under the IRX system

The NCBI also participates in an advisory and collaborative role with other government agencies such as the Patent and Trademark Office and the Department of Agriculture on programs involving biotechnology information Within the NIH, the NCBI coordinates with other institutes and particularly with the National Center for Human Genome Research on databases and informatics programs that impact information exchange on a national level

Extramural Programs

The NLM's Extramural Program (a separate division of NLM) offers a program of grants for computer analysis of molecular biology data A wide variety of work in computational biology has been supported through the program including methods and algorithms for sequence analysis, structure and function prediction, new machine architectures and specialized databases Postdoctoral training in the cross-disciplinary areas of biology, medicine, and computer science is also funded through the NLM's informatics fellowship program

Biotechnology Information in the Future

The explosive growth in the fields of genetics and molecular biology reinforces the need to build and maintain a strong infrastructure of information support NCBI continues to be engaged in developing and employing new methods for disseminating knowledge to the biomedical community Based on a core of advanced intramural research in several areas of computational biology, NCBI rapidly addresses the evolving informatics needs for genome research with state-of-the-art software and databases Genomic information resources such as NCBI have repeatedly demonstrated their value as indispensable discovery tools for basic research The value of these resources will only continue to grow as they support the breakthroughs in basic research and provide us with better understanding and treatment of human disease

EXTRAMURAL PROGRAMS

Milton Corn, MD
Acting Associate Director

The Extramural Programs Division (EP) of NLM continues to receive its budget under two different authorizing acts, the Medical Library Assistance Act (unique to NLM), and Public Health Law 301 (covers all of NIH) The funds are expended as grants-in-aid to the extramural committee in support of the goals of the National Library of Medicine Review and award procedures conform to NIH policies Budget figures are presented in Table 11

The Grant Programs

EP issues grants in several categories for which the motif in general is medical informatics

- Resource (for Information Management)
- Training
- Research (and Research Resources)
- Publication
- Educational Technology
- SBIR/STTR
- Other

These categories were used to organize discussion of EP activities for this report

Resource

The "Resource" grants described in this section are intended to strengthen the information management infrastructure of the grantee, and, therefore, provide significantly less overhead compensation to the grantee institution than do research grants The four increasingly complex resource programs described below are designed to address needs of the broad spectrum of American health care organizations

Internet Connections Grants (MLAA)

This program provides relatively small grants to health organizations that wish to make an initial Internet connection, or to broaden internal access to a connection already in place To qualify, institutions must already have some local area network (LAN) capacity The health science library usually has a key role in the Internet connection grants—primarily in training new users These grants are available in two forms $30,000 to single institutions and $50,000 to those extending their connection to other sites Grant funds support costs for router/gateway equipment and associated connection hardware, installation and leasing of communication circuits to connect to an Internet provider, and membership fees to a provider This program was initially offered for 3 years through the National Science Foundation, and in 1995 the Internet Connections Grant Program was transferred to and administered by NLM A Request for Applications was issued in January 1995, some 260 letters of intent to apply were received and 175 applications actually submitted A two-stage review was utilized with an initial Special Review Committee recommending 45 applications for further consideration In FY 1995 available funds yielded 25 Internet Connection Grants with the majority going to hospitals, there are some 10 collaborative Internet connection projects thus increasing the number of beneficiaries The Internet grantees include

American College of OB/GYN
Washington, DC

Baton Rouge General Medical Center
Baton Rouge, LA

The Children's Mercy Hospital
Kansas City, MO

Children's Research Institute
Washington, DC

Egleston Children's Hospital
Atlanta, GA

Kettering Medical Center
Kettering, OH

Kirksville College of Osteopathic Medicine
Kirksville, MO

Legacy Emanuel Hospital
Portland, OR

Lake Erie College of Osteopathic Medicine
Erie, PA

Long Island Jewish Hospital
New Hyde Park, NY

Louisiana State University
New Orleans, LA

Mary Imogene Bassett Hospital
Cooperstown, NY

Mercer University School of Medicine
Macon, GA

Mercy Hospital of Pittsburgh
Pittsburgh, PA

Michigan State University
College of Osteopathic Medicine
East Lansing, MI

Montana State University-Billings
Billings, MT

Mount Sinai Medical Center
Miami Beach, FL

Providence Hospital
Southfield, MI

Rapid City Regional Hospital
Rapid City, SD

St John's Mercy Medical Center
St Louis, MO

Saint Luke's Hospital
Kansas City, MO

St Luke's Regional Medical Center
Sioux City, IA

University of South Alabama
Mobile, AL

Vanderbilt University Medical Center
Nashville, TN

York Hospital
York, PA

Information Access Grants (MLAA)

Information Access Grants provide $12,000 for single institutions and $12,000 per member for consortia to purchase basic computer and communications equipment to access NLM's Grateful Med, DOCLINE, and Loansome Doc services, funds can also be used towards the installation of an integrated library system Internet Access is usually incorporated into these projects To foster NLM's ongoing Outreach Initiative, the grants supports consortia in remote, rural areas where outlying institutions can network with a larger site equipped with back-up collections and library staff Examples of FY 1995 awards to single institutions are Bear Valley Community Hospital in Big Bear, CA, and The William Backus Hospital in Norwich, CT Consortium Information Access Grants went to the Southwest Georgia Area Health Education Center (AHEC), the Western Arizona AHEC, the Hospital Consortium of San Mateo County (Burlingame, CA), the Western NY Hospital Library Services Program in Buffalo, the Rural Ohio Valley Health Sciences Library Network based at Ohio University in Athens, the Commonwealth of Pennsylvania for the libraries in its mental health institutions, and the Southside (VA) Area Health Education Center in collaboration with Tomkins-McGaw Library of Virginia Commonwealth University The consortium grants include some 85 institutions, thus increasing the impact of the Information Access funding

Information Systems Grants (MLAA)

Information Systems Grants, which range up to $150,000 per year for 1 to 3 years, are targeted for larger health institutions such as teaching hospitals and medical schools Projects support computer and communications networking, integration and connectivity and must include the library as a participating partner Internet capabilities are again emphasized by NLM as highly desirable Grant funds may cover personnel, equipment, software, communications expenses, travel and supplies Six Information Systems Grants were awarded in FY 1995 At the University of Kentucky a literature access and delivery system project will provide medical students and preceptors in rural practice sites (offices) with computers, communications, and fax machines to access Grateful Med and receive articles, training and document support are provided by the library staffs of the AHEC and the UK Medical Center A project based at the Eccles Health Sciences Library of the University of Utah will establish a national multimedia databank (1000 permanent items) and support center to encourage faculty to apply multimedia programs in their teaching A "concept to maturity" service will assist faculty in the creation of multimedia programs and in the evaluation of their effectiveness as teaching/learning tools Similarly, at the Countway Library of Medicine at Harvard University, a Knowledge Laboratory of Electronic Resources will be created to support integrated and interactive learning and research Two Information Systems Grants integrate drug information and library systems—the Philadelphia College of Pharmacy and Science Library and the Tompkins-McGaw Library of the Virginia Commonwealth University in Richmond At the Forsyth Dental Center in Boston, an Information Systems Grant will enable the library to connect with the institution's communications infrastructure and eventually become an integrated advanced information system

IAIMS Grants (MLAA)

Integrated Advanced Information Management Systems (IAIMS) are institution-wide computer networks that link and relate library systems with a variety of individual and institutional databases and information files, within and external to the institution, for patient care, research, education, and administration Resource grants are made to assist medical centers and health science institutions and organizations in planning and development projects that will lead to the implementation and operation of IAIMS The goal of the IAIMS program is to create organizational mechanisms within health science institutions to manage more effectively the knowledge of medicine, and to provide for a system of comprehensive, direct information access for health professionals

NLM provides grant support for (1) an institution-wide planning phase where support may be for up to $150,000 per year for 1 or 2 years, and (2) an operation phase in which IAIMS plans are implemented Operation phase grants may be for up to $500,000 per year for up to 5 years, or for $550,000 per year if support of an IAIMS apprenticeship option is approved

The total IAIMS funds awarded in FY 1995 were $2,231,000 which supported 3 new awards and 4 continuation

awards of projects begun in earlier years The new awards were for IAIMS Planning at the Henry Ford Health System, Detroit, Michigan, and IAIMS Operations at Vanderbilt University and at Yale University Continuation awards were for IAIMS Planning at the Universities of Missouri and Rochester, and the Medical College of Wisconsin, and for IAIMS Operations at the University of Washington

Training and Fellowships (MLAA)

Training in Informatics

Realizing the potential of computers and telecommunication for health care information management requires investigators able to address fundamental problems of knowledge representation, decision support, and human-computer interface NLM remains the principal supporter nationally of research training in the fields of medical informatics and biotechnology information

To complement the training of researchers, NLM now also offers training opportunities for health care professionals who want to *apply* the knowledge and technology of this field to some area of interest

The NLM provides three mechanisms of support for its training activities

Institutional training grants have been awarded to 10 institutions which support in total approximately 100 trainees Institutions currently receiving NLM support

1 "Boston Consortium"
(Harvard Medical School,
Massachusetts Institute of Technology,
Brigham and Women's Hospital,
Massachusetts General Hospital)

2 University of Minnesota

3 University of Pittsburgh

4 Stanford University

5 Yale University

6 Rice University,
Baylor College of Medicine,
University of Houston

7 Oregon Health Sciences University

8 University of North Carolina,
Duke University

9 University of Missouri

10 Columbia University

Individual informatics research fellowships are available to those who want research training similar to that received at the institutional training sites but at a site of their choosing NLM supported four fellows in this category in FY 1995

Individual applied informatics fellowships are available to individuals who want to learn informatics techniques and technology for application to their professional interests Eight such fellows were funded in 1995, of which five are medical librarians

Planning for the Education of Health Sciences Libraries

In early 1995 NLM, as a one-time initiative, issued a Request for Applications (RFA) for Planning Grants for Education and Training of Health Sciences Librarians to provide further planning for education in four areas identified by the NLM Planning Panel on the Education and Training of Health Sciences Librarians 1) evolving role for health sciences librarians, 2) professional education programs, 3) lifelong learning programs, and 4) recruitment including minorities Twenty-one applications were received and seven awards were made Welch Medical Library of The Johns Hopkins University, Baltimore, MD, Graduate School of Library and Information Science, University of Illinois, Champaign, IL, School of Library and Information Science, University of Missouri, Columbia, MO, School of Information and Library Science, University of North Carolina, Chapel Hill, NC, School of Library and Information Science, University of Pittsburgh, Pittsburgh, PA, College of Library and Information Science, University of South Carolina, Columbia, SC, and Eskind Biomedical Library, Vanderbilt University, Nashville, TN

Training of Minorities

NLM is participating in an NIH-wide fellowship program aimed at encouraging underrepresented minorities into research careers, and is currently supporting one fellow pursuing an MD/Ph D combined degree at Harvard Medical School

Research (PHS 301)

Research grants are made through a variety of mechanisms, including individual research projects, cooperative agreements, research resource grants and others

Medical Informatics

NLM's research grants sponsor the investigation of basic and applied medical knowledge issues that arise at the intersection of biomedicine, computer science, and human behavioral sciences The largest single research award was a continuation of a long-standing multi-project support grant to the Center for Advanced Medical Informatics at Stanford University

This year, NLM initiated 12 new individual informatics

research projects Other NIH programs co-funded several of them We encourage collaboration among the Institutes For example, the nursing and dental professions at NIH are currently exploring closer association with NLM Widening of the base of support beyond the NLM budget is essential if the rapidly expanding research needs of this field are to be addressed

A major effort has been the ongoing collaboration for research and development of Electronic Medical Record Systems (EMRS) NLM joins the Agency for Health Care Policy and Research in this activity This year both programs funded additional cooperative agreements to bring the total to eight NLM, however, has a funding interest in each project This past year was devoted to project organization, to language standards, and to barriers to exchanging patient data NLM also participates with 15 other organizations in the Human Brain Project, which seeks innovative methods for discovering and managing increasingly complex information in the neurosciences Some examples of informatics projects NLM co-funded an award to Professor Stanley Letovsky of Johns Hopkins for exploration of database methodology for archiving and analyzing collections of brain images, at Stanford University, Dr Mark Musen will pursue computer system architectures for medical decision support, at the University of Oklahoma Medical Center, Dr Lawrence Widman continues to investigate knowledge-based programs for monitoring cardiac arrhythmias, and has made the program available on the World Wide Web

Because finding support for research in the early years after training can be difficult, NLM places particular emphasis on awards to young investigators This year, NLM issued First Independent Support and Transition (FIRST)awards to three promising investigators in medical informatics

Biotechnology Informatics

The techniques of informatics are indispensable tools for handling the complex data generated by molecular biology research NLM continues to provide research grants for informatics projects in the area of biotechnology informatics A related problem concerns the development and maintenance of myriad electronic databases on which researchers increasingly rely, and for which no other source of support has yet been identified

In 1994, NLM published a request for applications for database support projects Some projects are now receiving support as a result of this initiative at New England Biolabs, Dr Richard Roberts will maintain and distribute REBASE, a well-established database of information on restriction enzymes, Professor William Pearson of the University of Virginia continues his development of software tools and environments for efficient sequence searching In this field too, emphasis is placed on research support grants for young investigators One such grant was awarded in biotechnology informatics in FY 1995

Publication Grants

The Publication Grant Program provides short-term financial support for selected not-for-profit, biomedical scientific publications Studies prepared or published under this NLM program include critical reviews or monographs on special areas of medical research and practice, research monographs in the history of medicine and the life sciences, writings on medical informatics, health information science and biotechnology information, and, in certain cases, secondary literature tools and scientifically significant symposia Resources in recent years have been used principally for history of medicine projects, but projects involving electronic publishing, video productions, and other media are also supported

During FY 1995 NLM awarded 16 Publication Grants totaling $513,000 Of these, 13 were new awards This small grant program has a current self-imposed annual ceiling on direct costs per grant of $25,000 The average grant awarded, including both direct and indirect costs, was under $30,000 per year for 2 years New awards in FY 1995 include, among others, "Women healers and female health in Puritan America," made to Dr Ann Hess of Harvard Medical School, for an examination of the role of women in the process of healing in colonial New England, preparation of a monograph on the 100-year history of the Medical Library Association as a part of the Association's centennial in 1998, a 2-year project supported by a new award to Dr Bernadine Barr of Stanford University will address how inmates of orphanages during the years 1900 to 1945 were used as subjects in medical and behavioral research, and the implications of such research for the foundations of pediatrics, child psychiatry, public health, and child development, a critical review by Dr Richard Rettig of the Rand Corporation to develop a book on the history of the End Stage Renal Disease Program of the Federal Government with an emphasis upon the impact of public policy for medical research and treatment

SBIR/STTR (PHS 301)

All NIH research grant programs, including NLM's, by Congressional mandate allocate a fixed percentage of available funds every year to Small Business Innovation Research (SBIR) grants These projects may involve a Phase I grant for product design, and a Phase II grant for testing and prototyping

This year, NLM's allocation, with co-funding contributions from other programs, was awarded to Dr John Nelson of Nelson Information Systems in Chevy Chase, Maryland for work on a reprint service for internists based on 10 core journals NLM also participates in the other mandated fund allocation program, Small Business Technology Transfer, but generally it contributes its small allocation to other NIH institutes

Educational Technology

EP's support for educational technology development is generally restricted to computer/telecommunication projects that incorporate strong research and evaluative components Because NLM's support funds for this area are small, those who seek funding for educational technologies have been urged to focus their work on some specific area of medicine, which might attract funding one from the other, larger Institutes

Other

Conference Grants

Support for conferences and workshops is intended to help scientific communities identify research needs, share results, and prepare for productive new work For example, a conference grant to Dr Russ Altman of Stanford University provided partial support for the third International Conference on Intelligent Systems for Molecular Biology

Biomedical Ethics

Ethical issues in health care and research produce an enormous literature from every quarter—law, medicine, public health, and government The National Center for Bioethics Literature at Georgetown University continues to offer invaluable resources and guidance for workers in this area An Extramural Programs contract maintains the Center A complementary contract from Library Operations supports an indexing activity that contributes to BIOETHICSLINE, one of NLM's MEDLINE databases

Other EP Activities

HPCC and Outreach

The Outreach and the HPCC initiatives of NLM are elements of the formal grant programs, and are being met more fully since revision of the resource programs, the continued success of the Connections program, and the Electronic Medical Record System cooperative grants

Other Minority Support

The Information Access Grant awarded to the Western Arizona Area Health Education Center (WAHEC) includes several institutional members serving minority populations Yuma City/County Public Library-San Luis Branch, Somerton/Valley Health Center, Yuma Regional Medical Center, and the Arizona Western College all serving significant Hispanic populations, and the Indian Health Service Hospital in Parker, AZ A Minority Supplement was awarded to Mr Temple Sinclair to work with Associate Professor Daniel Davison at the University of Houston on a Biotechnology Information Research Grant entitled "Multiple Sequence Alignment Server and Algorithm Development "

Review

First Level Peer Review

The Biomedical Library Review Committee (BLRC) is NLM's initial review group for evaluating the scientific and technical merit of grant applications The BLRC has expertise germane to the specific program areas library, informatics, and biotechnology The committee met three times in FY 1995 and reviewed 77 applications, 59 of which were scored and continued in the review process A roster of the Committee is in Appendix 5 In FY 1995 the Committee produced "Frequently Asked Questions," intended to assist potential applicants to NLM's grant programs, it will be available in print and on the Internet

Special Review Committees with focused expertise were appointed to review applications to the Institutional Academic Information Management Systems (IAIMS) program, individual fellowship applications, and applications having substantial involvement of regular BLRC members

Second Level Review

A second level of review is performed by the Board of Regents, which meets three times a year, approximately three months after the Biomedical Library Review Committee, and concerns itself with the mission and policy aspects of the applications The Extramural Programs Subcommittee of the Board reviews in depth "Special" grant applications such as those where the recommended amount of financial support is larger than some predetermined amount, where at least two members of the scientific merit review group have dissented from the majority, where a policy issue is identified, and those from a foreign institution The Subcommittee makes recommendations to the full Board

Review Reform

In FY 1995 NLM implemented an NIH-wide change in peer review process that permits a "triage" review to winnow out applications unlikely to be funded, and that need not be subjected to a full review In this early NLM experience, approximately a third of the applications were designated at triage as "not recommended for further consideration "

Divisional Operations

The operating budget was adequate to permit reasonable staffing, site visits when appropriate, and continuation of the Division's on-going maintenance and replacement policies Reorganization in response to streamlining goals is in progress As one step in the process, Mrs Jackie Atwood joined the Division as Administrative Officer

Summary

NLM's EP, like almost all extramural grant divisions at NIH, regrets that not all applications of good quality can be funded, but the grants which are made are furthering NLM goals in most key areas However, support for developing the educational technology of informatics remains uncomfortably small, and, most importantly, we have not yet expanded the informatics research budget commensurate with the increase in informatics scientists leaving our training programs

Table 11

Extramural Grant and Contract Program (dollars in thousands)

Category	*FY 1993*		*FY 1994*		*FY 1995*	
	No	*$*	*No*	*$*	*No*	*$*
Resource projects	**25**	**4,878**	**38**	**5,150**	**54**	**5,421**
IAIMS	(5)	(3,150)	(10)	(3,115)	(7)	(2,231)
Access	(9)	(589)	(2)	(80)	(11)	(772)
Systems			(9)	(1,283)	(10)	(1,438)
Connection			(17)	(672)	(26)	(980)
Research	**51**	**11,674**	**53**	**12,436**	**64**	**13,680**
Informatics	(31)	(6,899)	(19)	(5,681)	(25)	(5,966)
Biotechnology	(13)	(3,915)	(13)	(3,776)	(21)	(4,390)
Cooperative agreements	(5)	(3,150)	(3)	(1,008)	(6)	(2,002)
Career awards			(16)	(1,725)	(11)	(1,138)
Library science			(2)	(246)	(1)	(184)
Training	**16**	**4,138**	**19**	**4,372**	**25**	**5,072**
Institutional	(10)	(3,878)	(10)	(3,980)	(16)	(4,676)
Fellowship	(6)	(260)	(9)	(392)	(9)	(396)
Publications	**9**	**269**	**8**	**239**	**16**	**513**
Bioethics			**1**	**400**	**1**	**416**
SBIR/STTR			**2**	**145**	**1**	**191**
Regional Medical Library	**8**	**5,500**	**8**	**5,678**	**8**	**5,545**
Totals:	**109**	**$26,459**	**129**	**$28,420**	**169**	**30,838**

OFFICE OF COMPUTER AND COMMUNICATIONSYSTEMS

Fernando Burbano
Director

The Office of Computer and Communications Systems (OCCS) provides information processing capabilities to meet NLM information needs

Major Developmental Activities

TESS

TESS (Technical Services System) integrates various functions of the Technical Services Division with emphasis on the cataloging processes It is a client/server application with the major databases residing on the IBM mainframe and the editing of records on PC workstations The communication subsystems are based on the TCP/IP protocols making TESS operable over both Local Area Networks (LANs) and the Internet TESS began production use by TSD in the late 1980s The system controls the creation and maintenance of bibliographic and name authority records for NLM NLM distributes this data to ELHILL and to subscribers of USMARC records

Initial releases of TESS provided for the creation and maintenance of original cataloging, followed by a framework for the integration of acquisition and cataloging activities Next authority control for the cataloging function was integrated into TESS This release also included the capability for creation and maintenance of the name authority file

During 1995, the major effort was a modification of the databases and software to comply with the USMARC standard for Format Integration Phase I, Phase II is to be implemented during 1996 A basic Z39 client was established to permit FTP transfer of data from the Library of Congress Software was also developed to allow the batch loading of USMARC data tapes from outside sources

Information Systems Laboratory (ISL)

The Information Systems Laboratory was created within the Development Branch in 1991 It was intended as a core facility to help OCCS modernize and enter the emerging technology domains of distributed processing, open systems, high speed networks, and worldwide connectivity and service provision An early software product, TC_COMM, has been widely used for LAN communications for other production systems such as TESS, Locator/CMS, and the Z39 50 server

Over the years the ISL has supported the development and implementation of Locator, the NLM public access catalog, NLMPUBS, the anonymous FTP service providing online copies of NLM technical publications, and Implement, a meta-DBMS toolkit designed to address the special problems of bibliographic data storage and retrieval The ISL also supported developments for remote cataloguing and indexing activities

The ISL is continuing to introduce open systems computers and workstations to support operational requirements Efforts continue to redesign existing systems and develop new systems to use multiplatform open system servers TCP/IP communications and Internet connectivity The Internet has now become a major domestic and international access pathway The ISL has become the core team for Unix systems hardware and software support in OCCS Several Unix based production systems now depend upon ISL hardware and software in order to support public user access to NLM data

NLM Locator

In 1991 OCCS developed a prototype Online Public Access Catalog (OPAC) which became a full-scale development effort in FY 1992 The operational system, named NLM Locator, was introduced to the Reading Room on February 22, 1993 In May 1993 the system was made available over the Internet and usage continues to grow NLM Locator provides direct access to the NLM collections through the ELHILL databases CATLINE (monographs), AVLINE (audiovisuals), SERLINE (serials), and DIRLINE (information resources)

One of the important concepts of the client/server architecture is the ability to adapt to change without reengineering the application NLM Locator utilizes a workstation client communicating with function servers which in turn communicate with a data server The client workstations in the Reading Room are DOS PC's while Internet users log in as VT-100 terminal sessions to a Unix client process executing in the function servers The function servers are Sun computer systems running the Unix operating system Having multiple function servers permits reliability as well as additional capacity, should usage require it The data server is the NLM mainframe computer utilizing the ELHILL retrieval system No changes to the legacy systems were required to implement Locator

The second phase of the project was to provide circulation control and collection management features for a combined system the Locator/Collection Management Systems This effort was completed in 1994 and it provides online patron registration, availability data, status information, requests for library materials, and a great number of management reports to the Public Services Division In 1995 the ELHILL Retrieval agent subsystem was converted to C++ and it now shares much of this code with Z39 50 sever discussed below, although both systems run on separate Unix servers

Z39 50 Server

The project to make MEDLINE available to Internet clients via the Z39 50 protocol started in late 1994 and reached beta-test in May 1995 The Z39 50 server system

consists of an ELHILL retrieval agent, a Z39 50 protocol engine that delivers MEDLINE information over the Internet in Z39 50 format, and a subsystem for dynamically converting ELHILL data into Z39 50 formats The Z39 50 formats delivered include Simple Unstructured Text Record Syntax (SUTRS) and MARC, which is the most widely used Z39 50 format

The ELHILL retrieval agent supports simple searching and full Boolean searching It is written in C++ and it runs under the Solaris operating system on a Sun computer The Z39 50 protocol engine is written in C and also runs on the same Sun computer Progress has been made with the beta testing and evaluation of the Z39 50 server and it is scheduled to go into full production in October 1995

Local Area Networks

The Network Engineering Section of OCCS is responsible for the development, implementation, administration, and support of communications systems to meet NLM's missions Most ADP systems at NLM require an extensive data communications capability in order to provide distributed processing capabilities as well as computer access for internal staff, and visiting and remote patrons to the various mainframe, minicomputer, server, and microcomputer-based systems

NLM has implemented Local Area Network (LAN) and Wide Area Network (WAN) technologies and services in order to satisfy the requirement for high speed and reliable internal and external data communications services Remote access is provided via WAN systems such as FTS 2000, value added networks, and the Internet

In 1995, NLM awarded a 5 year competitive contract to BBN Planet to provide dedicated communications facilities to the Internet for the NIH In December 1995, new dedicated facilities were installed and became active in order to upgrade NLM's connections to the BBN Planet network for the Internet

NLM received from GSA an extension to the exemption from mandatory use of the FTS2000 Packet Network though December 1995 This was based on higher cost projections than the existing Value Added Network (VAN) contracts, and technical problems which needed to be resolved NLM plans to make the transition from the VANs to the FTS2000 Network in 1996 if all issues are resolved

NLM, working with other NIH organizations, initiated a project to construct a conduit from Bell Atlantic's facilities on Rockville Pike to Building 38A, and then on through the existing NIH conduit facilities on campus to Buildings 12 and 10 and back to Rockville Pike for the installation of SONET fiber cable system This SONET Ring will bring a reliable, high-speed networking capability to the NLM and NIH when completed in 1996

As computing systems continue to become more distributed and powerful, increasing demands are placed on the NLM communications facilities in terms of speed and throughput NLMNet will be enhanced and expanded over the years to continue to meet communications requirements for NLM

Grateful Med

During 1995, almost 5 million ELHILL searches were performed using Grateful Med The number of Grateful Med searchers continues to increase, now accounting for 80% of all ELHILL searching The use of TCP/IP remains popular, almost 40% of all Grateful Med users access NLM via the Internet A transition from the VANs (Tymnet, Telenet, and Compuserv) to AT&T's FTS2000 Packet Switch Service for Grateful Med modem access is scheduled for 1996 New Grateful Med communication scripts were developed and tested this year in anticipation of this transition

Grateful Med sales continued to be strong in 1995 There were 11,256 PC versions and 2,821 Macintosh versions sold this year Also, updates for both versions were developed and distributed The PC update was sent to 46,561 users, and the Macintosh update was sent to 11,541 users The development of a windowing version of Grateful Med continued during 1995 A beta version was tested by a group of users with very positive results It is anticipated that a Windows version of Grateful Med limited to MEDLINE will be available in 1996

Programming Support Services

DOCLINE (Interlibrary Loan)

- Software was added to the online system to refer requests that NLM cannot fill to a library that reports holding the journal
- Full citation information was added to calendar year ILL statistics to make it easier for NLM to identify why requests were not filled
- Quarterly and calendar year statistics for regional libraries were made available via FTP
- Software enhancements were made to allow rush requests to come to NLM throughout the day
- Loansome Doc processing now accepts SPACELINE requests
- A more flexible ISO interface was added to Loansome Doc processing for Windows and Internet Grateful Med to use Foreign addresses, Internet requests and comments fields can now be accommodated
- A new version of ILL post-processing was established so requests would be "not filled" in case of a furlough

Enhancements to NLM's publications systems

- Software was written to consolidate statistical reports for publications to streamline the interface between Medlars Management Section, OCCS Production Control, and the Government Printing Office

- The *Hospital Literature Index* became the *Hospital and Health Administration Index*
- A tag-delimited form of the List of Serials Indexed was made available on the NLM public server
- Publication types now appear in the MeSH Annotated Alphabetic List
- The print order that accompanies data for publications at GPO was automated A library containing a member for each publication was created so that more than one job could be run simultaneously Parallel proof reader's reports are automatically generated for each publication

Enhancements to NLM Billing systems

- To economize on postage it was decided to issue quarterly rather than monthly invoices to MEDLARS users
- A new field, EMAIL, was added to the INQUIRE Users database and the Medlars II Users File
- To accommodate the deluge of new Medlars II Users, a new format for user codes was provided The new format allows for more possibilities since the former supply was rapidly being depleted

More than 10% of the NLM bibliographic data of over 7 million records were class maintained this year Class Maintenance is the adding of new terms, deleting of old terms, and replacing terms with preferred ones in the MEDLARS data base New data fields are introduced to records as required A significant effort was expended developing software to map associated Pharmacological Action(s) terms as applicable for pre-exploded chemical terms, merge the HEALTH Planning and Administration (HEALTH)and Health Services Technology and Research (HSTAR) databases, and to develop a new way of assigning Unique Identifiers (UI's) to individual citation data

NLM continues to collaborate with publishers and to write software to convert their journal citation data encoded in the Standard Generalized Markup Language (SGML) to MEDLARS II format as an alternative to keyboarding the data SGML is part of the International Standards Organization initiative

ADMINISTRATION

Sally Burke
Deputy Executive Officer

National Performance Review

This year the NLM developed a Streamlining Plan in response to Federal downsizing initiatives, and continued to be actively involved in a systems reinvention project under its role as a reinvention laboratory Both initiatives respond to the Administration's National Performance Review

Streamlining

A streamlining committee appointed by the NLM Director consisted of senior and mid-level staff and also had employee representation After reviewing their organizations, NLM Associate Directors presented streamlining recommendations to the committee Additionally, more than 100 suggestions were received from NLM employees for the streamlining effort The committee considered all presentations and employee suggestions and developed recommendations on how to improve NLM operations and still meet reduced FTE (full-time equivalent) ceilings and targets for supervisory ratios, senior level positions, and "control" positions (budget, personnel, acquisitions, accounting, and computer series positions) The NLM Streamlining Plan was completed in June 1995 In transmitting the plan to the NIH, Dr Lindberg noted that its development represented a collaborative work by all NLM employees as well as supervisors and managers He noted that through their efforts reduced allocations will be made without sacrificing the quality of services for which the Library is known He said that if the number of staff continues to be further decreased there clearly will come a time when the NLM will be unable to continue the same level of service that is now expected by its patrons

Systems Reinvention Project

The theme of NLM's "Reinvention Laboratory" is to reinvent information systems, to move to a more flexible, powerful, and maintainable computer system that will both improve internal processing and provide innovative services to outside users This 3- to 5-year system reinvention effort is divided into three major components internal support systems (including internal file building and maintenance), retrieval engines (focusing on replacing the venerable ELHILL retrieval system), and user access services (including new versions of Grateful Med and document delivery systems) One major outcome of the work this year is the Internet Grateful Med which will soon move into production mode

Financial Resources

In FY 1995, the Library had a total appropriation of $127,889,000 Table 12 displays the FY 1995 budget authority plus reimbursements from other agencies, and the allocation of these resources by program activity

TABLE 12

Financial Resources and Allocations, FY 1995 (dollars in thousands)

Budget Authority	
Appropriation, NLM	$127,889
Plus Reimbursements	12,901
TOTAL	**$140,790**
Budget Allocation	
Extramural Programs	30,874
Intramural Programs	101,748
Library Operations	(59,030)
Lister Hill National Center for Biomedical Communications	(25,502)
National Center for Biotechnology Information	(9,719)
Toxicology Information	(7,497)
Research Management and Support	8,168
TOTAL	**$140,790**

Personnel

The NLM closed FY 1995 with 586 full-time equivalents (FTE) The employment freeze imposed by the Public Health Service in FY 1994 lasted through February 1995 During the last quarter of FY 1995, however, another employment freeze was imposed by PHS due to the need for placing approximately 250 employees displaced as a result of the merging of administrative functions of the Office of the Secretary and the Office of the Assistant Secretary for Health

In October 1994, the NIH once again received authority to offer buyouts under the Voluntary Separation Incentives Program NLM offered the incentives to all its senior managers, supervisors, and employees in control positions, i e personnel, budget, accounting, contracts, grants management, and computers Thirteen employees took advantage of the offer

In April 1995, Mr Kenneth G Carney, Executive Officer, NLM retired from government service Mr Carney joined the Library in 1968 and served in a variety of positions until selected as Executive Officer in 1981 During his career

he was the recipient of various awards for his outstanding contributions to the administrative management of the Library

In May 1995, the NLM became one of the three NIH campus sites for the Employee Express facility This com puter-based systems allows employees to make changes to their personnel records Transactions permitted include home address changes, tax withholdings, financial allotments and direct deposit

Appointments

In March, Melvin Spann, Ph D was appointed as Associate Director, Division of Specialized Information Ser vices Previously he served as chief of SIS's Biomedical Information Services Branch where he was responsible for managing a variety of information products and services concerning toxic substances and their effects on health In addition, he was responsible for directing a toxicology information outreach project to strengthen the capacity of Historically Black Colleges and Universities to train medical and other health professionals in the use of toxicological, environmental, occupational, and hazardous waste information resources developed by NLM Dr Spann serves on the Environ mental Justice Subcommittee of the HHS Environmental Health Policy Committee and he is presently an adjunct professor in the Chemistry Department of the American University in Washington, D C

In July, Michael Ackerman, Ph D , was appointed as NLM Assistant Director for High Performance Computing and Communications In this capacity Dr Ackerman will continue in his role of Head, High Performance Computing and Communications Office, within the Lister Hill Center and will serve as the focal point within NLM for providing coordination, consultative, and advisory services relating to HPCC-funded activities

Dr Erik van Mulligen was appointed as a Visiting Fellow with the Lister Hill National Center for Biomedical Communications (LHNCBC) Dr van Mulligen received his Ph D degree in Medical Informatics in 1993 and since that time was working as a scientific staff member at Erasmus University on the development of the HERMES integrated physician workstation While with the LHNCBC, Dr van Mulligen will work on a medical informatics research project which involves testing the efficacy of the Unified Medical Language System knowledge sources in the context of the HERMES system

In September, Elizabeth Fee, Ph D joined the Library as the Chief, History of Medicine Division Dr Fee received her doctorate from Princeton University and has worked as a Professor of History and Health Policy at the Johns Hopkins University for the past 20 years where she has taught courses in history of medicine and public health Di Fee has conducted extensive research on the history of public health leading to the publication of various books in the subject and numerous other publications Dr Fee is a historian recog nized for her interest in women's health and for her work in the history of public health

In August, Arcady Mushegian, Ph D was appointed under the Post-doctoral Intramural Research Training Award Program to a position with the NCBI Dr Mushegian received his Ph D in molecular biology from Moscow State Univer sity During his stay with NCBI, Dr Mushegian will gain research experience on the computer-assisted analysis of sequence databases, more specifically, on the characterization of the ancient conserved regions

The NCBI has recruited four visiting scientists through the NIH visiting program They are

- Detlef D Leipe, Ph D , appointed as a Visiting Associate on June 1, 1995 Dr Leipe is a graduate from Freie Universitat in Berlin, Germany where he did a comparative study of the ultrastructure biology of protists, a classical systematists project At the NCBI, Dr Leipe will conduct research in the area of computational biology and work on the design, revision and refinement of the taxonomic database associated with the GenBank database
- Wojciech Makalowski, Ph D was appointed as a Visiting Fellow On October 1994 Dr Makalowski received his Ph D degree from Poznan University in Poznan, Poland where he worked on transfer RNA and ribosomal RNA genes, gaining experience in both experimental and computational molecular biology At the NCBI, Dr Makalowski will receive training and experience in bioinformatics with the general goal of applying computational tools to the organization of electronic data in molecular biology and genetics
- Christopher Hogue, Ph D was appointed as a Visiting Fellow in January 1995 Dr Hogue is a graduate of the University of Ottawa (Canada) His thesis work includes an extensive comparative analysis of proteins in the tryptophanyl tRNA synthetase family employing modern sequence and structure-based methodology and worked as an independent developer of database software during and before his graduate studies At the NCBI, Dr Hogue will work on software development for the NCBI macromolecular structure database
- John Kuzio, Ph D was appointed as a Visiting Fellow in March 1995 Dr Kuzio received his Ph D in virology at Queen's University in Ontario Canada His research has focused on bacoluviruses, their basic biology as well as their application as vectors While at NCBI he will develop software applications in molecular biology

Awards

The NLM Board of Regents Award for Scholarship or Technical Achievement was awarded to Jonathan A Kans, Ph D and Gregory D Schuller, Ph D for their outstanding technical achievement contributing to the development of

Entrez, an innovative information retrieval system that provides researchers worldwide with integrated access to the databases and literature of molecular biology

The Frank B Rogers Award recognizes employees who have made significant contributions to the Library's fundamental operational programs and services In 1995, Peri Schuyler received the award for her exceptional contributions and leadership that have significantly improved the automation activities and expanded the scope of Medical Subject Headings

The PHS Special Recognition Award was presented to Michael J Ackerman, Ph D for his innovative direction and leadership of NLM's pioneering electronic imaging research project, the Visible Human

The NIH Director's Award was presented to two em ployee this year Susan P Buyer and Robert Mehnert, Office of the Director, NLM Ms Buyer was recognized for her superior leadership in the development and management of the NLM Long Range Plan Mr Mehnert was recognized for his outstanding effort in imaginatively and effectively communicating the mission of the NLM

The NLM Director's Award, presented in recognition of exceptional contributions to the NLM mission, was awarded to three employees this year Kenneth G Carney, Dr Harold Schoolman, and Ennis Wilson Mr Carney was recognized for exceptional expertise in administrative management and for exemplifying the highest standards of public service Dr Schoolman was recognized for his invaluable contributions to the research mission of the NLM and effective leadership of the Lister Hill National Center for Biomedical Communications Mr Wilson was recognized for demonstrating exceptional initiative, skill, and knowledge in developing and directing a highly effective NLM property management program

The NIH Merit Award was presented to six employees this year Sally Burke, with the Office of Administration, George Hazard, Jr , Division of Specialized Information Services, Joyce Backus and Nancy Selinger, Division of Library Operations, David Kenton, Office of Computer and Communications Systems, and Peter Clepper, Division of Extramural Programs Ms Burke was recognized for her consistently excellent staff work provided in support of the Office of the Director, NLM as well as her contributions to the administrative management functions of the Library Mr Hazard was recognized for innovation and diligence in making chemical information available to the scientific community with easy to use retrieval methods and reasonable prices Ms Backus was recognized for exceptional leadership and achievement in developing and maintaining automated systems for the Public Services Division and NLM Ms Selinger was recognized for sustained contributions to enhancing the accuracy and quality of the MEDLINE database Mr Kenton was recognized for his creative work in the design, development, and implementation of a proximity search capability for the MEDLINE Retrieval System Mr Clepper was recognized for superb professionalism bringing critical new extramural pro grams to fruition expeditiously and with commendable ingenuity

TABLE 13

Staff, FY 1995 Full-Time Equivalents

Program	Full-Time Permanent	Other
Office of the Director	13	3
Office of Public Information	6	1
Office of Administration	50	9
Office of Computer and Communications Systems	57	8
Extramural Programs	13	5
Lister Hill National Center for Biomedical Communications	70	9
National Center for Biotechnology Information	21	15
Specialized Information Services	31	5
Library Operations	236	34
TOTAL	**497**	**89**
TOTAL FTEs	**586**	

Appendix 1: Regional Medical Libraries in the National Network of Libraries of Medicine

1. **MIDDLE ATLANTIC REGION**
The New York Academy of Medicine
1216 Fifth Avenue
New York, NY 10029
(212) 876-8763 FAX (212) 534-7042
States served: DE, NJ, NY, PA

2. **SOUTHEASTERN/ATLANTIC REGION**
University of Maryland at Baltimore
Health Sciences Library
111 South Greene Street
Baltimore, MD 21201-1583
(410) 706-2855 FAX (410) 706-0099
States served: AL, FL, GA, MD, MS, NC, SC, TN, VA, WV, DC, VI, PR

3. **GREATER MIDWEST REGION**
University of Illinois at Chicago
Library of the Health Sciences
P.O. Box 7509
Chicago, IL 60680
(312) 996-2464 FAX (312) 996-2226
States served: IA, IL, IN, KY, MI, MN, ND, OH, SD, WI

4. **MIDCONTINENTAL REGION**
University of Nebraska Medical Center
Leon S. McGoogan Library of Medicine
600 South 42nd Street
Omaha, NE 68198-6706
(402) 559-4326 FAX (402) 559-5482
States served: CO, KS, MO, NE, UT, WY

5. **SOUTH CENTRAL REGION**
Houston Academy of Medicine-
Texas Medical Center Library
1133 M.D. Anderson Boulevard
Houston, TX 77030
(713) 790-7053 FAX (713) 790-7030
States served: AR, LA, NM, OK, TX

6. **PACIFIC NORTHWEST REGION**
University of Washington
Health Sciences Center Library
Box 357155
Seattle, WA 98195
(206) 543-8262 FAX (206) 543-2469
States served: AK, ID, MT, OR, WA

7. **PACIFIC SOUTHWEST REGION**
University of California, Los Angeles
Louise Darling Biomedical Library
10833 Le Conte Avenue
Los Angeles, CA 90024-1798
(310) 825-1200 FAX (310) 825-5389
States served: AZ, CA, HI, NV and U.S. Pacific Territories

8. **NEW ENGLAND REGION**
University of Connecticut Health Center
Lyman Maynard Stowe Library
263 Farmington Avenue
Farmington, CT 06030-4003
(203) 679-4500 FAX (203) 679-1305
States served: CT, MA, ME, NH, RI, VT

Appendix 2: Board of Regents

The NLM Board of Regents meets three times a year to consider Library issues and make recommendations to the Secretary of Health and Human Services on matters affecting the Library

Appointed Members:

NEWTON, Carol M , M D , Ph D (Chair)
Professor of Biomathematics
University of California
Los Angeles, CA

ALBRIGHT, Tenley E , MD
Two Commonwealth Ave
Boston, MA

BALL, Marion, Ed D
Vice President for Information Sciences
University of Maryland at Baltimore
Baltimore, MD

BOOKER, Naomi C
Chair and President
Marketing and Management Innovations
Baltimore, MD

CORTEZ, Edwin M , Ph D
Asso Professor, School of Library and Information Science
University of Wisconsin
Madison, WI

DEBAKEY, Michael E , MD
Chancellor
Baylor College of Medicine
Houston, TX

FULLER, Sherrilynne, Ph D
Director, Health Sciences Library
University of Washington
Seattle, WA

JOYNT, Robert J , M D , Ph D
Vice President and Vice Provost for Health Affairs
University of Rochester
Rochester, NY

NOLAN, George H , MD
Director, Department of Obstetrics and Gynecology
Henry Ford Hospital
Detroit, MI

PHILLIPS, Steven J , M D
Senior Heart Surgeon
Mercy Hospital Medical Center
Des Moines, IA

Ex Officio Members:

Librarian of Congress

Surgeon General
Public Health Service

Surgeon General
Department of the Air Force

Surgeon General
Department of the Navy

Surgeon General
Department of the Army

Under Secretary for Health
Department of Veterans Affairs

Assistant Director for Biological Sciences
National Science Foundation

Director
National Agricultural Library

Dean
Uniformed Services University of the Health Sciences

Appendix 3: Board of Scientific Counselors/ Lister Hill Center

The Board of Scientific Counselors meets periodically to review and make recommendations on the Library's intramural research and development programs

Members

MUN, Seong Ki, Ph D (Chair)
Director, Division of Imaging Physics
Georgetown University
Washington, D C

BRINKLEY, James F , M D , Ph D
Research Assistant Professor
Department of Biological Structure
University of Washington
Seattle, WA

BUCHANAN, Bruce G , Ph D
Professor of Computer Science
University of Pittsburgh
Pittsburgh, PA

HUNTLEY, Joan S , Ph D
Research and Development Project Leader
Weeg Computing Center
Iowa City, IA

KAHN, Michael G , M D , Ph D
Assistant Professor of Medicine
Division of Medical Informatics
Washington University
St Louis, MO

MITCHELL, Joyce A , Ph D
Director, Information Science Group
University of Missouri-Columbia
Columbia, MO

WILKERSON, LuAnn, Ed D
Director, Center for Educational Development
UCLA School of Medicine
Los Angeles, CA

Appendix 4. Board of Scientific Counselors/ National Center for Biotechnology Information

The National Center for Biotechnology Information Board of Scientific Counselors meets periodically to review and make recommendations on the Library's biotechnology-related programs.

Members:

SAUER, Robert T., Ph.D. (Chair)
Professor, Department of Biology
Massachusetts Institute of Technology
Cambridge, MA

CANTOR, Charles R., Ph.D.
Director, Center for Advanced Research in Bioltechnology
Boston University
Boston, MA

FITZGERALD, Paula, M.D., Ph.D.
Senior Research Fellow
Department of Biophysical Chemistry
Merck Sharp & Dohme
Rahway, NJ

PACE, Norman R., Ph.D.
Distinguished Professor of Biology
Indiana University
Bloomington, IN

SCHLICK, Tamar, Ph.D.
Associate Professor
Chemistry Department
New York University
New York, NY

WILLIAMS, Myra N., Ph.D.
Vice President, Information Technology
Glaxo Research Institute
Triangle Park, NC 27709

ZAMUDIO, Carlos
Director, Bioinformatics and Engineering
Sequana Therapeutics
La Jolla, CA 92037

Appendix 5. Biomedical Library Review Committee

The Biomedical Library Review Committee meets three times a year to review applications for grants under the Medical Library Assistance Act.

Members:

PEAY, Wayne J. (Chair)
Director, Eccles Health Sciences Library
University of Utah
Salt Lake City, UT 84112

BROERING, Naomi C.
Director, Biomedical Info. Resource Center
Dahlgren Memorial Library
Georgetown University Medical Center
Washington, D.C.

BUNTING, Alison
Associate University Librarian for Science
Louise Darling Biomedical Library
University of California
Los Angeles, CA

CLEVELAND, Ana D., Ph.D.
Professor of Information Science
School of Library and Information Sciences
University of North Texas
Denton, TX

EZQUERRA, Norberto F., Ph.D.
Associate Professor
College of Computing
Georgia Institute of Technology
Atlanta, GA

IYENGAR, S. Sitharama, Ph.D.
Professor and Chairman of Computer Science
Louisiana State University
Baton Rouge, LA

JACKSON, Sara Jean
Director, Research Medical Library
M.D. Anderson Cancer Center
Houston, TX

KULIKOWSKI, Casimir A., Ph.D.
Professor of Computer Science
Rutgers University
New Brunswick, NJ

MAVROVOUNIOTIS, Michael L., Ph.D.
Associate Professor
Chemical Engineering Department
Northwestern University
Evanston, IL

MUSEN, Mark A., M.D., Ph.D.
Assistant Professor
Depts. of Medicine and Computer Science
Stanford University
Stanford, CA

RANKIN, Jocelyn A., Ph.D.
Professor of Library Science and
Director, Medical Library and Learning Resources Center
School of Medicine
Mercer University
Macon, GA

ROE, Bruce A., Ph.D.
Professor of Chemistry and Biochemistry
University of Oklahoma
Norman, OK

ROSSE, Cornelius M. M.D., D. Sc.
Professor and Chairman
Department of Biological Structure
School of Medicine
University of Washington
Seattle, WA

SEARLS, David B., Ph.D.
Research Associate Professor
Department of Genetics
University of Pennsylvania
School of Medicine
Philadelphia, PA

VRIES, John K. M.D.
Assoc. Vice Chancellor for Medical Informatics
University of Pittsburgh Medical Center
Pittsburgh, PA

Appendix 6. Literature Selection Technical Review Committee

The Literature Selection Technical Review Committee meets three times a year to select journals for indexing in *Index Medicus* and MEDLINE.

Members:

COLON, Angel Rafael Jr., M.D. (Chair)
Professor of Pediatrics
Georgetown Univ. School of Medicine
Washington D.C.

ALTAMORE, Rita Ann, M.D., M.P.H.
Senior Lecturer
Department of Health Services
University of Washington
Seattle, WA

FURANO, Anthony V., M.D.
Chief, Section on Genomic Function and Structure
Laboratory of Biochemical Pharmacology
Nat. Inst. of Diabetes and Digestive and Kidney Diseases
National Institutes of Health
Bethesda, MD

HOAK, John C., M.D.
Director, Div. of Blood Diseases & Resources
National Heart, Lung, and Blood Institute
Bethesda, MD

MAKINEN, Ruth H.
Head, Technical Services
University of Minnesota
Bio-Medical Library
Minneapolis, MN

MATHIEU, Alix, M.D.
Professor of Anesthesia
University of Cincinnati
College of Medicine
Cincinnati, OH

PINCUS, Harold A., M.D.
Director, Office of Research
American Psychiatric Association
Washington, DC

PITTMAN, Constance Shen, M.D.
Professor of Medicine
University of Alabama
Birmingham, AL

ROLETT, Ellis L., M.D.
Professor of Medicine
Dartmouth-Hitchcock Medical Center
Lebanon, NH

STRICKLAND, Ora Lea, Ph.D.
Professor, School of Nursing
Emory University
Atlanta, GA

THOMAS, John A., Ph.D.
Vice President for Academic Affairs
University of Texas Health Science Center
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