Organising Learning and Knowledge Spaces for Occupational Safety and Health with Visual Structure Interfaces (VSI)

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Abstract
The contribution at hand proposes an approach for designing learning and knowledge spaces in respect of occupational safety and health with the aid of visual structure interfaces (VSI). The focus is on the development of strategies and components that support and improve on-the-job training concerning safety and health at the workplace as well as teaching and learning in the educational system. As a knowledge generation tool we introduce the PIMEX (PIcture-Mix-EXposure) method for visualising workplace hazards. Derived knowledge is structured by means of VSI using a simple graphical user interface. Starting from the centre of a knowledge structure associated information is connected using self-describing relations. VSI represent specific safety and health topics, are easily expandable, and provide the content for training and instruction (e.g. on the basis of e-learning units composed of thematically related VSI). Applying visual structure interfaces for safety and health issues is expected to increase employees’ awareness of work-related hazards to health and facilitate the assessment of potential risks.

Keywords: Knowledge representation, Visualisation, Occup. safety and health

1 Introduction
Company structures and work processes increasingly become more complex and knowledge-intensive due to the transformation of work environments in recent years. As a consequence, acquirement and dissemination of knowledge as well as learning in general gain in importance, which places high demands on employees. In addition to the acquirement of technical and vocational skills the understanding and intensive examination of safety and health at work presents a basic necessity. The ability to assess the impact of work-related strains and exposures on human health on the one hand and the effect on productivity on the other hand proves to be a key competence in order to actively participate in corporate prevention and health promotion processes. Novel strategies and tools such as visualisation techniques are required for the purpose of enabling companies and training institutions access to knowledge and resources.
In this contribution we propose an approach for structuring knowledge about occupational safety and health. The PIMEX method with its visualisation features is applied as a knowledge generation tool in this context. We introduce the concept of visual structure interfaces (VSI) for knowledge representation and as a source for the design of learning concepts.

2 PIMEX: A Knowledge Generation Tool

PIMEX (PIcture-Mix-EXposure), also known as VEM (video exposure monitoring) is a method for visualising health hazards at the workplace (Rosén and Lundstrom, 1987; Mc Glothlin, 2005).

A work sequence is recorded by video camera, and simultaneously all exposures as well as medical information are collected via direct reading instruments. By displaying an operational procedure in relation to the measured expositions and the physiological data, interrelations between a certain work sequence and prevalent hazards as well as specific strains can easily be recognised and measures against harmful peak loads can be derived (Rosén, 2002; Rosén et al, 2005).

PIMEX has been applied for analyses of exposures due to hazardous substances (such as aerosols, solvents, cooling lubricants, styrole, isocyanates, etc.) and physical load (noise, heat, vibrations). In addition, ergonomic factors (lighting, thermic comfort, work postures, psychological stress) and biomonitoring parameters that serve as individual stress indicators (pulse, heart rate variability, breathing rate, body temperature) have been investigated.

The approach enables the analysis of working processes and an assessment of risks, resulting in a package of measures for the purpose of workplace improvement and risk optimisation. A priority objective is to increase employees’ awareness of health hazards by imparting knowledge about interrelations between occupational strains, exposures and their consequences on health.

2.1 Health Promoting Design of Work

A systematic and anticipatory debate on occupational safety and health forms the core of a health promoting design of work. By applying the PIMEX method the focus shifts to a comprehensive view on prevention. A structured and traceable proceeding in the course of a PIMEX intervention provides the basis for an integrated management approach.

Achieving an optimal design of the system composed of worker, work equipment, workplace, work environment, work content and work flow constitutes the aim of any PIMEX intervention (Kauer et al, 2005). A key aspect for a health promoting design of work by means of an all-embracing working system analysis with the PIMEX method is the involvement of at-risk personnel in the analysis process. Other factors are the visualisation of relevant information at the time of data acquisition, the representation and assessment of risks, the evaluation of effectiveness and the provision of a meaningful documentation. Results from PIMEX interventions turn out to be a starting point for establishing a knowledge base for employee training and instruction as well as the development of individual learning concepts (Kviecien, 2006).
3 Visual Structure Interfaces (VSI)

Visual structure interfaces provide means in order to structure derived knowledge from PIMEX interventions. Occupational safety and health topics are visualised by the use of a simple graphical user interface. A topic or meta concept forms the centre of a knowledge structure. Thematically related information items or other knowledge structures are connected to the centre by means of self-describing relations. The intended purpose of visualising information items as well as their interrelations is to create a visual anchor for viewers in order to facilitate learning (Kauer et al, 2005). In the following we suggest different levels for creating and organising learning and knowledge spaces.

3.1 VSI Level 1

Visual structure interfaces on level 1 include information items from various sources that are connected to a specific topic, such as data from PIMEX observations, publications, general guidelines, best practices, documentation of successful workplace improvements, personal experiences, etc. An example representing structured knowledge regarding exposures and strains in connection with lifting high maintenance patients is depicted in Figure 1.

3.1.1 VSI Level 1*: Assessment of a Working System Analysis

We consider the risk assessment at specific workplaces in the course of PIMEX interventions as a special case. Results from working system analyses are presented with the aid of visual structure interfaces according to the criteria specified in the management cycle (see Figure 2). Structured knowledge from several investigations at similar workplaces may be grouped together in order to derive best practices, successful change processes in such workplaces and sector-specific issues.

![Figure 1. Knowledge structure example](image-url)
3.2 VSI Meta Level 2: Management Cycle
Potential work-related hazards to health usually stem from deficiencies regarding the technical protection of labour (tools and supplies for work, etc.), personal protective equipment, work behaviour and awareness of risks, and work organisation. The components of the management cycle organised in a meta level structure are depicted in Figure 2.

![Figure 2. Management cycle](image)

3.3 VSI Meta Level 3: Knowledge Compendium
Expanding the visual structure interface approach by adopting meta levels enables the composition of a comprehensive thematically interconnected knowledge base. A conceivable topic structure for a knowledge compendium regarding occupational safety and health on the top level is shown in Figure 3.

![Figure 3. Knowledge compendium](image)
The concept of visual structure interfaces was developed with a specific content management system in mind. None the less visual structure interfaces are conceptualised for being applicable for any kind of knowledge base.

4 VSI Learning Support
Visual structure interfaces are intended to support and improve on-the-job training concerning safety and health at the workplace as well as teaching and learning in the educational system, including traditional didactic methods, blended learning and e-learning approaches. A schematic representation of the components of a knowledge and e-learning environment based on PIMEX and visual structure interfaces as well as knowledge processing in this context is depicted in Figure 4.

Figure 4. Knowledge and eLearning environment

Kauer et al proposed a constructivist blended learning approach based on the visual structure interface concept in respect of work-related strains and exposures that was applied in health care and nursing schools (Kauer et al, 2005). The elaborated knowledge structures (equivalent to VSI Level 1) provided the content for the e-learning units.

5 Summary and Future Prospects
We have introduced an approach for representing and organising knowledge about health and safety at work using the PIMEX method as a knowledge generation tool. Gathered knowledge surrounding a specific topic is structured based on a visualisation concept. Easily expandable knowledge structures that can flexibly be interconnected provide the basis for designing and implementing learning and knowledge environments.

Future work will concentrate on the implementation of the visual structure interface concept on all levels described, the adoption and testing of novel learning approaches based on visual structure interfaces as well as the automation of parts of the visual structure interface generation process. The latter particularly refers to documentation and results from PIMEX interventions and the assessment of workplaces according to VSI Level 1*.
References


