# THE ASTRONOMICAL LIBRARY OF THE FUTURE

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Daniel Bell, of Harvard, has said that "The world society is like a set of giant Calder mobiles, shifting in uneasy balance in accordance with the winds of change, but the exact configurations are difficult to capture - especially for twenty-five years from now." Twenty-five or thirty-five, the number is not important - any look into the future is difficult and risky. In order to get a sense of what the future of astronomy libraries may be, I want to talk about some of the changes that are beginning to take shape and then look at the effect those changes are likely to have on all libraries including those that concern us today - astronomy libraries.

We know, first of all, that technological change associated with computers has been extraordinarly rapid in the past thirty years. We have seen computers shrink from a room full of vacuum tubes and wired boards down to "lap-top" computers which people carry around at meetings and on airplanes. At the same time we have seen the computing power, speed, and storage capacity increase at seemingly unthinkable rates - doubling every few years. Along with these global changes we also find that young people are becoming increasingly familiar and comfortable with computers - in this country and elsewhere, children use them in their first years at school and college freshmen are, in some cases, required to bring them to school, much as they would have taken a slide rule or a typewriter barely a generation ago. These are the broad, sweeping changes that are easy to see. But other more, subtle developments will affect not just the amount of use but also how we use the so called "information technologies."

In contrast to the image they often evoke, libraries are technology-intensive environments. For decades, if not centuries, librarians have turned to technology in its various forms as a means of coping with the ever increasing masses of infomation in their charge. Until quite recently the adoption of microcards, microfilm and micro computers ( to name a few ) was simply a means of fiscal survival and a way to do traditional tasks faster and better. The new storage media of microforms and compact disks temporarily solved the problems of storage and preservation, while micro

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and main frame computers provided accelerated access to authors, titles, and subjects of the traditional card catalog.

But the world is changing, and the new technologies go far beyond allowing librarians simply to do things faster. Technology now opens up libraries in previously unimagined ways. The barriers to access and use of information, which generations of library patrons have taken for granted, are now thrown aside and, in a very real sense, traditional libraries are fading from the scene. What will wreak such change as to cause the disappearance of the traditional library? Artificial intelligence is a large and critical component of that change.

It is not suprising that people are confused, and even put off by the phrase artificial intelligence. It has two senses. When we speak of artificial flowers we may talk about how real they look, yet they have none of the other properties - the feel, the smell, and the eventual wilt - of flowers. They are imitation - fabricated to look like something they are not. Artificial light or artificial diamonds are also fabricated, but once created they behave like the real thing and serve the functions of natural light or mined diamonds. Individuals who see the promise of artificial intelligence see it as being as useful as natural intelligence and serving many of the same functions as natural intelligence.

A particularly appealing way for information people to think of artificial intelligence is the following: it puts into motion the thinking that is embodied in writing. We are comfortable with the written word, yet it substitutes for the speaker and is artificial in that sense. The link between AI and writing is interesting in that it places AI technology on a continuum which began with the invention of symbol systems in 4,000 or 3,000 BC. The invention of moveable type in the 15th century was revolutionary in its impact on sharing knowledge, and AI, 5 centuries later, is the next giant step along the continuum.

What will AI mean in practical terms - what will it do for our day to day use of information? First of all, it will allow better integration of multiple technologies. Currently we find libraries using compact disks or CD ROMs, microcomputers, dial-up access to large databases as well as local systems for online catalogs and circulation systems. We can look forward to an integration of these and other still-developing technologies all working together more effectively to serve the needs of the individual user. We now have software tools that allow for the integration of text,

graphics, sound, and animation so that, to the user, they appear to be a single medium rather than a set of separate juxtaposed tools. This integration has created a new challenge for designers of information systems. It offers a new medium with which to create a more complete, or all-encompassing, environment for information transfer. The challenge is learning to deploy the medium effectively. We need to learn how to compose creatively in all these media, simultaneously. We are moving toward a new literacy - one which uses all the senses to teach rather than recording abstract symbol systems alone.

One role of today's librarian is to assist the user in determining which information resources to use, and how to get access to them. The days of merely going to the shelf and pulling off what you need are fading fast. Some of the most powerful information tools we have are not on our library's shelves but at the end of a telecommunications link. Such resources are usually expensive to use and difficult to manipulate. They are built to take advantage of a particular body of knowledge or tailored to the needs of a specific clientele. For a non-specialist they can be nearly impossible to use productively. That too is changing as a result of artificial intelligence. Systems which have an overlay of AI will be able to do what the librarian does now - question the user about their needs and provide access to the appropriate systems. Expert systems fulfill such a role in many settings today. They are not yet able to span the breadth or diversity contained in the ordinary library, but that will come. Much of the work that remains to be done in fact calls upon the skills of the librarian. Information must be structured and linked in ways that make it capable of manipulation by computer systems. No profession understands information better than the librarian, yet the librarian has not played a significant role in the field of AI. This is something that should concern each one of us.

Let me move on to another change - the creation of systems that meet the individual needs of a user, systems that are *user sensitive*. Librarians have traditionally forced individuals into conforming roles. Whether in card catalogs or online catalogs, users had to search using standardized formats, by author, title, or "our" subject headings. They had to view the world as we did or our systems were not useful to them. Although in general terms our minds all operate in comparable ways, within our various cultures the frames of reference are different, and within each culture for every individual the structures and systems of the mind are unique. In the near future users will be free to use their own thought patterns, their own associations and view of the world, to retrieve information.

As increasing amounts of information become available online, users will have entirely new options for identifying what is relevant. Computer-based systems will perform simple mappings between the vocabulary of the astronomer and that of the beginning student. Systems will help users move among files and separate systems regardless of how different they are from one another.

The concept of the personal computer will also change. As the costs of computer time and equipment decline and the cost of human time increases, we will see a growing use of computing directed at individual productivity. Such equipment and software will be personalized to an individual's needs and will change over time as the system "learns" from its human companion how she or he works - how the individual prefers information to be sorted and displayed, what level of error is acceptable for various tasks, what authors or journals are most valued, etc. These qualities describe today's librarians. In the future those functions will be part of an information system, not the responsibility of an individual.

There is a third, and critical, trend - that of the disembodiment of the traditional library. Some kinds of information will remain very much unchanged - popular novels, newspapers, some magazines. For those kinds of information the convenience of print on paper remains critical. For scientific information, however, we will see a dramatic change. A considerable proportion of the scientific literature that we come into contact with on a daily basis is, at some point in its production, in electronic form. In the case of some journals the manuscript is submitted on floppy disks, edited online, and sent to a computer-driven printer. Up until now electronic information available in libraries has primarily been about information - that is cataloging records, citations to articles, etc. Because libraries have held the actual information, the journals and the books, they remained very much in the picture. As increasing numbers of journals become available as full text files, the role of the library changes. Information that is available electronically does not need a library to store it. Users will be able to access it from their offices, the remote observatory, and their homes and they will decide what to print out. Print will still be important but the choice will be the individual's. Just as you go into the library now and photocopy an article, you will eventually look at the journal online and only print off what you really want to study. No one is suggesting astronomers or anyone else will spend hours staring at screens reading *Astrophysical Journal?* They will print out what they want quickly and in a high quality form.

What does this say for the astronomy library and the astronomy librarian? I believe it will mean less face-to-face contact between librarians and patrons - users will have access to information when and where they want it. They will decide what to transfer into print, what to store in a personal database, and what to ignore. Librarians will not be building physical collections as in the past; they will be designing systems and organizing knowledge. I believe there will be a closer correlation between what information is produced and what is needed. There will be less guesswork, because the demand for discrete kinds of information will be easier to track through electronic systems.

We will see at least two levels of "publishing". There will be the traditional, juried, controlled publications with high standards and "credit" toward tenure and promotion for the authors whose papers are accepted. There will also be unjuried, rapidly available information separated into highly specialized subdiscipline files. We have this now in the invisible college which operates between researchers whose electronic mailboxes are constantly busy as selected colleagues send and receieve electronic preprints.

The ability of individuals to use their idiosyncratic thought patterns in approaching the information warehouses will demand that librarians create new information structures, ones that enable people to wander around while at the same time providing signposts to show where they are. For instance, how can a user effectively tell where they are in an online journal article? How do they know when they find five references to a topic that some may be only a mention of the topic while others may lead them to an entire article on the topic.

Of course there are broader social issues as well. How do we create systems that do not lock some users out because they are unable to afford the cost of access to the online system? Yes, there will be charges for the new systems. Today's libraries are not free, we all know that even if no user charges are levied. We certainly must assume a future where charges will be imposed for access to information. It is the role of the librarian to assist in the design of systems that are equitable as well as viable, notably providing alternatives for users who cannot pay.
There are many challenges as we move forward. Although I feel that eventually there will be more distance between the librarian and the library user, initially it will be necessary to relate very closely to our users. We need to be sure we understand what the astronomer at the telescope

needs, and how to deliver it in a useful way. We need to work with the theoretician as that individual moves about the world of information pulling ideas and facts together building new models of the universe. We must be willing, also, to refine our skills and change our priorites from selecting and preserving information to creating systems which will, one day, replace us, or those who follow us.

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