therefore, to favour the concentration of the university's bibliographic resources in one centrally organised repository.

The concept of interdisciplinary studies is not especially new. Since the revival of learning in the 15th and 16th centuries, classical studies have been an interdisciplinary field par excellence, and the old arguments over the place of mathematics in the hierarchy of knowledge will reflect the pervasiveness of that subject and, by implication, its interdisciplinary character. Indeed, the concept should hold great appeal for a librarian, whose attitudes will be normally geared to as broad-fronted an approach as possible. It is the acquisition and organisation of material which will provide the greatest cause for challenge and the most urgent need for co-operation.

IS A SCIENCE OF INFORMATION POSSIBLE?

CARMEL MAGUIRE*

IF a science needed only local habitation and name as credentials, information science would be well established. Many universities and colleges house schools of information science, but on closer inspection they often turn out to be schools of computing science or rather less often schools of librarianship. The field of computing science is interdisciplinary in that it combines the methodologies of engineering in the creation and study of computer hardware and of mathematics and logic in the creation and study of computer software. Yet to equate computer science with information science hardly does justice to the subtlety and variety of factors involved in the creation, processing and transfer of information. Robert Hayes points out that "Because computer science has become formalised at the same time as information science and because the computer is the most clear-cut example of an information system, it has been natural to identify information science with computer science".[1] But Hayes is also anxious to make clear that "Although mechanisation has provided the catalyst and has made information science of immediate value and importance, the problems are present in *any* system, whether mechanised or not".[2]

To librarians information science offers what their field has lacked too long, a theoretical basis. It is no accident that librarians have remained bound to their institutions in fact as in name whereas doctors have never been hospitalarians and have long since ceased to operate in barbers' shops. There is no doubt that many

* Lecturer in Librarianship, University of New South Wales.

of the research findings in psychology, linguistics and sociology, for example, are relevant to the design and operation of bibliographical and document delivery services which seek to make accessible whatever portion of recorded knowledge is required. Whether the information sought is recorded on paper, film or magnetic tape has little bearing on whether its presence is indicated in such a way as to permit its retrieval when needed, or indeed on whether the seeker will approach the most likely source for information. Yet when schools of librarianship become schools of information science what usually happens is not the opening up of a new area of interdisciplinary studies but the addition to the curriculum of well- or ill-assorted courses in systems analysis, computer programming and text handling, and in mechanised information retrieval.

In some schools information science is used as a synonym for the study of information transfer among scientists. The development of this concept of information science has no doubt been influenced by the fact that the pioneer work in the study of information users, or in what might be termed the sociology of science information, was done for scientists and largely by scientists like J. D. Bernal and Derek De Solla Price. Moreover, although engineers have had some attention, studies of the users of information have been much more numerous among research workers in the physical and biological sciences than in other disciplines.

Information science may be regarded as evidence of the truth of Piaget's assertion that "In general it is repeatedly stated that the future lies in interdisciplinary research, but in fact this is often very difficult to organise because of mutual and sometimes deep-rooted ignorance".[3] To take what is probably the most complete definition of information science attempted is to realise how much ignorance the representative of any one specialty who comes to consider the field is likely to command.

> *Information science* is that discipline that investigates the properties and behaviour of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. It is concerned with that body of knowledge relating to the origination, collection, organisation, storage, retrieval, interpretation, transmission, transformation and utilisation of information. This includes the investigation of information representations in both natural and artificial systems, the use of codes for efficient message transmission, and the study of information processing devices and techniques such as computers and their programming systems. It is an interdisciplinary science derived

from and related to such fields as mathematics, logic, linguistics, psychology, computer technology, operations research, the graphic arts, communications, library science, management, and other similar fields. It has both a pure science component, which inquires into the subject without regard to its application, and an applied science component, which develops services and products.[4]

Even at such length Borko has not included in that definition any reference not only to the obvious importance of sociology in information studies but also to the relationship of information science to epistemology and cybernetics, two fields which on reflection in depth like that of Piaget appear to subsume information science.[5]

Researchers early in the field of information science were inspired with the hope of being able to expand Claude Shannon's mathematical theory of information into a general theory. Their hopes proved premature but mathematically oriented researchers like Gerard Salton at Cornell and Mike Lynch at Sheffield would probably still maintain that advancing knowledge will reveal the wholeness of all aspects of information, mathematical, technological, biological, psychological and sociological. Others like Robert Hayes remain doubtful that progess in information science is possible unless we recognise that "while 'information science' may in principle be concerned with pure analysis of processes, in reality it cannot be separated from the methodology of specific disciplines. It is therefore more appropriate to talk in terms of 'information science in genetics', or 'information science in social theory', or 'information science in documentation', than to talk of 'information science' in isolation from specific systems".[6]

The ground has recently been prepared by the Association for Computing Machinery for the creation of a new field of "information science in management". The A.C.M.'s Curriculum Committee on Computer Education for Management sees as urgently necessary a marriage between "the two cultures of organisational environment and computer environment" because "Much existing education for management [in American universities] deals with making decisions on the basis of available data and does not prepare the student for clinically analysing information needs in a systematic fashion. Similarly, existing computer science education, usually emphasising algorithmic problem solving rather than system dynamics, does not prepare the student for the discipline of evolving system specifications".[7] The A.C.M. Committee has specified a range of abilities and knowledge of people, models, systems, computers, organisations and society, needed by information systems developers.

The academic arms of other professional societies might do well to follow the A.C.M.'s example, since some hope of progress in information science seems to lie in such approaches of one discipline to another rather than in grandiose attempts to create new curricula to be expounded by interdisciplinary teams with members collectively knowledgeable in all the aspects of information. Perhaps this is in line with what Piaget is suggesting when he writes that "The first goal of the [interdisciplinary] research is therefore to select possible elements of comparison from the current developments in the human sciences, in such a way as to promote interdisciplinary exchanges and collaboration, or simply to further research in each discipline by means of the comparisons provided between them".[8]

The attempts so far to make information science into a megascience have not been particularly happy, and Ferdinand Leimkuhler of Purdue has recognised the dangers of unfulfilled expectations for the future of both information science and his own field, operations research. Leimkuhler compares the earlier easy availability of resources for research in both fields with the fact that "Today, however, the rise of technological disillusionment, scientific recession, and concern for the limits of growth are forcing both fields to re-examine their premises and their promises of a Utopian future".[9]

So far information science appears to have encouraged rather than prevented the re-invention of wheels. In fact if an essential feature of a science is that its knowledge is cumulative, a science of information cannot be claimed to have been delivered yet. The re-discovery of long-held knowledge has been obvious in such manifestations as the disillusionment of computer specialists after their initial pride in such crude indicators of the contents of documents as K.W.I.C. (Keyword in Context) and other forms of computer-produced permuted title indexes. Librarians have been aware of the usefulness and limitations of title-word indexing at least since nineteenth century debates on the merits of Schlagwort catalogues. Computer-produced indexes may be quicker and cheaper but their quality is governed by the same laws which apply to those produced by the technology of pen, typewriter or printing press. Some of these laws have been identified by librarians but, possibly because of their "low level of interaction with other fields",[10] they have been unable to contribute to computer science the rudiments of classification theory. Unfortunately there are also indications that the new generation of "information scientists" are as likely as librarians to limit communication to their own small group. In fact a recent study of citation patterns in the

information science literature reached the conclusion that, rated on the number of references per paper, information science scored as "less scholarly than pharmacy".[11]

At least as disturbing as the findings of the last two studies cited is the fact that the methodology of both is open to question on whether the measurements made refer to the phenomena they set out to evaluate. Further unfavourable reflection on the status of information science as an independent discipline may be derived from Gerard Salton's report that there are no names in common in the two lists of what he calls "consensus authors in information science" which he has compiled for 1962 and 1972.[12]

Though the validity as well as the utility of much of the research so far produced as information science may be questioned, there have been notable contributions made on which a better understanding of the way people in various fields use and mis-use information. One example is the series of British studies known as INFROSS.[13] This investigation into information requirements of the social sciences was also notable in that it attempted to put into practice some of its own theory. Part of the investigation involved the appointment of an Experimental Information Officer in the Social Sciences at the University of Bath. INFROSS has been succeeded by the DISISS (Design of Information Systems in the Social Sciences) Project which is also centred on the University of Bath.

While there has been unreasonable criticism of the pure research conducted in information science as not being applicable to real problems, few attempts have been made to apply the findings of applied research. A glaring example is in the use of libraries in academic environments by students, teachers and researchers. Virtually every study conducted has shown that essential bibliographical skills are lacking in all the groups which make up the tertiary education community and that the tools and systems devised by librarians and publishers of abstracts and indexes in printed or digital form are imperfectly adapted to the needs of these users. Yet the idea of finding time in all courses for a segment on bibliographical skills and communication patterns in the disciplines is usually treated with derision. The introduction of one such course which could be regarded as an attempt to cover the fundamentals of information science in medicine has been reported at Johns Hopkins.[14]

Improvement of the skills in information-gathering and information transfer of students, teachers and researchers in all disciplines presents challenges to the prejudices of some and the imagination

of others. Improvement of information systems design presents much greater challenges and demands progress towards a general theory of information. Edwin Parker, who heads at Stanford one of the few schools of information science which can be considered true to label, believes that "The nature of information and information processes may be the fundamental focus of science for the next century, just as science in the past two centuries has focused on matter and energy. Information processes control the utilisation of matter and energy".[15] Parker also believes that "Although the analogies have yet to be formalised into an abstract theory of information, there are interesting similarities between machine information processing in computer systems, cognitive information processing in humans (biological systems), and human communication in social systems. All three aspects are involved in the development of information systems. Better understanding of the fundamental processes would be certain to lead to improved system design".[16]

It is difficult to disagree with another of Parker's assertions, namely that "The problems of information are so fundamental and cut across so many present disciplinary boundaries that it is nearly impossible to find an academic department within existing university structures in which to pursue a fundamental theory of information without being constrained by the assumptions of a particular discipline or profession".[17] The problem is to provide an academic environment flexible enough to bring together representatives of a variety of the disciplines from which light can come on how information is created, stored, retrieved, transferred and transformed with optimal efficiency. Australian institutions of tertiary education are hardly remarkable for their flexibility. Yet there are signs that Australia is becoming an increasingly information-conscious society. Interest in "Open Government" and in urban planning is evidence of widespread demand for more information by the community as a whole; moves are in progress towards formulation of a national and rational policy for scientific and technological information;[18] concern has been voiced in educational, business and news media circles about delays in the introduction of advanced communications technology such as cable television and data transmission networks.

At the teaching level there is no reason why, in addition to the provision of elementary courses in information skills for under-graduate students in all disciplines, there could not be mounted "information science in science" courses to prepare graduates capable of assisting scientists and technologists in defining their information needs and in streamlining the flow of information to

them. Such courses could, say in a four-year undergraduate programme, cover the technological, behavioural, managerial, sociological and political aspects of information, at a level sufficient to make their graduates capable of communicating with scientists and technologists and of specifying the performance requirements of improved information systems for them rather than of designing systems. Curricula could be devised in interdisciplinary consultation among academic representatives of professional societies such as the Royal Australian Chemical Institute, the Institution of Engineers Australia and the Library Association of Australia. To which schools or faculties such courses are attached should absorb much less of their planners' energy than concern for their introduction while the political climate is favourable and for the insurance of adequate support for them. There is again no reason why similar courses could not be provided for the social sciences. The Postgraduate School of Librarianship and Information Science at the University of Sheffield has for several years run a successful M.Sc. in Information Studies programme which is open to graduates in science and technology. In October 1973 Sheffield began teaching a course leading to the degree of M.Sc. in Information Studies (Social Sciences). The Nuffield Foundation has funded the introduction of the new course in the hope that its graduates will prove as useful as information specialists in the social sciences as graduates of the earlier established course have proved in science and technology. At undergraduate level, Leeds Polytechnic has recently restructured the three-year B.Sc. Information Science programme first offered in 1964. This course combines basic physics, chemistry and biology with study of modern languages and of the sociology of information transfer in science as well as of information storage and retrieval systems. The Departments of Librarianship, Sciences, International Studies, Mathematics and Computing, and Business Studies are involved in teaching it.

At the research level in Australia encouragement needs to be provided in the form of opportunities for advanced study of the information needs and information processing capabilities of particular groups and of the characteristics of all the information systems which govern our lives. How else but through combinations of the talents of scholars interested in fundamental problems of information and drawn from every discipline is "the human use of human beings" to be achieved? The phrase is of course borrowed from Norbert Wiener, one of those who helped convince us of the pervasive importance of information in all the systems which make up man and his world and who thus set us on the search for a basic science of information—a science for which a satisfying

general theory may only be found after the environments in which it is sought have multiplied and diversified.

NOTES

[1] Hayes, R. M. "Information Science in Librarianship", *Libri*, Vol. 19, No. 3, 1969, p. 221.

[2] Hayes, R. M., *op. cit.*, p. 218.

[3] Piaget, J. *Psychology and Epistemology: Towards a Theory of Knowledge*, Harmondsworth, Mddx.: Penguin University Books, 1972, p. 86.

[4] Borko, H. "Information Science: What Is It?", *American Documentation*, January 1968, p. 3.

[5] Piaget, J., *op. cit.*, p. 95.

[6] Hayes, R. M., *op. cit.*, p. 221.

[7] Ashenhurst, R. L. (ed.). "A Report of the ACM Curriculum Committee on Computer Education for Management", *Communications of the ACM*, Vol. 15, No. 5, May 1972, p. 369.

[8] Piaget, J., *op. cit.*, p. 86.

[9] Leimkuhler, F., "Operations Research and Information Science—a Common Cause", *Journal of the American Society for Information Science*, Vol. 24, No. 1, January/February 1973, p. 3.

[10] Saracevic, T. and Perk, L. J. "Ascertaining Activities in a Subject Area through Bibliometric Analysis: Applications to *Library Literature*", *Journal of the American Society for Information Science*, Vol. 24, No. 2, March/April 1973, pp. 120-134.

[11] Windsor, D. A. and Windsor D. M. "Citation of the Literature by Information Scientists in Their Own Publications", *Journal of the American Society for Information Science*, Vol. 24, No. 5, Sept./Oct. 1973, pp. 377-381.

[12] Salton, G. "On the Development of Information Science", *Journal of the American Society for Information Science*, Vol. 24, No. 3, May/June 1973, pp. 218-220.

[13] Bath University Library, *Investigation into Information Requirements of the Social Sciences: Research Reports Nos. 1-5*. Bath: 1969-1971. Project Head: Maurice B. Line.

[14] Lunin, L. F. "The Rationale and Planning for an Information Science Course in a 'Foreign' Discipline: Medicine", in *Directions in Education for Information Science*. Edited by E. Mignon, Washington: ERIC/CLIS, 1971, pp. 90-116. (ED061947.)

[15] Parker, E. "Information Science Education", in *Directions in Education for Information Science*, p. 56.

[16] Parker, E. *op. cit.*, p. 57.

[17] Parker, E. *op. cit.*, p. 58.

[18] Australia. Scientific and Technological Information Services Enquiry Committee, *The STISEC Report: Vol. 1*. Canberra: National Library of Australia, 1973.

A MASTER'S DEGREE PROGRAMME IN ADMINISTRATIVE STUDIES AT THE AUSTRALIAN NATIONAL UNIVERSITY

JAMES CUTT*

BEGINNING in the 1974 academic year, the Faculty of Economics in the School of General Studies at the Australian National University will offer a new twelve-month Master's degree programme in Administrative Studies. This note provides the rationale for that programme and a brief overview of its structure.

* Professor of Administrative Studies, Faculty of Economics.