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Visualization and establishment of product design regulations as interactive modules

An interaction design study at IKEA

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Abstract

Purpose – This paper aims to explore the preferable manner for visualizing different product regulations to be used in the training of and communication between people working at different levels in the production process. Many organizations struggle to communicate important and compulsory regulations, but the intended users are often reluctant to use them.

Design/methodology/approach – The study has an action research approach, and the visualized regulations were the result of a human-centered design process that considered aspects for successful organizational change.

Findings – The action research approach proved to be a successful framework to design the transformation of well-constructed illustrations in interactive guides, communicate and convince managers and users of the potential of the concept, develop a number of different well-functioning guides and establish regulations with illustrative elements and interactivity in a long-term perspective of an organization.

Research limitations/implications – Further research is needed to follow-up the usage of visualized regulations to clarify how communication and quality are supported in design and production processes.

Practical implications – The study shows how different product regulations should be visualized and established in an organization, with a potential for further dissemination. It is likely that the approach to design and visualize regulations in this study can function in other branches.

Originality/value – The study finds a preferable manner for visualizing different product regulations to be used in the training of and communication between people working at different levels in the production process.

Keywords Management, Communication, Action research, Regulations, Interaction design, Visualization

Paper type Research paper

1. Introduction

1.1 Visualization of regulations

Many organizations struggle to communicate important and compulsory regulations, but the intended users are often reluctant to use them. Could more illustrative forms of information technology visualize regulations with good usability and change that attitude?

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The challenge of integrating evidence-based knowledge and research into practice is of vital importance to achieve reflection and learning at workplaces (Nilsen *et al.*, 2012). One such approach is by means of regulations. These are generally based on legislation, best practice and research and are used in information and quality management systems to ensure high quality by supporting design, production and communication processes. Regulations are often presented with a conventional system on an intranet and are suitable for printouts. They are visualized as a traditional text-based report with a list of headings accompanied by tables and pictures, or presented as paper documents in manuals or binders (Edwards and Gibson, 1997; Huarng *et al.*, 1999; Blomé *et al.*, 2003). Such approaches do not always correspond to the usability requirements of some companies. The extensive documentation of quality management systems can appear meaningless and time-consuming to the users (Edwards and Gibson, 1997; Karltun *et al.*, 1998; Chaudhuri and Acharya, 2000). It can also lead to reduced flexibility and increased workload (Lundmark and Westelius, 2006). Furthermore, technological achievements in social media and entertainment have changed attitudes as to how information should or can be presented. We have to embrace and explore how new visualization technology can help us present regulations so that they are easy to find and interpret, and even enjoyable for the intended users. A general question, then, is: How do you design and successfully implement a suitable visualization of important regulations? The visualization of content and the visualization process are thus vital to ensure valid content along with the fulfillment of the users' and their organization's needs for an established, user-friendly system of regulations.

1.1.1 Visualization of content. Written text is the most common presentation form of information in regulations. But other and more illustrative media have a great potential to communicate information. People like pictures and learners rate materials that contain illustrations as more enjoyable (Levie and Lentz, 1982). However, purely decorative pictures have no beneficial text-learning effects, whereas pictures that are representational, organizational, interpretational or transformational can provide quite substantial benefits (Levin *et al.*, 1987; Carney and Levin, 2002). In short, decorative pictures simply decorate the page, representational pictures mirror part or all of the text content, organizational pictures provide a useful structural framework for the text content (e.g. an illustrated map), interpretational pictures help to clarify difficult text (e.g. representing blood pressure in terms of a pump system) and transformational pictures include systematic mnemonic (memory enhancing) components designed to improve a reader's recall of text information (e.g. keyword illustrations connecting words with illustrated objects).

It is clear that well-selected or well-constructed pictures reliably improve the reading-to-learn process (Levie and Lentz, 1982; Mayer, 1989; Carney and Levin, 2002). The ability to design informative pictures and interactive illustrations has increased with advanced information and communication technology. It is rather easy to replace static pictures with animations in information systems, but several studies show a lack of the general superiority of animations compared to static pictures on learning outcomes (Tversky *et al.*, 2002; Lewalter, 2003). However, a meta-analysis of instructional animations versus static pictures carried out by Höffler and Leutner (2007) found a rather substantial overall advantage of the animations. This advantage was particularly evident under specific combinations of instructionally relevant circumstances.

"Multimedia" refers to a computer-delivered electronic system that allows the user to control, combine and manipulate different types of media, such as text, sound, video,

computer graphics and animation Merriam-Webster (2013a, 2013b). Approaches to visualize information by means of multimedia to support learning have been explored in the research fields of educational psychology and interface design. These approaches have resulted in better learning effects with animation and narration compared to written text and static illustrations (Mayer and Anderson, 1992; Mayer, 2003). The results of these studies are based on experiments with high school and university students. However, due to the complex information systems and demands on employees to understand information in companies and organizations, the implementation of visualizations and multimedia also has a great potential for working life organizations. One example is a study in the automotive industry, which confirmed the assumption that a visualized quality system is faster, easier and more interesting to use than a paper system. In the study, a conventional system of ergonomic guidelines was compared to a visualized system of interactive pictures of the same information (Blomé *et al.*, 2006). The conclusion was that the system based on interactive drawings, pictures and animations supported by text was generally faster and more enjoyable to use than the conventional system. A question worth exploring is if a more illustrative approach enhances the usability and user experience for product design guidelines or regulations in general.

1.1.2 Interaction design and establishing a new system. User-centered design is fundamental to accomplish an information system with great usability and user experience.

There are several interaction design methods with slightly different titles, but they all stress the importance of understanding the user, specifying requirements, producing prototypes/design suggestions and applying an iterative approach of user tests and improvements until a final product fulfills the specified requirements (Faulkner, 2000; Huang, 2005; Sharp *et al.*, 2011). These aspects are also described in a general framework for user-centered design by the ISO standard (ISO9241-210, 2010), see Figure 1.

An appropriate definition of usability can be found in the ISO's *Guidance on Usability, Ergonomic Requirements for Office Work with Visual Display Terminals*, which states that it is "[…] the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO9241-11, 1998). This definition means that important heuristics need to be considered. Heuristics refer to experience-based techniques for problem solving, learning and discovery (Merriam-Webster, 2013a, 2013b), and several different sets of heuristics exist for evaluating interfaces. Norman (2002), for example, provides general recommendations for interface design, and Shneiderman (1998) presents a set of eight golden rules for interface design. Nielsen (Sharp *et al.*, 2011; Nielsen, 2012) presents a list of ten important heuristics to evaluate interaction usability that includes Shneiderman's rules and considers Norman's principles:

(1) visibility of system status;
(2) match between system and the real world;
(3) user control and freedom;
(4) consistency and standards;
(5) error prevention;

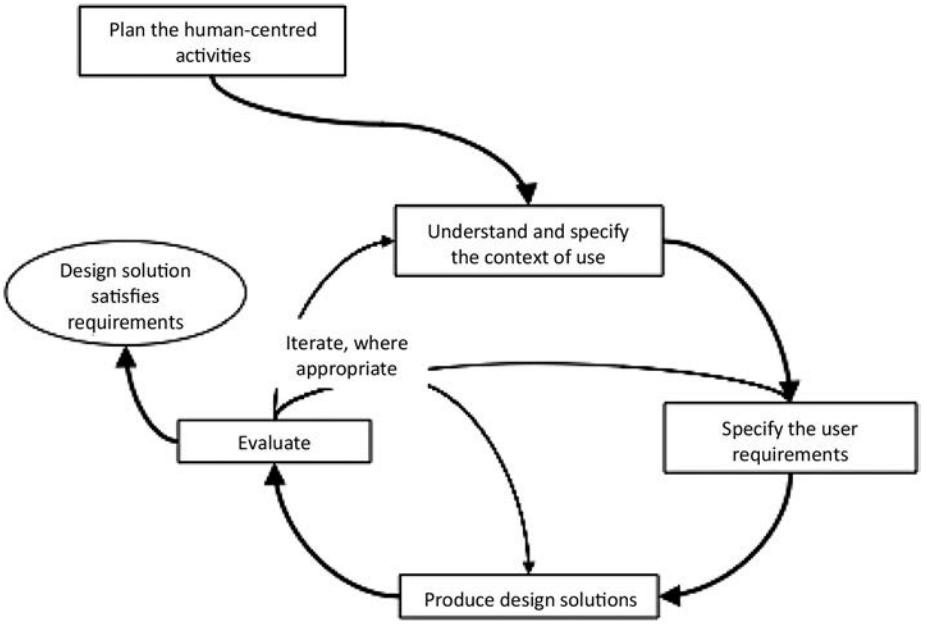

Figure 1.
The interdependence of human-centered design activities (ISO9241-210, 2010)

(6) recognition rather than recall;
(7) flexibility and efficiency of use;
(8) aesthetic and minimalist design;
(9) help users recognize, diagnose and recover from errors; and
(10) help and documentation.

Users of a set of regulations or guidelines explore information by navigating and viewing, and not by making changes or adding information. Thus, most of the heuristics are easily fulfilled by following established design standards from Web sites, such as symbols for navigation control. However, most iterations of the design process are likely to take place during the visualization of regulation content to fulfill the heuristic "aesthetic and minimalist design". Norman (2002) provides a general minimalistic recommendation of only making the relevant parts visible. Sharp *et al.* (2011) develop this further by recommending a design that is made as simple as possible by removing unnecessary functionality, process steps and visual clutter and that also strives to be aesthetically pleasing and offer a pleasurable experience. Jordan (2000) also highlights the importance of pleasure of use that has both functional and emotional benefits. This position is clearly apparent among commercial multimedia products, entertainment and in social media that strive for usage based on curiosity and attention.

The interaction design process results in a final product, and its establishment in the users' organization is meant to occur as a consequence of involving users throughout design and development. ISO9241-210 (2010) promotes such participation because it can increase user acceptance and commitment. This recommendation is not sufficiently concrete, though, especially if the establishment is intended to lead to major changes in

the users' working situation. The general change process for continuous improvements described by Deming and Kilian (1992) in the *Plan, Do, Study, Act* (PDSA) model is well-established in quality work and standards (ISO 9001:2008, 2008). It emphasizes the importance of methodically starting on a small scale and thoroughly evaluating before implementing and standardizing the results in the organization. The establishment of a product or a system in an organization is a process of changing the behavior of users, and as such, some aspects are important to consider. Participation and commitment are vital for handling the general human fear of the unknown and benefit the users' experience and perspective throughout the process (Wilson and Haines, 1997). To overcome resistance to change (Kotter, 1996, Alvesson and Spicer, 2012), maintain energy and make changes stick in an organization, it is valuable to consider the eight-step process of creating change described by Kotter (1996):

(1) establish a sense of urgency;
(2) create the guiding coalition;
(3) develop a vision and strategy;
(4) communicate the changed vision;
(5) empower a broad base of people to take action;
(6) generate short-term wins;
(7) consolidate gains and produce even more change; and
(8) institutionalize new approaches in the culture.

If these steps can be integrated with human-centered design activities (Figure 1), we will have a well-founded framework for designing and establishing a new system of product design regulations in an organization.

1.2 Aim of the study

The study explores the preferable manner for visualizing different product regulations to be used in the training of and communication between people working at different levels in the production process. The research questions are:

RQ1. How should the visualization process be designed to present regulations with illustrative elements and interactivity in a long-term perspective?

RQ2. What are the usability and user experiences of product regulations visualized with interactive drawings, pictures and animations?

RQ3. What are the important organizational considerations for implementing visualized regulations with increased illustrations and interactivity?

2. Materials and methods

2.1 Choice of organization and subjects

The study has an action research approach that in general involves the following three phases:

(1) unfreeze by awareness of dilemma;
(2) change by exploring new models of behavior; and
(3) refreeze by adopting new behaviors (Lewin, 1958).

In this study, an organization becomes aware of the problems with existing regulations, new models are explored and tested and finally adopted into the organization. The study explores the potential and effects of interactive visualizations in a large global company with a diverse product portfolio and employees and suppliers with varied nationalities and educational backgrounds. Field studies were carried out at the Laws & Standards Department at IKEA of Sweden AB, a company located in Sweden that designs and commercializes a wide range of home furnishing products for a global market. The company has approximately 1,200 employees and is a member of the global retail IKEA Group with 127,000 co-workers in 41 countries. The Laws & Standards Department is responsible for the content of a wide range of product regulations, and for training and supporting communication of these throughout the production process.

There were two groups of subjects. The first represented the Laws & Standards Department. The group consisted of the manager and co-workers with in-depth knowledge and responsibility for specific product regulations. They were involved with the author in the design process of the interactive regulations.

The second group consisted of employees at different levels who received and worked with the regulations. There were three categories:

(1) *The test lab*: Located at IKEA of Sweden where tests and training were held.

(2) *Trading*: A division that explains regulations to suppliers and purchases products from suppliers to be sold at IKEA stores.

(3) *Suppliers*: Manufacturers that supply products that have to meet IKEA regulations.

A short-term evaluation of usability and user experience focused on the second group with nine respondents who completed and returned questionnaires and participated in summative discussions. The respondents included one Swede from the test lab, three Poles and two Russians from trading and two Poles and one Swede representing the suppliers.

A long-term evaluation was based on a questionnaire sent to 30 users via e-mail, with nine respondents from the first group and five from the second group in the trading category. The questionnaire results were then summarized and discussed with one manager and two key people representing the first group of subjects and who were responsible for the visualized modules of the regulations.

2.2 Conventional system of regulations

The existing regulations had been presented as traditional text documents with headings, text blocks, tables, photos and black and white drawings in the form of a guide (Figure 2). The guide for each set of regulations consisted of between 10 and 35 pages. At Laws & Standards' employee training days, the guides were accompanied by an oral presentation, with slides explaining different aspects of the product, and a guided tour of the laboratories where the products were assembled and tested. The users received the regulations as paper printouts or in electronic form suitable for printout distributed by the Laws & Standards Department. However, the company wanted to improve the usability and user experience of their regulations to improve education and communication throughout the production process.

Figure 2.
Example of traditional documented regulations

2.3 The visualization process

The three central aspects of action research – awareness, changes and adopting new behaviors (Lewin, 1958) – were fulfilled in a visualization process considering aspects for successful organizational change. The visualization process followed the human-centered design process (Figure 1.) and integrated the PDSA (Deming and Kilian, 1992) cycle as well as Kotter's (1996) eight-step process for successful change.

The visualization process was planned and anchored in dialogue with managers and colleagues at the Laws & Standards Department. These discussions included the first four steps of Kotter's (1996) process where all participants agreed on the urgency and joint responsibility to change and improve their regulations with visualization techniques. The group then decided to test the approach on the bunk beds product segment because it was considered urgent and a high-risk product, with strict demands on correct information. A broad base of people from the Department was then involved to generate a successful module in a short-term perspective. This corresponds to Kotter's (1996) steps five and six; it also meets the recommendations of the PDSA cycle to start on a small scale. A short-term evaluation of this visualized regulations module was performed in 2004. The evaluation confirmed that the approach was successful, and the last step of the human-centered design process (design solution satisfies requirements) thereby confirmed the first step (plan the human-centered activities) (Figure 1). Because of this, the study continued with other product segments resulting in new modules.

The author and the person responsible for the specific regulations at Laws & Standards, who had extensive experience in formulating and communicating such regulations, developed each module of visualized regulations iteratively according to the four inner steps (understand, specify, produce and evaluate) of the human-centered design process (Figure 1). Several informal meetings were held with colleagues and managers at the Laws & Standards Department to inform them about the status of the project and collect viewpoints. The Laws & Standards representative contributed knowledge and experiences of the specific regulations, such as practical examples, situations and intended use. The author contributed knowledge and experiences from

earlier case studies that involved combinations of pictures, animated scenarios and models with text and hyperlinks.

The development of the first visual artifact (bunk beds) took approximately 35 days over four months, with frequent meetings and e-mail exchanges. Much of the time was spent on coming up with suitable ways to visualize the information by creating appropriate illustrations and icons. The guides that followed benefited from these templates, and this reduced the development time to 10-15 days.

2.4 Implementation and evaluations

According to the last step of Kotter's (1996) process, a short-term evaluation is necessary to decide whether to implement and standardize the findings into the organization, and a long-term evaluation is necessary to clarify if the approach has been successful in institutionalizing new approaches in the culture.

The short-term evaluation was carried out in 2004 on the first set of the visualized regulations: the bunk beds product segment. The Laws & Standards representative and the author presented and discussed the visualized module with the first group of subjects – one manager and six co-workers at the Laws & Standards Department – in a two-hour session. The author took notes. A few weeks later the module was introduced and evaluated by the second group of nine subjects from Sweden, Poland and Russia during a training day. The participants visited the test lab and were able to view tests and ask questions. They were then presented information on the regulations with traditional presentations and with the new visualized regulations. They evaluated the visualized regulations at the end of the day in writing by filling in a questionnaire, followed by a general discussion with the organizers, the author and the responsible person at the Laws & Standards Department. It was decided at a follow-up meeting to visualize five other product segments (fire, formaldehyde, law labels, work chairs and risk hazards) using the same approach as with the first module.

The long-term evaluation was carried out six years later in 2010 on five distributed regulations modules by means of a questionnaire sent to 30 users via e-mail. Several questionnaire reminders were also sent out. In all, 14 users returned the completed questionnaire for a response rate of 47 per cent. The questionnaire results were then summarized and discussed in a three-hour-long, recorded follow-up meeting with one manager and two key people responsible for the visualized modules of the regulations. One of the key people had designed the questionnaire with the author and distributed it to the group of 30 users outside the Department.

The data collected from both sets of questionnaires went through a content analysis (Patton, 2002), which reduced the qualitative data to identify core consistencies and meanings. The content analysis started with an inductive approach to discover patterns, themes and categories. Then deductive comparisons were made with definitions of usability from ISO9241-210 (2010) and Sharp *et al.* (2011).

3. Results

3.1 The interactive regulation modules

The regulations were visualized with illustrations and animations, enlargement of details, testing equipment and scenarios (Figures 3-5). However, one of the six modules, fire regulations, was not fully completed and released.

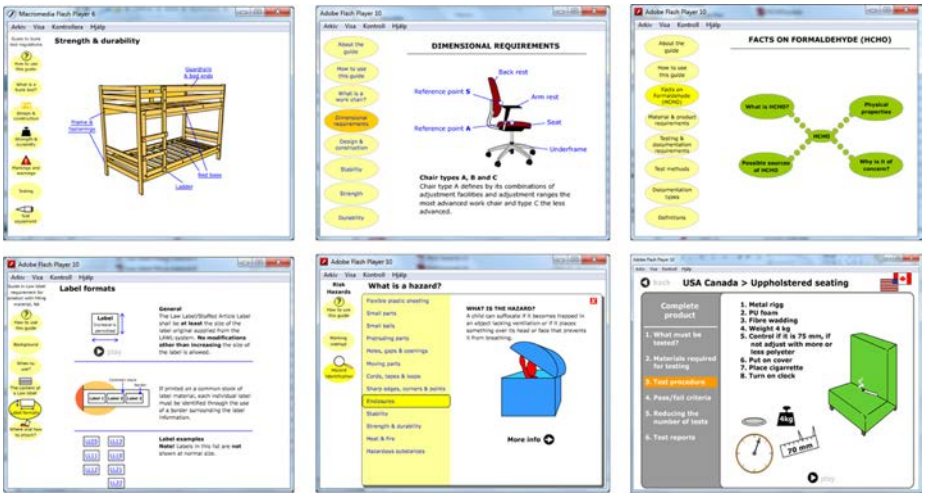

Figure 3.
Screenshots of six interactive regulations: bunk beds, work chairs, formaldehyde, law labels, risk hazards and fire

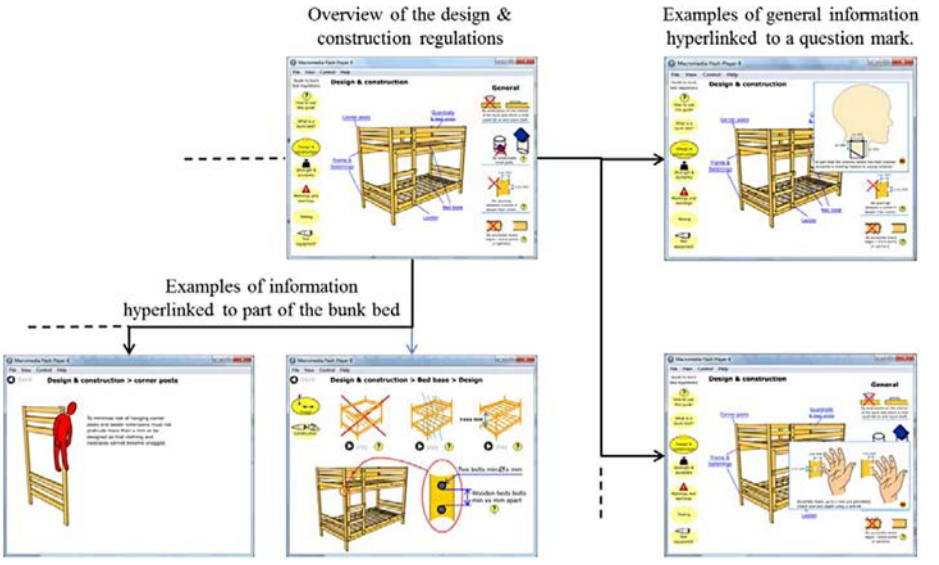

Figure 4.
Five screenshots of the visualized bunk bed regulations showing paths to specific scenarios and specific regulations

3.2 Short-term evaluation

The observations and notes from the meeting where managers and colleagues at the Laws & Standards Department interacted and discussed the module, showed an active and positive attitude toward its visualization. They proposed several additional product segments that would be suitable to visualize. Alternative visualizations and an increase of information were discussed. In the beginning, the group wanted to add more and more information, but restricted themselves after a while. They decided to evaluate the new module during a training day and based on the results, decide if the module should be released and if the project should continue with other product segments.

Figure 5.
Example of an animation of a risk hazard

The discussions during the new interactive module training day focused on the visualized information with specific questions about it. After evaluating the module by filling in a questionnaire, the participants had a general discussion in which they stressed the importance of using practical examples. They requested immediate access to the visualized regulations so they could start using them right away in their daily work. The usability and user experience aspects from the questionnaire are summarized in Table I. They were condensed into a report and distributed to the Laws & Standards Department, and it was convincing enough for them to decide to continue with the project and develop more interactive modules for other areas.

3.3 Long-term evaluation

The long-term evaluation took place at a meeting six years after the short-term evaluation of the first module. The results of the e-mailed questionnaires were distributed to the meeting participants and were based on the answers of 14 users (Table II). The organization had changed over the years – the Laws & Standards Department had been renamed and expanded from 7 to 20 employees. They are now responsible for a variety of documentation. Among them are about 25 guides that complement the regulations and are used for education; the interactive modules are included in this group. The status of the six modules or guides can be summarized as:

(1) *Bunk beds*: Still being used but needs revision.

(2) *Law labels*: Still being used and is somewhat revised.

(3) *Risk hazards*: Still being used and is under revision.

(4) *Formaldehyde*: Has been used, but will be replaced with a condensed document.

(5) *Work chairs*: Still being used and has been extended to include all chairs.

(6) *Fire*: Has never been fully developed and released.

The experts use the guides as a dictionary, and the guides are well-suited for new and inexperienced suppliers. The guides are also self-instructive and easy to distribute.

Questions	Summarized answers	Distribution (%)
Usability aspects		
Relevance and utility: how can the module help/support you?	For education and support (6)	67
Can you use the material directly or will you have to adapt it?	Yes, directly (7)	78
	Adapt it a little bit (2)	22
Learnability: is it easy to understand the content of the module?	Yes (9)	100
	Clear and easy with pictures and animations (2)	22
User experience aspects		
What do you think of this?	Good (9)	100
	Good with pictures and animations (2)	22
	It's not boring and supports imagination (2)	22
Is the level of detail: too simple, just right, too complicated	Just right (9)	100
Adjustments/suggestions?		
	Some clarifications (3)	33
	Release it and give us access (3)	33
	More cases (1)	11

Table I. Short-term evaluation of visualized regulations–summarized questions and answers, $n = 9$ subjects

Laws & Standards wants more guides to simplify and enhance the communication in certain identified areas of interest. They are facing great challenges to handle updates and develop the whole range of documentation in which the guides are included. They want to change the product description system, but have not decided on new tools for the guides. There are also ongoing discussions on how to distribute the guides and who should have access. Personnel turnover and job mobility within the company has increased in general, a somewhat deliberate strategy to encourage career development. This has increased the need for fast and easily accessible documentation.

4. Discussion

The regulations used were visualized in a way similar to the ergonomic guidelines in the automotive study (Blomé *et al.*, 2006), using simplified illustrations and animations of products, their details and their functionality. The visualized modules at Laws & Standards, however, had greater diversity and also presented risk scenarios and their consequences. In addition, a new area with visualized test methods had to be developed, showing position and duration of forces as well as tolerances and usage of different testing equipment. The applied iterative and participative approach to visualize the interactive modules succeeded in designing them. Thus, the visualized modules in this study contained well-constructed illustrations, according to definitions by Levin *et al.* (1987) and Carney and Levin (2002):

- representational (e.g. an animation of a dangerous scenario);
- organizational (e.g. illustrated products with interactive hyperlinks to further information);
- interpretational (e.g. animations of how products are tested with specific testing equipment); and

Questions	Summarized answers	Distribution (%)
Usability aspects		
How often do you use the interactive guide/guides?	Often	7
	Sometimes	57
	Seldom	36
How do you use the guide/guides?	As a reference document used by myself	71
	As introduction/presentation material for myself	57
	As introduction/presentation material to use and discuss with others.	50
	Send it directly to the one asking questions, including suppliers	14
Advantages or disadvantages?	Easy to understand	79
	Adequate level of information	50
	Too simple – more information is needed	43
	Informative and interesting illustrations and animations	50
User experience aspects		
What is your general opinion of the interactive guides?	Excellent	14
	Very good	57
	Average	29
Adjustments/suggestions?		
	Should be possible to save and print	21
	It must be reliable regarding updates	21
	Would be perfect to have such guides for more things: labeling, packaging, etc	7

Table II. Long-term evaluation of visualized regulations–summarized questions and answers, $n = 14$ subjects

- transformational (e.g. hyperlinks illustrated as products or parts of a product, accompanied by a keyword).

The short-term evaluation showed that the neutral and simplified illustrations worked well because the attitudes of the users in general were very good. The discussions during the evaluation were focused and inspired detailed questions. This indicates that the usage of the modules was successful. The users could see the benefits and generally asked for immediate access to the guide. Thus, the participative approach, combining the company's expertise in specific regulations with the visualization of guidelines, appears to be successful in designing useful guidelines and sufficiently convincing the company to design more modules.

The long-term evaluation showed that all fully developed guides have been established in the organization according to Kotter's final step for successful change (Kotter, 1996). They are used as personal reference documents and introduction material, but also as an introduction and presentation of material to use and discuss with others. These results are very positive and relevant, considering the need for enhanced communication and supportive learning tools to manage the personnel turnover and expansion of the Department.

The results show a contradiction regarding the amount of information in the interactive modules – some users considered it adequate and some wanted more of it.

Considering the comments and challenges to update and provide accurate information, it is important to be clear about the level of detail in the guides. If they are to be complete, the amount of information provided has to increase. It is also important to have a well-functioning system to handle updates. However, if the amount of information were enough in most cases, it would be acceptable to refer and link to additional documentation for further and more detailed information. The purpose and references in some guides are stated on the first page, and in some not. One step to clarify the guides would be to have a somewhat standardized first page where the purpose and context of usage is stated.

In general, there are benefits with animations over static pictures, according to Höffler and Leutner (2007), especially under certain circumstances. This study indicates that a participative approach guides designers in choosing a suitable form of visualization. The long-term evaluation reveals a particularly important aspect for industrial companies – fast and easy updates of visualized information. As a result, one of the interactive modules was to be replaced by a condensed, static document because the ease of updating outweighed the potential positive learning effects, and the information was not considered complex enough to motivate an interactive module. It would be most interesting to evaluate this replacement for further recommendations considering the approach and design of guides in industrial companies.

There were also some contradictions regarding the ease of access to the modules via the Web site, but the overall results indicate that the accessibility should be improved. How this should be accomplished will be the result of the ongoing discussion of how to distribute the guides and who should have access.

5. Conclusions

The study shows that a successful approach to designing a visualization process integrates the human-centered design process (Figure 1) with the PDSA (Deming and Kilian, 1992) cycle as well as Kotter's (1996) eight-step process for successful change in organizations. This approach proved to be a successful framework to design the transformation of well-constructed illustrations in interactive guides, communicate and convince managers and users of the potential of the concept, develop a number of different well-functioning guides and establish regulations with illustrative elements and interactivity in a long-term perspective of an organization.

The visualized and interactive guides have proved to be applicable in a variety of product areas at IKEA, with a potential for further dissemination. The interactive guides work well as reference documents and introduction material for individuals and in discussions. However, the challenge is to meet increasing demands for fast and reliable updates as the information gets more specific.

It is important to find a suitable level of complexity and detail in the visualizations. This study shows the significance of a participative approach with short- and long-term evaluations to confirm the potential values and clarify needs of improvements. It is likely that the approach to designing and visualizing regulations presented here could function in other branches. It would be of great interest to follow-up the usage of visualized regulations throughout the organization to clarify how communication and quality are supported in design and production processes. Such information can help to enhance the design process of visualized regulations.

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