"By the people, for the people":
Can People Really Design Their Own Information Systems?

Mika P. Nieminen

Helsinki University of Technology TKK, Department of Computer Science and Engineering
mika.nieminen@tkk.fi

Abstract: This paper describes a year in a design project; the objective of this project was to create a concept for a next generation Enterprise Resource Planning (ERP) system. Over the course of the project, the existing system's users were enticed to specify their needs and requirements, to create new designs to remove unsolved problems, and to evaluate and enhance a prototype of the new design. The goal was to enable people who were unfamiliar with information system (IS) design to improve their current work processes and tools and to produce new creative design solutions for the future releases of their information system. Traditionally, user-centered design (UCD) processes involve studying and analyzing users in order to enable the designer or researcher to create a new improved design. In this project, however, we encouraged the users to become active participants in creating the contents for the new design artifacts, and our roles (the designer and researcher roles) became more editorial. The seven guidelines for design science in information systems research, from the seminal article by Hevner et al., are used as an analysis framework to recount the various aspects of the user-generated artifacts and user involvement. In the end we argue the potential and observed success of information systems designed by their users.

Key words: User-Centered Design, Concept Development, User Involvement, Idea Generation, Paper Prototyping, Information System Design.

1. Introduction

1.1 Context, Goals and Stakeholders

Modern day manufacturing seeks efficiency and cost savings through better management of production knowledge and processes [1]. A crucial part of this effort is better and real-time control of the entire production process, from initial customer contact to the last billing transaction and after-sales support. The massive information systems designed for this task are called Enterprise Resource Planning (ERP) systems. Similar to desktop text editors, which have evolved to complete publishing systems, the current trend of ERP systems is towards internalizing an increasing number of functions outside of the systems' previous focus on purely manufacturing-oriented functions. These extended features include customer relationship management (CRM), product data management (PDM), project management (PM) and support for more service-oriented business models, for instance maintenance activities.

All of the major ERP vendors make large-scale customizations to the systems they offer to their customers, leading to a situation where almost every system in use is different. Also, the user groups using any ERP system are very diverse and include almost every role in manufacturing, from the sales personnel to production designers and managers, to factory floor workers and shipping and handling personnel. Many of these participants and roles have been outsourced to sub-contractors and components or services are acquired dynamically from competitive markets.

Due to their size and complexity, which has arisen from customizations and the extremely heterogeneous user groups, ERP systems are poorly rated on usability and user satisfaction [2]. Literature offers several paths to improve the situation, from task-based tailoring [3] to developing the system towards more equal collaborator with its users [4]. There exists an obvious necessity to more thoroughly understand not only the manufacturing processes, but the people performing the production tasks. User-centered design (UCD) is suggested as a cure for ERP implementation and adoption problems [5]. Eliciting user involvement in a system design effort has been shown to improve their attitudes towards the system and enhance its perceived importance and relevance [6], but potential gains pose challenges for the successful execution of the user-designer joint effort [7,8] or UCD's ability to answer the right question in the first place [9].

This paper describes part of a two-year project launched by a large Scandinavian ERP software vendor to create a new concept for a next ERP system planned for release in five to ten years' time. The vendor's current product is a market leader in its primary markets; however, based on customer feedback, it has been seeking improvements in the usability aspects of its system for many years. This project was the vendor's first larger-scale trial in UCD and using external design and research partners to assess, and assist them with the collection of, user requirements and in developing a new overall concept and product roadmap for its ERP product. Additional goals for the project included contributing in the short-term to the ongoing product development by introducing new features to a product release within a year after the project's completion.

In order to collect credible user data, the project invited four customer companies of the current system to participate as pilot customers and co-designers for the design research effort described in this paper. Two of the four participants were Small and Medium Enterprises (SMEs) while two were a little bit larger. The companies' areas of business varied significantly, including specialty vehicles and their components, protective constructions (shelters) and dental equipment, yet we found them challenged with comparatively similar problems relating to their current manufacturing practices and processes.

In order to obtain an unbiased external opinion, we included in the last user episode (prototype testing) one company that utilized a competitive ERP system; this company's employees were able to provide a fresh view on the prototype system since they were not familiar with the functionality of the system being enhanced.

1.2 User-Centered Concept Development Process

The project loosely followed a process model for user-centered concept development [10], a branch of UCD specifically targeting new product development. This process has been successfully applied to various projects

(for example, see [11]) and includes five phases: 1) Project commitment; 2) User/technology research; 3) Innovation sprint; 4) Concept creation and validation; and, 5) Project assessment.

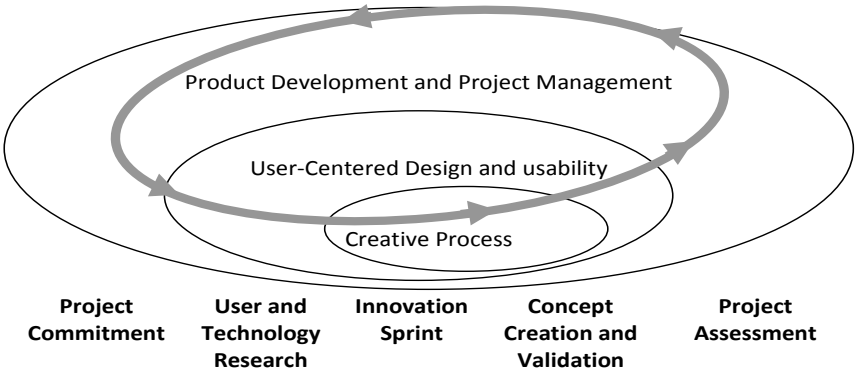

Figure 1. Phases and aspects of user-centered concept development

Error! Reference source not found. illustrates the nested nature of these five phases. The outer-most shell of managerial functions embeds a user-centered approach and methodology, with the more elusive creative process in the middle [12]. In this paper, we address only the three parts of the process that have active user involvement. Contrary to traditional UCD practices [13], as well as our earlier use of the process [11], we did not, in this effort, set out to understand the users' needs in order to be able to design the new improved system; instead, we tried to make the actual users of the system do all the "heavy lifting" in creating the content for the new system concept. Our role as researchers became more editorial, even though our actual workload was several orders of magnitude heavier. We collected and distilled the user feedback and proposed the condensed observations back to the users to stimulate their next steps in defining their ideal ERP system. The research team inevitably inserted bias into the results during the qualitative analyses; however, the only design choices that did not arise directly from users were the standard *graphical user interface style guide* and the concept and visualization of the *DataNavigator* (more on these in Chapter **Error! Reference source not found. Error! Reference source not found.**).

2. Introduction of the User Episodes

2.1 Defining the Design Themes

The user involvement in the design of the next generation ERP system was organized into three phases during the summer 2008, autumn 2008 and spring 2009. In the first user episode each of the four companies' backgrounds and organizational aspects were studied using dialogical methods (for example, see [14]). Half-day workshops were attended by a total of 42 people, not counting the researchers. The topics included change management, challenges of international projects and aspects of manufacturing and product knowledge specific to each company. The discussions were transcribed and comments relating to information systems or work practices were organized into five themes using affinity diagrams [15]; these were to be taken back to the companies for idea generation. The proposed themes were: 1) Securing all *communications* into the system; 2) Availability of *documents and tools* in the system; 3) Improving visibility and traceability of *changes;* 4) *Fragmentation* of information within the system; and, 5) *Trust* towards the system and (real time) accuracy of its data.

2.2 Idea Generation Workshops

The second episode was the idea generation workshops. One workshop was held jointly for two companies, and two companies each had their own workshops. Each workshop was attended by five persons from the pilot companies as well as two researchers and two silent observers from the ERP vendor. After first verifying the acceptance of the proposed themes (a pre-selection of three of the proposed five per company) and defining their own problem statement, the participants used three well-reputed creative problem solving methods to generate ideas for the development of the new ERP system concept. The methods used were classical brainstorming [16] with some additional rules [17], Method 635 [18] and "Six Thinking Hats" [19]. All idea-generation methods were executed in forty minutes, while the theme discussions were given fifty minutes. The resulting ideas were rated openly by each participant after each session by distributing ten markers to the best ideas. The results of the workshops are summarized in **Error! Reference source not found.**. For further details see [20].

Table 1. The number of ideas generated in the idea generation workshops

		Quality*				
Workshop	**Quantity**	**Selected**		**Rejected**		**Implemented****
		n	**%**	**n**	**%**	
A						
Group discussion	17	13	76 %	2	12 %	9
Brainstorming	39	25	64 %	3	8 %	7
Method 635	54	27	50 %	1	2 %	10
Six Thinking Hats	20	9	45 %	5	25 %	3
Total	130	74	57 %	11	8 %	29 (39%)
B						
Group discussion	7	3	43 %	0	0 %	1
Brainstorming	20	3	15 %	5	25 %	2
Method 635	50	31	62 %	5	10 %	9
Six Thinking Hats	16	11	69 %	0	0 %	7
Total	93	48	52 %	10	11 %	19 (40%)
C&D						
Group discussion	10	5	50 %	0	0 %	0
Brainstorming	21	15	71 %	1	5 %	7
Method 635	36	26	72 %	0	0 %	11
Six Thinking Hats	18	11	61 %	2	11 %	1
Total	85	57	67 %	3	4 %	19 (33%)
All workshops	**308**	**179**	**58%**	**24**	**8%**	**67 (37%)**

* as rated by a consensus of the system developers

** in parentheses: *implemented ideas* expressed as a percentage of *selected ideas*

After the three idea generation sessions per company, audio recordings were combed for ideas based on preset criteria [20]. An idea was defined as a verb-object phrase that represents a solution relevant to the problem statement. In other words, an idea expresses a thought in a meaningful, relevant and unique way. An idea was

considered unique if it had not appeared earlier during the workshop or it was not simply an elaboration of a previously stated idea.

The workshops produced a total of 308 ideas. Another two-day workshop was organized with the researchers and the ERP system developers to process the results. First, the ideas from each idea generation workshop were separately categorized using affinity diagrams and then rated by three developers into three main categories: 1) *Feasible* (approved for further study); 2) *Rejected* (unrealizable or out-of-scope); and, 3) *Implemented* (already partially available in the system or under development). In the analysis, the *Selected* category includes both the *Feasible* and the *Implemented* ideas because all of them were rated as suitable for development (either as a result of the current study or prior to it). Removing the ideas already under construction from the ideas that had been rated as feasible left a rather promising number of 112 new ideas (or 36% of all ideas) available for inclusion into future releases of the ERP. A longitudinal study to validate the actual adoption of the generated product features into the future releases is under preparation.

2.3 Prototype Evaluations

After removing the *Rejected* ideas from the results of the idea generation workshops, the remaining ideas were combined into 17 descriptions to outline the concept for the new system. The most notable new feature sets were: 1) offering a highly customizable personalized desktop for each user; 2) centralizing all production related communications into the system (away from emails and phone calls); 3) reclaiming the usefulness of alarms with more finely-tuned visualizations (color-coding, separation of must-know and good-to-know items); and, 4) making information that is embedded deeply in the data hierarchies more visible at the top levels. A paper prototype was constructed in order to evaluate the new features and the look-and-feel of the new ERP system concept. The new features and concepts could not be demonstrated using the current product. Due to the inherent complexity of ERP systems, the prototype could only cover parts of the system; therefore, we decided to make the paper prototype as more of a "show and tell" concept demonstrator to be presented to the users via preset scenarios and task sequences rather than allowing the users to use the prototype for their own tasks.

We opted to design the new ERP's graphical user interface according to rather strict compliance with the 2007 Office System style guide [21] and hoped it would restrict the designers' hands so that the users' original ideas would transfer to the concept as accurately as possible. One of the new topics that was suggested in all the workshops was the "need to see the connections between various objects in the production process"; however, as the users offered no clear indication of a possible solution, we made our own interpretation. This was the only main feature which did not directly originate from the users. We proposed a DataNavigator, a browsable, fisheye view visualization of the network of interconnected production knowledge objects. By entering the DataNavigator from the actual ERP system, the users could follow the trails of their customized production processes and safely, in a read-only state, find necessary information among the objects closely related to each other.

The paper prototype evaluation sessions were one and a half hours long, with one to three employees representing one work role (e.g. sales, product design, manufacturing, and logistics) at a time. Three companies

could arrange time for the evaluations and we held three sessions in each of the three pilot company, with total of 16 users. We also arranged a similar evaluation session with a company that used a competing ERP system; in this company, three users commented on the new concept.

First, the participants' memories were refreshed by recounting the earlier idea-generation themes developed in that company, followed by an approximately thirty-minute walkthrough of the paper prototype. The walkthrough covered the new user interface conventions and the new features, such as the personal desktop and DataNavigator. We had prepared a semi-structured interview, followed by a second opportunity for the users to see the various views and functions of the paper prototype, and allowed questions and comments during the walkthrough. The evaluation sessions were videotaped, and the user comments were later transcribed and categorized based on new features in the concept.

To our surprise, the paper prototype received an extremely positive, yet passive, response from the users. The overall appearance was appreciated, the new features were judged to be major improvements over the existing system and several users recognized their own earlier ideas within the paper prototype; however, the users could not be coaxed into offering criticism or comments of the paper prototype. The only clearly controversial new feature was the designers' vision of the DataNavigator. The concept of visually navigating the production data structures and forms had not been raised by the users during the idea generation sessions, causing it to be received with a mixed reaction during the prototype evaluations: half of the users saw it fit for novice users, or people seeking related information outside their own scope of work duties, while the other half simply dismissed it as unusable for themselves.

In our opinion, there are several reasons for the lack of critical user response towards the prototype:

1. The users were not able to form a clear opinion of the evaluated complex information system in a very limited time, as they could not use it themselves or apply it directly to their everyday tasks.
2. The presentation of a limited functionality paper prototype according to a preselected scenario had a very high task-selection bias [22]: we only showed features that were easy to use and were specifically adapted to fit the users' tasks.
3. The current ERP solution had received so much criticism that the users accepted any change as an improvement. This is emphasized by the dramatic change in the graphical user interface which was updated from the nineties' era Visual Basic forms (with several dozen separate windows) to a glossy Windows Office 2007 theme with a single desktop window with tabs and expanding/collapsing sidebars.
4. As many users identified their earlier contribution to the system design, they may have been reluctant to criticize their own, or others' ideas, to avoid embarrassing themselves or their colleagues.

3. Can People Really Design Their Own Information Systems?

In their seminal article, Hevner, March, Park and Ram [23] define seven guidelines for effective design science in information systems research. The guidelines crystallize the main aspects of design research, and at the same time present a good analytical framework to portray the various aspects of a design effort. The following sections

of this paper discuss the previously-described user episodes from the viewpoint of these guidelines. The guidelines offer different depth of insight into the various user sessions due to different maturity of the artifacts.

For the following recounting of the facts, it is necessary to clarify the three groups of active participants within the reported design case. Most importantly, the *Users* are members of the participating companies; their expertise is in manufacturing, business or leadership and not in IS design. Secondly, in the short-term, the project has worked within the limits and capabilities of the ERP *Developers* to assess and evaluate the technical, social and even philosophical aspects of suggested features for the new concept. Finally, the *Researchers* who selected the applied methods and facilitated the user involvement in the design process, gathered, summarized and edited the design decisions and activities, and ultimately produced the artifacts that are assessed in this chapter.

3.1 Design as an Artifact

Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation [23].

The first user episode produced a list of five design themes resulting from the *users'* challenges with their current ERP system. The second user episode produced 308 design ideas, of which 158 ideas, constituting 17 design candidates, were rated by the *developers* as usable in future product development. The third user episode produced a limited functionality paper prototype which enabled the user evaluations of features that would comprise the new concept.

3.2 Problem Relevance

The objective of design-science research is to develop technology-based solutions to important and relevant business problems [23].

The first user episode's design themes offered the *designers* an opportunity to plan and focus the subsequent steps on the most relevant problems for each participating company; this is implicitly also the most relevant development path for the *developers*. In the second user episode, the users produced new ideas directly related to those tasks, functions and problems that were most relevant to them in their everyday tasks, and they envisioned several solutions for previously unmet needs. The prototype evaluations did not contradict the suitability of the *designers'* and *developers'* offering to the *users'* tasks and therefore, ultimately, its contribution to the efficiency of the companies' entire production process. Note, however, that lack of evidence from the prototype evaluations prevents us from claiming that the design criteria were fulfilled; see the end of chapter 2.3.

3.3 Design Evaluation

The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods [23].

The design themes from the first user episode were valuated, adapted and committed to by the *users* at the beginning of the idea generation workshops. The generated ideas were rated by the *users* at the end of each idea

generation session and by the *developers* afterwards. The prototype was evaluated in accordance with the best practices of usability engineering [24] with 16 *users*.

3.4 Research Contributions

Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies [23].

We hope that the conclusions of this paper provide a contribution in the area of user-centered design, illustrating the advantages of including subject matter specialists into the core of new product development.

3.5 Research Rigor

Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact [23].

The *researchers* have utilized a well-established methodology for recording and analyzing the user studies and generating ideas to fuel the concept development. The *researchers* provided the other stakeholders, especially the *users*, ample opportunities to reflect and augment the results, and have plans to follow the future actions of the *developers* in a longitudinal study to document the implementation or rejection of the various features of the proposed new product concept.

3.6 Design as a Search Process

The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment [23].

The users committed themselves to actively search for the ideal ERP system design and utilize their invaluable subject domain knowledge to focus the design process and to evaluate the results. In the first user episode the *users* approved and committed themselves to the design themes derived from their individual production contexts. In the idea generation workshops the *users* literally searched for the ideal design, using both paradigm preserving and paradigm stretching creative problem solving methods.

3.7 Communication of Research

Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences [23].

The results have been critiqued by the *developers* from methodological, technical and business perspective and will produce an enhanced roadmap document that will be used as a guideline for the ERP product's future development. The *users'* representatives, acting at various levels of corporate and product management, have personally contributed to the design process and thus have become product champions for the new concept in their respective companies.

4. Conclusions

In this article we have asked and explored the question: can people design their own information systems? We have outlined the subject matter domain of production management and ERP systems, and proposed that our selected discipline of User Centered Design (UCD), more precisely User-Centered Concept Development, can produce new designs that cater to the needs of the users. We claim that the resulting concept development, and thus the new concept, is a contribution directly from the participating users. Of course, the ERP system's developers and the facilitating researchers managed the process and created all the artifacts (i.e. design themes, design candidates and prototypes), but the process that we used explicitly forced the users to approve and augment the results that were presented to them and thus, in the end, accept them as their own.

Did the people actually *design* an information system? We argue "Yes". From the end-user's perspective, the use and user experience of a product **is** the product. Although the users did not contribute to the technical architecture of the system and could not evaluate (nor at points appreciate) the difficulties with the implementation of desired new features, they did (in an informal manner) draw up the requirements, both for the contents and logic of the system and its new improved user interface. The fact that an expert in requirements engineering documented the results and that a programmer created the prototype does not remove or diminish the credit from the originators. This user-generated injection of effort and innovation does not make the design process any easier for the professionals; on the contrary, the researchers, designers and developers need to learn new listening, learning, and adapting skills instead of design, development and implementation skills.

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