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A framework for information management: Using case studies to test application

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Abstract

An analysis is undertaken of a disciplinary framework for information management suggested by Rowley in 1998 in order to consider its applicability to information services. The analysis uses several case studies that have been conducted on the development of scientific and technological information (STI) services. These services have all been involved in the creation of bibliographic and associated databases of Australian STI material. The analysis examines information management domains through the looking glass of the Rowley framework which has as its elements the information environment, information context, information systems, and information retrieval. It is concluded that while STI services exemplify information management in terms of the framework suggested, that the framework could be adapted to be of more benefit in expressing the disciplinary basis and its professional setting. This might be achieved by removal of the differentiation between environment and context, and by elaborating the information systems and information retrieval levels further into analytical and operational domains.

Keywords: Information management; Discipline formation; Information services; Information models; Australia

1. Introduction

A recent study of Australian scientific and technological information (STI) services was undertaken to examine their characteristics and progress. Part of the analysis was concerned with the extent to which their development reflected discipline formation in information management. The analysis was based upon case studies of several services maintained by government and the private sector, and is reported in detail elsewhere (Middleton, 2006a, 2006b). This paper draws upon that investigation by making use of the case studies to examine the applicability of the framework of information management suggested by Rowley (1998).

Studies of the disciplinary framework within which information professionals practice have ranged from investigation of the boundaries of subject content, through to analysis of the ways in which the members organise themselves and provide education for those entering the profession. Subject content has been principally an academic concern with a concentration upon the elements of information science, and explanation of research areas to be pursued. Analysis of professional organisation has come more from

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professional associations as they assert territory, or practitioners within such associations who are interested in professional development.

This study attempts to bridge the discipline content and professional concerns by investigation of information practice in a particular environment, and by relating that practice to the disciplinary areas of information science. The Rowley framework is chosen, since it is an endeavour to provide a model for that bridge. As the cases appear to represent specific examples of information principles being put into practice, they are worthy of examination with respect to an information management model.

This work begins with a brief review of studies of professionalism and discipline formation. It then uses the chosen disciplinary framework that has been proposed, in order to test its applicability to what might be represented as an information management working environment.

2. Profession and discipline

Information professionals have for some time wrestled with the issue of whether they comprise a profession that is based upon the tenets of a coherent discipline. Sociological enquiry into the features of professions in general has led to identification of professional characteristics along the following lines:

(i) An evolving corpus of tested knowledge that is generally accepted by its adherents.
(ii) Acceptance of underlying models of explanation for the knowledge base.
(iii) Continuing effort to develop the knowledge base through research.
(iv) Application of the theoretical and intellectual knowledge in a particular ways to solve human and social problems.
(v) Utilisation of guidelines for application of professional practice and technical standards.
(vi) Development of guidelines for conduct of professional practice, for example through a code of ethics.
(vii) Altruism, whereby unselfish concern for others is supposed, although this may perhaps be 'by means of a reward system in which moral obligation and self-interest often coincide and fuse, the institutional arrangements of the professions tend to make it a matter of self-interest for individual practitioners to act altruistically' (Merton & Gieryn, 1982).
(viii) Provision of guidelines for preparation and the training into the area.

The main emphasis of this paper is points (iv) and (v) from the list above. That is, there is a consideration of the bridge between the theoretical principles that are espoused in the field, and the way that they are put into practice using the development of STI services as case studies.

Elements (i)–(iii) are principally concerned with an accepted knowledge base, and are usually a focus for those who approach understanding of a discipline from an academic viewpoint—continuing to ask the question of what constitutes information science. A number of works have provided overviews and debate about information science's disciplinary boundaries. For example there have been compilations of papers that endeavour to show the range of investigation within the topic. An early example was that of Saracevic (1970), and in subsequent decades there have been similar collections of papers accompanied by commentary on what constitutes the field, for example by Meadows (1987) and Williams and Carbo (1997).

These collections have been complemented by expositions that seek to provide a consolidated overview of information science. For example the work by the Vickerys has reached its third edition (Vickery & Vickery, 2004) since original publication in 1987, with later editions incorporating more on information seeking to complement the systems-oriented information retrieval. Raber (2003) considers information from physical, behavioural and social viewpoints after first considering the matter of definition of information. Many enquiries take as their starting point the problem of defining 'information', and some concentrate upon it. For example Bates (2005) has reiterated the enduring designation of information as 'pattern of organisation of matter and energy' for its usability across the physical, biological and social contexts.

A continuing theme has been the interdisciplinarity or 'boundary spanning' of research. Less often is there exploration of the application of information science in areas such as systems and management, although Griffiths (2000) gives examples of practice. 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 studies as

diverse as cybernetics, bibliometrics, semantics and systemics. In research terms, this has been recently manifest in the USA by the I-School movement where there has been an alignment toward inclusion of multidisciplinary approaches to information research, rather than attempt to create boundaries around particular aspects of information study (Harmon, 2006).

Items (vi)–(viii) from the list above are about how entry of new professionals is managed, and how the profession comports itself. Entry is managed through educational requirements, and there has been a continually evolving discourse on curriculum for example by Gorman and Corbitt (2002), and by Tedd (2003). This has been accompanied by research into educational requirements, for example by Abbott (2003), along with the suggested courses or curricula that are advanced by the professional associations themselves. These same associations may also produce codes of practice as in the case of AIIP (Association of Independent Information Professionals, 2005).

Analysis of this connection between discipline and profession may take the form of statements of what an information professional does and what principles this work is based upon. For example, Hornby and Andretta (2001) canvass contrasting views on convergence and diversification of the profession. They maintain that in Britain diversification has been turned into a strength by promoting information management as a discipline that is highly flexible in addressing the diverse needs of the information profession. This has been achieved for example through modularisation within qualification degree structures. The changing boundaries of practice have been debated at some length by Myburgh (2005). She considers that the traditional paradigm of the profession is 'riddled with anomalies' and lacking fundamental theories, and looks for a new way forward with less document-based interpretation of 'information'.

This paper is less concerned with information science as a discipline, or the way in which those who apply it organise themselves professionally. It is more concerned with how the principles of the science may be employed in practice (as indicated in items (iv) and (v)). This gives the opportunity for expressing information management as a discipline with its own principles (drawing upon those of information science). Although much has been written about the elements of information management, there is relatively little that tries to express a framework of principles under which it is carried out. One who has suggested a framework that associates principles with practice is Rowley (1998, 1999). Her propositions are used as a lens through which the case studies are examined with a view to test the framework's application to a specific setting for information management.

2.1. A discipline of information management

Both information systems and information management are spoken of as disciplines in the practice of information science (Vickery & Vickery, 2004). However, there seem to be professional, research and conceptual barriers that inhibit an inclusive approach to them as a discipline across such applications.

This disjunction has been observed repeatedly. For example, Martin (1993) observed that the data processing, management and information science fields showed little overlap of coverage in three different databases with respect to information management documents. Later, Ellis, Allen, and Wilson (1999) used citation analysis of the subfields of user studies and information retrieval to illustrate the lack of dialogue between respective fields. Markedly a recent review of information science as a discipline in the UK (Webber, 2003) makes little reference to studies in information systems, or examination of an information systems/information science boundary.

In disciplinary study of information systems, 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 led to a mutual centre of attention. For example a joint disciplinary consideration of information systems and information science (Khazanchi & Munkvold, 2000) found a need to differentiate them, seeing information science as a secondary reference discipline of information systems.

Wilson (2003) 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. 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. If we are to convey information management as the practice of information science, then it is necessary to define a framework, but this is unfortunately clouded by the many interpretations of the words 'information management'. As noted by Macevièiûtë and Wilson (2002) the term may be used to represent the management of IT, information systems management, or management information systems, and may also be confused with the more recent catchphrase knowledge management.

There continues to be limited conceptual reinforcement between the science of information and its application through management. However, Rowley has attempted to express a framework that characterises information management as a discipline by considering how information science principles are applied in practice. Rowley adopts a viewpoint that information is practice-based with both systems and behavioural dimensions. She puts forward 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.

Rowley envisages information managers working at different levels within the framework. She portrays this framework as having different levels: information environment; information contexts; information systems; and information retrieval. 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*, information processing is carried out by systems, 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.

Can such a framework be used to illuminate the information processing that happens with provision of bibliographic information services? Case studies of STI services in Australia are used to explore this.

3. Case studies of STI services

The study of Australian STI services was undertaken as part of research that examined the influences on their initial development in Australia, but which also analysed their progress from the viewpoint of discipline formation in information management.

The services on which detailed analysis was conducted were: Australian Agriculture and Natural Resources Online (*AANRO*), produced by Infoscan for several government instrumentalities; Australian Medical Index (*AMI*), produced by the National Library of Australia (NLA); Australian Nuclear Science & Technology Information (*ANSTI*), produced by the Australian Nuclear Science and Technology Organisation (ANSTO); Australian Transport Index (*ATRI*), produced by ARRB Group Ltd (formerly Australian Road Research Board); *AusGeoref* produced by Geoscience Australia; and the Australian Engineering Database (*ENGINE*), produced by Engineers Australia.

The *AMI*, *ANSTI*, *ATRI* and *AusGeoref* databases are each coupled with pre-existing international databases in the same subject area. *AMI* is supplementary to *Medline* and *ATRI* to International Transport Research Documentation (*ITRD*), although in each case there is some overlap of content. *ANSTI* is a subset of the International Nuclear Information System (*INIS*) and *AusGeoref* is a subset of *Georef*.

3.1. Method

A descriptive case study methodology (Yin, 2003) was applied with the unit of analysis comprising a system of action, applied over multiple cases. The case study protocol was carried out with assistance from interviews with key participants, use of different versions of databases, and reference to literature, archives, and supporting material created to support database users.

Case study questions were structured according to the context of a recent book where information management is expressed in terms of the domains: *Operational* (the procedures required for structured information handling); *Analytical* (user, resources and systems analysis and evaluation); and *Administrative* (policy and planning aspects and strategic). These three domains of information management, outlined earlier by Diener (1992), were expanded in some detail in the book (Middleton, 2002). The book acts as a description of a disciplinary framework for information management, and its precepts may be tested in environments thought to be representative of information management.

The information collected from case studies exploring this work was reported by Middleton (2006a, 2006b). The services examined were found generally to operate within the information management framework expressed in terms of domains. This paper takes the opportunity to examine the STI services more specifically with reference to the alternative framework proposed by Rowley (1998) in order to consider the extent to which these services may be explained within such a framework as exemplary of information management. Thereby the explanatory power of the Rowley model is tested. The following subheadings are based upon the levels of Rowley's framework. Within each, there is further subdivision to consider particular aspects of the level with respect to the STI services.

3.2. Information environment

The STI services were initiated during the 1970s in the setting of an information environment where the influences could be regarded as public policy development (political element), along with a drive by some institutions and scientific disciplines to provide for better information access through documents (societal element), and improvements in information retrieval systems (technological element).

Rowley's 'environment level' sees information management being carried out at this level corporately—that is by institutions taking into account a societal framework. If this is happening with respect to the STI services, we might expect them to be developed within a public policy agenda, or to address the professional demands of the scientific and technological disciplines that they may service, or to respond to technological changes that facilitate improvement in information management. Each of these elements is considered in turn.

3.2.1. Public policy development

With the exception of a government paper in the early 1990s that strove to articulate the elements of a national policy (Australia—Parliament, House of Representatives, Standing Committee for Long Term Strategies, 1991), Australia has eschewed integrated information policy.

Present interest in the area is driven by communications, the media, and development of information industries. However at the time of development of STI services, public policy was focused more strongly on scientific information provision, for example through the Department of Science (Australian Department of Science, 1985), and as a result of the STISEC proposals (Australia—Scientific and Technological Information Services Enquiry Committee, 1973). These proposals included both the development of a national information policy, and a national central STI authority to act as focus for activities and promote their orderly development.

However, a focus for STI leadership was never satisfactorily attained, because the interests of the two most prominent and likely lead agencies, the NLA and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), were not fully reconciled. Nevertheless, piecemeal policy initiatives within individual government departments did stimulate the progress of STI services. In some respects the progress they achieved was in spite of policy and the lack of coordination between the lead institutions that established and provided the services. Regardless of the misgivings about coordination, the ad hoc development resulted in

extensive services based upon international databases, complemented by the production of local databases. More detailed discussion of public policy factors at the time is provided in Middleton (2004, 2006a).

From the viewpoint of information management, a lively policy environment existed that had bearing upon the formation of STI services in the 1970s. There was recognition of the need for a framework to promote a more significant role for STI resources in economic development, and a desire to record comprehensively the national scientific documentation output. Strategies to achieve this included improving representation of local scientific and technological output within international databases, or complementing of those databases with local material. These strategies were applied at the level of particular scientific disciplines rather than across the broad range of science and technology.

3.2.2. Disciplinary demand

Bibliographic control of STI in Australia was fragmented as noted by STISEC. However, at the disciplinary level this was addressed in a number of quarters by specific agencies that supported the professions. For example in the case of earth sciences information, the Australian Mineral Foundation (AMF) was established, among other things to launch a resource centre for the mining and petroleum industries. It was given a mediating role for a national coordinated information scheme.

This brought together in a clearinghouse, material from a variety of agencies that generated significant amounts of information, among them the State Geological Surveys, and Mines Departments; the national Bureau of Mineral Resources, Geology and Geophysics (BMR); the mineral research areas of CSIRO; and a number of mining and exploration companies that had repositories of their own material, but had previously undertaken little collaborative effort to share it. AMF began to produce print-based current awareness services, and built the *AESIS* database which was the precursor of *AusGeoref*.

In the case of transport information, ARRB was established in 1960 as a national research body financed by the federal government along with State government road authorities through the National Association of Australian State Road Authorities. Its objectives included provision of a national centre for road research information. The then director was a visionary who gave particular attention to the information needs of professionals such as engineers working in the area, and to the research literature that had examined such needs. He was fully cognizant of the importance of cooperative input, and of bibliographic control standards for documents, for example, 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.

ARRB provided an information service 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. 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 then *IRRD* (now *ITRD*) database. In May 1979, a participants group was formed for discussion of developments to, and improvement of, the system and databases. ARRB subsequently hosted annual meetings in order to foster continuing cooperation.

Both *AusGeoref* (formerly *AESIS*) and *ATRI* have for many years now been online bibliographic databases that support professional needs.

3.2.3. Technological change

Initial development of services was undertaken at a time when systems were moving from batch mode to online. Those working in the area were beginning to realise the potential of moving on from what were initially typesetting programs to assist the batch production of abstracting and indexing services in print form.

The examples that follow are essentially the product of information management at the systems level, but have arisen because of the capabilities introduced by technological development of both software and hardware capabilities.

Procedures were established that would enable building of search profiles for searching of updates—selective dissemination of information (SDI). For example CSIRO had participated in a pilot current awareness service from *Chemical Abstracts* from 1967. Then, beginning with Chemical Abstracts Service CA *Condensates*, it made available databases from 1972 for batch current awareness searching through its

Division of Computing Research. For searching purposes, all overseas databases arriving on tape were converted to a common local format aligned to the extant standards, MARC and ANZI Z39.2. 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.

The *INIS* service had begun in the early 1970s to create profiles for batch searching of tapes from the consolidated *INIS* database. Similarly, both the Victorian and New South Wales Departments of Agriculture experimented with production of printed current awareness indexes using batch software. These turned out to be forerunners for the current *AANRO*.

These and the other STI services gradually moved to online delivery beginning with the *Medline* service in 1975. Migration to *Medline* was undertaken along with the reformulation of about 1600 existing current awareness profiles for the new software (Middleton, 1977). The network supporting *Medline* was then developed with links established initially to a limited number of institutions.

These facilities were initiated to provide services from international databases. However, in a number of cases they engendered Australian databases. The locally produced compilations became practicable with the advent of online services. *ANSTI* begins life as a subset of the international database *INIS*, before being hived off for local use. *AusGeoref* is created as a subset of the international *Georef* database. *ATRI* is created along with input to *ITRD*. *AMI*, *AANRO* and *Engine* are produced as stand alone databases of national material. *AMI* now provides links to full text provision of material as well, *AANRO* does this for material that is already digitally available, and the others are looking to follow suit.

3.3. Information context

The contextual aspect is seen by Rowley as the second level of macroinformatics, symbiotic with the environment. It is described variously as institutional recognition of information as a resource, and as the circumstances that affect the functions that a system is expected to perform. The context encompasses the user, so information needs of STI system users should be taken into account.

If this 'contextual level' is interpreted, then we would expect to see attempts by managers to value either qualitatively or quantitatively the resources being managed, as well as to plan services to accommodate functionality improvement derived from research and development. Further, the services should be managed to address user needs through some formal analytical process. Examining each of these in turn:

3.3.1. Information as a resource

There is a lack of evidence that information has been treated as a resource (in the sense of putting a monetary value on it as a product), by the organisations that have created the STI services. There has however, been an appreciation of the costs of maintaining such services. For example Tellis (1981) provided a variety of details of costing for the *AESIS* database production. He published direct costs of management and support services (processing and production), materials and salaries. He used these along with amortisation estimates of development costs to infer a unit cost figure for processing of metadata records. However, the figures do not put a value on the accumulated information.

The database vendors were more forthcoming with information on costs of maintaining databases. For example Klingender was associated with AUSINET, which for a time provided the platform of several of the databases. He considered ways in which public information should be delivered over a private network, while justifying the unpopular decision to drop certain low use databases from his network (Klingender, 1981). He was seeking more certainty to enable the private sector to generate the profits to make service viable, such as government commitment not to establish similar networks, fixed term exclusive contracts, and release from obligation to mount databases.

3.3.2. Circumstances affecting functionality

All of the STI services have had to accommodate functionality change over time. This may have been due to technological change as exemplified above. It may also have been due to institutional policy change in areas like platform and software support, or of scope and coverage.

Although all except one of the STI service databases are now available through one vendor, Informit (2006), produced by RMIT Publishing, they have previously been migrated across platforms with different capacity and information retrieval functionality. In Australia these platforms included:

- AUSINET, which from 1978 used the computing facilities at what was then ACI Computer Services (later Ferntree) at Clayton in Victoria, with initial participants using leased line services. There was stress on the development of uniquely Australian material. AUSINET functioned with IBM STAIRS software which facilitated databases structured with paragraphs (text search facilities such as Boolean and proximity), and formatted fields (coded data permitting relational operations, typically used to refine a search); sorting of search results and saving of search statements for re-use was possible.
- CSIRO's AUSTRALIS which was initiated in 1987 to enable consumer access to scientific databases reticulated through CSIRO's telecommunications network CSIRONET, or via the telephone service. Databases were moved from it when Informit went online in 1998. Retrieval software was also IBM STAIRS.
- The NLA's OZLINE which ran from 1987 to 1998 with both a STAIRS, and alternative SOFI public user interface.

Coverage and scope of the services had to be established initially and may then have been varied over time. For example in the case of *AMI*, it commenced 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 7000 items which were complementary to the Australian *Medline* input that had been created in the USA since the 1960s.

3.3.3. User information needs

Most of the services were commenced without formal detailed user needs analysis. In a number of cases, because locally built databases were created to complement existing international equivalents, user needs were seen simply as an extension to existing services in order to bolster local content. For example, in the case of *AMI*, the inclusive coverage of health materials complementary to the existing *Medline* database was thought to address anticipated user requirements, given the flexible retrieval software. Similarly judgments about *ARRB* content were based upon the already defined scope of *IRRD* and influenced by requirements of existing library users. However, the Australian Road Research in Progress (*ARRP*) that was built concurrently by ARRB gave valuable insights into information requirements of users.

In the case of *AESIS* there was a significant survey of anticipated user needs (Dixon & Tellis, 1972). This sought information on individual user needs within surveyed organisations. However, the resulting document confined itself to reporting institutional coverage and current information provision along with recommendations concerning an agency to handle an STI service.

3.4. Information systems

Rowley, and later Frishammar (2002) point out that the entire framework under discussion may be considered as an information system. However, this present analysis follows Rowley's initial proposition that the system is generally thought of in terms of the technological capability for supporting the process. Therefore, the information managers are seen to be the systems analysts and designers.

Systems analysis and design is therefore taken into account. However, although Rowley does not mention system evaluation in its own right, it is included here and differentiated as an aspect of information systems that requires separate consideration.

3.4.1. Systems analysis and design

Initial development of services was undertaken prior to the online era. Development of user interfaces was not an issue. Output requirements for batch processes of what was then termed SDI services were developed for intermediaries rather than end users. CSIRO developed a batch current awareness search facility for databases. For its time it had advanced search functionality notable for providing for a combination of

Boolean and weighted search logic and truncation. It was adaptable to locally produced databases such as *ABOA* (a precursor of *AANRO*).

The databases dealing solely with Australian content were begun after the commencement of the online era. Generally they were created and searched using existing software 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. There was limited development of it to accommodate the specifics of STI services. One mechanism for initiating this was the AUSINET User's Committee. For example it sought database structuring to permit merged postings across databases. The AUSINET implementation of this was CROS—after 'cross-searching' the index of databases, one could then move to the database of choice.

3.4.2. Evaluation

Evaluation plays a significant part in information management, but it has not been given any prominence by Rowley. It seems reasonable that it should play a significant part in both information systems and information retrieval level at least, and it is included here particularly to address system performance analysis.

For the STI services of the case study, there are many aspects of information management for which performance evaluation could take place. These include assessment of the quantity of coverage and throughput of records, interface evaluation, system online availability, and range of use by the market. For information retrieval they may include indexing consistency and search performance.

While some analysis has been carried out on an ongoing basis by the different services, for example for internal annual reporting purposes, there has not been much formal evaluation conducted for public scrutiny. An exception is performance evaluation undertaken on *AESIS* that included the use of an evaluative framework set up in a study of the *Georef* database (Tellis, 1986). This was used to evaluate such things as coverage by subject and form of material; currency; incidences of duplicate records; indexing; and training programs. There was also examination of performance in terms of cost effectiveness and benefit.

Evaluation includes determination of quality. It would normally be accompanied by procedures for maintaining information quality, such as in the case of STI services, the application of controlled vocabularies. Thesauri are indeed used by each of the services in the study. However data are not maintained regarding consistency of application of terms, utilisation of uncontrolled keywords, or utilisation of vocabularies for searching.

3.5. Information retrieval

Information retrieval is conceived as the part played by individuals in the information management process. It can therefore be undertaken by end users of information, or by those who are concerned with getting the information to the end users.

As information managers, these may be intermediaries such as database designers, interface designers, and indexers. As identified in the case studies, these may be regarded as those responsible for the processes of information selection, design, organisation, and retrieval.

3.5.1. Information selection

Each of the STI services has operational procedures for selection of material. In some cases, such as with *AANRO* there is a contextual setting using a formal document that may be used for guidance. When the *AANRO* databases were combined into one, a document was produced to provide detailed guidelines on selection of material including differentiation by form and level of description (collective and item level) (Quinn, 2004).

The *ANSTI* database includes material that is selected according to detailed documents developed at the international level by the International Nuclear Information System. The national database is created from material that is transferred back from the INIS international database following inclusion there. The *ATRI* database is also linked with an international service, namely the *ITRD*. In this case the local database is created first and includes local material of wider scope than the database on which it is modelled. About 30–40% of material annually is submitted to the international equivalent. *AusGeoref* in its current form is created nationally but subsumed within the international *Georef* database. It may be searched as a subset of the database but does not exist independently.

The health material included in *AMI* is substantially wider in scope than that which is also provided as the Australian *Medline* component. Initially there was a conscious policy of complementing rather than replicating any of the Medline material. However in recent years material from the Australian component of Medline has also been included in *AMI*.

ENGINE is not linked with an international service. It mainly covers material published by Engineers Australia.

3.5.2. Information design

Many of the services were developed initially with internal structuring and formatting, and were then reformatted for availability through online service vendors mentioned earlier: AUSINET in the 1970s, CSIRO's AUSTRALIS facility and then the NLA's OZLINE facility. In 1998, RMIT Publishing's Informit facility was commissioned and many Australian databases are now aggregated for delivery through it, including all of the STI databases in the case study except for *AusGeoref*.

Access to the databases is provided through a common interface, but the databases each retain their own data elements. Standard metadata elements for description and indexing, along with links to full text or websites where appropriate are provided for all databases. These are complemented with specialised metadata such as sponsorship elements in the case of *ENGINE* and *AANRO* (which appears on Informit as *ANR-I*), and geographic data in *ATRI*.

In its earlier manifestation as *AESIS*, the earth sciences database had a number of specialised data elements such as map references. Its structure and presentation is now as per *Georef*. *AANRO* though appearing through Informit as *ANR-I* is also freely available online through aanro.net (Infoscan Pty. Ltd., 2006). The site is termed a knowledge base and provides a coherent integration of references to documents, references to ongoing and completed research projects, and a gateway to sites through search interfaces that include a graphic interface based upon mapped regions of Australia.

3.5.3. Information organisation

Indexing and classification is undertaken for each of the STI services. In cases such as for *Engine* and *ANSTI* this has been undertaken in-house by librarians or information officers Contract indexing is also undertaken, for example on a piecework basis for *AMI*.

Each of the services uses a controlled vocabulary based upon an international thesaurus. For example *ANSTI* uses the INIS Thesaurus and *AMI* uses MeSH. Although *AusGeoref* now works within the *Georef* framework, when in its former manifestation of *AESIS*, a thesaurus developed in Australia was used for the database. Some of the databases also use identifiers for further uncontrolled subject description. *ANSTI* additionally makes use of INIS category codes.

3.5.4. Information retrieval

Search intermediaries continue to provide information retrieval for end users through the subscription-based Informit.

However, much information retrieval is undertaken by end users who use the databases that have been created on internal networks at the creating institutions, or through Informit, which provides access to all databases except *AusGeoref*, or in the case of *AusGeoref* as a subset search directly from *Georef*.

AANRO is alternatively available freely and directly from a web portal as part of a knowledge base that also includes links to non-bibliographic material. This is based upon the principle that end users will search it directly from the web, but that intermediaries will use the more advanced search features available through its Informit manifestation.

4. Discussion

A paper of this constrained length provides limited opportunity for describing the STI services in detail. However its objective has been principally to see how examples as outlined may exemplify the Rowley framework. Rather than comprehensive description, selected examples have been provided.

It has been possible to explain STI service provision in terms of Rowley's framework, so it can be said that information management is applicable in the situation under consideration, even if it is not always being undertaken to the extent that participants might wish. Still, there are ways in which the framework might be refined to provide further illustrative capacity for information management.

It would appear to be preferable to identify the information processing constituents as 'assemblies' (or a similar term), rather than 'information processors' as they are now identified (Rowley, 1998). All of the information processors are individuals (as are all the information managers), but they are functioning with different levels of aggregation within the recognised levels. So while the information processing happens with different degrees of aggregation, the processors in each case are individuals, who may be contributing professionally as information managers, or alternatively participating at a lay level.

'Information retrieval' may be a misleading rubric to use for those operations inclusive of wider operations than retrieval itself. It is explained as including a range of information organisation procedures (such as indexing) that facilitate retrieval. It is also exemplified by Rowley (1998, p. 364) as including information selection by individuals with particular information needs. It should also include selection undertaken by information mangers as intermediaries. In the case of STI services, this includes making decisions about scope of inclusion and about which material to choose within the scoping policy. A more comprehensive term such as 'information processes' may be appropriate. Given this, it would remain necessary to differentiate it from the information technology procedures, supporting the 'information systems' rubric as defined.

Evaluation is a significant element of information management that has not been emphasised by Rowley, perhaps because it is seen as happening at each level of the proposed framework. For the cases under investigation it has been included under information systems. Yet in the case of STI services it might well have been exemplified under information retrieval as well. It would seem appropriate to find a way to make it explicit.

Differentiation of environment and contextual levels by Rowley seems to have been made with a view to separating consideration of information management strategy and administration within organisations from those influences that come to a business from outside. This may be useful for institutions that are primarily concerned with creation and maintenance of internal information resources. Yet for the many institutions continually participating in business-to-business interaction or subject to government-to-business policy influence, it is difficult to separate environment from context, and the two levels may reasonably be conflated for the purposes of the framework.

The explanatory power might be increased if the levels were further explained in terms of domains of interest (Diener, 1992; Middleton, 2002). Thus Rowley's four levels may be contrasted with the three domains that are used to explain information management: operational, analytical, and strategic. The operational domain includes carrying out the processes of information management; the analytical domain includes determining the needs of information users, the value of information, and the performance of information processes; the strategic domain includes planning and contextualisation within policy agendas.

5. Conclusion

The framework proposed by Rowley may be applied to the case of provision of STI services as an example of information management. Nonetheless, the framework would benefit from further elaboration and modification to take account of explanation of domains of information management. Such adaptation would provide the framework with more universal explanatory power.

Adaptation could include the following:

- Removal of the differentiation between environment and context. In situations where enterprises and their systems have significant interaction with the wider community and other enterprises, separating these into different levels is as difficult as separating the parts of a jellyfish. They might reasonably be combined as an administration level that is concerned with the strategic domain of information management.
- The information systems and information retrieval levels could each be elaborated in terms of an analytical and an operational domain.

In the case of information systems, the analytical domain would be concerned with determination of information seeking behaviours of interest groups, carrying out requirements analysis for systems, and evaluating the performance of systems. The operational domain would be concerned with the development and maintenance of such systems and training in their use.
In the case of information retrieval, the analytical domain would be about the determination of value of information, the identification of extent and scope of information repositories, and the evaluation of how effectively the information is organised in and retrieved from such repositories. The operational domain would be concerned with processes including metadata provision, vocabulary control, search strategy development, maintenance of business intelligence profiles, and training in the application of these processes.

- The information retrieval level could be better named as an information processes level. As presently explained by Rowley it concerned the actions procedures and methods for recovering information from stored data. As these processes include the preparation of the stored data by information managers, a broader term would be more expressive of what is happening.

Further interpretation of the parts played by information managers and information processors is necessary. Managers are themselves processors, and users may play a part in each of Rowley's information processor levels, not just the retrieval level. It may be preferable to speak in terms of information processing levels each of which involves individuals, either as information managers or as users, but differentiated by different degrees of assembly.

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