Scientific and technological information services in Australia

II. Discipline formation in information management

Michael Middleton

QUT School of Information Systems, Brisbane, Australia

m.middleton@qut.edu.au

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Abstract

This second part of an analysis of scientific and technical information services (STI) in Australia considers their development in the context of discipline formation in information management. The case studies used are the STI services from Part I. A case study protocol is used to consider the extent to which the development of the services may be described in terms of information management domains. Specific reference is made to Australian Agriculture and Natural Resources Online (*AANRO*), the Australian Medical Index (*AMI*), Australian Nuclear Science & Technology Information (*ANSTI*), Australian Transport Index (*ATRI*), *AusGeoref* and its forerunner *AESIS*, and the Australian engineering database (*ENGINE*).

Introduction

This is the second part of a two part work that looks into scientific and technological information (STI) services. The first part[1] focuses on their history and development in Australia. In this second part, the services are examined through the lens of an information management disciplinary framework. An objective is to discuss the extent to which information management may be regarded as a discipline, and then to consider how present understanding of information management has been informed through the development of STI services. Case studies of the administration of STI services in the areas of earth sciences, engineering, health, natural resources, transport, and nuclear science are used to support the analysis. A rationale for the choice of these cases is given in Part I.

A major factor in the characterisation of a profession is the body of knowledge to which it subscribes. Although this may be relatively coherent in fields of scientific endeavour, in the social sciences the body of knowledge may be drawn from disparate subjects and the practitioners are less likely to come from the same educational background. This seems very much the case with information professionals. Their professional training, even when focused on information, may come from streams as diverse as journalism, public administration, librarianship, recordkeeping, communication, information systems, or organisational research.

Is there a body of knowledge that these groups may jointly make use of so that they can advance as a coherent profession? Consideration of what constitutes a discipline normally takes place by examination of the underlying principles and models of the body of knowledge. This has been done regularly for the information professions through deliberation

upon what constitutes 'information science'. Although this paper reviews disciplinary approaches to information science, its attention is more focused by way of contrast on information *practice* in order to suggest elements of a discipline through information management as derived from principles.

Research method

This paper has arisen from a detailed case study of several STI services using a case study protocol which is explained in Part I, and that is supported by interviews with key participants, use of different versions of databases produced, and reference to literature, archives, and supporting material created to support users of databases.

The project's case study questions were structured according to the context of a recently written book on information management[2], because this book uses defined domains of information management to describe how information science principles are applied with practical examples. The three information management domains as detailed in the book are:

- *Operational*, referring to the different tasks carried out during staged processes of information handling, for example the creation, distribution, organisation (including provision of metadata for information medium and content), retrieval, navigation processes for interaction, presentation, and where necessary, disposal or retirement of information.
- *Analytical* referring to user needs and systems analysis, information resources analysis including audits and assessing information worth, and evaluation procedures.

- *Administrative* in this context referring to policy and planning aspects and strategic approaches in general.

Outcomes are documented as characteristics of the STI services in Part I, and then interpreted in the context of discipline formation here in Part II as factors within the domains outlined above.

Studies that investigate some of these factors have been carried out in Australia previously in similar contexts, for example:

- Some analytical and operational factors were investigated to provide general guidance for database production by Judge and Gerrie[3], who surveyed about 40 database producers in Australia and itemised examples of design and operational requirements.
- An approach at the analytical level and applied to information users as well as to the information sources that they use was carried out with respect to Australian STI services in general by Maguire, Weir & Wood[4]. They interviewed research scientists from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), academic scientists from universities, and technical managers from industry in order to tabulate a range of formal and informal resources consulted, and to isolate unsatisfied information needs.
- At the analytical level, examples of user needs identification described from the perspective of individual professionals rather than as research studies, have been reported in a number of Australian forums. For example, both Lay and Thomas provide an engineering viewpoint[5].

This part of the study examines the characteristics of the STI services by interpreting the extent to which they correspond to the defined domains, and in this manner represent an evolving disciplinary framework.

Discipline formation

There has been a limited amount of explicit consideration of information management discipline formation, so it is necessary to look beyond the field in order to take into account methods that have been used for identifying discipline formation in other areas of knowledge and their application.

The process of discipline formation is sometimes characterised as providing new ways of looking at knowledge. For example the publication in the seventeenth century of Newton's *Principia* provided mathematical principles for natural philosophy, and thereby introduced a formal language that was able to introduce disciplines such as physics and astronomy.

Examination of how disciplines form must first decide what a discipline is. Becher and Trowler have reviewed different approaches to this[6], noting such aspects as tradition, sets of values and beliefs, mode of enquiry, conceptual structure, and a network of communications. They make a distinction between two types of emphasis in investigative studies. These are either an epistemological one where the focus is concepts and fundamental aims, or a sociological one where there is a focus on organised social groupings. Nevertheless they recognise that most commentators pay attention to both aspects.

Study of discipline formation is often pursued in general terms by philosophers or sociologists, or in relation to particular disciplines, normally by authorities within those

disciplines who are trying to establish disciplinary limits. Their approach might best be described as historiographic analysis of documentation[7]. Abbott's sociological approach has focused on the professions[8]. He acknowledges that the clarity with which the professional borders are defined may affect what he terms the jurisdiction of a profession, and therefore its vulnerability. His approach to defining professions is relevant to examining discipline boundaries, particularly since he has specifically considered the information professions.

Information science as a discipline

There have been many years of debate on what comprises the defining knowledge of the field of information science. Several works have provided overviews and debate about disciplinary boundaries. Examples are the early compilation by Saracevic, and more recent accounts by Norton, and by Griffiths[9]. In each case they emphasise the interdisciplinarity or 'boundary spanning' of research, but they do not explore to a great extent the application of information science in areas such as systems and management, although Griffiths does give some examples of practice. Elsewhere, information systems and information management are also spoken of as disciplines. However there seem to be professional, research and conceptual barriers that inhibit an inclusive approach to them as a discipline across the applications.

The disjunction between information science and information systems researchers has been observed repeatedly. For example Martin[10] noted that database searching for information management material showed little duplication of coverage in three different databases favoured by the data processing, management and information science fraternities. Later, Ellis, Allen, and Wilson[11] used citation analysis of the subfields of user studies and information retrieval to illustrate the lack of dialogue between respective fields. Likewise, a

recent review of information science as a discipline in the UK[12] makes little reference to studies in information systems, or examination of an information systems/information science boundary.

In information systems study, emphasis seems to be substantially on the systems and process; in information science the emphasis seems to be substantially on the information and its content. They have in common an emphasis on social context and use, but this has not brought unity of focus. For example a joint disciplinary consideration of information systems and information science[13] found a need to differentiate them, seeing information science as a secondary reference discipline of information systems.

Debate in the information science area has an epistemological orientation, in that it is more concerned with knowledge that is pertinent to study of information, than it is with the way in which findings of this study of information are applied. If there is a discipline of information science then, it is perhaps a meta-discipline that draws upon what Griffiths terms 'disciplines of information' that include study as diverse as cybernetics, bibliometrics, semantics and systemics.

Information management as a discipline

It seems that a commonly accepted disciplinary paradigm for information science remains some way off. A paradigm for information management is similarly inchoate. Although some scholars have spoken of an information management discipline, the relationship between what is pursued through research and what is applied by practicing information professionals remains tenuous. Wilson has stated that a coherent educational curriculum and a research

agenda must be associated with information management if it is to have a viable role in organisational performance, with its functions being accepted as a key part of organisational structures[14].

There appears still to be a lack of conceptual reinforcement between the science of information and its application through management. However, there have been attempts by Rowley to characterise information management as a discipline by considering how information science principles are applied in practice[15]. Her work builds upon studies that analyse the work carried out by people who are information professionals[16].

If we are to differentiate information management as the practice of information science, then it is necessary to define a framework. As noted by Macevièiûtė and Wilson[17] the concept depends on the interpretation of the words 'information management'.

> It is not only the concepts of "information" as such, but the multiple meanings of the phrase, emphasis of its elements, or the word order as well as the scientific perspective. The phrase is also used to mean something other than what the LIS field considers to be the management of information resources. For example, it is used as an abbreviation for: the management of IT, information systems management, management information systems, etc. The meaning of the phrase is even more clouded by the emergence of new, related terms, such as "knowledge management", which in many cases has an identical meaning to information management …

These writers have later produced a compilation[18] in which authors of earlier original papers have been asked to revise those papers in order to address them to researchers who are following discipline development. From these revisions Macevièiûtė and Wilson noted such

developments as the expansion of study of information networking, the proliferation of application areas, and the emergence of knowledge management (as a term rather than a new field). After conducting a bibliometric clustering analysis using term association of research publications, they remark upon the continuing diversity of the field.

Typical of the elements used to describe information management work are: evaluation and selection of sources of information content; acquisition of sources and services; information research; description, provision of metadata, and organisation of information repositories; managing information content created by organisations; preparing interfaces for presentation or processes for dissemination of packaged information; undertaking information analysis and value-adding; determination of user requirements of information systems and application of these to system development; and training of users of information systems.

The most explicit attention to discipline formation in information management has been paid by Rowley[19]. The approach that she has adopted is discursive, and involves characterisation of what are perceived to be elements of the field taking historical approaches into account. It is to some extent historiographic as a contribution to its model building. She adopts a viewpoint that information is practice-based with both systems and behavioural dimensions. She regards information *processing* as an activity common to all information users, and information *management* as being the province of professionals (albeit with imprecise professional boundaries), who draw upon many contributing disciplines including management science, information systems, computing science and cybernetics. She maintains that the structuring of information is fundamental to the professional approach and requires agents who will take responsibility for such structure, taking into account issues such as selection, time, hierarchy and sequence.

With Butcher, Rowley has proposed model that they term the 7Rs. This involves information passing through a cycle between individuals and organisations and successively requiring Reading (where it comes from the public to the personal domain) Recognition, Re-interpretation, Reviewing (following here it may pass back to the public domain), Release, Re-structuring, Retrieval, then resuming the cycle. Their approach would appear to owe something to the philosophy of Popper, for example the distinction between private knowledge and social knowledge as described by Kemp. It also seems to reflect to some extent the models of scientific communication explicated twenty years earlier by Garvey although there is no reference to these as sources[20].

Rowley also speaks in terms of information managers working at different levels within the framework of an information environment that she in turn portrays as having different levels: information contexts; information systems; and information retrieval. Within each of these she sees information managers as working within different levels of definition of information. Thus for her at the:

- *Environment* level, the information processors are society as a whole, the information managers are corporations and educational institutions, and information is a commodity and constitutive force.
- *Contextual* level, the processors are organisations, information is seen as a resource and the information managers are working in strategic positions or as organisational scientists.
- *System* level, processing is carried out by a system, the information managers are system analysts and designers, and information is seen as data or thing.

- *Retrieval* level, information processors are individuals, information managers are indexers, database designers, interface designers and information is regarded as subjective knowledge.

Frishammer, building upon Rowley's work, has attempted to place information management and related activities such as environmental scanning and market research within an information processing context[21]. It is suggested that while Rowley subsumes information systems within information management, that an alternative perspective might actually be that the entire framework is concerned with information systems, since either an organisation or an individual can be regarded as an information system.

Rowley's 4 levels may be contrasted with the 3 domains[22] that are used to explain information management and used in the case study protocol. The *retrieval* level may have components that are operational or analytical (through evaluation); the *system* level may be operational (system development and maintenance), or analytical (system, user or requirements analysis and evaluation); and both the *contextual* and *environmental* levels may be regarded as part of the administrative domain's strategic concerns.

As is the case with information science, information management is often described as interdisciplinary or multidisciplinary. Its proponents have yet to settle upon carefully developed procedures and methods that might assure disciplinary integrity and coherence. However there are many professionals who believe they are carrying out information management, and a variety of professional associations that have been formed making claims on the terminology[23].

The research reported in this paper attempts to extend the examination of discipline formation by consideration of how information science principles have been put into practice in the process of managing STI services. In this respect therefore, information management is defined as application of information science. It is the application of policy, analysis, and principles to techniques for improving representation, organisation, storage, retrieval and dissemination of information.

Information management in STI service development

This work extends an earlier analysis that looked at information management as applied in one Australian STI service[24]. It analyses several such services in order to consider the extent to which their genesis and development has taken place within an information management framework.

Services analysed are the Australian Medical Index (*AMI*); Australian Nuclear Science & Technology Information (*ANSTI*); *AANRO* including in particular its Informit component, the Australian Natural Resources Index (*ANR-I*); Australian Transport Index (*ATRI*); *AusGeoRef*, the Australian component of the international *GeoRef* service, and its forerunner *AESIS*; and *ENGINE*, the Australian engineering database. Whereas Part I examined them in terms of characteristics, history and development, here they are interpreted within an information management model, in order to see the extent to which they exemplify such a framework.

The following analysis therefore looks at the extent to which the STI services functioned within administrative, analytical and operational domains as defined for information management

Administrative domain

This domain of information management should embrace a planning and policy framework and therefore take account of the environment in which the information services operate, and strategy for implementation. Despite the struggle towards information policy that was outlined in the accompanying article (Part I), there were no concerted attempts by the STI services to embrace resource provision, to address overlap of coverage between databases, or to provide a platform with a standard interface through public policy.

However, that is not to say that a planning framework was absent. It existed within individual institutions, and in some cases through collaboration between like-minded parties who could see the benefits within their subject areas. Some examples are as follows.

Genesis

The strategic planning that led to the creation of the various services with their databases took place essentially within the disciplines that were interested in the content and application of the databases.

However, there were moves from narrowly focused internal institutional approaches towards cooperative approaches in disciplinary areas. For example, Levick and Russell who were prominent in agricultural database development, were nevertheless pessimistic about cooperation in database development at the end of the 1970s. However from it not being a practical short term ambition, by 1983 a different perspective applied:

> … We felt that from a national viewpoint, the resources necessary to achieve such contributions would be better devoted to efforts by these organisations to improve their bibliographic control. What we did not foresee was that in such a short time, these respective objectives would no longer be seen by the organisations concerned as competing uses of such resources: that they would find, as they have found, contributing to a national effort one way of achieving internal objectives[25].

In some cases it took visionary individuals to prime the pump. Max Lay, then director of ARRB gave particular attention to the information needs of professionals such as engineers working in roads research, and to the research literature that had examined such needs[26]. He was fully cognisant of the importance of cooperative input, and of bibliographic control standards for documents. With respect to awareness of the importance of the role of unpublished reports (elsewhere called 'grey' literature), and in reporting their content along with that of the more formal documentation of published books, journals and proceedings he wrote:

> The problem with these less formal documents is collecting them and ensuring that they are added to appropriate indexes. Often this task is made more difficult by the poor bibliographic standards of the report in question… The other problem related to the report literature concerns the confidential and restricted nature of many reports. However, the insertion into open indexes of bibliographic data for a confidential report is always encouraged as even the fact that the report on a subject exists is often a valuable guide to a searcher…[27]

ARRB did this through its library, through provision of a current awareness bulletin based upon material coming into its own collection, and through a periodic bibliography on roads and road transportation. However it was recognised that service could be improved if road authorities nationally through cooperative effort produced a joint index of publications. The National Association of Australian State Road Authorities (NAASRA, predecessor of Australian Roads) financed a pilot issue in 1973, which led to the first issue of Australian Road Index (*ARI*) in 1975.

The *AESIS* database was initiated in 1976, following a national meeting at the Australian Mineral Foundation (AMF) in 1975, at which existing in-house systems of different agencies were discussed. AMF was accorded a mediating role for a national coordinated scheme with a governing council comprising representatives of the petroleum and exploration industries (which carried the main operational costs)[28], along with professional and industrial associations and universities. *AESIS* was created using computing facilities made available by CSIRO who provided the platform for the database.

International relationships

There were efforts to reconcile Australian and international coverage of information. ARRB became involved in OECD's Road Research Program from 1977, and this entailed input of records of Australian documentation in order to receive the International Road Research Documentation (*IRRD*) database.

> They delegated all of the operations of Australia's membership of that program to the Road Research Board and membership of that program involved not only scientific exchange and cooperative research programs and international meetings ... They had a very strong information program and membership of that program, which Australia joined as they saw it as a means of getting access to the world's information on roads and transport. Membership of that program carried a commitment to contribute as well as to use, and Australia began to contribute to the international road research database in late seventies … ARRB set up its information management library type systems to conform with the very well documented standards that the International Road Research Documentation system had. (S. Quinn, personal communication, 22nd June, 2004)

Whereas a subset of *ATRI* provides Australian international input, *ANSTI* consists of Australia's entire input to the International Nuclear Information System (INIS) of the International Atomic Energy Agency (IAEA), downloaded from the international database and reformatted. Australia's membership of IAEA obligated it to begin contributing records to INIS from commencement in 1972. The entire framework for the system including scope and forms of input, software support, evaluation of potential use, vocabulary maintenance and establishment of a clearinghouse for material, was created by a secretariat in Vienna, Austria. Any influence on direction of the service from individual countries was provided by national liaison officers.

Creation of *AMI* began in 1983 following discussion by the Life Sciences Consultative Committee which was responsible for the administration of Medline. NLA committed funding for indexing and data entry for the first 7,000 items which were complementary

to the Australian Medline input that had been created in the USA since the 1960s. Neither *AMI* nor Medline before it was introduced within the framework of a general national information policy that tried to provide guidance on how publishing and documentary output across the disciplines should be reported and managed. Neither were there debates about institutional responsibility for processing the material, particularly with respect to overlap with other disciplines. Since 2001, some key Australian journals which are covered in Medline have also been covered in *AMI*. All aspects of health and medicine are covered, with emphasis on clinical medicine and paraprofessional fields.

Governance

AusGeoRef, *ANSTI, AMI* and *ENGINE* are each created by individual institutions that administer all aspects of the service.

Because of ARRB's founding membership within AUSINET, the governance of that network was a significant influence on the strategic development of *ATRI*. The ARRB was a relatively small institution among bigger players on AUSINET, and the financial commitment as a member was considerable. It justified this because it could use AUSINET as a database creator as well as user; because it provided access to the systems staff, and more powerful computing facilities than it could justify for its own purposes alone; because it opened up access to a wider use community; and as it felt a commitment to support for production and dissemination of Australian databases.

An AUSINET Users' Committee had been established at the outset for network management in 1977, with its first meeting in Hobart. It was to guide such matters as negotiation with ACI Computer Services concerning access, costs and scheduling of

databases, negotiation with respective database suppliers, provision of documentation, and maintenance of communication between users. The Users' Committee comprised all organisations joining the network. There was also a technical sub-committee, for resolution of technical issues such as database conversion and structures, system performance, and scheduling, and an AUSINET Liaison Committee, which was a committee of NLA's Council and representatives of database suppliers with an operational role advising on development and use of resources[29].

Analytical domain

The analytical domain of information management is part of both the operational level through performance evaluation, and the systems level, for example through user needs and requirements analysis. Although each of the services carried out informal analysis, the extent of formal assessment of both requirements and performance varied widely.

User needs

For *AESIS* was the major analysis of anticipated user needs for the service was a 1972 survey. However although this survey sought information on individual user needs within surveyed organisations, the resulting document confined itself to reporting institutional coverage and current information provision along with recommendations concerning an agency to handle an STI service[30]. Subsequently, AMF strove to be comprehensive within the subject areas delineated.

With *AMI*, there was no specific attention to user needs or requirements analysis (for example by survey), as part of the process of establishing *AMI*. Instead, the inclusive coverage of health materials, allied with flexible retrieval software was assumed to address anticipated user requirements.

In the case of *ATRI*, no formal evaluation of user requirements preceded database creation. Database elements were defined according to the full extent of bibliographic data at the time, and most elements were made searchable for flexibility using the AUSINET STAIRS software. This flexibility has been maintained on the subsequent platforms and carried through to Informit.

Judgments about content were based upon the scope of what library users required, and the already defined scope of *IRRD*. However, the database of Australian Road Research in Progress *(ARRP*) that was built concurrently by ARRB gave valuable insights into information requirements of users:

> The other component … was the annual surveys we did of Australian road research in progress with a triennial updating survey, … fully done to the IRRD specs and that documented the research effort within Australia. They were big survey exercises … information was not only available in our local database but also in the international one, and we also printed it in directories. (S. Quinn, personal communication, 22nd June, 2004)

System requirements

The initial development of services was before the online era. Development of user interfaces was not yet on the agenda, and output requirements for batch processes of what was then termed Selective Dissemination of Information (SDI) services were essentially developed experimentally. For example, before the development of *ANSTI* an SDI service from INIS tapes was developed. It provided a batched facility with limited Boolean search capability, data element and category searching.

CSIRO, which had participated in a pilot current awareness service from *Chemical Abstracts* from 1967, developed a batch current awareness search facility at its Division of Computing Research. The search functionality was notable for providing for a combination of Boolean and weighted search logic and truncation which had to be established on punched cards, and was adaptable to locally produced databases such as *AGRIS* and *ABOA* (precursors of *AANRO*).

The databases with Australian content were established within the online era, and generally were created and searched on systems that had been developed generically to deal with a range of databases (as Informit does now). IBM's STAIRS retrieval software was most prominent in this respect. Any development of it to accommodate the specifics of STI services was limited, but would have taken place as a result of representations of the AUSINET User's Committee mentioned above.

There were search functionality improvements in STAIRS such as the Bibliographic Retrieval Services Inc version in 1979, and database structuring to permit merged postings across databases. For the AUSINET implementation this was CROS – after 'cross-searching' the index of databases, a searcher then moved to the database of choice.

Resource identification

For *AMI*, the NLA was in a strong position to undertake journal coverage, and it was seen as appropriate to begin a distinct national database.

> I don't think there was a lot of research but we were aware that some other regions of the world had constructed regional adjuncts to Medline. … because there were a lot of Australian journals and we (NLA) had access …, … a useful thing for the library to do, and we had strong support from the Department of Health. (S. Henderson, personal communication, 24th June, 2004).

The identification and evaluation of journals to be covered was undertaken by medical librarians in New South Wales.

For *ATRI*, the identification of documents required for coverage is carried out based upon ARRB's knowledge of material being published in Australia, complemented by material being reported by the cooperating institutions.

Performance analysis

For *AMI*, performance evaluation of searches being conducted for 'end users' by library intermediaries has been carried out, but in general there have not been attempts to monitor the performance of searching either by intermediaries, or by end users.

Another aspect of performance that might be monitored is the indexing input:

> … there was meant to have been an evaluation of the indexing services but some of the evaluations were put back for various reasons, economic and how many the library could handle at once…. It hadn't been done up until the time I left the indexing service, … (S. Henderson, personal communication, 24th June, 2004)

For *AESIS* performance evaluation carried out included the use of an evaluative framework set up in a study by Pruett on the international *Georef* database. This was used with reference to *AESIS* to evaluate such things as subject and material (e.g. thesis) coverage; currency (shown to be markedly higher than other geoscience services); incidences of duplicate records; indexing; and training programs. There was also examination of performance in terms of cost effectiveness and benefit[31].

Operational domain

This domain may be thought of as any technical operations carried out within an information life cycle, ranging from creation of information and metainformation, storage, organisation of the information (in this case within databases), retrieval and presentation.

In the development phase of Australian services, storage was of much greater concern than now. A cause of considerable issue with the then Medlars Advisory Committee was the scheduling of aggregations of a database so that a span accumulating to three years was produced, then the oldest year dropped off in order to begin accumulating from the most recent 2-3 years. On AUSINET where a number of large international databases such as parts of *SSCI*, *Compendex* and *INSPEC* were stored, there was scheduling of these databases so that different ones were online at different days of the week. At the time (late 1970s), *SSCI*

was about 100 Mb and *Compendex* about 500 Mb (far bigger than the Australian databases mounted with them). Even in the 1990s the Department of Health's Medline platform had 1966 and 1972 backfiles online on Wednesdays only.

The issue faded away, not just because of leaps forward in storage capacity, but because of greatly increased telecommunications bandwidth (and reduced access costs) to international database, making their mounting in Australia unnecessary.

Creation of databases

The creation of the databases was initially undertaken via coding sheets corresponding to database definitions, with data entry and batch creation of databases taking place. For example the *AESIS* database was created on CSIRONET by dispatch of coding forms to CSIRO from AMF for paper tape data entry. Later data entry took place directly from AMF, and from 1982 this was managed through a host DEC PDP11/44 minicomputer for validation, then storage on a Cyber76 on CSIRONET in Canberra. Software support was provided by CSIRO's CILES System Development Group. The live database was updated monthly on CSIRONET. From 1980, quarterly updates were also produced for AUSINET where they were mounted after conversion to STAIRS with software developed by ACI Computer Services.

Australia's input to INIS (later to become *ANSTI*) also began by transfer of coding sheets to paper tape which was sent to Austria for input to the international database. Paper was soon replaced by magnetic tape, and eventually the database went online. All of the indexing of documents is carried out by ANSTO. When Australia first began contributing

to INIS, it provided input on punched paper tape according to a structured worksheet format. Before long, this approach was supplanted by magnetic tape images of input.

ANSTI is now created by downloading the Australian affiliation content using the BASIS software that supports INIS, and combining this with the Australian source input, where together they are reformatted according to the requirements of Informit.

Where documents include abstracts these may be written, or existing journal abstracts may be used. For example, because ANSTO has since 1983 been part of the CSIRO Library network, it has access to CSIRO's journal publishing data, and is able to use abstracts from relevant items:

> … we're part of the CSIRO electronic journal access which they run off their own server in Canberra, what they call their CSIRO electronic journal collection where they've gone out and negotiated with various publishers and then they bring the data inhouse and then we're part of that … So we're able to log in … for CSIRO electronic journal collection and … can get Elsevier and …. CSIRO Publishing…. (S Gorringe, personal communication, 28th June, 2004).

AMI data entry was initially undertaken at NLA from the worksheets using an adaptation of the Health Department's software for input to their library catalogue, *HEMLOC*. This software, Data Input Management System (DIMS) was converted to a generic form for data entry purposes. Validation was undertaken on a batched basis of the MeSH indexing terms and for citation format. Subsequent data correction was carried out manually. Now

that Informit is the platform, indexing is done directly into a DB/Textworks database and uploaded from there.

When ARRB became a member of AUSINET, it began producing the hard copy of *ARI* as an equivalent Australian Road Research Database (*ARRD*), making use of the Advance Text Management System (ATMS) for database creation. Creators of records for all databases on AUSINET were introduced to the text management software, and functionality such as tagging syntax and text manipulation, by a series of 'Learn ATMS' lessons and an introductory manual. This complemented a manual for using IBM's STAIRS retrieval software.

A subset of *ARRD* comprising Australian input for *IRRD* that at the time was growing at the rate of about 12,000 records per year. The *IRRD* database was initially held in 2 forms: as a consolidated international database, and as a latest month file that enabled current awareness profiles to be run off with each new update.

> … so that there were several really good cooperative reasons for having that system. There was the national system of various state bodies and the national research body that benefited by having a shared information resource, and from that we could extract the material that was appropriate to put into the international database and just spin it out and send it away on a tape. The international database had more stringent requirements for inclusion, anything that was included had to be innovative, it had to be research oriented, it had to have an informative abstract and it had to be indexed in a greater degree of detail. (S. Quinn, personal communication, 22nd June, 2004)

IRRD became International Transport Research Documentation (*ITRD*) and *ATRI* and the *ITRD* component are now produced concurrently. Records are tagged in *ATRI* and processed in monthly batches in-house in *ITRD* format and emailed to TRL (UK) which manages the database.

Examples of elements of record formats for databases are in Part I.

Thesauri and indexing

For *AMI*, contract indexers provide input on a piecework basis. The rates initially established assumed that they would be indexing 4 items per hour. Worksheets require bibliographic details of documents received at NLA along with an abstract if none was already provided, and indexing based upon MeSH, controlled vocabulary of the U.S. National Library of Medicine (NLM). Principles adopted for indexing follow closely those that have been employed by NLM since the initiation of its Medlars service.

The thesaurus used for indexing references that go into *ANSTI* is the INIS thesaurus which has been utilised by all INIS contributors since the beginning of the database. The thesaurus has been reprinted regularly as part of a report series. The thesaurus is used in conjunction with database building so that narrower terms assigned by indexers automatically generate additional hierarchically broader terms for the same record, to support searching. For example ‘iodine’ generates ‘halogens’, ‘nonmetals’ and ‘elements’.

A formal process enables contributing countries to propose and have terms included. Therefore there are not local variations on the thesaurus, thus in Australia's case the vocabulary is identical for INIS and *ANSTI*.

Because of the extent of bibliographic control employed for *INIS*, and in so doing also enjoyed by *ANSTI*, there is other documentation used to standardise input, improve information quality, and thereby assist with searching. This includes terminology and codes for countries and international organisations; authority lists for corporate entries, report number prefixes, and journal titles; and an outline of broad subject categories, their codes, and scope descriptions.

Training and user assistance

Training tools comprise database guides for individual databases that outline their structure. In the case of *AMI* not only is there an AMI Manual but there's a Medlars Course Manual, a Medlars searching self-training guide, a NETSDI manual and various working tools for MeSH – the Medical Subject Headings as an annotated alphabetical list, in permuted form, and as hierarchical 'tree' structures.

Much of the material from different manuals, and in particular the interfaces for online searching was brought together in the *Recipe book service*[32]. This loose leaf service was commenced in 1980 and continued until 1995, in order to consolidate in one document the information that online users needed to be aware of in searching multiple databases in multiple services. It was organised according to online service. Databases available on services were itemised, but the emphasis was on operational aspects such as connection

and charging. These accompanied an overview of general approaches to searching, and therefore of the retrieval software such as STAIRS on AUSINET and AUSTRALIS.

Current awareness

Initially SDIs were run on update tapes. For example with INIS and Medline, a retrospective search was carried out, and the ongoing profile was maintained for sequentially processing with batches of other profiles against update tapes.

Other current awareness products were developed. For instance, from *AESIS* there was *Earth Science and Related Information Selected Annotated Titles* (*ESRISAT*) that selectively covered earth sciences serial publications received by the AMF and South Australian Department of Mines and Energy libraries and State Library of South Australia. Seven indexes: subject, locality, author, map sheet, mine/deposit/well/name, stratigraphic and serial title were created for a monthly service which also had semi-annual cumulations[33].

Discussion

The term ‘information management’ was not used during the genesis and development of STI services in Australia. However, many of the principles by which it is presently guided were employed, if not expressed. Most of the elements of information management as it is currently practised were present during development, and may in some cases be regarded as exemplary for present systems.

It is possible to look at the services from an information management standpoint that considers the extent to which they have been developed within the framework of a domain model. To an extent, the principles as expressed by Rowley are also accommodated, although they would benefit from some modification using the domain-oriented approach.

From Rowley's *environmental* viewpoint, the services have certainly been developed within a strategic planning framework. In these cases the planning has owed more to the requirements of individual information sectors, than to a concerted public policy approach. This has had the advantage of the engagement of the respective sectors, but has led to uncoordinated coverage, unstandardised metainformation, and therefore barriers to sharing information. It has also produced alternative approaches to international coverage of material, so that there is no consistency in the way that Australian material published locally and internationally is consolidated.

If Rowley's *contextual* level is employed, there appeared to be significant attention paid to establishing databases as information resources when they were first created. However, there appears presently to be some risk to the continuation of these resources, because their coverage is being constrained or poorly resourced, and there is limited drive for their development to support other functions such as digital repository linkage and research performance analysis. It is encouraging however, to see the *AANRO* evolution to support a combination of a web-based knowledge base and an alternatively formatted resource via Informit, with different groups of users in mind.

Although the environmental and contextual are separated above, there does not appear to be any benefit in doing so, since an administrative domain with its focus on policy and planning

encompasses both. It could be that environmental and contextual approaches are separable respectively into external and internal planning influences. However, there are many information management situations, including those for STI services, where it is problematical to differentiate these in relation to strategic planning. Public policy and business-to-business relationships while external in origin, greatly influence internal planning.

The analytical domain of information management was possibly the most underdeveloped at the outset of services. Although there was some attention to user requirements, the overall context in which databases were being used could have been better researched. This omission continues to be reflected in the present. More sensitivity to the context in which the services are operating may have seen them produce more in the way of tailored or current awareness products, along with alternative functionality such as ability to measure research performance through citations. This domain may be construed as an element of Rowley's *system* and *retrieval* levels

At a *system* level the analysis required to develop the services in the first place was experimental rather than user-directed, and subsequent performance analysis has been relatively perfunctory. Nevertheless the way forward was shown. The analytical domain at the *retrieval* level should principally be about performance evaluation and quality control. While procedures are in place for monitoring and quantifying throughput, little attention has been paid to areas of evaluation such indexing quality, thesaurus utility, and retrieval effectiveness.

The operational domain may also be taken to be part of Rowley's *systems* and *retrieval* levels. At the systems level, the current platforms provided by *Georef* and by Informit are established and provide routine functionality. The current Informit platform provides a unifying influence for five of the services. It may also provide the flexibility and the vitality to see them developed to support additional services. Operational retrieval features including metainformation creation, vocabulary control, information retrieval and presentation have been present since the initiation of the services, and have been improved along with developments in software and technology.

Conclusion

Part I of this work provided an overview of the characteristics of a number of Australian STI services, with reference to the policy environment in which they were developed, and with some commentary about their continuing utility. Part II takes these same services and considers them as exemplars of discipline formation in information management. This is done using making use of Middleton's book on information management and Rowley's work on discipline formation, each of which endeavours to articulate a framework in which information management takes place.

The analysis shows STI services provide useful models for expression of the information management framework. The work is limited in scope by its restriction to bibliographic services, and limited in detail by gaps in documentation about these services and recollections of stakeholders. However it complements case study work in information management documented for example by Orna[34], and extends this work by showing that a useful

framework may be used for more discipline-based analysis of such cases. The protocol that was employed provided a useful analytical approach that may also be adopted to examine other information services and the information management milieu in general. Hopefully, this will add to the rigour of case documentation, which in turn will help to improve disciplinary definition.

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References and notes

1 M Middleton 'Scientific and technological information services in Australia I. History and development' *Australian Academic and Research Libraries* vol 37 no 2 2006 pp111-135.

2 M Middleton *Information management: a consolidation of operations, analysis and strategy* CSU Centre for Information Studies Wagga Wagga 2002.

[3] P Judge & B Gerrie (eds) *Small scale bibliographic databases* Academic Press Sydney 1986.

[4] C Maguire T Weir & L Wood *Scientific and technological information: Its use and supply in Australia* Department of Science Scientific Development Division Canberra 1987.

[5] Described in separate contributions by Lay and Thomas in L Lane (ed) *Engineering information and documentation in Australia: Problems and solutions; proceedings of a national seminar conducted by Footscray Institute of Technology, 25 November 1983* Footscray Institute of Technology Footscray 1984.

[6] T Becher and P R Trowler *Academic tribes and territories: intellectual enquiry and the culture of disciplines* 2nd edn SRHE & Open University Press Buckingham UK 2001.

[7] Their study involves relativist analytical approaches that seem to range from Kuhnian philosophy of science, to Foucaultian examinations of disciplinarity and the power structures involved in its construction, for example: P Baehr *Founders, classics, canons: modern disputes over the origins and appraisal of sociology's heritage* Transaction Publishers New Brunswick NJ 2002; and H Pai *The portfolio and the diagram* Cambridge MA 2002

[8] A D Abbott *The system of professions: an essay on the division of expert labor* University of Chicago Press Chicago 1988.

[9] T Saracevic *Introduction to information science*. NY: Bowker NY 1970; M Norton *Introductory concepts in information science*. Medford, NJ, USA: Information Today Medford NJ 2000; J-M Griffiths 'Back to the future: information science for the new millennium' *Bulletin of the American Society for Information Science* vol 26 no 4 2000 pp24-27.

[10] W J Martin 'Information management in the United Kingdom' in A Kent & C M Hall (eds) *Encyclopedia of library and information science* Vol. 51 suppl 14 Dekker, NY 1993 pp266-276.

[11] D Ellis D Allen & T Wilson 'Information science and information systems: Conjunct subjects disjunct disciplines' *Journal of the American Society for Information Science* vol 50 no 12 1999 pp1095-1107.

[12] S Webber Information science in 2003: a critique *Journal of Information Science vol 29* no 4 2003 pp.311-329.

[13] D Khazanchi & B E Munkvold 'Is information systems a science? An inquiry into the nature of the information systems discipline' *Database for Advances in Information Systems* vol 31 no 3 2000 pp24-42.

[14] T D Wilson 'Information management' in J Feather & R P Sturges (eds) *International encyclopedia of information and library science* 2nd edn Routledge London 2003 pp. 263-277.

[15] J Rowley 'Towards a framework for information management' *International Journal of Information Management* vol 18 no 5 1998 pp359-369; J Rowley 'In pursuit of the discipline of information management' *New Review of Information and Library Research* no 5 1999 pp65-77.

[16] A seminal study that identified broad categories of information work was A Debons D W King U Mansfield & D L Shirey *The information professional: survey of an emerging field* Dekker NY 1981; Abbott *op cit* characterised the information professions as qualitative (principally librarians and journalists), and quantitative (a "complex and contentious group" including accountants, statisticians, operations researchers, and the like), and foresaw these groups coalescing under one jurisdiction stimulated by the joint catalysts of computing technology and of information science; the periodicals of professional information associations often examine the boundaries of the field, and what employment in it means, for example M Corcovan L Dagar & A Stratigos 'The changing roles of information professionals' *Online* vol 24 no 2 2000 pp28-33 report excerpts from an *Outsell Inc* study on information management roles

[17] E Macevièiûtė & T D Wilson 'The development of the information management research area' *Information Research* vol 7 no 3 http://InformationR.net/ir/7-3/paper133.html [19th March 2006]

[18] E Macevièiûtė & T D Wilson (eds) *Introducing information management: An information research reader* Facet London 2005. (updates of papers appearing published with the same title at http://InformationR.net/).

[19] J Rowley 1998, 1999 *op cit*

[20] D Butcher & J E Rowley 'The 7 Rs of information management' *Managing Information* vol 5 no 2 1998 pp34-36; D A Kemp *The nature of knowledge: an introduction for librarians* Bingley London 1976; W D

Garvey *Communication, the essence of science: facilitating information exchange among librarians, scientists, engineers, and students* Pergamon Oxford 1979.

[21] J Frishammar Characteristics in information processing approaches *International Journal of Information Management* vol *22* no 2 2002 pp143-156.

[22] M Middleton 2002 *op cit* pp13-14

[23] M Middleton 2002 *op cit* pp22-28 for examples

[24] M Middleton 'Discipline formation in information management: Case study of scientific and technological information services' *Journal of Issues in Informing Science and Information Technology* vol 2 2005 pp543-558. http://2005papers.iisit.org/I45f78Midd.pdf; http://eprints.qut.edu.au/archive/00001433/

[28] G Levick 'Bibliographic systems and their development' in P Montgomery (ed),*Computerised information systems in agriculture: proceedings of a national workshop on developments in computerised information systems in agriculture, Melbourne, Victoria June 22 and 23, 1983* Department of Agriculture Melbourne 1983 pp13-17.

[26] ARRB was established in 1960 as a national research body financed by the federal government and State road authorities through the National Association of Australian State Road Authorities (NAASRA; subsequently known as Austroads). Included among its objectives was to provide a national centre for road research information.

[27] M G Lay *The ARRB information system* Australian Road Research Board Vermont South 1979 (ATM No. 7).

[28] D A Tellis 'AESIS: a cooperative public/private sector development initiated by the private sector' in G Peguero (ed.), *Australian clearing houses and data bases: towards a national policy; proceedings of a national seminar conducted at Footscray Institute of Technology, 19 November 1982* Footscray Institute of Technology Footscray 1983 pp67-86.

[29] The committee structure is described by Bays who was critical of the initial loose arrangement and advocated a more formal arrangement with a secretariat: M Bays 'The Australian Road Index: a cooperative venture' *Australian Special Libraries News* vol 12 no 1 pp34-37 1978; M Bays *The beginnings of Ausinet and the committee structure by which the network is currently managed* Australian Road Research Board Vermont South 1978(ARRMS 78/152).

[30] P Dixon & D A Tellis *AMF information services survey* Australian Mineral Development Laboratories, Adelaide (AMDEL Report; 911); an overview of the *AESIS* analytical approach is given in M Middleton 2005 *op cit*.

[31] D A Tellis 'Management, control and cost benefit' in P Judge & B Gerrie (eds.) *Small scale bibliographic databases* Academic Press Sydney 1986 pp73-98; an overview of *AESIS* performance analysis is in M Middleton 2005 *op cit*.

[32] *Recipe book service of online searching* 1-14 edn Online Information Resources Ltd Doncaster 1980-1985.

[33] D A Tellis 1983 *op cit*.

[34] E Orna *Practical information policies* 2nd edn Gower Aldershot 1999