

INAUGURAL LECTURE: Prof JA van Biljon

TITLE: KNOWLEDGE VISUALIZATION IN ACADEMIC REPORTING: A HUMAN-COMPUTER-INTERACTION PERSPECTIVE

## ABSTRACT

Researchers often invest more time, interest, and effort in the production of new knowledge than in the dissemination of their research results. This may constitute a major barrier to the diffusion of research results, to adding to the body of existing knowledge and potentially minimises the impact of the researcher's work on other research, policy-makers and practitioners. Given the increased pressure on academics to publish and the competition for research funding it is important to consider what researchers can do beyond traditional knowledge generation and dissemination to facilitate the wider reception, more effective knowledge transfer and consequent utilization of generated knowledge. One approach to improving knowledge transfer and adoption is the use of knowledge visualisation techniques. This study investigates the problem of knowledge visualisation in academic reporting. To contextualise the problem we start by identifying the categories of under-visualisation, over-visualisation and incorrect visualisation as challenges and then focus on developing guidelines for more effective visualisation in academic reporting. Theoretically this paper departs from traditional information visualisations by reflecting on the similarities and differences between information visualisations as a discipline of Human-Computer Interaction in Computer Science while knowledge visualisation is primarily researched in the field of Education and Knowledge Management. Knowledge visualisation is a valuable tool in making research knowledge accessible but for various reasons knowledge visualisation has not been widely applied in academic writing. This paper provides an overview of knowledge visualisation guidelines and contrasts that with information visualization guidelines to synthesize a set of guidelines for knowledge visualisation in academic reporting. This research should be of interest to researchers, supervisors, research managers.

Keywords: knowledge visualisation, information visualisation, academic reporting

## 1. INTRODUCTION

Against the background of the global competition for recognition and funding, researchers are compelled to make their work as accessible as possible. However, researchers often allocate more interest, time, and effort to the production of new knowledge than to the dissemination of their research results (Becheikh *et al* 2009). This may turn into a major barrier to the diffusion of research results to the body of existing knowledge and the potential impact of the work on other research, managers, policy-makers and practitioners are lost. This lecture will focus on knowledge visualisation as an approach to support knowledge dissemination in a way that will enhance knowledge reception, transfer and adoption. The contribution is a set of guidelines for knowledge individualisation in academic reporting.

## 2. KNOWLEDGE VISUALISATION VERSUS INFORMATION VISUALIZATION

In discussing visualization, the terms data, information and knowledge are used in an interrelated context. In many cases they indicate different levels of abstraction and understanding therefore it is necessary to explain the semantics of these terms in this study. Table 1 provides a formal definition in the first column followed by an explanation in the second.

**Table 1: Defining data, information and knowledge**

| <b>Formal definition of concept(Chen et al., 2009)</b>  | <b>Explanation (Keller &amp; Tergan, 2005)</b>  |
|---|---|
| Data [Cdata]: a representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by human beings or by automatic means   | Data represents a fact, statement of event without any relation to other data. It could be symbols or isolated and non-interpreted facts.   |
| Information [Pinfo or Cinfo]: the meaning that is currently assigned by human beings or computers to data [Cdata] by means of the conventions applied to the data.  | Information is data that has been given meaning through interpretation by way of relational connection and pragmatic context. (Keller & Tergan, 2005)   |
| Knowledge [Pknow]: understanding, awareness, or familiarity acquired through education or experience. Anything that has been learned, perceived, discovered, inferred, or understood. The ability to use information [Pinfo and/or Cinfo] . | Knowledge is information, which has been cognitively processed and integrated into an existing human knowledge structure. The most important difference between information and knowledge is that information is outside the brain and knowledge is inside. (Keller & Tergan, 2005) |

The Data Information Knowledge Wisdom (DIKW) hierarchy is used to explain the progression from data to knowledge where processed data becomes information, processed information becomes knowledge and processed knowledge becomes wisdom. Each level of processing adds subjectivity and it is not trivial to describe the relationship between that Pdata, Pinfo, and Pknow. However, consensus exists that data is not information and information is not knowledge, Pdata, Pinfo, and Pknow are not mutually disjoint and none of them is a subset of another (Chen et al., 2009).

Against this hierarchy, this study is concerned with the differences, similarities and synergies of knowledge visualisation and information visualisation. Visualization has potential for enhancing knowledge transfer as images are impressive, expressive and present reality (Burkhard, 2005).

Furthermore most humans interpret images far better than they do words, images address emotions and they can be inspiring, appealing, motivating and energising. There are however, risks and pitfalls in using visualisation and therefore guidelines are necessary.

Information visualisation is the use of computer-supported, interactive, visual representations of abstract data to amplify cognition (Card et al., 1999). The goal is to enable the reader to create new knowledge by using the innate human ability to find patterns and structures in visual data.

Knowledge visualisation has been defined as the use of visual representations to improve the transfer and creation of knowledge and reduce information overload ( Eppler & Burkhard, 2007).

Information visualization developed in the field of Human-Computer Interaction which lies in the field of Computing. Knowledge visualisation developed later and is mainly researched in the fields of Education and Knowledge Management. Knowledge management is a management perspective that offers theories, strategies, and methods to manage, i.e., to identify, access, share, and create knowledge in organizations (Burkhard, 2005). The aim of knowledge management is to help an organization to compete by being more innovative, effective, and thus more profitable.

**Table 2 Similarities between information visualization and knowledge visualization**

| <b>Information Visualization</b>   | <b>Knowledge visualization</b>                     |
|--|--|
| User-centred design  | Know your data, know your audience                 |
| Overview first, zoom in and filter, then show details on demand (Schneiderman, 2002)<br>Selective omission (Card) i.e. Fisheye menus | Focus and context<br>Don't distract your audience. |
| Be consistent  | Be consistent and avoid decoration                 |
| Affordance: recognition-based approach rather than recall  | Use natural representations                        |
| User satisfaction  | Motivate your audience.                            |

Moving beyond principles towards frameworks Eppler and Burkhard (2004) proposed a knowledge visualization framework which consists of four perspectives that need to be considered when creating visual representations that aim to transfer and create knowledge. These perspectives are the following:

- function perspective answers why a visualization should be used,
- knowledge type perspective clarifies the nature of the content,
- recipient type perspective points to the different backgrounds of the recipient/audience,

- visualization type perspective structures the main visualization types according to their individual characteristics

Eppler and Burkhard (2007) later expanded these four perspectives to five perspectives that answer key questions with regard to visualizing knowledge, these questions are the following:

1. What type of knowledge is visualized (content)?
2. Why should that knowledge be visualized (purpose, km process)?
3. For whom is the knowledge visualized (target group)?
4. In which context should it be visualized (communicative situation: participants, place/media)?
5. How can the knowledge be represented (method, format)?

In the next section we will discuss the application of these frameworks to academic writing.

### **3. KNOWLEDGE VISUALISATION IN ACADEMIC REPORTING**

The power of the unaided mind is highly overrated. Without external aids, memory, thought and reasoning are all constrained. But human intelligence is highly flexible and adaptive, superb at inventing procedures and objects that overcome its own limits. The real power comes from devising external aids that enhance cognitive abilities. (Norman, 1993)

Accepting that people need cognitive support aids, the next question is what kind of support would be appropriate for researchers. Regarding academic writing this is confined to non-interactive visual support where visualization is used to find ways to compress knowledge and present that in a format which enhance transfer and prevents information overload. Another less prominent yet important function in knowledge visualization is that it should also have the element of reducing uncertainty about the findings (Chen et al., 2009). Contextualising this framework to academic reporting can lead to a set of guidelines for academic reporting as depicted in Table 3.

**Table 3: Guidelines for academic reporting**

| <b>ACADEMIC REPORTING (NO INTERACTION)</b>                 | <b>KNOWLEDGE VISUALIZATION</b>   |
|--|--|
| For whom is the knowledge visualized?<br>(target group)    | Know your data, know your audience.  |
| In which context should it be visualized?                  | Distinguish context and focus.<br>Show overview first and then details.  |
| Why should that knowledge be visualized?<br>(purpose)      | transferring (clarification, elicitation, socialization)<br>codifying (documentation, summarising, abstracting, externalising)<br>creating (discovery, combination, synthesis), finding,<br>assessing(comparing, evaluation, rating)                             |
| What type of knowledge is visualized?<br>(content)         | <ul style="list-style-type: none"> <li>• declarative knowledge (know what)</li> <li>• procedural knowledge (know how)</li> <li>• experiential knowledge (know why)</li> <li>• orientation knowledge (know where)</li> <li>• people-related (know who)</li> </ul> |
| How can the knowledge be represented?<br>(method, format). | Heuristic sketches, conceptual diagrams, visual metaphors,<br>knowledge animations, knowledge maps, domain<br>structures, charts.  |

## 7. CONCLUSION

This lecture considered the principles of information visualization and knowledge visualization, to compare, contrast and integrate these principles towards identifying visualization guidelines in academic reporting. Two complementary approaches have been proposed to knowledge visualisation, namely bottom-up (direct perception) and top-down (constructive perception) (Burkhard, 2005). The top-down approach to the problem of knowledge visualisation in academic reporting offered guidelines that may be interrogated and tested by applying them in different situations. The bottom-up approach would consider the parts of the theory and then the whole as described by Weber in his article on evaluating theories in Information Systems (Weber, 2012).

To describe the parts of the theory we need to identify the constructs of knowledge visualisation, their associations and appropriate states. Further research should investigate this bottom-up approach to knowledge visualization towards a formal theory of knowledge visualization in academic reporting.

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