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Information access in the digital era: document visualization strategy

Abstract
In this work, we focus on the document visualization strategy to support access to information in the digital era. First, we discuss the dynamics of the document visualization approach and the ability to generate innovations with a direct impact on the competitive digital transformation scenario. Second, we discuss the visualization and computational intelligence methods such as data mining and knowledge discovery as important tools to improve the decision-making process. We then present the concept of knowledge organization systems and the main challenges related to document visualization strategies. Finally, we discuss the increasing prevalence of digital and visual literacies in relation to how we read and view information and communicate with others to meet the demands of the changes brought by the digital age.

Introduction
Continuous improvements in technology, networking, software and hardware, including mobile and wireless services and protection of content and services, have made possible the development of advanced digital content. Greater cooperation is a major challenge, since the production of digital content requires agreements between content developers, equipment manufacturers and information distribution.

Digital information now occupies a key place in organizations’ decision process. Libraries are acquiring digital information and providing access to users. Most of the information accessed today is digital and the Internet is playing a decisive role in these processes. Even analogue information is being converted to digital for ease of access and use.

Digital content has become a major driver of change in this digital age. Technological innovation and current information users’ demands are leading to new and direct ways of addressing knowledge organization, new methods of access, use and appropriation of information. Research results, for example, are becoming more accessible, and digital content requires new tools for information searching.

Technological innovation and the ubiquity of communication tools, economic uncertainty, changes in workplace and educational structures, the global economy, generational differences, the blurred distinction between the production and consumption of information, and heightened national security production and consumption of information are just some of the factors affecting the creation of knowledge in the digital era.

An important part of a digital library is the ability to access stored information effectively. Due to recent developments in information retrieval, a digital library is usually equipped with an automatic search and retrieval system which library users may
employ to find documents.

Against such a backdrop, this article proposes to examine a document visualization strategy to support information access in the digital era. Regarding research methodology, we will implement a case study research method, focusing on the necessary management changes to put such a strategy into practice within the workplace. Scrutiny is hereby placed on each key stage of the process, not necessarily the long-term outcome.

**Document visualization approach**

Document visualization is a class of information visualization techniques that transforms textual information such as words, sentences, documents, and their relationships into a visual form, enabling users to better understand textual documents and to lessen their mental workload when faced with a substantial quantity of available textual documents. Document visualization has significant benefits in helping users to analyze and control large amounts of textual information (Gan 2013), as shown in Figure 1.

![Figure 1: Document Visualization – Function Observatory Information](https://www.adbs.fr/lobservatoire-de-fonction-information)
With the exploding amount of document information and sources, efficient and intuitive visualization tools are desperately needed to assist users in understanding the contents and features of a document, while discovering hidden information (Gan 2013).

Data visualization is an extensive field at the crossroads of mathematics, computer science, cognitive and perception science, engineering, and physics. The goal of data visualization is to use images to improve our understanding of a dataset, drawing on techniques from mathematics, computer science, cognitive and perception science, and physics (Telea 2007).

A huge amount of data on the Web has geographic features. The World Wide Web Consortium (W3C) and the Open Geospatial Consortium (OGC) want to facilitate the Web of Data development using the Web infrastructure as well as the infrastructure of geospatial systems, as shown in Figure 5.

Figure 2: Web of Data and Geolocation Development

![Image](source: www.computerworld.com.pt)

One of the greatest scientific challenges of the 21st century is how to master, organize and extract useful knowledge from the overwhelming flow of information...
made available by today's data acquisition systems and computing resources. Visualization is the prime means of taking up this challenge.

Visualization is the process of representing data, information, and knowledge in a visual form to support the tasks of exploration, confirmation, presentation, and understanding. Scientific visualization is concerned with techniques that allow scientists and engineers to extract knowledge from the results of simulations and computations. Tremendously large collections of numerical values, which contain a great deal of information, are being produced and collected. The problem is to convey all this information to the scientist so that effective use can be made of it. This requires a method of communication with a high bandwidth and an effective interface. Computer generated images and human vision mediated by the principles of perceptual psychology are the means used in scientific visualization to achieve such communication (Bonneau 2006), Figure 6.

Figure 3: Scientific visualization

Source: NASA/Goddard Space Flight Center Scientific Visualization Studio
To accomplish all these goals as far as visualization technologies are concerned, the use of digital technology is evolving toward comprehensive solutions to manage information systems using a single repository and a single interface, dramatically reducing the costs and complexity of managing technological resources, including mobiles, IoT - Internet of Things, tablets, and networking devices. Innovations continue to emerge at a frenzied pace, driven by the rapid advancement of technology and the big data phenomenon. Information is a key asset in the digital era, pressing the organizational environment to produce tangible and sustainable results (Paletta 2008).

Despite the importance of the connection between technology, innovation and economic prosperity, organizations must be able to adapt and evolve if they wish to survive. Businesses operate with the knowledge that their competitors will inevitably come to the market with a product that will change the basis of competition.

According to Trott (2010), the ability to change and adapt is essential to survival and the idea of innovation is widely accepted. It has become part of our culture. In the competitive digital transformation scenario, visualization and computational intelligence methods such as data mining and knowledge discovery are important tools to improve the decision-making process.

**Knowledge Organization Systems – the IAEA case experience**

In the context widely known as the world’s “Atoms for Peace” organization within the United Nations family, the IAEA is the international centre for cooperation in the nuclear field. The Agency works with its member States and multiple partners worldwide to promote the safe, secure and peaceful use of nuclear technologies. According to the IAEA (2015):
For managing knowledge organization systems which follow W3C standards, a tool has been acquired which allows users to create KOSs, transform existing ones into the SKOS format and import them, edit KOSs, and publish them on several media, most prominently the Web. In addition to the basic functionality of managing KOSs, the tool offers features for interlinking KOS concepts, and linking the concepts to external data. This opens onto the world of linked data, the Internet of data in which data are treated in an analogous way to documents. Obeying the naming conventions of each single term by URIs (unified resource identifiers), data may be interlinked with other data, forming a knowledge network. The number of information sources which are published in this way grows continuously as shown in Figure 2 (AIEA 2015).

[…] this allows the construction of extensive knowledge graphs to enable discovery of knowledge, meaning that a search will return not only results by full text search, but also related items. For representing knowledge domains, this technology, often referred to as “semantic technology”, allows the generation of content-rich knowledge models, providing the user with a navigable knowledge map which may be queried with a specific query language (SPARQL), and which are often supported by visualization and refined semantic search tools (AIEA, 2015).
Semantic technologies are not specific to an application area or knowledge domain. The distinguishing feature of semantic technologies instead consists in building applications based on knowledge organization systems and/or taking advantage of linked (open) data sources.

An essential point to note is that if an organization is to be fully effective, every part of that organization needs to actively contribute to innovation (Goffin and Mitchell, 2010). Innovation should not only originate in the R&D department in a manufacturing company or the strategic planning group in a service operation. The functional areas that should be involved are:

- Research and Development
- Marketing
- Operations
- Finance and Accounting
- Human Resource Management
- Outside Resources

According to AIEA (2015), knowledge organization systems provide powerful means of modelling knowledge domains. Linked data allows a KOS base to be enriched with other sources which are increasingly being published by many organizations on the web. Publicly available sources such as Wikipedia and restricted, topical data sources may contribute significantly to enhance established concepts, leading to rich knowledge bases which lend themselves to knowledge discovery as described previously. Such knowledge bases provide an excellent backbone for constructing knowledge portals, enabling improved search by automatically categorizing documents, translating their taxonomical hierarchy into site pages, and linking pages to internal and external information sources.

The more changes there are in the technology of products, services, and operations, the more changes take place in administrative procedures – new strategies, new organizational structures, and new operating processes will be required to successfully capture the potential benefits of the venture. The failures of technological change typically occur when either too much technology is adopted too quickly, or not enough technology is adopted to stay ahead of the competition (Ettilie 2006).

**Conclusion**

We need to have both digital and visual literacy skills to evaluate, use, and create digital resources. Being able to read screens with deeper understanding and to interpret meaning from pictures enables us to make educated judgments about what we find online. Shaw (2016) states that digital literacy refers to the competency to:

- Read and Write with technology tools
- Find, evaluate, utilize, share, and create content using information technologies
and the Internet

- Use and manage technology proficiently
- Comply with ethical and legal technology use

Visual literacy is the ability to draw information and inferences from photographs, pictures, or illustrations, whether still or moving.

[...] visual literacy is a set of abilities that enables and individual to effectively find, interpret, evaluate, use, and create images and visual media. Visual literacy skills equip a learner to understand and analyse the contextual, cultural, ethical, aesthetic, intellectual, and technical components involved in the production and use of visual materials. A visually literate individual is both a critical consumer of visual media and a competent contributor to a body of shared knowledge (Shaw 2016).

Accordingly, Pratish (2006) states that visual literacy refers to the competency to:

- understand the subject matter of images,
- analyze the syntax of images including style and composition,
- analyze the techniques used to produce the image,
- evaluate the aesthetic merit of the work,
- evaluate the merit of the work in terms of purpose and audience, and,
- grasp the synergy, interaction, innovation, affective impact and/or ‘feel’ of an image
- analyze and interpret images to gain meaning within the cultural context the image was created and exists

Digital and visual literacies have become common to how we read and view information and communicate with others. Digital and visual literacies help us interpret what we experience, analyze what we are exposed to, and make conclusions using our critical thinking skills (Shaw 2016)

In order to further research in information science, it is essential to continue studying technology transformation with regard to how users search, access and use information in the digital era and the role of document visualization strategies to help improve new knowledge development in the competitive global economy.


References


