The Economic Justification for Taxonomy in Enterprise Information Systems

Jeremy Ellman
School of Informatics,
University of Northumbria, NE1 8ST, UK
Tel +44 (0)191 227 3461
Fax +44 (0)191 227 3662
Jeremy.Ellman @northumbria.ac.uk

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Abstract

A taxonomy is a critical part of an Enterprise Information System. An information management process that does not include a taxonomy is almost certainly incomplete as a taxonomy plays the key role of providing the whole organization with a controlled and consistent way of naming, labelling and distributing information.

This paper aims to provide concepts and ideas to help the reader to make two interlinked cases for using a taxonomy in their business. The first case maintains that information management is a critical organizational activity, and suggests ways of measuring and supporting that contention. The second case argues that a taxonomy plays a critical role in information management, and that no information management strategy should ignore it.

1. Introduction

Several component applications in the corporate information architecture, such as content management and document management systems depend on a suitable a taxonomy being available. This is rarely the case as taxonomies are extremely resource intensive to construct. Consequently non-specialists often put in place an application specific hierarchy that is bound to one particular application, and would need radical restructuring or development to be useful elsewhere. We are concerned here then to produce a methodology that will economically justify taxonomy building as a basic component in the information architecture.

We take the view that a taxonomy is minimally composed of a hierarchical classification plus metadata (Hunter 2001, Gilchrist 2003). This may also be called an ‘ontology’ (Vickery 1997) although the intent here is that the taxonomy is a working component of the information architecture, rather than an attempt to formally describe the field of Knowledge Management (e.g. O'Donovan & Roode 2002, Kakabadse, Kakabadse & Kouzmin 2003, Perez et al. 2002).

Gilchrist (2003) has described this emerging use of terminology with the claim that ‘ontology’ and ‘taxonomy’ have been appropriated by workers in the information sciences. Soergel (1999) however points out that classification has many functions, such as the provision of a classification for actions, supporting information retrieval, improving communication and learning, and providing the conceptual basis for knowledge based systems. Consequently, a corporate taxonomy is a very real piece of intellectual capital or property (O'Donnell, O'Regan & Coates 2000)

Many of the applications of taxonomies noted by Soergel (1999) and Gilchrist and Kibby (2000) are related to key information systems components. For example, Rapoza (2002) describes several applications that classify text into a taxonomy structures as part of content management systems; Domingue el al. (2003) consider taxonomies in e-commerce; Visser, Stuckenschmidt, and Wache (2003) explain how ontologies are used in a data integration application areas, and Fensel (2000) argues that ontologies are a general solution to problems in Knowledge Management or e-Commerce.

We argue that the business benefits that follow from the consistent application of a taxonomy justify its construction as a primary component of an enterprise information system. Whilst large enterprises have built taxonomies for a number of

years (e.g. Dale 2001, Hemmings & Alterman 2003) it is often necessary to produce a cost justification for the necessary investment as the Knowledge Management field matures (Swartz 2003, Dilnutt 2002).

The process we propose is described as follows: Firstly the importance of measurement is considered using the information audit as a means to identify business processes that may benefit from a taxonomy. Next, we make a case for taxonomy by considering its applications to search and metadata processes before proposing a number of possible benefits derived from its use.

2. Establishing a cost benefit baseline

Quantifying the benefits of improvements in knowledge management in order to justify investment is notoriously difficult (e.g. Grantham 1995)[1]. Often technology salesmen say: "Today the cost of your transaction is $2.00; with our new system in place it will be $1.00. Therefore, your $10m investment is paid back in 6 months." The information management field has its own version of this simplistic approach based on the cost of the search process. It runs like this: "Our employees spend 3 hours per day searching for information. Their time is worth $20 per hour. If we make search 50% easier, we save 1.5 hours per employee per day = 300 hours per year = $6000." Unfortunately, these assumptions may be questioned. If time is freed, how will it be used? These employees will still be on the payroll, so where will the savings come from? For these reasons, many large organizations draw back from cost-benefit cases and calculations of return on investment (ROI).

Chong et al. (2000) report a survey of senior managers in 25 large companies (defined as having a turnover > $75M p.a.). They found that whilst 92% were aware of Knowledge Management issues, 71 per cent did not monitor or had no mechanisms of tracking knowledge related issues, resulting in some considerable losses caused by communication breakdown, personnel changes, copyright issues and sub-optimal decision making.

The Ford Motor Company, for example, owns and uses a highly developed collaboration network, and has reaped significant benefit from it, but prefers to think of the network as a means of adding value to its business by avoiding repeated mistakes (McDermott & O'Dell 2001).

Collaboration is one of many key organizational processes that are difficult to quantify since it is may not be studied in isolation (see e.g. Marwick 2001). The cost of replacing an expert, retaining a customer or developing a technical innovation may be difficult to quantify (Gummesson 2004), yet it is here that a business case for taxonomy may be made, by identifying the processes that deliver value and quantifying the role that information plays in each of them. In other words, the business case does not rest exclusively on the efficiency of the information retrieval process, but rather on the value that information delivers to core business activities. The value of measurement not only lies in building the business case – it also provides the evidence from which a strategy may be derived. Even for medium scale measurement, resources are required. Research methodologies must be designed, and qualified people recruited to carry out an assessment that needs to start with an information audit.

[1] Although see Lu & Zhang (2003) who have suggested a number of factors to consider in relation to e-service provision.

3. The information audit

The information audit is recognised as critical in identifying, evaluating, and managing information resources (Swash 1997, Buchanan and Gibb 1998). Although understood as being essential for the library function (Pantry and Griffiths 2002), the information audit is also required to define a baseline in any modern information dependent organisation.

Buchanan and Gibb (1998) review a number of methods to carry out the information audit, whilst Pantry and Griffiths (2002) offer advice on executing the audit. Although obvious, it is wise at this early stage to ensure that only one team is engaged in this activity. Stories abound of large organizations in which more than one a content management project is simultaneously being working on, each of which is to be deployed "enterprise-wide" (e.g. Reneker & Buntzen 2000). If there are existing projects with closely related interests, the key people should join together.

The team carrying out the information audit for the taxonomy-building project needs to be authoritative in order to get cooperation and acceptance. Consequently, at least one of the sponsors should be at board level. Furthermore, A multidisciplinary team is needed that should have representation from business, information management and technology disciplines (Bruno et al. 2003). Subject experts should be drawn from the organization's key departments. It will be impossible for the team to understand the challenges facing R&D or marketing, say, if they have no representation.

A wide range of application areas are related to taxonomies. These include portal; content, and document management systems. Additionally, records and digital asset management; search and retrieval; and enterprise application integration, should be considered (see Marwick 2001).

The project must be sold to these stakeholders (Fowler 2001). They need to understand why this work is being carried out, why their time and energy is being demanded, and what the rewards will be. They, in turn, will need to sell these ideas to people in the business units. All members of the team will act as links to sources of information, especially your subject experts, who will be needed to document information processes. Central office functions like IT, information, HR and finance often have good and complementary overviews.

The exercise has to be carefully scoped. Arbitrary statements such as "We won't include structured data." should be avoided. An overview is needed at the start. If a particular business activity or type of information is to be excluded, the decision needs to be taken carefully. Preferably, the decision is not taken early for budgetary or political reasons. This information may be minimally recorded as lists or tables, but taxonomy management or visualization or mind mapping software can give views of information that communicate structure and data better than lists and tables.

In the following, the information audit is divided into four components; Processes, Information assets, Technology assets, and Miscellaneous issues, and we offer several suggestions related to each.

Processes

Some information processes - ERP or workflow systems, for example - are likely to be extensively documented although more elusive processes also need to be considered. The sales process, for example, might involve prospect databases, dialogues with potential customers supported by sales information, tender documents,

quotations, invoices and standard contracts. The product development process might likewise call on a range of diverse technologies and information assets.

The information audit must establish what these processes are, their costs, and their benefits to the business. It needs to understand and document the role played in these processes by information. Where are the overlaps with other activities? Does poor information available to the sales force require the purchase of a customer relationship management (CRM) system – or would the team benefit more from migration to the existing portal and the provision of better content? Whilst inefficiencies may be identified, the real point of this activity is to identify the benefits. If, as a result of having better access to information, the telesales team can handle greater call volume and give better responses to customers, revenues can be increased.

Current and pending regulatory requirements for information should also be considered. All companies must produce annual reports, all buildings must seek planning approvals, and some industries, such as pharmaceutical and financial services, must submit information to regulators. The cost of producing and submitting this information should be assessed. When making the case in areas that relate to compliance, risk should also be considered. The submission of an incorrect planning application, for example, may result in a delay to project start and construction. The use of an inappropriate contract might have a negative impact out of all proportion to the size of the error itself.

How does the organization publish information? An engineering services company, for example, has made enormous improvements in efficiency, productivity and quality of service by its ability to deliver technical information to engineers in the field, through a support portal. What often took two engineer visits can now be achieved in one, resulting in a better utilization of the engineering workforce. So the efficiency here is not in the search process itself, but in the resultant improvement in utilization (Mack, Ravin & Byrd 2001).

Many information processes are less formal. Emails, letters, memos and other documents maybe distributed without an established procedure. The benefits accrued from the capturing and sharing of this information need to be considered, as should the exchange of tacit knowledge by phone call, or conversation at the water cooler (Marwick 2001). Knowledge management practitioners believe that the majority of the organisation’s knowledge assets have never been codified, and reside in the minds of employees. When those employees leave the company, that knowledge leaves with them. A taxonomy is one device that may be used to extract, store and share that knowledge.

The analysis undertaken should yield a range of processes and activities in which benefits will be delivered through better information management. The rollout of new information structures polices and processes is very likely to be phased. The single most compelling of these scenarios should be chosen as the focus of the business case for the taxonomy to carry out the first phase of implementation.

Information assets

Standard accounting conventions do not cater very well for information assets. The cost of producing information is often unidentified. A marketing campaign, for example, might involve the production of high-value information such as advertising copy or stills photography. But that cost may well not be distinguished from the cost of disseminating that information by buying media. The information – for

information, we read copy, footage, photography, artwork – may very well be reusable. Its reusability distinguishes it from the use-once assets such as media.

The information audit needs to examine and understand where know-how, expertise, and content lies in the organization. It should also consider the provisions for information reuse; accessibility and internal publication. These assets are among those you will need to register. Others may include contracts, forms, policy statements, technical documentation, product specifications, sales and marketing collateral, customer information, publications, and web information.

Information overload is one of the major problems that an information management strategy must address. The development of policies and frameworks to ensure that information is used selectively, targeted narrowly to the correct audience, and disposed of at the appropriate time will maximize information effectiveness, and reduce overload.

Finally, we touch on conventional "information assets", in the form of the many external information sources to which the organization subscribes. Their cost is easily measured. One useful outcome of the information audit may be a rationalization of these sources and a reduction in cost although the aim may also be to increase utilization.

Technology assets

Inevitably, a wide range of technology assets will be in place, and the information audit should seek to identify them and measure their effectiveness. It should recommend which of these assets are to be retained, and outline ways in which their value can be maximized. The scope of this review needs to be set carefully. Obviously, technologies that relate to unstructured information should be reviewed carefully, and this is likely to encompass text databases, intranets, web sites, web content management systems, employee portals, search and navigation applications, categorization applications, document, digital asset and records management systems.

Broader issues should be considered, such as the amount and kind of information that can be stored and used on local drives, employee access to and use of the Web, and the nature and range of structured information sources used by employees, customers and partners. The audit should also consider ways in which these systems interoperate. Interoperability is a key consideration, and can unlock significant value from existing systems. A product manager, for example, should be able to view all relevant information sources from a single point of access.

Finally, we need to understand who the information users and audiences are, and who they might be in the future, and how they interact with information. Employees, regulators, partners and customers are obvious user types. Other analyses may follow from analysing portal usage and assessing what employees expect and attempt in that environment.

Miscellaneous issues

So far, we have concentrated on ways of identifying issues, costs and benefits. Other areas might be marked for special attention. Consider for example, information shared across geographical boundaries, cultural differences (either nationally, or arising, for example, from past mergers or acquisitions), technological barriers, or provisions for speakers of other languages.

Research Methods

Formal Research methodologies are needed to produce a convincing information audit (e.g. see Blaxter Hughes & Tight, 1996, Jankowicz 1998). These will support a

detailed report on the existing environment, and the definition and recommendation for changes. Formal techniques also allow change monitoring, which is an essential project-monitoring tool. These may include (but are not limited to) any of the following:-

- Desk research
- Interviews with administrators
- Studies of existing information systems
- Server statistics
- Studies of user behaviour
- Monitoring uses of information by selected groups of employees performing definable tasks
- Development of prototype systems performance comparisons against incumbent systems
- User surveys for quantitative data
- User attitude surveys
- Focus groups

The research programme needed to evaluate the role that a taxonomy may play should be able to:-

- Analyse and report on the existing environment
- Track the changes you introduced, ideally over a phased rollout, giving indications of where modifications need to be made
- Maintain monitoring in the long term.

Choo et al. (2000) also propose the use of capability indicators such as the extent of documentation, sharing of plans, and policies and information for auditing knowledge flow.

4. The Case for Taxonomy

At this point a case has been made for information management. Now let us examine the case for taxonomy. Firstly, information management is too important to be left to technology alone, and technology is not yet advanced enough to displace the skills and judgment of people. Secondly, the key to effective information management lies in well-planned strategies for labelling the information with metadata (see e.g. El-Sherbini 2001). Metadata labels have to be consistent throughout the organization. If they are not, all the old problems will recur. That is why a taxonomy is needed – to act as a consistent central point of reference for both content authors and information seekers. We now take each of these points in turn, and provide a more detailed justification.

Technologists often believe that problems of information management may be addressed by purely technological solutions. Consequently it is important to understand the value and the limitations of technology.

We will focus principally on the limitations of search engines. First and foremost, search engines are limited by the behaviour of their users. Search engines perform best when they are provided with rich and detailed descriptions of what the user is looking for. This is why librarians and other information professionals, as well as subject experts, can get excellent results from keyword search engines. Unfortunately, most users do not provide rich expressions. The average query consists of 2.35 terms (Silverstein et al. 1998, see also Jansen et al 1998). User problems with search arise from the variation in terminologies that people use. For example, my heart attack may

be your cardiac arrest, which may in turn be the doctor's myocardial infarction. Thus, webmasters complain about information seekers using the "wrong keywords" (Hagen et. al 2000, Jordan 2001). This is an illustration of interlinked problems – of content authors giving insufficient thought to how resources are described; of users expressing themselves badly, and of interfaces delivering nothing more than a box that instructs "Type your keywords here."

In information retrieval, technologies are assessed on how precisely they match the user's requirement, and how comprehensively. All technologies trade between these measures of precision and recall (see Baeza-Yates and Ribeiro-Neto 1999 for comprehensive review of Information Retrieval). It might be possible to recall all the relevant documents, but they would usually then be buried among thousands of false positives. Unfortunately, no technology is likely to unravel all of the complexities of human language to deliver precisely the results the user has in mind. This is not to say that search and categorization technologies are not valuable. On the contrary, we find it hard to conceive of an information system that does not include a searchable index. A taxonomy naturally provides a browsable interface over this index and can improve the accuracy of user queries through the addition of synonyms to user queries (Offsey 1997, Greenberg 2001, Finkelstein et al. 2002). Synonyms however are only one aspect of taxonomy nodes, the most notable of which is metadata

Metadata is the key to effective information management

Metadata is a simple concept: labels can be created in a controlled and methodical way and "attached" to documents. The metadata label resembles a library index card. Using an indexing system built with metadata (or index cards), you can not only search for documents about a given subject, but you can use the fields in the metadata to define parameters on which to search. So, for example, you could look for <tenders> in a given industry, say <oil pipeline construction>, written by employees of the <oilfield services> division, after the timeline <1999>. If documents meeting these criteria existed, they would be returned to you.

This is only the beginning of metadata's usefulness. Besides powering search with parameters, it also feeds navigation interfaces, and allows the building of user focused information architectures. Using the above example, it would be very easy to create a "virtual" tenders database and present it to users, even though the tenders were held along with all the other documentation in a single content store. So metadata allows you to control information in new and inexpensive ways, even if the project in question is named "Trans-Alaskan High Throughput Pipeline" in the financials system and "High-throughput pipelines: Trans-Alaskan" in the document store

The sources of authors, descriptions and subjects are all branches of a taxonomy. The fact that this same taxonomy is always shown to authors when they save information ensures that the metadata labels remains consistent. In many content management systems inadequate provision is made for the taxonomy. Indeed, in some cases no taxonomy is provided. Then, the danger arises that a mess of inconsistent metadata is applied, making information harder to find rather than easier.

A wide variety of mechanisms are available for adding metadata to documents and other digital assets, with content and document management systems the most obvious candidates. Automated categorization systems are in effect adding subject metadata to documents, and these can be used in conjunction with CMS. You will need to consider carefully how you add metadata, and particularly how you can ensure that metadata is used consistently regardless of location or application.

The Benefits of using a Taxonomy

Taxonomies lead to the consistent use of metadata as the names used by different components in the organisation may be uniquely associated with one entry in the taxonomy. This ensures that information assets are consistently labelled, which can yield a wide range of benefits (Mack, Ravin, & Byrd 2001, Zwass 2003). These include:

Improved integration of content systems: When consistency in metadata is introduced, it becomes much easier to retrieve content from diverse systems. Users can access information of which they may have been unaware, through a single interface, reducing search time.

Easy generation of navigation interfaces: Navigation interfaces in portal, intranet and web environments can be generated directly from the taxonomy server. This provides users with a critical missing link in the search process, and does so without the need for extensive development.

Rapid development of new content interfaces: One of the key concepts in metadata is the separation of the metadata layer from the content repository. With this separation in place, changes can be made to the design of the metadata without modifying or moving any of the content. To return to our earlier example, Mike Jones could use metadata to create three separate interfaces to the content – "Documents by Mike Jones", "Tenders" and "Pipelines". The content's location will not change, only its presentation to users.

Reduced cost of localization: Localization is a key challenge in today's global markets. Here, taxonomy can make a major contribution. Advanced taxonomy systems can store and display multiple language versions of taxonomies. Metadata can therefore be added in a variety of languages, and multilingual search and navigation interfaces presented to users.

Easy accommodation of name changes: Content management systems can be easily disrupted by name changes. When a project graduates from a project name to a product name, old metadata can often become obsolete. A taxonomy system solves this problem by mapping the new name to the existing one.

Rescue of unsuccessful technology projects: There are many instances of content management or portal programs that are failing to deliver on their original promise. Often, the failure relates to the lack of attention paid to information architecture, metadata schemas and taxonomies. The adoption of a taxonomy can do much to increase the relevance of the portal and therefore the contribution it makes to the business. It can also add meaning and intelligence to a "dumb" content management system.

5. Conclusion

It has been argued that a taxonomy should be considered an independent element in an enterprise information architecture as it is a key component of several systems, such as document and content management systems, as well as intranet or Internet portals.

Although taxonomies have been widely recognised as having a place in Knowledge Management (Gilchrist 2001), their development is both time consuming and expensive. Consequently, A business case may be required to justify the investment in their constructing. This economic justification starts with an information audit that identifies relevant expenditure and provides monitoring criteria so that change and improvement can be identified after the taxonomy has been

implemented. These changes relate to the consistent use of metadata for document labelling, and improving the effectiveness of information storage and subsequent retrieval. Other applications of the taxonomy will follow once the resource has been created.

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References

Alavi M., & Leidner D. E., 2001 "Review: Knowledge Management And Knowledge Management Systems: Conceptual Foundations And Research Issues" MIS Quarterly, 02767783, Mar2001, Vol. 25, Issue 1

Baeza-Yates R. and Ribeiro-Neto B. 1999 “Modern Information Retrieval” Addison-Wesley Harlow UK ISBN 0-201-39829-X

Blaxter Hughes & Tight, 1996 “How to Research” Open University Press ISBN 0-20335-19452-4

Bruno D., Heather R. 2003 "The Truth About Taxonomies." Information Management Journal, Mar/Apr2003, Vol. 37 Issue 2, p44-52

Buchanan S.; Gibb F. 1998 “The Information Audit: An Integrated Strategic Approach” International Journal of Information Management, February 1998, vol. 18, no. 1, pp. 29-47(19)

Chong C.W., Holden T., Wilhelmij P., & Schmidt R.A. 2000 "Where does knowledge management add value?" Journal of Intellectual Capital Vol. 1 No 4 Pp: 366-380

Dale, 2001 "Designing Taxonomies at Unilever" Knowledge Management Review; Jan/Feb2001, Vol. 3 Issue 6, pp30-34

Dilnutt R. 2002 International Journal of Accounting Information Systems Vol. 3, No. 2, August 2002, Pages 75-81

Domingue J., Stutt A., Martins M., Tan J, Petursson H., and Motta E. 2003 “Supporting online shopping through a combination of ontologies and interface metaphors”, International Journal of Human-Computer Studies, Vol. 59, No. 5, November 2003, Pages 699-723

El-Sherbini M., 2001 "Metadata and the future of cataloging" Library Review; Volume 50 No. 1;

Fensel D. 2001 “Ontologies: Silver Bullet for Knowledge Management and Electronic Commerce.” Springer-Verlag, ISBN: 3540009663

Finkelstein L, Gabrilovich E., Matias Y., Rivlin E., Solan Z., Wolfman G., and Ruppin E., "Placing Search in Context: The Concept Revisited", ACM Transactions on Information Systems, 20(1): 116-131, January 2002

Fowler D. 2001 "Harnessing the power of knowledge management" netWorker Volume 5, Number 3, Pp 18-24

Gilchrist A. 2001 "Corporate taxonomies: report on a survey of current practice" Online Information Review Vol. 25 No 2 Pp 94-103

Gilchrist A. 2003 “Thesauri, taxonomies and ontologies - an etymological note” Journal of Documentation Vol. 59 No. 1 pp 7—18

Gilchrist, A. and Kibby, P. (2000), “Taxonomies for Business: Access and Connectivity in a Wired World”, TFPL, London.

Grantham L. 1995 "Justifying office automation: benefits and problems" Industrial Management & Data Systems Vol. 95 No. 8 Pp 10-13

Greenberg J. 2001 “Optimal Query Expansion (QE) Processing Methods with Semantically Encoded Structured Thesauri Terminology” Journal of the American Society of Information Science, Vol. 52, No. 6

Gummesson E., 2004 "Return on relationships (ROR): the value of relationship marketing and CRM in business-to-business contexts" The Journal of Business and Industrial Marketing; Volume 19 No. 2; 2004

Hagen P. R., Manning H., Paul Y. 2000 " Must Search Stink?” UK Internet User Monitor Forrester Research Inc. Jun. 2000

Hemmings P. and Alterman S. 2003 Thames Water follows roadmap to make taxonomy relevant. Knowledge Management Review Jul/Aug2003, Vol. 6 Issue 3, p10-11

Hunter A. 2001 "Classification systems." Knowledge Management; May2001, pp14-18

Jankowicz, A.D. 1998 “Business Research Projects” Chapman & Hall (2nd Edition) ISBN: 0 412 63650 6.

Jansen, B.J., Spink, A., Bateman, J., and Saracevic, T. 1998 Real Life Information Retrieval: A Study of User Queries on the Web, SIGIR FORUM, 32 (1) pp 5-17.

Jordan K. 2001 "Are You Targeting The Wrong Keywords?" 4th August 2001 http://www.high-search-engine-ranking.com/Are_You_Targeting_The_Wrong_Keywords.htm

Kakabadse Nada K., Kakabadse A., and Kouzmin A. 2003 "Reviewing the knowledge management literature: towards a taxonomy" Journal of Knowledge Management Vol. 7 No. 4 2003, pp. 75-91,

Lu J. & Zhang G. 2003 "Cost benefit factor analysis in e-services" International Journal of Service Industry Management Vol. 14 No. 5 Pp 570-595

Mack R., Ravin Y., & Byrd R. J. 2001 "Knowledge portals and the emerging digital knowledge workplace” IBM Systems Journal Volume 40, Number 4, 2001: Knowledge Management pp. 925-955

Marwick A. D 2001 "Knowledge management technology" IBM Systems Journal Volume 40, Number 4, 2001: Knowledge Management pp814-830

McDermott R. & O'Dell C. 2001 "Overcoming cultural barriers to sharing knowledge" Journal of Knowledge Management; Volume 5 No. 1;

O'Donnell D., O’Regan P., & Coates B. 2000 "Intellectual capital: a Habermasian introduction" Journal of Intellectual Capital, Vol. 1 No. 2, 2000, pp. 187-200.

O'Donovan B. & Roode D. 2002 "A framework for understanding the emerging discipline of information systems" Information Technology & People, Vol. 15 No. 1, 2002, pp. 26-41.

Offsey S. 1997 “Knowledge Management: Linking People to Knowledge for Bottom Line Results” Journal of Knowledge Management Vol 1 No 2, pp. 113-122.

Pantry S. & Griffiths P. 2002 “The internal information audit: conducting the audit and implementing the results” Business Information Review, March 2002, vol. 19, no. 1, pp. 43-54(12)

Perez M. P., Sanchez A. M., Carnicer M. P. de L., and Jimenez M. J. V. 2002 "Knowledge tasks and teleworking: a taxonomy model of feasibility adoption" Journal of Knowledge Management Vol. 6 No. 3 pp. 272-284

Rapoza J. 2002 "Three Paths to Sorting Content" e-week July 15, 2002. Available on-line: http://www.eweek.com/print_article/0,3048,a=29100,00.asp

Reneker M. H., & Buntzen J. L. 2000 "Enterprise knowledge portals: two projects in the United States Department of the Navy" The Electronic Library; Volume 18 No. 6; 2000

Silverstein C., Henzinger M., Marais H, and Moricz Michael. 1998 Analysis of a Very Large AltaVista Query Log, SRC Technical note #1998-14. On-line at http://citeseer.nj.nec.com/silverstein98analysis.html

Soergel D 1999 “The rise of ontologies or the reinvention of classification” Journal of the American Society of Information Science, 1999, Vol. 50 No. 12 pp: 1119-1120

Swartz, N. 2003 “The 'Wonder Years' of Knowledge Management.” Information Management Journal, May/Jun2003, Vol. 37 Issue 3, pp53-58

Swash G.D. 1997 “The information audit” Journal of Managerial Psychology Vol. 12 No. 5, 1997, pp. 312-318.

Vickery B.C. 1997 "Ontologies" Journal of Information Science Vol. 23 No. 4 Page: 277-286

Visser U., Stuckenschmidt H., and Wache H. 2003 "Ontology-Based Information Integration" Proc. IJCAI-Tutorial SP5 Acapulco, Mexico August 10, 2003 Available Online at: http://www.cs.vu.nl/~heiner/IJCAI-03/Tutorial.html

Zwass V. 2003 "Electronic Commerce and Organizational Innovation: Aspects and Opportunities” International Journal of Electronic Commerce / Spring 2003, Vol. 7, No. 3, pp. 7-37.