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The Role of a Virtual Library in the Coming Decades

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Abstract. This paper consists of the keynote address presented by Dr. Narlikar, distinguished and renowned scholar and founder-director of the Inter-University Centre for Astronomy and Astrophysics. Dr. Narlikar critically examines the nature of library and information centers of the past and future through anecdote, example, and philosophical examination. He discusses the synergies between astronomical research and library science, speculates on the future of authenticity in a web-based environment and describes the futuristic "virtual library."

I stand before you with some apprehension because you expect me to make some wise remarks, produce some original ideas and generally keep you entertained in my keynote address. The trouble is that the organizers very kindly made available to me the keynote speeches at the preceding LISA conferences, and I found that the previous speakers have covered, in a comprehensive way, practically all important aspects of libraries and information services of relevance to astronomy. Naturally, my job has been made more difficult as I search for a suitable topic. I hope you will bear with me.

Russell's Nightmare

I wish to begin by recalling an account from the book *A Mathematician's Apology* by G. H. Hardy. The story relates to a nightmare that Bertrand Russell had. Russell dreamt that the year was 2100 AD and he was in the top floor of the Cambridge University Library, watching a member of the library staff sorting out the books. As the Cambridge Library is one of the select copyright libraries that receives a copy of every book published, its storage problem would naturally become acute. So the librarian was trying to select the books which he considered worth keeping. Russell saw the staff member pick, look and discard in a bucket a number of well-known books, retaining only a few on the library shelf: until he came to Russell's own magnum opus the *Principia Mathematica*. Russell watched with bated breath as the library assistant picked up the book and started scrutinising it. Would he consign it to the short-listed few on the shelf or would it go down into the bucket of rejects? That was when the nightmare ended and he woke up sweating, not knowing what finally happened.

This anecdote illustrates the problem faced by the librarians of a bygone era ... Hardy's book was written in 1940. The problem of storing the books within a limited space, as their numbers multiplied, must have brought nightmares to many conscientious librarians. If a book is too good to be discarded, where does one store it? Mathematicians and scientists would no doubt have relieved the suspense of Bertrand Russell by assuring him that his classic book would make it back to the shelf. But that would not have solved the perennial space problem of the librarian.

The Virtual Library

Today I have a different nightmare! The year is the same, 2100 AD, say. I am visiting an astronomy institute with state-of-the-art facilities. The director of the place is proudly showing me all of them as he takes me round the premises. As he comes close to the tour, I notice something missing. "Where is the library housed?" I ask him and he replies somewhat bemused, "What do you mean by 'housed?' We no longer need a building for it. Go to any networked PC and you can access any book, journal or document. You can transfer it to your palmtop if you wish." In short, in today's jargon the library in my dream had gone virtual. It did not require any space at all. With suitable search commands, a user could access whatever he needed.

Somehow, to one born in the twentieth century, this futuristic arrangement does not conceptualize the library in the same sense he or she had. The pleasure of browsing by the shelfside, picking a book and opening it at some arbitrary page and reading on from there may not be achievable in the virtual form by clicking suitable icons on your PC or palmtop. But in terms of the end-result of providing the 'reading information,' the new method will be much more superior.

Of course, one has to ask here what do we expect from a library? Is our purpose always 'information'? Certainly, a member of an astronomy research institute will most likely have 'information' as the primary reason and there the virtual library will be most effective as the information provider. But for a student reading a classic textbook by Jeans, Eddington or Hoyle, or the 1965 paper of Penzias and Wilson announcing the discovery of "an excess antenna temperature," the hardcopy edition with pages to thumb through will be a far more attractive option than the digitised version.

The Advantages of a Virtual Library

Nevertheless, speed is of the essence in the fast life of the twenty-first century and there the virtual library (VL) scores over the traditional one. I illustrate with a personal example.

In my childhood I had read a romantic novel in Marathi called *Viradhaval*. In his preface the author Nathamadhava had stated that the story of the novel was based on the novel *Kenneth* by Reynolds. As I liked the novel very much, I wanted to read the original that had inspired the Marathi writer. The novel, however, was not available to me in Varanasi where I spent the first nineteen years of my life. When I went to Cambridge, I tried the University Library, only to find that the novel was not there. The only library, I was told, that would have it was the British Library in London. Enquiries with the London library yielded the information that the book was there. However, as it was in a very frail state, it could not be lent outside the library premises, say, with an inter-library loan. I was welcome to visit the library and read the book *in situ*.

As I had problems doing that, I next tried the Library of Congress in Washington, DC where I was to visit. A senior lady officer in the library, whom I knew well, very kindly made enquiries and told me that the book was not available there, but copies existed in four libraries in US cities. Unfortunately I was not planning to visit those cities and so had to give up the search.

Eventually, when I returned to India and joined the Tata Institute of Fundamental Research in Mumbai, I happened to mention my problem to the TIFR Librarian. "Let us try the Bombay University Library" he suggested. I agreed but without much hope,

since I did not expect to find the book in the local library after having failed to get it at major international libraries. In this expectation I was proved wrong. *The book was there!* Again, because of its frail condition it could not be issued out but I was invited to go there and read it. This was now manageable and my quest was finally over.

In the futuristic days of the virtual library, how would the story go? With a suitable web-based search routine, I would discover that the book exists, with one of the original copies in the Bombay University Library. But I would not need that frail copy, for the book would have been digitised and included in the database of such books. I would need to access that database, which I could with a few commands from my desktop PC. It would then be a simple matter to bring the book on my screen, page by page. If I wished, I could get it printed on my desk-top printer. Thus, provided efficient search and access systems existed, I would get what I wanted within 10–15 minutes, if not less.

One crucial part of the above example is the availability of digitised literature. This has been happening slowly but surely. In India, within the university sector we are now witnessing what must surely deserve to be called a revolution. Until a few years ago, our fund-starved universities were reduced to subscribing to very few research journals, for the reason that the subscription costs were beyond their meagre budgets. I recall being shocked when, in 1974, a senior professor of Presidency College, a prestigious college in Kolkata, told me that because of paucity of funds their library had stopped subscribing to the journal *Physical Review*. Today, the library network called *Infonet* set up by the University Grants Commission, New Delhi, subscribes to a large number of electronic versions of journals. By the time of writing up this account, the number had crossed 3200. By becoming members of the network at costs much less than for subscribing to all these journals, the universities now enjoy access to the information contents of these journals. By now, some 157 universities have come forward to take advantage of the *Infonet* arrangement.

Apart from swift access at low cost, and operating within a small volume of space, the electronic system has the added advantage of being very versatile. For example, in a conventional book, one reads in a sequential manner, page following page. This pattern may not follow the reader's interest. The reader may wish to switch half way to another part of the book or to another book altogether. Sometimes in a conventional book, such jumps are facilitated by cross-referencing. But reaching the reference target in the conventional way takes time. For example, reading a review of how our concept of the planetary system evolved from ancient to modern times, one may come across the work of Aryabhata, the Indian astronomer from the fifth century AD. The text may refer to a verse from his book the *Aryabhateeya*, with the comment that it shows his awareness of the spin of the Earth. The reader may at this stage wish to access that reference if only to know the context in which Aryabhata wrote the verse.

In the electronic system, this would be easy. A link to the book in question can be placed and the reader can bring the relevant text on the screen. This makes the electronic version multi-dimensional. The challenge lies in carrying this multidimensionality within the specified data-space of the reader. Thanks to the remarkable growth in the storage capacity of electronic systems, this constraint may not be hard to meet. Nevertheless, those involved in making a software for such a virtual library would be motivated by considerations of efficiency.

Astronomical Connections

Many types of software, including image processing, had their origin in some astronomical applications. Curiously, this is the reverse of what happened to the telescope. It was invented for ground-based operations with ready takers in the army. Galileo later adapted it for observing the heavens. Like the telescope, other astronomical instruments are designed to work at the maximum efficiency possible, since one is more often than not looking at very faint sources. Thus, the more photons out of the few emitted that are received, the greater is the value of the image. So astronomers learned to make their software maximally efficient and later found that for this property, it should have terrestrial uses as well.

Let us make a comparison with the VO. The training one receives in making up the virtual observatory would surely help in making a virtual library. In both, one is tapping different and inhomogeneous databases. Both require interaction with the link, including tapping other links. The search techniques may also address similar types of questions. It is not surprising therefore that the LISA meetings have had a close connection with astronomical institutes. In this connection I am happy to recall that the connectivity to Indian universities which I referred to earlier came about largely through the efforts of Ajit Kembhavi at this centre.

Perhaps it is worth taking a pause to see why astronomers are so vitally dependent on data. The science of astronomy sets its aim very ambitiously, to understand the large scale structure of the cosmos. The term "large scale" is to be taken in a very broad sense. It may include comets or planets on the one hand and galaxies, their clusters and superclusters, on the other. It is concerned with radiation in all its manifestations. It deals with gas in atomic and molecular state, dust in various forms and the so-called dark matter that no one knows the composition of. Theorists interpreting the cosmos have various branches of physics at their disposal; this is how astrophysics has evolved. The discoveries of giant molecular clouds have opened up the subject of astrochemistry. And, if one may speculate, that day is not far off when astronomers will be forced to consider astrobiology ... dealing with biological processes on the cosmic scale.

Thus, in all these applications astronomers need data to test their theories and the numerous observatories operating at various different wavelength ranges try to satisfy their needs. Perhaps the first historical example of this data–theory interaction takes us back to Isaac Newton who waited before publishing his law of gravitation until he was satisfied that the data of planetary and lunar motion were consistent with it. And often the data are not available in a very clear form. Very faint images may be crucial to the theoretical model and to extract that information demands a high level of ingenuity. This is why astronomical software has proved useful in other areas also where the extraction of information from very 'noisy' data is difficult.

User's Requirements

What are the user's expectations from a library or information service? The answer to this question has varied from time to time. The user in the era before printing was invented would have to rely on manuscripts. Storehouses of manuscripts like the ancient library in Alexandria were valuable to scholars. The destruction of the Alexandria Library meant a grievous loss. Although scholars are not unanimous in deciding when exactly the ransacking of the library took place, it is established that with it a large

number of books were destroyed. However, some manuscripts like Ptolemy's *Syntaxis* were later translated by the Arabs. Thus Ptolemy's work survived as an Arabic translation, as *Almagest*. This episode illustrates the vulnerability of a library as well as its useful role in transmitting information. So the early libraries were concerned with the preservation of their manuscripts as translations if not in the original: both against the wrath of an unruly mob and the ravages of time.

The ransacking of the library of the Bhandarkar Oriental Research Institute in Pune, India by a mob in the year 2004 brought home to all of us that despite cultural evolution, animal tendencies still take over the human mind if suitably instigated. By contrast, a virtual library is not so vulnerable to hooliganism of this sort. It faces threats of the more advanced kind: by hackers and viruses. Viruses are well known and there is a continuing battle between those who wish to destructively interfere with the contents of a file by introducing deadly viruses and those who devise firewalls and other protective devices, anti-viruses, etc. While a virus manifestly corrupting a file is unpleasant, far more dangerous is the hacker who subtly alters the contents of the file thus making it hard to show that it has been tampered with. Since a library (and source of information) is catering to a large body of users engaged in scholastic work, it is essential that its own resources are uncorrupt.

This brings me to the requirements of 'accuracy' and 'authenticity' which the user expects from the virtual library. Since the explosion of information through web sites, the common user takes it for granted that the information so provided is correct. What guarantee do we have for this assumption? To some extent there is a self-correcting tendency in such information because it is openly displayed. A knowledgeable reader may notice the error and correct it. The Wikipedia has this facility of editing out the incorrect. However, a virtual library needs to establish more alert watchdogs to tell the users of any possible sources of inaccuracy of information supplied.

It is of course too much to expect a virtual library to check each and every website for accuracy. A practical solution is to establish a checking procedure with an ISO-type (or like the hallmark certifying gold purity) recognition of those websites whose information is accurate. Such 'certified' websites can then display the virtual library mark of correctness. Users of website information would then look for such a mark before relying on the information provided there.

So far, I have been emphasizing the information aspect, which is more dynamic, constantly evolving when compared to the archival aspect of a library. For the latter, it is necessary to digitise as much of the archives as possible. This is not an easy job, but I am confident that with the rapidly evolving capacities of computers, a simple way of doing this will be found. Astronomical examples tell us of cases where new discoveries were made from archival data. The quasi-stellar sources were so called because they were mistakenly classified as stars. Further studies revealed their extraordinary character. Archives are static reservoirs of knowledge: they call for someone to dig and delve to find nuggets. The relationship of the Chinese and Japanese records of the year 1054 AD of a 'guest star' to the Crab Nebula seen today as the relic of a supernova could be established because of those available archives.

In Conclusion ...

I have tried to share with you my idea of what a future library and information service can do. I have not been exhaustive here, and may well have left out aspects which some

of you might value much more. The main issue to highlight here is the rapidly growing facility of information collection / transfer / search. This is bringing many changes to our notion of a library. While the "hard copy" version may continue for some time, the virtual version is around the corner and is bound to dominate in the future. Thus, what I have called a virtual library will increasingly satisfy user needs. Indeed, not taking advantage of what information technology has to offer is like missing the bus. I conclude by wishing LISA a successful bus-ride in its future and futuristic enterprises.

IUCAA, a beautiful haven for astronomy (Photo: E. Isaksson)