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# The Health Sciences Librarian as Knowledge Worker

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## ABSTRACT

TECHNOLOGICAL DEVELOPMENT, ECONOMIC constraints, and changing expectations about ownership of, and compensation for, intellectual property, challenge librarians to demonstrate more forcefully the value of their contributions to their institutions. Knowledge work in the library setting is defined as the development of products and services designed to meet client information needs. In an academic setting, client information needs revolve around the activities of scientific communication. Health sciences libraries have begun to change in fundamental ways to meet this challenge, redefining their missions, re-educating their staff, and re-engineering their programs. Examples are drawn from the Welch Medical Library and other academic health sciences libraries to demonstrate different strategies for achieving a competitive edge in the campus information environment.

## INTRODUCTION

This article presents the changing role of health sciences librarians in academic medical centers and their part in the institution's scientific communication activities. Although discussion and examples highlight experiences of academic health sciences libraries, the concepts also apply to other kinds of libraries. Knowledge work in the library setting is the design of products and services to meet information needs. In the environment of scientific communication, those needs revolve around the retrieval, creation,

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LIBRARY TRENDS, Vol. 42, No. 1, Summer 1993, pp. 196-219

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manipulation, management, and dissemination of new knowledge. The current environment for knowledge generation in the academic medical center is characterized by rapid technological change, turbulent economic conditions, and changing expectations about the value and ownership of inventions and intellectual property. In this highly competitive setting, all partners must add measurable recognizable value to the enterprise if they are to receive continued institutional support. Products that no longer meet critical information needs of the institution's populations are discarded or left under- or unfunded; new products and services arise which support themselves through a mixed funding base dependent upon continued measurable usage.

### FUNDAMENTAL ASSUMPTIONS ABOUT LIBRARIES

The library is not simply a service organization but an institution that creates *products* and *services* to meet the information needs of its clients. This is as true for the small hospital information center as it is for the large academic medical library. Management and process models borrowed directly from manufacturing industries often divide the world into "production" and "service." This approach inappropriately limits the library's vision of how it can and should operate. Historically, the term "manufacturing" has been used to describe the development of a material product that is no longer the responsibility of those who designed and built it once it leaves the factory or foundry. An important difference between a library and a manufacturing company is the fact that the library also designs and provides *services* to support its *products*. Knowledge work involves the development of integrated information products and services. Services are tightly coupled to products; products are not developed without a complement of services, and services are not offered independent of products for which they were designed. Many libraries must change in fundamental ways to fit this model, redefining their mission, re-educating their staff, and re-engineering their programs.

Another basic assumption is that, as the scholarly communication system shifts from a paper-based system to a network-based electronic information transfer medium, the traditional roles of libraries will change in the process. Libraries, authors, publishers, and information seekers have shared responsibility for various parts of the existing scientific communication system. In the electronic networked environment, librarians will be required to demonstrate their value to the communication system through their knowledge work activities if they are to continue to be seen as viable participants in scientific communication. As the rewards for intellectual invention are

redistributed to recognize the value added by each contributor in the process, the value of the library's contribution must be clear. If the library is viewed as only a storage or service center rather than as an active participant in the information life cycle, then its value to the institution will diminish as new less costly storage media and service options appear on the horizon.

A final assumption is that libraries themselves must seek new roles in their respective information environments. It would be rare to find today an academic librarian who has not heard the terms "transformation," "restructuring," or "re-engineering" used by deans and other strategic planners on their campuses. The traditional roles and values of the past, where libraries operated as uncompetitive cost centers on their campuses, protected by noble values of "intellectual freedom" and "equal rights to information," are fast crumbling under the pressures of the new economic order. Health sciences libraries whose institutional support derives partly from fee-based health services and research grants—two intensely competitive domains—are increasingly called upon to prove their value to the institution through evaluative data and cost/benefit analyses. Such self-assessment cannot effectively be done within the traditional service center model of libraries.

#### *Management Perceptions of Libraries*

Nolan (1990), Drucker (1991), and Schlesinger and Heskett (1991), among others, insist that survival in the information economy of the 1990s and beyond means organizing for innovation, productivity, and competitiveness. Their point is that many services will experience in the 1990s the obsolescence and restructuring that has plagued manufacturing since the 1980s. Large automobile and steel plants closed, but smaller restructured plants opened in other parts of the country under different management philosophies. How can libraries benefit from this knowledge? What can be done to avoid obsolescence?

Academic libraries view themselves as knowledge-based organizations, and librarians view themselves as knowledge workers. They, along with their more satisfied scholarly clients, often describe the library as being "the heart of the university" or the "most valuable resource on campus." Yet little of the management literature outside the information science disciplines reflects such views, nor do management analysts seem to consider libraries to be critical elements of the academic enterprise. One problem is the perception that libraries are slow in stimulating and disseminating new technologies. Straub and Wetherbe (1989) note that: "Computerized libraries, on-line external database searching, and data extraction and conversion software" will be "technologies with limited impact during the

1990's" (p. 1337). "Even though computerized libraries, for example, would be 'a valuable increment in our capabilities' their impact will be limited, first affecting researchers and only later management..." (p. 1337). Without a proactive role in introducing and integrating technologies into the scholarly communication process, libraries are thus seen as ineffective.

Another problem is the perception that the library as an enterprise is outdated and/or dysfunctional. Management advisors and commentators call for the transformation or restructuring of academic and service organizations like libraries (Nolan, 1990; Schlesinger & Heskett, 1991; Penrod & Dolence, 1991; Roach, 1991). Bottom line values once were measured in terms of growth, size, number of transactions, and acquisition of new technologies; now they are more often calculated in terms of cost, benefit, quality, speed of response, functionality, and adaptability. Being the first to apply new knowledge, rather than being the first to apply a new technology, is now the measure of success. Technology is not itself a source of competitive advantage but rather a resource and support tool for achieving that advantage.

A more general, and more insidious, problem lies in the lack of well-recognized desirable products and services for which the library is seen as the best source. When librarians do not characterize their work in terms of products and services designed to meet information needs, they fail to clarify the parameters of their knowledge work for themselves or their information-seeking clients. Since the introduction of online MEDLINE searching in the 1970s, health sciences libraries and librarians have explored a number of additional roles and responsibilities in health information management and dissemination, including a range of what might be called "personal shopper services." They have acted as agents for the information seeker by gathering published information, seeking new sources, weighing responses, consulting on the design of personal databases, and packaging results into customized products. They have taken some services beyond the walls of the library, joining teams of clinicians or researchers to provide on-site consultation and delivery of information services or teaching the use of information management techniques and technologies in classrooms, labs, and offices. While doing this, health sciences librarians have been successful in acquiring new computational skills, deeper understanding of the distinctive information needs in subject disciplines, and expertise about the management of knowledge in distributed technology-intensive environments. They have been less successful at using their new knowledge toward innovation, permanent

membership in teaching, clinical service, or research teams, and product development for different markets.

In their search for organizational relevance, librarians have continually asked themselves what change is required. The question, Can we package the data we have differently? translates to actions like automating circulation. The question, Can we make libraries more useful? is answered by attempting to offer existing services in new locations, like the office or the bedside. Information industry analysts such as Collier (1991) say that these are the wrong questions. The proper question is, What information products and services do people in this area actually want and what will they pay for? For administrators as well as researchers, the desirable library of the future gives access to information products, tools, and services which meet immediate needs at an acceptable cost. For administrators, the issue of return on the investment is drawn in terms of financial resources; for researchers, it is drawn in terms of time and cognitive energy.

#### *Products, Services, and Work in Libraries*

The standard dictionary definition of a product is "something produced"—commodities or goods which receive tangible form through manufacture. Products have no innate qualities or utility; they are simply "available for use." Products have a known cost for materials; the product's value to any single user is not known and, hence, is not calculated into the direct cost. Service, on the other hand, is defined as labor that does not produce a tangible commodity. Service involves a transaction; implicit in the definition is an exchange between two parties. The cost of services is negotiable between the server and the served based on direct costs and expected value. Tangibility is a crucial element in both of these definitions. Services can produce satisfied or dissatisfied customers, but they cannot produce products. A third important term is "work." Work creates products by expending labor, whether the labor is mental or physical. Like service, work involves exertion; unlike service, work results in a product. These definitions clearly draw upon the manufacturing industry for conceptual underpinnings; products are *made*; service is *performed*. Work creates tangibles, service creates intangibles.

How well do these definitions of products, work, and services apply to what goes on in libraries? Libraries generally define themselves as purely service institutions. In this context, libraries create no products, and librarians do no work. Rather, they provide services for others, using their own labor and products available to them through the library setting. Clearly, a number of important traditional library activities are services, including question-answering, document delivery, and circulation. In the networked

computer-rich campuses of the 1990s, database searching, network management, and publication support are also important library services.

If the activity of libraries is viewed differently, however, one can easily identify a number of products which result from the knowledge work of librarians. For example, the physical collection of books and journals can be considered a product if assembly is an act of manufacturing (and manufacturing makes products). Tools that facilitate the use of the collection, like the online catalog or a network of CD-ROM players, are also products "engineered" by constructing an assemblage of other tangible goods. Even the library's skilled staff can be considered a product: resources brought to the library in different states, shaped through experience and continued learning. Other products typically developed by librarians include online tools such as tutorials and help screens for problem-solving algorithms, scripts for verifying bibliographic citations, and instructional programs for personal information management.

The importance of identifying the library's products is that it clarifies the fact that libraries produce something, and products can be assigned values and costs. Once the products are identified, the nature and substance of the services which support them are more easily characterized. By defining clearly their products and services, and by assigning properly the costs of production and support, libraries are in a position to evaluate their current programs, to make the case for new programs, or to re-engineer for competitive advantage. Without this background, libraries are not positioned to compete successfully against other suppliers of information products and services now populating the campus.

### *Competitive Advantage and Productivity*

An important part of competitive advantage is productivity, a composite measure of the rate, quality, and impact of product development. Once the library is seen as a place where products are created, attention turns naturally to the library's productivity—the fluency and quality and effectiveness of its knowledge work efforts. Health sciences libraries, as all units within the health industry (schools and hospitals alike), must confront the demands for improved productivity. That does not just mean doing more of the same thing faster or at a cheaper rate. Rather, it means increasing quality and quantity of the products without working harder or longer (Drucker, 1991). It means offering enough value that the benefit to the customer exceeds the price, which in turn exceeds the cost to the library for producing or supporting a product (Grenier & Metes, 1992). When the customer asks, Why shouldn't I do this for myself? the answer

has to be that she or he receives more from the library than if the work were done personally. Measures of a library's productivity might include the number and skillfulness of independent information seekers that graduate from its parent institution, the number, kind and usefulness of tools developed by the library, the extent of penetration into different information markets on campus, and so on.

Schlesinger and Heskett (1991) offer an instructive example of productivity and competitive advantage, contrasting the trajectories of two fast-food companies. Up to the mid-1980s, one company was enormously successful with its mass-production approach of creating a product and then marketing it. At the end of the 1980s, it had flat or falling sales, little or no growth in productivity, rising costs, and increasingly disaffected customers. To maintain competitiveness, Company #1 invested in creating and marketing new mass-produced food products with little success. In this same period, Company #2, another fast-food operation, started with service rather than food production as its core structural design. Instead of the manufacturing-derived "what you see is what you get" approach, Company #2 concentrated on customer desires for fresh, healthy, tasty food at low cost served in clean surroundings. As a result, Company #2 experienced phenomenal growth. This company recognized the demand of its customers, designed the product, and put additional energy into product-related services. By recognizing itself as a products *and* services operation, Company #2 gained competitive advantage over Company #1.

The analogy for libraries may be more obvious with hardware stores rather than fast-food companies. Old-fashioned hardware stores offered a small stock of basic items coupled with staff expertise on how and when to use them. The huge warehouse-style hardware stores with miles of aisles and multiples of very similar products, which replaced the old style stores, are finding themselves no longer competitive. They cannot maintain the inventory, and customers want something else. Customers value the service model where the staff know the products so well that they lead the customer to what is needed to solve a problem; advise on quality, strengths, and weaknesses of the products; help assemble all the parts needed to get the job done; and, in some instances, contract with the customer to do the job. When hardware stores failed to recognize that they were offering both products and services, they reduced the initial competitive advantage gained by "one-stop shopping" and wide-ranging choice.

### COMPETITIVE STRATEGIES FOR LIBRARIES

In every sphere of traditional operations (e.g., document delivery, bibliographic instruction, reference services), the library now has

competitors. Schlesinger and Heskett's (1991) statement about commercial service operations applies equally to the environment in which libraries now find themselves: "For years, customers had no alternative but to accept the poor performance and limited quality that were designed into almost every service operation. Today they do" (p. 81). Without recognizing and measuring their own productivity, librarians cannot capably defend themselves against charges of inefficiency and dysfunction, or against incursions by other information services vendors into their once-protected turf. One approach to this kind of self-guided transformation has been termed re-engineering (Hammer, 1990). Re-engineering focuses attention on the operational levels of an organization and mandates the re-evaluation, realignment, and redistribution of work tasks in relation to desired outcomes. Re-evaluation means questioning the purpose and value of existing products and services and discarding those that do not capitalize on technological capabilities. Realignment means organizing services around products and organizing work around outcomes. Redistribution means giving decision and control to those who use the output of a process (e.g., the product or the service). Libraries and organizations that have engaged in serious strategic planning over the past decade will find it easier to apply the principles of re-engineering than will those operating in the "business-as-usual" mode.

#### *Strategies for Document Delivery Services*

One arena of library operations where the competition is keenly felt is the delivery of published information to clients. Increasingly, publishers and commercial entities offer document delivery services directly to information seekers, bypassing local libraries completely. For example, one document service offers document delivery from tables of contents of 12,000 journal titles at a fee of \$10-12 per article.<sup>1</sup> Delivery via electronic facsimile can be within 24 hours for an article processed for the first time or within minutes for items previously processed. Primary scientific publishers like Springer-Verlag and Elsevier have been positioning themselves over the past decade to become the sole source for their publications in electronic form, and Williams & Wilkins has begun to offer document delivery for articles in journals it publishes. These services strike at the heart of the traditional view of libraries, where providing access to documents is the library's *raison d'être*.

Some strategies for competitive survival in this arena are beginning to emerge in academic libraries. The library can act as a *facilitator*, encouraging the relationship between the library's clients and commercial vendors. This approach has been adopted by the

Applied Physics Laboratory (APL) Library of The Johns Hopkins University (JHU).<sup>2</sup> The APL Library plans to provide its users with direct access to a document delivery service. APL Library clients can treat the service as an index to the library's journal collections. Users can charge document orders directly to their departmental accounts or to personal credit cards. Of course, users can also continue to use journals in the library or request interlibrary loans for articles in journals not owned by the APL Library. However, the APL Library expects over time that users will find the convenience of direct ordering and rapid delivery worth the costs and will use the library less and less as a document source. Employing a product developed outside APL, the library re-engineered its document delivery services by placing the user in charge of identification and ordering.

A second approach libraries can adopt in the document delivery arena is that of direct *distributor*. At least one health sciences library is negotiating with a publisher to be its electronic document dissemination source on an experimental basis. A few university libraries, such as the University of Southern California and Cornell University, have other collaborative experiments with publishers well underway. In a different scenario, the library might instead opt to act as the user's agent, developing in-house products and services to support fully-electronic transfer of locally-mounted materials. This approach, more in line with traditional views of the library, is to assume the role of a network server. As a *server*, the library mounts electronic text and data files and provides access routes to them via the campus network. Within the University of California system, mounting full-text files for multicampus access is under investigation.

If electronic books and publisher-controlled on-demand journal articles are commercially viable, academic institutions may re-enter or compete more strongly in the scholarly publishing industry, as they did prior to the 1970s. In this scenario, the library might assume publishing roles such as providing scientific editing services, data management and quality control of electronic text, and "outsourcing" database extracts to typographers and printers. This fourth strategy, adopted by the Welch Library in its work with authors and editors of *Online Mendelian Inheritance in Man (OMIM™)*, the *GDB Human Genome Data Base (GDB™)*, and the *Principles of Ambulatory Medicine (PAM)*, involves the library directly in the processes of scientific communication as a publisher.

#### *Strategies for Library Instruction Programs*

Bibliographic instruction is another fertile ground for re-engineering in health sciences libraries. Training individuals to use the bibliographic tools that provide access to biomedical knowledge

has been the mainstay of library education programs. As personal computers became ubiquitous, many libraries broadened their instruction programs to include training on a very broad array of software packages for scholarly information handling from desktop publishing to database development. Likewise, as online bibliographic databases became a significant reference source for scholarship, libraries added database search training to their array of courses. The focus of these educational services has usually been to provide familiarity with products or tools and their features. Introduction to DOS, Using WordPerfect™, Using GRATEFUL MED™ are typical of such courses. Increasingly, however, computer centers, campus continuing education programs, and off-site consultants or software stores offer a vast array of training options for adults seeking to learn to use computers or improve their skills with application programs. Integration of computing in elementary and secondary education are making introductory computing skills courses unnecessary for incoming students.

Rarely have library instruction programs attempted to teach their clients how to apply technologies to solve their domain-specific information needs. The shift in emphasis is subtle but important—such courses must be content-centered rather than process-centered, building technical proficiency in the context of scientific research. Information seekers are not seeking primarily to become expert searchers. Rather, they wish to learn the most effective strategies for finding and managing knowledge. In 1991, the Department of Biological Chemistry at the Johns Hopkins University offered a credit course, organized and taught by the Welch Library, entitled *MEDLINE and Beyond: Survival Skills for Information Management*. In this course, retrieval and organization of scientific information were taught within the context of the department's disciplinary knowledge, with problems and examples drawing upon chemical/structural or molecular biology/genetics databases for answers.

In shifting emphasis from process to content, library education programs can help improve the institution's knowledge productivity by teaching clients to apply tools to solve their information problems and by educating clients to design better tools to accomplish their work. Such programs are best designed and presented as a curriculum. The Welch Library's curriculum in scientific communication includes ten lectures and workshops on such topics as drafting a research paper, citation management, peer review, developing poster sessions, slide preparation, and abstract writing. Information literacy programs that incorporate increasing levels of complexity and content management are another important example of curriculum design for knowledge work (Ball et al., 1989; Association of American Medical Colleges, 1989).

*Strategies for Reference Services*

Another indication of the changing perspectives and needs of information seekers is the demand for new and different services. For several years, the Welch Library has managed a small satellite library for the Oncology Department, providing a traditional array of reference services and on-site collections. In the latest renewal negotiation for the management contract, the department proposed to eliminate most of the print collections and all traditional reference desk services such as citation verification and question-answering. In their place, the department funded a full-time "knowledge worker," a librarian whose job is to: (1) teach students, faculty, and staff to find and manage the information they need for their work, (2) assemble computing and communication technologies for use in scientific communication, and (3) provide consultation on tools and techniques for solving specific information problems.

The oncology example is one way a library's reference service can be re-engineered for competitive advantage. When the library's primary mission is the design of products and services to meet information needs, the appropriate response is a radical restructuring of this type, rather than an attempt to convince the department that existing programs are simply misunderstood or misused. Another approach adopted by health sciences libraries is to maintain traditional reference desk functions and complement them with specialist positions that cater to individual and departmental requests for assistance. Often, these specialist positions require a doctorate in a subject discipline relevant to the institution's research or clinical programs. The Personal Information Management Specialist positions at the Welch Library and the University of California, San Francisco Library are examples of this approach.

Re-engineering reference services presages the need for a fundamental redefinition of scope for the library's other programs, so that courses on software application or the design of a workstation environment replace bibliographic instruction programs or a mediated search service. It also results in a need for tools—guides, tutorials, menu interfaces—which help the independent information seeker to work effectively. The shape and function of these tools are defined through the dialogue between the librarian-knowledge workers and their clients.

*Building Tools for Scientific Communication*

The traditional expertise of librarians lies in several arenas. Perhaps the most fundamental and enduring is the creation and management of a system for organizing and describing information entities. In current terminology, this involves categorization,

knowledge representation, and database design. Periodically, this knowledge is re-invented or, occasionally, rediscovered. For example, those who have enthusiastically embraced document image processing (DIP) have discovered the need for retrieval mechanisms such as indexes, subject headings, and vocabulary control.

These and related library techniques have evolved over untold thousands of worker-years of deep experience in document-collection management...But think for a minute. Did librarians come up with such schemes because they enjoy complication? More likely, these techniques exist because they—or something very much like them—are crucial to doing the job. (Locke, 1991)

A second arena of librarian expertise is facilitating access to information, including the Johnsonian kind of knowledge (i.e., knowing where to find information on a subject) and also assembling the means for getting it. Computer terms for this work include interface design, network engineering, and knowledge acquisition.

As technologies have made it possible, the expertise of librarians has increasingly been expressed through computational tools that are the work of librarians themselves. The lineage in health sciences libraries includes Frank B. Rogers (the National Library of Medicine's MEDLARS system), Estelle Brodman (first automated card catalog and online serials control system named PHILSOM, for Periodical Holdings in Libraries of Schools of Medicine), Irwin Pizer (developer of the SUNY Network, precursor to BRS), and Naomi Broering (MiniMEDLINE™, LIS™, and BioSYNTHESIS) (The National Library..., 1961; Pizer et al., 1963; Pizer, 1984; Broering, 1985; Georgetown University, 1988; Broering et al., 1991). Over the past two to three years, some other library management tools have been reported in the literature but, by and large, tools that improve individual or functional productivity have not emerged from libraries (Slach, 1985). This is partially a reflection of the traditional library ethic that emphasizes service over product development.

To build effective tools for scientific communication, libraries need to be deeply involved in the creation and management of new knowledge developed at their institutions. Helping researchers locate published knowledge does not provide sufficient insight into the functional requirements of tools for knowledge work. Call it toolworks or something else, but some group in the library must be charged with the responsibility for finding and/or building tools for managing knowledge. They must be constantly evaluating new products in light of their clients' information needs, making office calls, providing consultation services, offering themselves as contractors, gathering feedback, and measuring product effectiveness. The toolworks group must also create new tools, tools that can be

used by different departments within the institution, tools that can be taken to market by entrepreneurs. The biological sciences environment understands productivity of this kind as professionalism. Broering's development and sales of the LIS™ System was a proof-of-concept as well as a major breakthrough, earning for herself and her library the latitude and freedom to pursue innovative research (Broering et al., 1991).

The roles that health sciences librarians play in the electronic scholarly information systems of the future will be shaped by how scientists and clinicians view the library's importance to managing the knowledge of their disciplines. Understanding the integral nature of service to product is a critical concept in the networked electronic information environment, one that is new for many scientists. In the past, authors were concerned solely with the creation of intellectual products. Their responsibility for these products did not extend to maintenance of the product longitudinally in a real-time fashion. For example, four years could pass before another edition of a textbook had to be prepared. Gathering information for updating the edition could be left until the year before publication. Feedback from users of the product (i.e., readers and colleagues) was expressed in terms of sales and, sometimes, personal glory. Rarely were authors contacted directly to support or explain their claims, nor were they asked to offer support to the users of their products, beyond the informal collegial exchange of data and experience. That model of communication, mandated by the processes of the publishing industry, is not viable in the fast-paced creative environment of networked science. In the networked environment, few information products can stand alone without a support system. In the networked environment, the scientist must build a library rather than a manuscript. That is, the creation of an information product (i.e., a manuscript or text) must be accompanied by appropriate services (e.g., question answering, consultation, quality control).

### INTEGRATION AS A COMPETITIVE STRATEGY

In the networked environment of scientific communication, the health sciences library has an opportunity to market its expertise directly to the scientists at its institution. The Welch Library's Applied Research Laboratory has integrated the library into scientific communication at Johns Hopkins through its work in the development and management of the Online Mendelian Inheritance in Man database (OMIM™) and the Human Genome Data Base (GDB™). In each case, librarians worked with scientists and software engineers throughout the various steps in designing, building, testing, and implementing an important source of disciplinary knowledge.

Integration at each step demonstrated the value added by library expertise to the entire project, and clarified the continuing roles appropriate for the library in ongoing management. For example, the interface design and search features for the software used to search OMIM™ were shaped by the online searching experiences of the librarians, who provided a context that the author himself could not. Software tools used by the author and his editorial staff underwent constant modification as the advantages of online searching and editing became more apparent to them. Welch librarians initially provided user support to the author and editorial staff as they learned to use the authoring tools. Later, this support extended to distant users as the database became available across national and international networks. Collaborative roles in managing the OMIM™ online database extend to the production of *Mendelian Inheritance in Man*, a printed derivative from the online file. Book format design and presentation are determined by the author and publisher. Requirements for the production tape, from which the book is electronically typeset, are determined by the publisher, printer and the library's book production manager. Book production for the tenth printed edition of *Mendelian Inheritance in Man* was managed by the Welch Library's Assistant Director for Database Development & Access (the equivalent of the Head of Technical Services in other library organizations). The value of the library's work in the publication of the book is recognized through an agreement wherein the publisher, author, and library share royalties on sales.

Staff at the Welch's Applied Research Lab are similarly integrated into the production and management of the GDB™. Because the GDB™ is a scientific data file whose contents are continually reviewed and updated by the scientific community, domain knowledge is required of Welch staff who work with the database content and scientific editors. Training and user support services for the GDB™, a relational database with hundreds of data elements, require staff to understand questions being put to the database, and to understand the data structures and query capabilities of the software as well. The educational and experiential requirements for librarians seeking integration into scientific knowledge work of this kind are being clarified as the database grows and matures. For now, they include library science training, graduate-level biological science, and computer science skills.

*The Integrated Academic Information Management System (IAIMS)*

Participation in the daily work of scientists is not the only integrating strategy employed by health sciences libraries. For a

decade, since the publication of the IAIMS report (Matheson & Cooper, 1988), academic health sciences libraries have explored mechanisms for integrating information within their institutional settings (Lucier, 1990; West & Katz, 1990; Moulik & Lai, 1992; Lorenzi, 1992). In many IAIMS models, the library sits at the center of the campus information network, serving as an integrating force and a central access point for the medical center's disparate scientific, administrative, and scholarly databases. In these settings, coordinated access to the university's information resources is offered through an information system centered at the library. At Columbia University, the Augustus C. Long Library's leadership of IAIMS development led to the Columbia-Presbyterian Medical Center's CPMC/IAIMS network, providing access, through a single "window," to clinical information systems, administrative files, scholarly databases, and electronic mail for its on- and off-campus clients (*Guide to the CPMC-IAIMS Network*, 1992). The Willow interface, developed at the University of Washington, offers access to a similar range of resources through an innovative interface which integrates information-seeking functions regardless of the type of database being searched (Ketchell, 1992). Similarly, through BioSYNTHESIS, Georgetown University offers an interface that gives clients access to locally mounted full-text resources, medical decision support tools, and bibliographic files, as well as providing a gateway through national networks to remote information resources (Broering et al., 1991).

IAIMS models embed the library into the corporate framework of the institution in new and powerful ways. As Anderson and Fuller (1992) note, IAIMS requires "the participation of librarians in areas outside their traditional purview in order to support the institution's general educational and administrative goals" (p. 200). For example, early IAIMS activities at the University of Utah led to institutional integration beyond the medical center. The Eccles Health Sciences Library's work on networking information resources, and the early introduction of a public computing center at the library, brought campus-wide recognition of the library's leadership role in developing information management systems. The director of the health sciences library now chairs the university's task force on computing, responsible for allocating several million dollars for instructional computing (W. J. Peay, personal communication, August 31, 1992). In these and other IAIMS models, the library's role as an initiator of action places it at the center of a larger institutional landscape. The emphasis on integrated access increases the importance and visibility of knowledge network administration and highlights the need for institution-wide agreements about appropriate databases and access levels.

*A Model Integrative Strategy: The WELCH Workstation*

A view of the Welch Library's strategic plan is offered as an example of how the library's products and services can be arrayed to accentuate their place in the processes of scientific communication. In this picture, the focus is on creation and dissemination of new knowledge. If a different aspect of the institution's mission were addressed (e.g., the service or education goals), a different view would prevail. The workstation metaphor employed in the example emphasizes the fact that the scientist's knowledge work is the center of attention. The name of the workstation, the Welch Electronic Library and Center for Health Knowledge (WELCH), reflects the presence on the user's desktop of the Welch Library's considerable human and knowledge resources. The menu structure for the workstation groups the library's products and services in terms of the fundamental activities of scientific communication—i.e., retrieval, organization, creation, management, manipulation, and dissemination of new knowledge.

The initial entry menu to the WELCH workstation serves as a directory to library offerings (see Figure 1). A library card is the switch that turns on the WELCH workstation. Each selection on the general menu represents a significant library program; library programs are centered on activities in the information life cycle.

**Databases Menu:** The Databases selection on the workstation's entry menu supports *retrieval of knowledge* from existing databases. Databases may be locally developed, commercially developed and locally managed, or remotely located and managed. They may be bibliographic databases or scientific data files.

Databases listed on the WELCH workstation are public databases available to all library card holders, defined as important bibliographic or data sources for the library's community of scientists. Figure 2 illustrates the current set of databases available to the Johns Hopkins Medical Institutions (JHMI) community; they include locally mounted and managed files and links to remote files:

- the JHMI Online Catalog, an integrated file of book, journal and audiovisual holdings in libraries on The Johns Hopkins University's East Baltimore campus;
- MED2000+, offering access to MEDLINE and Health Planning and Administration databases;
- Hopkins Current Contents™; a link to a locally-mounted Current Contents™ database jointly funded by the Welch Library, the University of Maryland's Health Sciences Library, and the APL Library;

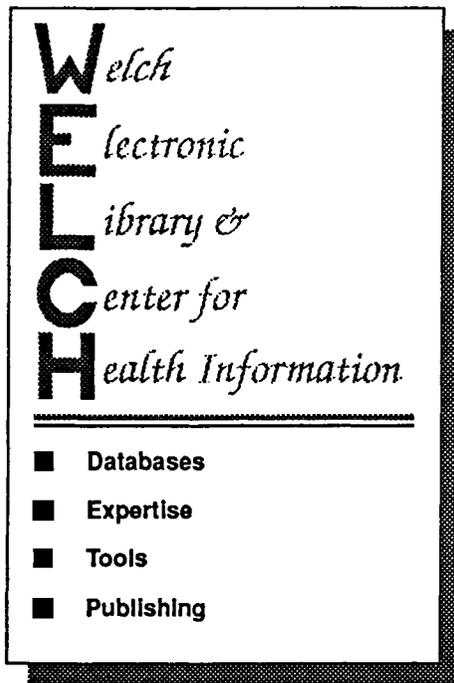


Figure 1. The WELCH main menu

- GDB™ and OMIM™, human genome databases hosted at JHU and managed by staff and faculty at the Welch Library's Applied Research Lab;
- WELCORK, an alcohol resources database developed at Dartmouth;
- JANUS, the online catalog of JHU's Milton S. Eisenhower Library;
- Gateway to BRS Colleague™ databases, the most popular commercial source of information for departments at JHMI;
- NIH Clinical Alert(s) made available locally online.

Ideally, any database listed on the workstation's entry menu offers a standard complement of products and services—no database is added to the Databases menu without this minimal set in place. These requirements include:

- *Registration*: New users can register online for passwords and access.
- *Tutorial*: Users can choose self-instruction through programmed tutorials. These tutorials may be developed in-house or purchased from database vendors.

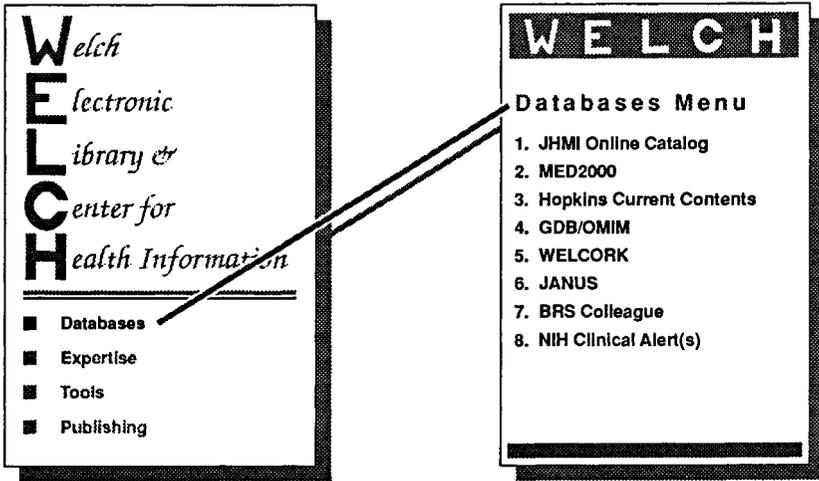


Figure 2. The WELCH databases menu

- *Online help:* Users can get online assistance when working where in-person consultation is not available.
- *Directory of consultants:* Users can identify librarians and other campus resources with expertise about this database or topic.
- *Directory of training:* Users can find and register for course offerings to obtain in-person instruction for this database.
- *Search and retrieve:* Users interact directly with the database. Ordering items listed in the database is offered within the search & retrieval module.
- *Direct order:* Users who know what they want can order directly without entering the search and retrieval module of a database. Orders may be for items the library owns, or for data to be borrowed or purchased from another source.

**Expertise Menu:** The Expertise menu (see Figure 3) supports the *knowledge organization and management* needs of the library's clients. It describes products and services available via individual consultations with library staff. In addition to their work developing the knowledge bases accessed through the Databases selection, Welch librarians offer tailored support for scientific communication activities. Products and services that draw upon library expertise include:

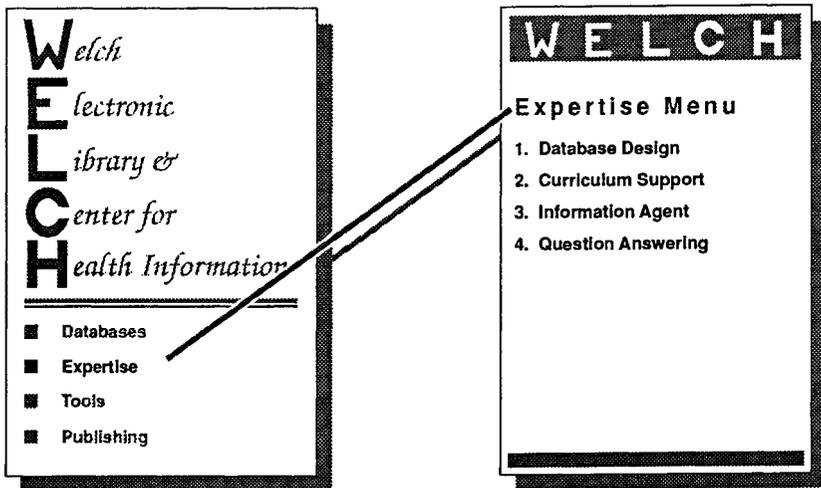


Figure 3. The WELCH expertise menu

- **Database design:** Users can request assistance in designing personal databases for storing scientific or bibliographic information to be used for research and publishing. Guidance on managing reprint files, thesaurus and index design, and recommendations for appropriate technologies are part of this consultation.
- **Curriculum support:** Users who teach can arrange to incorporate information management techniques or products into their courses. Formal instruction within classes, development of new courses and curricula emphasizing information management skills, computer-based instruction, journal clubs, and lab sessions are curriculum options.
- **Information agent:** A consulting service which gathers and packages information on a subject. The result is an information product built or selected based upon specifications from the information seeker.
- **Question answering:** Traditional in-person question answering available at reference desks is also offered.

**Tools Menu:** The information life cycle involves *creating and manipulating new knowledge* before it is disseminated via formal

and informal media. The library provides a set of tools (see Figure 4) for knowledge work whose design draws on librarians' own experience as purveyors of information products and services. A conceptual framework exists for these tools, based on the Welch Library's knowledge work with OMIM™, GDB™, and PAM. The tools are often locally developed shell scripts, templates, and macros. They may also be public domain products gathered and assembled with the community's needs in mind, or commercial products for which site licenses and network accessibility have been arranged.

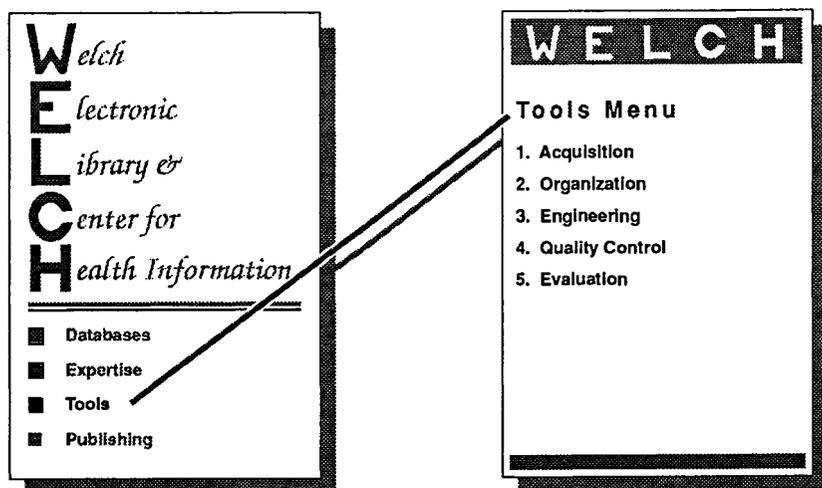


Figure 4. The WELCH tools menu

- *Acquisition tools:* Authors need tools for reviewing and compiling knowledge from outside sources. Acquisition tools include scanners, import/export tools, "cameras" to capture data snapshots online, and dumping programs which transfer data directly from one database to another.
- *Organization tools:* Authors need tools for structuring and indexing data they create or acquire from other sources. These include automatic thesaurus construction for documents, files, text segments, or data. Database programs are organizing tools, as are outliners and graphic mappers.

- *Engineering tools*: Users will want to reconfigure data to fit different programs or uses. For example, a bibliographic record captured from a remote database can be stripped, restructured, and matched to the library's online catalog or the researcher's personal files to see if the item is locally available.
- *Quality control tools*: Typographical errors, missing fields, and other problems which impede retrieval must be amended. Authority control, spell checking, and dictionary and field matching are other examples of quality control activities.
- *Evaluation tools*: Quality testing of databases via sampling, review of user transactions and characteristics, comment capture, and automatic statistical comparisons and growth projections are examples of evaluation techniques which require tools.

**Publishing Menu:** The Publishing selection on the WELCH workstation's entry menu (see Figure 5) offers scientists tools and services that support *dissemination of knowledge* through formal and informal channels of scientific communication. Although libraries have traditionally remained outside the publishing process, their work in designing and managing knowledge bases created on their campuses positions them to take a leadership role in this area. The selections on the Publishing menu include:

- *Authoring*: Shell scripts, translators, and parsers for introducing Standard Generalized Markup Language (SGML) or other markup into standard word processing files allow the author to work with familiar tools to develop a more flexible manuscript file. Presentation graphics and layout tools offer preliminary views of the written text and numeric data.
- *Scientific editing*: Electronic collaborative writing requires tools for exchanging and marking up documents shared among authors. Text analysis programs provide data about the level and nature of the manuscript's contents. Editorial consultants can also be requested.
- *Publication management*: In the networked environment, scientific authors will publish by drawing data from personal and public databases and reformatting it for publication. Generating indexes, extracting data to fit established templates, verifying file sizes, and other production activities require electronic tools. The library may offer publishing services such as scheduling production of manuscripts and extracts, organizing sources to handle printing and distribution, preparing tapes for electronic typesetting, and running data verification programs.
- *Electronic conference*: Informal communication among scientists is supported through conference facilities which make moderating

and reviewing incoming messages possible with familiar tools. Simple extracts from personal files (e.g., unpublished data) are made by the scientist without library assistance.

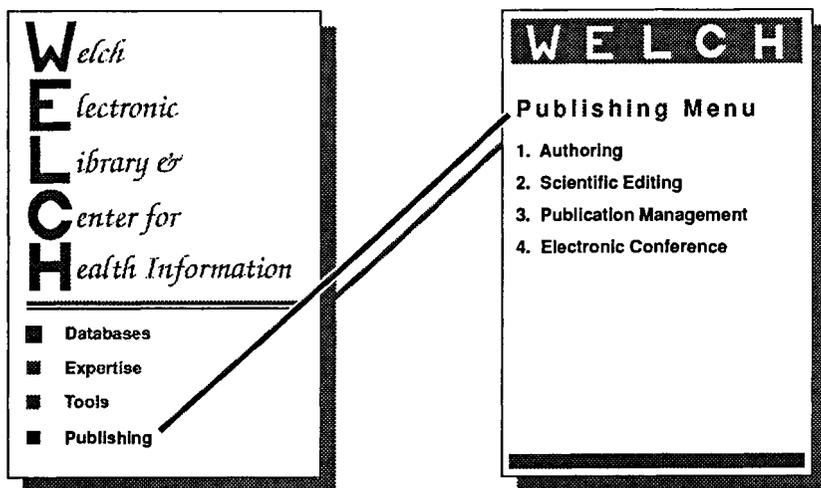


Figure 5. The WELCH publishing menu

## CONCLUSION

Academic institutions devote their resources and energies to research, teaching, and service. The Welch workstation, with its menus of knowledge-centered products and services, exemplifies one future for health sciences libraries, a future where the library is both integral and critical to the university's mission to create and disseminate new knowledge. The library designs and offers products and services that help scientists locate, discover, shape, store, and publish the data which derive from their research. Products are chosen or developed on the basis of explicit demand, and services are tightly bound to products. Some products and services are prepackaged while others are custom-tailored to meet the needs of individual information seekers. Consultation to develop customized products and services generates new ideas for development of new, more general, offerings.

Other futures are possible, employing different integrating strategies or different mixes of products and services. Whatever path

is chosen, positioning the health sciences library for competitive advantage requires immediate action in two arenas: the library must exploit fully the capabilities of computing and communication technologies, and it must redefine its products and services to be (and be perceived as) integral to the work of the institution.

## NOTES

<sup>1</sup> CARL (the Colorado Association of Research Libraries) Uncover™ service provides this service to libraries across the United States. The FAXON Company's FAXON Research Service and OCLC, Inc. plan on providing similar services for at least 10,000 journals, and other firms, including Engineering Information, Inc., Marine Biology Laboratory Library at Woods Hole, and University Microfilms International are also getting into the business.

<sup>2</sup> The APL Library uses the CARL Uncover™ document delivery service for this purpose.

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