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A DECOMPOSITION APPROACH TO DESIGN INFORMATION AND KNOWLEDGE ISSUES FOR ENGINEERING DESIGN

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Abstract

A categorisation of the the Design Information and Knowledge (DIAK) domain has been established. This highlights 8 major areas that may be grouped into four views on the domain. This categorisation may be used to communicate and integrate the issues, to work globally and to plan and identify critical research areas. The information centric view arguably represents the overall information life cycle. The approach deals with not only the information life cycle but also user issues, technology issues and generic issues. The issue of 'quality' in information is an emerging new area and will be a critical part of new research initiatives. The various domain views illustrate the cross functional nature of the issues of managing design information and knowledge. The overall aim is to enable the development of a unified theory of design information and knowledge that will underpin and support the provision of appropriate and accurate information to engineering designers who are creating and embodying new products and systems

1 Introduction

The role of information and knowledge in the engineering design area is one that has become of increasing importance over recent years. As global markets become increasingly competitive, knowledge and information management tools have been identified as being key enabling technologies for engineering organisations (Drucker, 1993; Stewart, 1997). Over the last three decades enterprises have spent a substantial portion of their IT budgets on structured *data-centred* computer applications, although these were reported to deal with less than ~15% of an enterprise's information assets in knowledge intensive industries around 10 years ago (Sutton, 1996). It is apparent that better use must be made of the remaining information contained in other, often less formal, sources that are routinely used by engineers (Boston, 1998; Marsh, 1996).

The Authors have identified, in some detail, the range of activities that are associated with knowledge management in the engineering design arena (McMahon et al., 2004) In particular the 'split' or divergence between the two strategies of *personalisation* and *codification* identified by the Harvard Business School (Hansen et al. 1999) are noted. This paper describes a number of models which highlight the information (and thus codified knowledge) life cycle. These are then used to as part of the development of a categorisation of the

elements in this information and knowledge space. It is then shown how a number of views can be created to enable further refinement and understanding of the area.

2. Information life cycles and decompositions

Two models are reviewed and analysed as part of an understanding of the background issues. There are a number of others such as those described by O'Toole,1990, Hernon, 1994, Penn et al., 1994 and Hodge, 2000 that are not included. The two models have been chosen as they illustrate the cyclic nature of the information life cycle and also the semi-categorised and semi–cyclic approach. The latter approach is also extended very considerably and in some detail in the various categories by its creators, in this case the Government of Canada. Thus there are extensive guidelines and procedures associated with the various stages.

2.1 A cyclical model

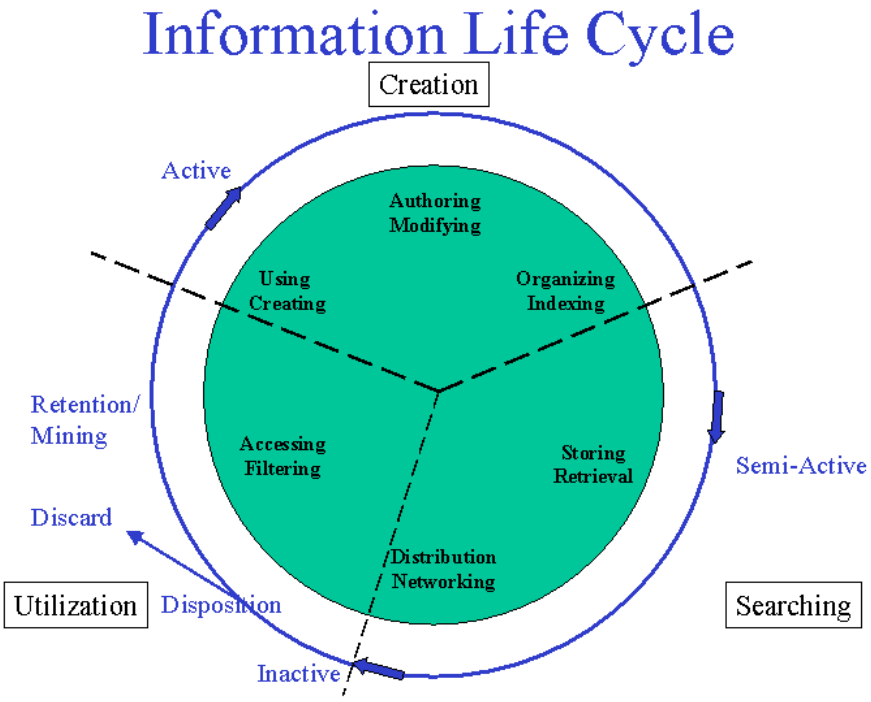


Figure 1A cyclical model (From the UCLA/NSF workshop on the social aspects of digital libraries).

The first information life cycle diagram (Figure 1) emerged from an NSF workshop in 1996 (NSF, 1996). It identifies three main aspects in the life cycle, namely creation, searching and utilisation. These creation process is further decomposed into using/creating, authoring/modifying and organising/indexing. This introduces the concept of an active process. The next phase (searching) is characterised as being a semi-active process as the time dependency is reduced and it deals with the more computer-based parts of the life cycle, namely, the storing/retrieval and distribution and networking. The final phase in this model consists of accessing and filtering and finally, utilisation of the information. But naturally, the process of utilisation may generate new information and so the idea of a life cycle arises. Also introduced is the idea of disposal, a very under researched area. This model is still used

by the digital library community in the U.S.A. and the components were again used in their recent follow up 2003 workshop (NSF, 2003).

2.2 A Hybrid approach

The second model (Figure 2), is part of a framework for the management of information used by the Government of Canada (Canada 2003).). Arguably it is a semi categorised and semi –cyclic approach. It has a slightly different characteristic to the model in Figure 1 in that it has a clear input and output and identifiable categories. It also introduces an overarching element associated with planning the particular elements of the various stages of the life cycle. But, in essence, the major steps, namely; 'collect, create, receive, capture', which can be thought of as the input block and the three other blocks of 'organise', 'use and disseminate' and then 'maintain and preserve' can be mapped on to the elements previously referred to above. Having identified the six major elements the government guidelines then list associated with the categories a range of detailed activities which are further decomposed and then expanded. This gives a very comprehensive set of procedures and instructions. Their rationale is to give an underlying and self consistent structure to the preservation of documents and records within the Canadian administrative structures.

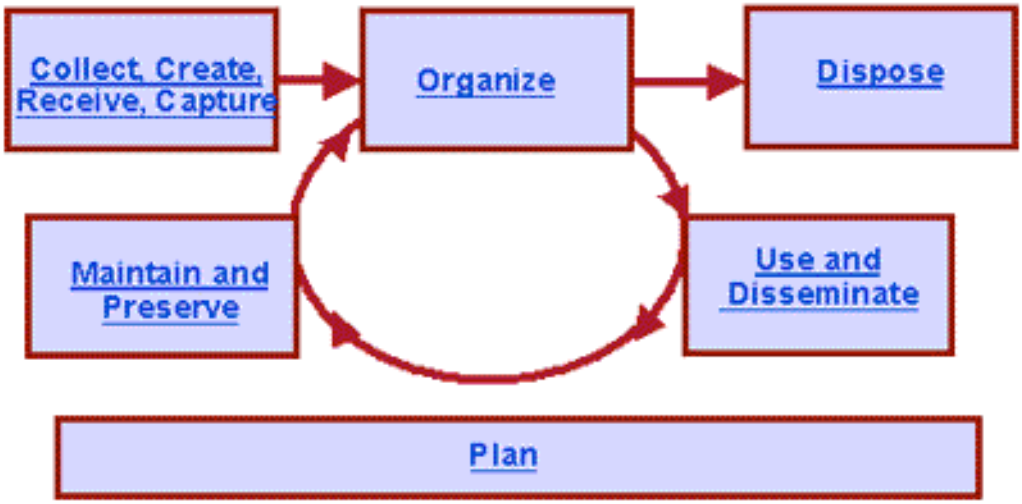
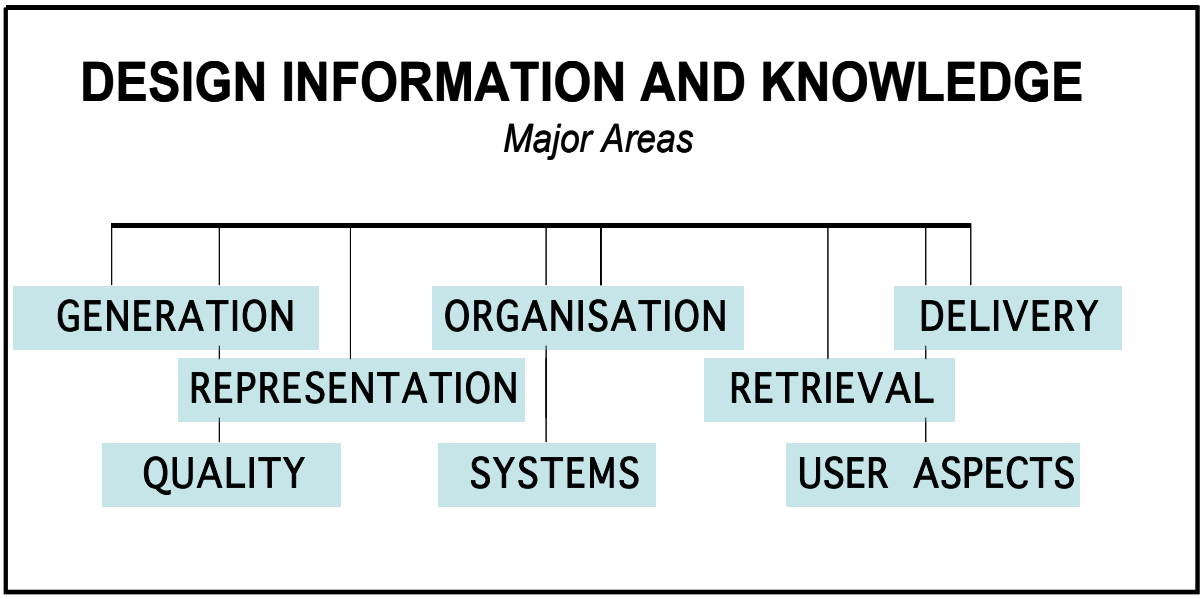


Figure 2 The semi categorised and semi –cyclic approach.

3. A categorisation of issues for engineering design information

There has been some general work on information structures in design (Hicks et al., 2002, Shooter et al., 2000). These approaches have a different purpose and look in more detail at the overall processes and issues associated with managing information.

The categorisation approach proposed by the authors has eight major elements (Figure 3). These include the majority of the elements used in the previously described life cycle diagrams . However, the authors have taken a broader view, and include such items as quality systems and user aspects. It is argued that these additional dimensions reflect a more complete picture of the information environment. Particularly when the area is now dominated by computer delivery, computer access and computer distribution.



Figue 3 Engineering design information - Categorisation of issues

It is then possible to reanalyse or re-categorise these elements, so that these wider considerations and their interrelationships can be understood (Figure 4). The four views proposed by the authors consist of an "information-centric" view, a "user-centric" view, a "system-centric" view , and finally a generic and all encompassing view. The information-centric view is the view that maps most closely to the two approaches discussed above. Its five elements are shown in a similar order and consist of the logical steps of generation, representation, organisation, retrieval and finally delivery. Delivery can be considered to include use and the diagram could if thought appropriate be made to represent a cycle by including a feedback line. However its main purpose is to characterise the domain and to enable the interrelationships between the different views to be understood. It is thus possible to be undertaking research work or systems development work which is about representation issues with a particular emphasis on the computing or systems aspects of that topic. It is thus possible to map and analyse research work and system competencies against these four views. It is particularly helpful as an audit process to identify gaps in activity or abilities of the various systems.

One of the important areas that has emerged from this analysis is that of quality. This analysis has shown a lack of understanding and lack of systems and procedures that are appropriate to deal with the quality dimension of information in engineering. For example, the Framework for the Management of Information in the Government of Canada (Canada, 2003). framework refers to data standards, audit trails and information transmission. But these are considered with regard to the documents themselves not with regard to the content of the document.

<table>
<tr><td>VIEW</td><td colspan="5">MAJOR AREAS</td></tr>
<tr><td rowspan="2">INFORMATION CENTRIC</td><td colspan="5">The information life cycle</td></tr>
<tr><td>GENERATION</td><td>REPRESENTATION</td><td>ORGANISATION</td><td>RETREIVAL</td><td>DELIVERY</td></tr>
<tr><td>USER CENTRIC</td><td colspan="5">HUMAN FACTORS, MAN -MACHINE INTERFACE</td></tr>
<tr><td>TECHNOLOGY CENTRIC</td><td colspan="5">SYSTEMS AND TOOLS</td></tr>
<tr><td>GENERIC</td><td colspan="5">QUALITY</td></tr>
</table>

Figure 4. Engineering design information - Viewpoints

4 Conclusions

There are a number of information life-cycle models that predominantly come from the library and information science communities. These models are used to organise and represent the domain and identify the various life phases. Two such approaches have been reviewed in this paper. A new, arguably broader, approach is proposed particularly for the information that engineers need and use paticularly when they are creating new products and systems.

The approach deals with not only the information life cycle but introduces a number of new issues or elements, namely user issues, technology issues and generic issues. It is these elements that enable this broader and more encompassing view of the area. From this the issue of 'quality' in information is seen as an emerging new area and will be a critical part of new research initiatives. The various domain views illustrate the cross functional nature of the issues of managing design information and knowledge. The overall aim is to enable the development of a unified theory of design information and knowledge that will underpin and support the provision of appropriate and accurate information to engineering designers who are creating and embodying new products and systems

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