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BIBLIO-, SCIENTO-, INFOR-METRICS??? WHAT ARE WE TALKING ABOUT?

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Abstract

This paper traces the origins of informatics, scientometrics and informetrics in the USSR and Hungary; the origins of information science, information studies and bibliometrics in Britain and the USA, and their interactions with library studies. Finally, three different contexts are suggested in which the three '-metrics' have distinctive and important roles.

1. THE IMMEDIATE ISSUE

Two years ago, when Leo Egghe invited us to Diepenbeek to give papers on *bibliometrics*, we thought we knew what was meant by that term. On arriving there we met, from Eastern Europe, well-known contributors to *scientometrics*. We were, of course, pleased to meet each other and found no difficulty in understanding each other's papers. When the Proceedings of the Conference [1] were published, the Belgian editors surprised us with its title *Informetrics*.

In calling this second Conference, Jean Tague wisely took no chances : she invited contributions on all three topics. But, as I had raised the terminological issue at Diepenbeek, Jean asked me to comment on these three terms and to clarify them if I could.

I welcome the opportunity to do so. I hope this series of conferences, initiated by Leo Egghe and seconded by Jean Tague, will continue at regular intervals into the future, making discernible progress from one conference to the next. For this dream to be realized, however, we must first clarify the terms we use. That could be done simply by tracing their origins, noting their contexts and connotations and then comparing them in their present usage. But we should also take note of the fact that the information world in which these terms first arose has been changing rapidly in recent years. If I am right to assume that our central interest is the measurement of information processes related to the use of books and journals, then we have to note that these sources are likely to become increasingly electronic. Applications of information science are also moving away from libraries into the design of information systems for business and all areas of social life.
Do we try to follow this trend with our measures? If so, we may need new analytical techniques and new institutions, academic or otherwise, to tackle the new problems. Can we peer through the commercial hype in which the present development of computer systems is now enveloped to see what new measures may be needed to check their information effectiveness?

When, with such issues in mind, I began to re-trace the history of the uncertainties that now beset us, I found that I had to go back to the years when library studies were first formalized, to note the issues that have arisen since, some not yet fully resolved, which may impede the free play of thought which some of the problems must command for their solution.

My outline history begins only from the late 19th century, not because I am unaware of the traditions that librarians cherish and which reach back to

much earlier centuries, but because I have to focus on the roots of our present uncertainties. So I attempt only an outline of the events which mark significant steps in the development of what the English-speaking countries of the West call Information Science and what the countries of Eastern Europe call Informatics. Both the Western and the Eastern lines of development share the same roots. Though they immediately diverged and went their separate ways for almost 50 years with little interaction, over recent years, I am pleased to say, there has been a new convergence of mutual interest.

In scanning the past 100 years, I also have to take note of the two world wars which interrupted our metric studies but which also modified them too. My account is that of an observer of the scene who is based in London, England, rather than in London, Ontario, and therefore closer to relevant events in Europe.

2.1. LIBRARIANS v. DOCUMENTATION PRE-1914

In the English-speaking countries, the professionalization of librarianship began with the founding of the two Library Associations, that of America in 1876 and that of Britain in 1877. These Associations initiated the formal training of librarians. As the central concern of both Associations was the bibliographic control of their common heritage of the English-language literatures to which both countries contributed, they shared similar interests and problems of library organization. They kept themselves well-informed about each other's progress.

Then, in 1895, two Belgians, Paul Otlet and Henri La Fontaine, founded the International Institute of Bibliography in Brussels. This term *bibliography*, however, was misleading in the Anglo-American context and it was subsequently changed to *Documentation*, a new term which was soon elevated into what some librarians regarded as an all-embracing mystical entity - as all-embracing and mystical as the term *information* has become today. As both Otlet and La Fontaine were lawyers and senators in the Belgian Government, they were interested in many kinds of documents professional librarians had taken little note of, such as public records of all kinds, statistical data, legal files and many kinds of items that librarians regarded as ephemera or trivia, such as picture post cards. In short, they argued that the total documentary paraphernalia of modern government, business and public life should be collected systematically and then be sorted, filed, indexed, photo-copied in microform - the high-technology of the 1900's - and so be made readily accessible to the public at large.

Librarians would have taken little note of these ideas - described some years later as 50 years in advance of their time - had Otlet and La Fontaine not demanded that established libraries become the operating centres for their plans, had they not criticized librarians for being inward-looking and parochial, had they not demanded that their plans be immediately operated on an international scale through a network of interacting national libraries.

By 1900, however, professional librarians were well-organized, confident about their own objectives and working steadily to achieve them. So they regarded the Belgian plans as a frontal attack on their profession and responded coldly. Here was the first impact between professional librarians and intrusive external forces. Librarians have retained a cautious defensive attitude to all such intrusions ever since.

Particularly in the vast open spaces of North America at that time - the early 1900's - both Canada and the USA were domestically heavily engaged in settling the millions of immigrants arriving at their ports from all parts of the world and establishing their own economic and social systems, so this call from Belgium for a much closer internationalist documentary system must have

fallen on very deaf ears. But, to appreciate the need as the Belgians then saw it, I think it helpful to outline the short but troubled history of Belgium.

2.2. BELGIAN INTERNATIONALISM

Belgium is one of the smallest but most densely populated countries of Europe. Its misfortune is to lie on one of the main cross-roads of Europe. It was set up by the European powers after they had finally defeated Napoleon in 1815 at the battle of Waterloo - in Belgium, of course. Having at last been freed from French occupation, the Belgians found themselves handed over to the Dutch. They immediately rebelled against the Dutch and the powers had to meet again. The British prime minister of that time, Lord Palmerston, was concerned to ensure that the new state would not become another focus of ardent nationalism to disturb the peace of Europe once again. So, in 1839, a treaty was signed in London which assigned roughly equal numbers of French-speaking and of Flemish-speaking peoples together with a smaller group of German-speakers by careful drawing of its new frontiers. A German prince, the widower of an English princess, was appointed king; French was made the official language and so Belgium was created "an independent and perpetually neutral country" guaranteed by the European powers.

Though the new state experienced internal stresses and strains as it tried to establish itself, the industrious and law-abiding Belgians did nothing to disturb the peace of Europe. In fact, they achieved a European respectability in the tradition of those times by acquiring, in 1880, a colony in Africa to exploit. By the year 1895, Belgium was only 55 years old but its cultural roots lay mainly outside its boundaries in the countries which almost wholly surrounded it on its landward side - France, Germany, Holland. Perhaps one can appreciate the problems that Otlet and La Fontaine met when trying to establish a Belgian documentary system and national archive.

Belgian internationalism had later manifestations. In 1914, Kaiser Wilhelm's German armies violated Belgian neutrality and occupied most of Belgium during the four years of the World War I and so Belgium again became a battlefield as the Allies, reinforced by American forces, gradually pushed the Germans back. Afther the War, La Fontaine was awarded a Nobel Peace Prize for his work in founding the League of Nations. But in 1940, Belgian neutrality was again violated, this time by the Nazi blitzkrieg which broke through to Paris. Again Belgium was occupied by German forces and again became a battlefield as again American and other Allied forces pushed the Germans back. It is therefore not surprising if Belgium took the lead in promoting the several steps which have now culminated in the Economic European Community. Brussels is now occupied once more - this time by the bureaucrats of the EEG and also by the headquarters staff of NATO. British information systems of all kinds are now having to be integrated into those of the Community. The spirits of Paul Otlet and Henri La Fontaine, wherever they may be, can now, I guess, rest in peace.

3. INFORMATICS, SCIENTOMETRICS, INFORMETRICS

I can think of no other head of state, revolutionary or otherwise, who has given so high a priority to the needs of education and training, to the organizing of libraries and reading rooms, to the assembling of all the printing and publishing hardware and the bibliographic apparatus needed by a modern state than Lenin. While an exile in Western Europe, he had followed in the steps of Karl Marx by working assiduously on his socio-economic theories in the libraries of Brussels, Paris, London and Geneva and he knew, of course, of Otlet's case for Documentation. Since the founding of the Fédération Internationale de Documentation (FID) in 1937, the USSR has been its most active and faithful supporter.

So, from 1917 onwards, the USSR set out on a line of development somewhat different from that of the West in re-establishing their library and information systems. It has served the USSR well, especially in World War II, when, after being taken by surprise, the Russians eventually fought the Germans to a standstill before Leningrad, Moscow and Stalingrad during a Russian winter and then pushed them steadily back to Berlin. It was a victory won first by Russian stubbornness and, finally, by superior Russian technology hastily developed at a safe distance from German bombers behind the ramparts of the Urals. The USSR learned that basic science and technology are crucial to the making of war - or the preventing of it.

The All-Union Institute for Scientific and Technical Information (VINITI) was set up in Moscow in 1951. The task assigned to it by the Russian National Academy of Sciences is to organize and maintain the science information systems of the USSR : its duties are partly operational, partly educational and are partly directed to research on scientific information processes. In Russian, the term *science* has the wider connotation of the German *Wissenschaft*, i.e. it embraces all forms of organized knowledge.

As Russian remains a minority language in world science, it is necessary for Russian scientists to acquire a working knowledge of at least one other foreign language. They do so. Whenever Russian scientists visited London, we found them as well-informed about Western research as we were and able to discuss it critically with us while we remained miserably ignorant of theirs until the translations came through. In Britain and the USA, that complacent view of foreign languages is still, I am afraid, prevalent.

When the Russians seek a new technical term, they always look critically at the nearest equivalent they can find in English, French and German before they make their decision. After one such procedure, they adopted the term they had noted was in use in East Germany and re-defined it for their own purposes. They defined *Informatics* as 'that scientific discipline that studies the structure and properties of scientific information and the laws of the processes of scientific communication' [2]. They saw it as a social science, As a discipline recognised by the Russian Academy of Sciences, it has a status in Russia not yet achieved by information science in the West.

The term *scientometrics* first came to my notice in one of VINITI's FID publications in 1969 [3] and one of its authors, G.M. Dobrov, visited me in London. He defined the new term as the measurement of informatics processes. To exemplify it, he told me that he had recently been measuring the performance of mathematical research institutes in the Ukraine. These institutes, 20 or more of them, were all similar in structure but differed in the numbers of scientists employed because some were longer-established than others. He had counted the totals of research papers, Ph.D's, patents and so on for each institute and then divided the duly weighted totals by the numbers of workers in each. The graph he then drew on my blackboard rose steadily from its start to a maximum for institutes with about 15 working scientists but thereafter it steadily declined as the institutions increased in size. I could see that a nucleus of some minimum size could well be helpful in stimulating creativity, but why should the average performance decline so steadily as the number of workers increased? He replied, somewhat ruefully : 'Well, you see - when we Russians get together, we soon start *administrating* ourselves'. I assured him that recourse to administration as a relief from the hard work of thinking was not unknown elsewhere.

In the 1970's, I much enjoyed three visits to VINITI to meetings of the FID Committee on Theoretical Informatics. I was impressed by the variety of disciplines - logic, mathematics, statistics, linguistics, philosophy and others - that was brought to beat on the critical discussions that followed the reading of papers and by their intellectual quality. My fourth visit,

however, was timed unfortunately to occur in a period of political tension in Moscow and in the discussion following my paper I offended Marxist-Leninist principles in some way I never fully understood. I was promptly put on the next Aeroflot plane to London. But two years later I gave much the same paper to an FID Conference in Edingburgh where, immediately after giving the paper, I was invited to the VINITI hospitality room nearby, toasted in vodka and presented with Tchaikowsky records, duly inscribed with complimentary comments. I assume that I had been reprieved. But such alternations of warmth, coldness and warmth again - as my experience testifies - made it difficult for the two lines of development of our metric studies to enjoy continuous and confident interaction. Though I have not returned to Moscow since, I again have amicable relations with members of VINITI.

Meanwhile, however, East and West have been able to interact with increasing freedom by means of the journal *Scientometrics*, founded by Tibor Braun, a professor of Analytical Chemistry at the L. Eötvös University in Budapest. As Braun has nurtured this journal over the years, it has gradually won recognition in the English-speaking world. He has also established a Department of Scientometrics within the Information Science and Scientometric Research Unit in the Library of the Hungarian Academy of Sciences. At this base in Budapest, he has devised a suite of programs for the analysis of ISI citation data, the performance of which has won for him the Derek de Solla Price Medal. Braun has now established strong links with research groups in Holland and elsewhere which have seized on his techniques for exploring Science Policy issues. So Braun has now led scientometrics out of its formative phase into a productive relationship with the wider field of social and economic studies. A critical examination of the applicability of citation analysis to these wider fields is now in progress since the interpretation of its results becomes of increasing interest to national science development planning.

Though the journal *Scientometrics* is still edited in Budapest, it is now published in Amsterdam - in English.

The term *informetrics* was proposed by Otto Nacke of West Germany in 1979. In 1984, VINITI set up an FID Committee with this name and persuaded Nacke to be its chairman. But he soon resigned and was succeeded by the Indian, Rajan of INSDOC, who re-formulated the objectives of informetrics to be the provision of reliable data for research and development; for policy-making and planning; and for the management of institutions, projects, programmes and activities. It is also said to be concerned with the origins and development of concepts [4]. As defined, therefore, it is the widest and deepest of the three metric terms we are concerned with.

In 1988, VINITI published a book edited by the mathematician Valentina Gorkova, with the title *Informetrics* [5]. It is an up-to-date compendium of results achieved in informatics, some familiar to Western readers. By using the Weibull distribution together with systems theory, Gorkova is able to derive a rigid nuclear group plus a sequence of steadily more relaxed sub-groups whose key parameters are shown to be related to the sequence of Fibonacci numbers. I look forward to a complete and competent translation of the new book which is at present available only in Russian.

That completes my summary of the work on the metrics in the USSR and the countries of Eastern Europe and I now turn to the more complex development of our studies in the West.

4. DOCUMENTATION BETWEEN THE TWO WORLD WARS

In Britain, the Association of Special Libraries and Information Bureaux (ASLIB) was founded in 1924. But a more direct link with Otlet's ideas was marked by the founding of the British Society for International Bibliography as the British branch of Otlet's International Society in Brussels. One of the founder members of that Society was S.C. Bradford, Director of the Science Museum Library in London, whose well-known paper formulating his empirical law of bibliography was published under the aegis of that Society. But, in 1937, the British Society for Bibliography was absorbed into ASLIB.

Meanwhile, on the Continent, as Otlet gradually withdrew from active work, his campaign was taken over by a new generation led by Donker Duyvis of the Netherlands. The centre of activity moved from Brussels to The Hague with the setting up of the Fédération Internationale de Documentation (FID) in 1937 to which Otlet and La Fontaine were elected Vice-Presidents. One of the major tasks the FID set itself was to develop a classification designed for international use - the UDC. Serious work on this project began, notably in Germany.

These events suggest that the more extravagant aims of the Otlet plan had been considerably modified by this time. The fact that serious work on an international classification system was only beginning some 40 years after the campaign had begun, points to a weakness in Otlet's plan which may well account for the doubts expressed by librarians.

The USA, more remote from these events, was slower to react to them, but in 1937, after wide discussion, the American Documentation Institute was set up among a loosely-knit group of libraries, learned societies and government agencies. The ADI did not become internationally visible until after World War II when it founded its own journal.

In 1939, our studies were again interrupted by war.

5. AFTER WORLD WAR II

5.1. INFORMATION THEORY, CYBERNETICS, COMPUTERS

As those parts of the world involved in World War II returned to re-construction and normal life, war-time inventions and discoveries not publicized during the War - as were the atom bombs which ended it - gradually emerged into public view. Three of these impinged forcibly on our studies.

One was the computer, prototypes of which were used for code-breaking and for computation. But it took some years to develop them on a commercial scale and adapt them to perform clerical operations on documentary files useful to librarians.

A more immediate impact was made by Claude Shannon's paper on *A mathematical theory of communication*, first published in the *Bell System Technical Journal* in 1948, and then, together with an over-enthusiastic popularization by Warren Weaver, as a book [6]. The title of this book changed Shannon's indefinite article so that '*A* mathematical theory...' became '*The* mathematical theory...'. This book had a great impact in Britain.

By this time I was lecturing in the Electrical Engineering Dept. of University College London. My academic interest in Shannon theory was reinforced by four international symposia organised by the Electrical Engineers of Imperial College London over the period 1950 to 1961. The last two symposia, organized by Colin Cherry, then Reader in Telecommunications at Imperial, extended the

reach of Shannon theory well beyond its technical origins into physiology, neurology, linguistics, mechanical translation, semantics, logic and philosophy - into, one might say, the deepest recesses of the academic mind. But I also remember papers by Robert Fairthorne, Calvin Mooers and Benoit Mandelbrot on aspects of document and information retrieval and the empirical laws of Willis in taxonomy respectively. Colin Cherry, the electrical engineer, was moved to write a book *On Human Communication.*

The third post-War development which made an immediate impact was Norbert Wiener's *Cybernetics* [7], also published in 1948. This theory explained the implications of *feed-back* in the automatic control of machines but it reached beyond the purely technical aspects of designing robots to animals, humans and human society. After attending one of Wiener's enthusiastic lectures in London, I began to formulate a cybernetic model of the growth of scientific knowledge which I saw as a system in which scientific discoveries were continually controlled and refined by critical feedback from other scientists.

This post-War eruption of the ideas of Shannon and Weaver and their extension to all the academic disciplines created intense inter-disciplinary ferment in Britain but in which the argument became greatly confused by the loose ambiguities of their key terms *information* and *communication.* As the local expert on Shannon theory in University College, I was frequently called on to discourage some of the wilder applications as, for example, when I was asked to support a research application for funds to rank the plays of Shakespeare in descending order of the number of Shannon bits that could be laboriously counted in their texts. The terminological confusions caused by assigning very precise technical definitions to terms of everyday discourse like *communication* and *information* made inter-disciplinary argument involving these technical terms very difficult as all possible meanings of these terms become inextricably conflated.

In the USA, an inter-disciplinary debate, similar to that in Britain but even more intensive and wide-ranging, initiated by Shannon and Wiener, raged over the same period. A summary of that debate organized by Fritz Machlup and reported in the book completed by Una Mansfield after Machlup died in 1983 [8] suggests to me that the Americans gave greater weight to Wiener's ideas and became more interested in their application to robotics and artificial intelligence than the British. This may have arisen because the British had been closer to Nazi ideology and felt less enthusiastic about Wiener's references to the control of human society [9].

The great mix of ideas thus generated around the fuzzy concept of *information* gave rise to what were then called the *information sciences.* But by this time the computer had become generally available and the inter-disciplinary debate subsided as sections of the spectrum of information sciences came to be marked off into areas of specialist interest and those concerned began to program their computers. From this complex of ideas, one part of the spectrum yielded a vague concept of what we now call information science that could be seen by those who looked for it. As it related to the use of bibliographical resources, it had some relevance to libraries.

During the War itself, the overall publication of books and journals had declined somewhat, though the most important journals continued to be published as normal. It has recently been revealed that German scientists were able to read Western journals and Western scientists to read German journals - acquired by both sides in microform from neutral sources. So both sides read the papers reporting advances in atomic physics, both sides making crucial discoveries of great interest to the other - at least until the Allies bombed Leipzig where the German journals were printed. So both sides learned from each other the basic *physics* of making atomic bombs. All that was then needed was a quiet base where the technology could be assembled and tested beyond the reach of

enemy bombs. Only the Americans could provide that base.

It seems incredible that the security services of both sides overlooked the scientific journals that revealed so much. But governments have now learned that lesson. Strict controls have since been imposed on the export of ideas of possible military interest, whether they are expressed on paper or as hardware or software. For this, and increasingly for commercial reasons, the world of science is not as open as it was in 1939. I doubt whether journals now accurately reflect the growth of scientific knowledge.

5.2. LIBRARIES AND INFORMATION

After World War II ended, the normal publication of books and journals resumed but, as Belver Griffith has shown, the tempo of publication soon attained a much higher rate than before the War. Britain emerged from the War bankrupt, the USA economically strengthened. As the spate of publications was accompanied by an escalation of costs, librarians found increasing difficulties in buying all their users sought from them. University librarians, who in pre-War days had confidently demanded new buildings when they had filled their existing shelf-space, were suddenly told to make the necessary space by discarding their least-used items and sending them to Boston Spa. There, a new National Lending Library for Science and Technology was being set up. One of its objectives was to acquire a comprehensive collection of the world's journals and another was to sort the discarded books received and make them available to other users. The new scheme worked well; users could call Boston Spa with the lists of papers they needed and photocopies were posted back on that same day.

At the same time, libraries began to form local interactive networks, again to improve their regional services at minimum total costs. The public libraries, notably those of Liverpool and Sheffield, began to implement regional documentation services very close to those advocated by Otlet.

These diverse rationalization projects demanded new objectives of library management, now greatly aided by the development of computer techniques for handling documents.

The long-established ASLIB, publishers of the *Journal of Documentation*, seemed to be the agency most suitable for promoting the new techniques required, especially as they continued to be on amicable terms with the Library Association. But in 1958, a group of the new kind of specialists broke away from ASLIB, impatient at the lack of progress towards their own objectives, to form the institute of Information Scientists. One member of this rebel group was Jason Farradane, who became the Secretary of the new Institute. He had experience as a research chemist in industry and was keen to exploit the new databases and to train others to use them. In 1961, he gave part-time evening courses in Collecting and Communicating Scientific Knowledge, in 1963 he started a course in Information Science in a London College of Advanced Technology, which in 1966 became the City University (TCU). By 1966, Jason was Director of the Department of Information Science at TCU and able to recruit staff and expand the courses for various academic levels as resources permitted. In 1986, the Department was able to celebrate 25 years of work in this new subject [10].

The Americans too were facing a great upsurge of publication. Though they were under less financial pressure than the British to rationalize library services, they too found problems of reducing the increased output of documents to bibliographic order and of speeding access to documentary sources for the specialist needs of science and technology.

The new American specialists in this work revealed themselves to British readers in the first issue of the *Annual Review of Information Science and*

Technology in 1965. The American Documentation Institute recognised the new trend by changing its name to the American Society for Information Science in 1968 and its new-named journal, JASIS, was first published in 1970.

My review has now reached the point at which I unexpectedly became personally involved in information work and I must report what happened.

6. INFORMATION SCIENCE OR INFORMATION STUDIES? A PERSONAL PROBLEM

In 1966, as I was about to make my annual visit to lecture to the Engineering Summer School at Ann Arbor, Michigan, I was surprised to be invited to abandon my post in Engineering to become Reader in Information Science in the Library School of University College. I declined the invitation. In Britain, a Reader is expected to give priority to the theoretical advance of his subject; that part of the invitation was attractive. But the Library School was a Department of the Faculty of Arts and had played no role in the inter-disciplinary discussions of the information sciences within the College. So I could not see how, in such a context, I could hope to develop a *science* which would be respected by my scientific colleagues.

I was asked if I could see a way out. I suggested that my title be changed to Reader in Information *Studies* but that I also be allowed to teach Information *Science* in the Faculty of Science. This proposal was agreed. So the School became the School of Library, Archive and Information *Studies* (which they liked) and the Science Faculty invited me to plan a B.Sc. course for Information Science as soon as I could.

So I left for Ann Arbor, intending to use my visit to see as much as I could of American developments in two weeks. In Ann Arbor, I spent a day with Manfred Kochen and then moved to Cleveland. There I hoped to catch Jesse Shera and William Goffman at Case Western but missed them both, though I met them in London somewhat later. But I had an insight into retrieval problems at the information centre of the Institute of Metals nearby and then moved on to Washington. There I visited the Library of Congress to see the MARC Project, temporalily held up by an appeal from London to make the MARC format more accommodating to British, French and German bibliographic descriptions, and the Library of Medicine to see how the MEDLARS database was operated. Finally, I went to Boston to look at Project INTREX at MIT before returning to London to plan my new courses.

The Science Faculty proposal was that I should offer a third-year option to students who had successfully completed the first two years of their Honours B.Sc. course in their particular science. So I was soon interviewing candidates for this option - from physics, chemistry, mathematics, biology; those who passed my third-year examination would be awarded an Honours degree in, for example, Physics-with-Information Science.

These bright B.Sc. students came to me already with useful experience of computer programming and in applying statistical techniques to experimental data. They seized on an American program called FAMULUS which provided a flexible format for bibliographical data and which they modified and adapted for experimental purposes. I looked to graduates from this group to work, in due course, for the higher degrees in Information Science that would be needed and, not least, to become the research assistants I would need.

Though the B.Sc. could be set up within the College, the M.Sc. had to be approved by the Faculty of Science of the federal University of London. So my M.Sc. proposal had to win approval from a hierarchy of Science Faculty committees and I had to argue the case for it at each level. At last my M.Sc. reached the final committee which I attended in the confident expectation that my tough arguments with critical scientists of all persuasions were over and

that my proposal would be approved 'on the nod'. But I was stunned to see that a rival proposal for an M.Sc. was on the agenda. It had reached this final level by a different administrative route and came from Colin Cherry's group at Imperial College - i.e. from Electrical Engineering. As I was preparing for another tough argument, someone noticed that *my* kind of Information Science was already being taught at the B.Sc. level whereas my rival's was not. Without further argument, I won on this technical point. I tell this story to indicate that there have been rival bids for the attractive name *information science*.

It must be already evident that at this time I saw information science as an emergent science which had no need to link itself to librarianship but which offered librarians an array of techniques which could help them to come to terms with computers, the databases, the problems of information retrieval, the design of effective networks, and so on which had caught them unprepared for the information revolution that had broken out around them. I assumed that, within a few years, librarians would absorb what ideas they needed from information science, gradually integrate them into an updated library science and that information science would continue to go its own way.

As an information *scientist*, I was interested in the work of Manfred Kochen, Derek de Solla Price, Belver Griffith, William Goffman and others who, in their various ways, were exploring the growth of scientific knowledge as revealed by its literatures. I had been Secretary of the British Society for the Philosophy of Science over the period when Karl Popper had been its President. So my personal interest was to explore the literatures of the sciences to test Popper's theory that the growth of scientific knowledge was a social process in which new ideas emerged in dramatic form in the current journals while the ideas they superseded quietly faded away to be forgotten - except by historians of the sciences.

I had noted that my scientific colleagues kept their own collections of journals, reference works and standard texts on which they mainly relied in their laboratories or offices and within easy reach. When these private collections failed them, they had to make what they regarded as time-wasting visits to a library. To dig out the data I needed, I explored the back-runs of the relevant journals and relied on the data I myself observed, checked and collected. I could argue that any results I found could be checked by anyone who cared to dispute them.

As a teacher of information *studies*, however, I needed techniques to help librarians set up hierarchical networks of libraries as effective and cost-reducing as possible. The measures I needed for this purpose had to rely on *usage* of the documents as recorded by the libraries concerned. And every library, of course, had its own characteristic pattern of usage. The techniques of measuring these matters could be similar, but the results for each library or library system would be different.

With these and other differences I felt between the *studies* and the *science*, I began my teaching.

In 1969, the Indian librarian S.R. Ranganathan, aware of the library rationalization problems of that time, proposed the term *librametrics* for the measurement of all quantitative data directly related to *libraries* [4]. Unfortunately, it takes time for Indian publications to reach Western eyes and, later in the same year, the keen bibliographer Alan Pritchard, busily exploiting computer techniques to update scientific bibliographies, proposed the term *bibliometrics* for the measurement of data delated to books and journals as an alternative to the ambiguous *statistical bibliography* [11]. This proposal was immediately seen by Western eyes and was adopted forthwith.

Had I known of Ranganathan's term in time, I would have adopted *librametrics* for information *studies* and *bibliometrics* for information *science*. But it was too late. Librarians liked bibliometrics too.

Unfortunately, the use of bibliometrics for both the science and the studies has led to some confusion. When I published papers on the histories of the sciences or of particular journals, I relied on *citation* counts to yield measures of what I called obsolescence. But these papers were immediately attacked by the librarians Maurice Line and Alexander Sandison who hotly defended their archival national libraries against the imputation that any of their precious stock might be obsolescent. They repeated my measures, in terms of the *usage* of their libraries, and their results, not surprisingly, did not agree with mine. But I could never persuade them that my problems in information science were different from theirs in respect of libraries. And this dispute, recorded in the pages of various journals over several years has never been resolved. In fact, Sandison renews his attack in the latest issue of the *Journal of Documentation* in which he dismisses citation studies based on ISI data as useless.

At the Diepenbeek Conference I was reminded of these disputes by a quotation from Maurice Line which Jean Tague published in her paper 'What's the use of bibliometrics?' [1]. Line suggests that anyone proposing to write a paper on bibliometrics should first ask two questions : 'Who precisely wants to know?' and 'For what precise purpose is the information wanted?'. If one seeks what philosophers now call the 'illocutionary force' of these questions, i.e. their purpose after studying the relevant background, I can only conclude that Line is saying that unless the proposed work relates to some problem of library housekeeping of which he approves, then it is a waste of time. In short, Line does not admit the possibility that bibliometrics is applicable to wider contexts.

Further evidence of the possessive attitude of librarians to bibliometrics is displayed by Lloyd Houser's content analysis of the first 15 years of JASIS [12]. Houser classifies the topics reported in that journal and ranks them in order of their frequencies of occurrence. The first three topics are *bibliometrics*, *indexing* and *information retrieval systems*. Houser then asserts that these three topics, plus 64 others of the 95 topics he lists, are, and always have been, components of library science, that information science fails to emerge as a coherent entity and that it therefore does not exist. Though I am not impressed by some of Houser's analytical techniques, I do fully accept his main conclusions.

I interpret Houser's paper as demonstrating, as I have long hoped to see, that librarians now feel that they have absorbed from information science all the techniques they need and have made them their own. They are confident that they can now go their own way. I find this a cheering conclusion because it also frees information science from the restraints that librarians have imposed on it for more that 20 years. So information science too, is free to go its own way.

The library schools in Britain have come to the same conclusion, though in a less dramatic way. They have either dropped the term 'information *science*' from their titles or have modified it to 'information *studies*'. For example, the one-time Post-graduate School of Librarianship and Information Science at the University of Sheffield has now become the Department of Information Studies. The Institute of Information Scientists is also now considering how best to change its name to reflect the changing interests of its members towards Information Management or Systems or Technology and other developments. There are, of course, some voices opposing any such change, among them that of Jason Farradane who pioneered Information Science in Britain, though as a subject not related to the needs of libraries. But I regard such opposition

as sentimental rather than realistic.

7. THE ROLES OF THE THREE '-METRICS'

7.1. BIBLIOMETRICS

I have no doubt that *bibliometrics* must now be conceded to library studies only. Its work is not yet ended as libraries continue to adapt to the changing world around them. And bibliometrics itself needs the continued interest of outside experts, statisticians and others, in developing and refining its techniques.

7.2. SCIENTOMETRICS

The term *scientometrics*, nurtured by Tibor Braun, has become fruitful in science policy studies. Its techniques have been developed by small groups of scientists working with single-minded enthusiasm in compact research units, notably in Budapest and Leiden. But other research units in Europe, East and West, are beginning to make contributions to scientometric studies. The term has now established a significant role in the social sciences. Applications have so far been restricted to exploitation of the citation data provided by ISI but further refinements are now being critically examined [13].

Though the techniques of scientometrics and bibliometrics are closely similar, their different roles are distinguished by their very different contexts.

7.3. INFORMETRICS

The term *informetrics* was adopted by VINITI, I believe, as a generic term to embrace both biblio- and scientometrics. Gorkova's recent book with that title supports that idea.

There are some residual problems from bibliometrics of no great interest to librarians. For example, the empirical laws remain empirical and so attract theoreticians to a resolution of the problems they present. Haitun pointed to the fact that the Zipfian distributions of the social sciences needed a new statistical approach [14]. Leo Egghe has noted a duality principle that has led him to an attempt to provide a complete mathematical framework for them and chose the title *Informetrics* to describe this theoretical work [15]. The statistician Sichel has been exploring the applicability of the Inverse Gaussian distribution to them [16]. I regard these theoretical explorations as exemplifying the kind of information science I hoped would emerge in due course.

I have long been awaiting the arrival of electronic journals. When they arrive, new forms of database will become feasible, automatically correcting and updating their contents as new issues are received. New measures will be needed for them. They could also become a valuable experimental resource for studying the interactions of users in a new kind of cognitive study.

A recent British study, attempting to forecast the development of computerized information systems into all aspects of social life over the next 25 years also stresses that new measures will be needed.

The term *informetrics* seems to be as appropriate for such theoretical studies as any I can think of. The journal established by Tibor Braun has been invaluable in promoting scientometrics : a similar journal *Informetrics* is needed to focus interest on metrical studies of information processes in general.

These are my recommendations concerning the three '-metrics'. I present them for your consideration.

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