Discovering Potentials in Enterprise Interface Design
A Review of Our Latest Case Studies in the Enterprise Domain

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Abstract: User interfaces in enterprise systems are primarily based on visualizations such as tables and forms, which are state-of-the-art since the middle of the 1990s. Additionally, most information is presented in a textual way and offers little capabilities to change the mode of presentation or the level of detail. The authors argue that these deficiencies are a major reason for existing usability problems related to the graphical user interface. Hence, this contribution presents four case studies, which aim to establish innovative visualization and interaction modalities in the field of enterprise systems.

1 INTRODUCTION

According to the worldwide enterprise software revenue of about $260 billion in 2011, enterprise applications are an important economic sector. (Gartner Inc., 2011) With regards to a survey conducted in Germany in 2009, ERP systems are used in more than 92% of all German industrial enterprises with more than 50 employees. (Konradin Business GmbH, 2009) These numbers give a first impression of the high diffusion rate of ERP systems and the resulting amount of users. Hence, existing usability problems – but also their solutions – would affect a broad user group and should be seriously taken into account.

However, latest research in the field of enterprise resource planning (ERP) has primarily focused on technological concepts to keep up with a steadily increasing complexity of business processes and the volatile market needs. Examples of these technological advancements are performance optimizations (Tertilt and Krcmar, 2011), service-oriented architectures (Seth et al., 2011) or cloud-based business applications (Ragusa and Puliafito, 2011). Therefore, it is not surprising, that ERP systems are primarily chosen due to their functionality, performance and migration aspects instead of usability and ergonomic criteria. (intelligent systems solutions GmbH (i2s), 2011)

In contrast to this technology-focused research and development, innovation concerning human-computer-interaction in the field of ERP is present, but significantly less considered. Whereas numerous research papers in the field of *user satisfaction* and *usability* have focused on the participation of users in the implementation process, top management support, self-efficacy or perceived usefulness of the system, the explicit investigation of usability barriers located in the graphical user interface (UI) is rarely discussed. Most of this research is focused on *Critical Success Factors (CSF)* to model user satisfaction (e.g. (Mitakos et al., 2011; Bin et al., 2010; Ozen and Basoglu, 2006)), but misses the explicit incorporation of the graphical user interface as a separate, influencing factor. Only few contributions are at least partially related to interface concerns. These papers identified critical deficiencies in the system usage, such as the identification of and the access to the right functionality, support in transaction execution, system output limitations, terminology and finally the overall system complexity. (Topi et al., 2005) Furthermore, user guidance, learnability and minimal memory load have been stated as important for the user-system collaboration. (Calisir and Calisir, 2004)

Although these findings date back several years, they revealed significant deficiencies in user interface design for ERP systems, that still exist today and which demand for further improvements in this field. Whereas the majority of current enterprise systems still utilizes modalities that are state-of-the-art since the middle of the 1990s (e.g. forms, tables, standard diagrams, mouse and

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keyboard interaction, cp. (SAP AG, 2012)), the potentials which arise from other domains – such as interactive and scalable visualizations or multi-touch and tangible interaction – are not considered so far.

On the one hand, this paper introduces the appliance of innovative visualizations instead of the established text-based information presentation. On the other hand, latest interaction modalities such as tangible and multi-touch interaction are applied to chosen enterprise scenarios. The authors argue that these concepts are able to significantly contribute to an intuitive system access and furthermore to ease the handling of enterprise systems.

2 CASE STUDIES

This section is dedicated to concepts and prototypes which have been created to mitigate existing barriers in enterprise system usage. In complement to the previously identified and UI-focused user needs from the related work, we conducted a survey of small and medium sized enterprises in a federal state of Germany. The 58 participants were belonging to several industry branches such as automotive, chemistry or mechanical engineering and used their ERP system for purposes such as article management, customer data or storage management. In this study, we investigated several user interface aspects such as *task-oriented visualizations*, *views for detail and overview*, *faceted browsing and semantic search*, *3D views on processes and facilities* as well as *multi-touch devices.* (Lambeck and Leyh, 2012)

The survey revealed that a major problem exists in the insufficient availability of *task-oriented visualizations*. This category includes the representations of enterprise information in a visual way in contrast to the primarily textual form known today. Thereby, the visual appearance allows for an advanced comprehension of temporal or topological correlations of information sets. The marginal availability of alternative visualizations in current ERP applications might be one of the reasons for the high responsiveness.

Similar, but less significant results have been observed for the paradigm of *detail and overview*. Users wish to adjust the level of detail according to their needs, which are driven by the experience and knowledge as well as the current task. Existing ERP systems seem to support this feature inappropriately, as they permanently offer a fixed and detailed view on the information space. The remaining aspects of *faceted browsing and semantic search*, *3D-views on processes and facilities* and especially *multi-touch devices* received significantly less popularity.

The following section presents concepts and prototypes, which address the aforementioned aspects. The case studies cover scenarios in the fields of manufacturing, real-time supply chain management (RT-SCM), advanced planning and scheduling (APS) and finally mobile business intelligence (BI). Each concept utilizes advanced visualization and/or interaction capabilities.

2.1 Graph-based Scheme

The bill of materials (BOM) is a central element in manufacturing-related ERP systems and lists all materials, resources and operations, which are needed to fabricate the final product. The BOM seems to be very appropriate to illustrate the dependencies of the final product, its required raw materials, their intermediate goods and the conjunctive operations in a visual manner. As a basis for the following concept, documentations from student workshops were taken into account. Herein, students from a business informatics course had to solve specific tasks in a productive case study. As a result, textual instructions and screen casts had been created that acted as an indicator for potential usability problems for this concept. The demand for user guidance could be approved as a major challenge in this scenario. During the analysis of the textual protocols and the corresponding videos, the following problems have been observed:

- several (obviously unrelated) windows are opened simultaneously, which caused confusion
- awareness of the current workflow status is missing
- incorrect production orders due to missing transaction summaries
- aspect-oriented views to support the user's process comprehension and awareness are missing (e.g. for time, cost, progress and availability)

To address these issues, a prototype has been created that offers a visual and interactive BOM. Hence, all information of the manufacturing order is accessible via the BOM. Thereby, it can be used as a central entry point to guide the user to the underlying and more detailed system forms. In contrast to current tabular presentations, the concept offers an interactive graph showing the dependencies via edges, availability information via a colour scheme and an adjustable level of detail. Furthermore, three information views for time, cost and progress are

offered, which can be combined as desired. Although the interactive BOM is still in a prototypical status, it indicates first potentials of task-oriented visualizations and a concept for detail and overview. The three different views of an exemplary BOM are illustrated in figure 1.

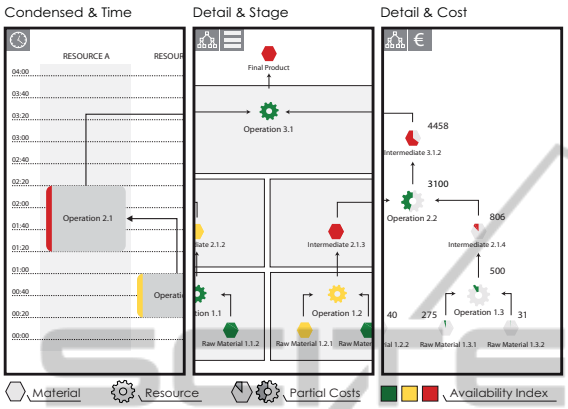

Figure 1: Concept of the interactive bill of materials showing three different levels of detail (Lambeck, Kirchner, et al., 2012).

2.2 Spatial Data Landscape

Many business processes, which are currently still characterized by linear step-by-step dialogs, are going to change to interactive and simulation based approaches. (Lambeck, Schmalzried, et al., 2012) This allows for the introduction of new interface concepts in the field of Supply Chain Management (SCM). The proposed dialog structure of this concept is as follows:

After the adjustment of initial calculation parameters for an overall optimization objective (e.g. maximized profit margin, minimal profit margin with restocking, meeting delivery dates), the system generates a whole result set at once by utilizing up-to-date multi-core and in-memory architectures. Afterwards, the emerging set of planning alternatives is jointly presented in a summarized visualization in the form of a data landscape as illustrated in figure 2. Previous concepts use a series of forms in a sequential user dialog to present the resulting schedules. The major benefit of the data landscape is an explicit and direct comparability of the calculated planning alternatives. Whereas conventional systems usually illustrate the simulation results in a tabular manner, the data landscape approach has the ability to give an impression of the result set's quality at once. Each peak represents a concrete production plan, whereas plans with similar properties can be found within the same area of the landscape. The height of the peaks is determined by *Key Performance Indicators (KPI)*, which illustrate the production plan's degree of optimization objective fulfilment. For the refinement of selected and promising production schedules, the user selects the desired region of interest (cp. figure 2, cyan rectangle). The results are getting more and more accurate from one iteration to the next and the user is continuously approaching the most suitable plan.

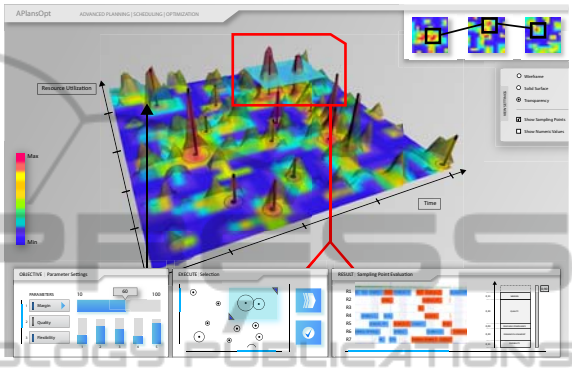

Figure 2: User interface of the SCM system with spatial data landscape (top) and detailed planning schedule (Gantt-chart, bottom right) (Lambeck, Schmalzried, et al., 2012).

2.3 Tangible Floor Plan

Nowadays, production planning is customarily based on spread sheets supported by planning and simulation tools that are limited to textual or diagram output. (Gissrau and Rose, 2011) Some tools visualize the planned tasks as a Gantt-chart, but direct interaction is not supported. A user's routine production planning workflow basically consists of two steps: (1) planning of upcoming processes with the help of optimization algorithms and (2) handling of deviations or interruptions during runtime. The suggested user interface is based on a floor plan that depicts the machines at their topological positions instead of the conventional textual presentation (see figure 3, no. 1). The machines have incoming and outgoing connections to visualize the material flows with regard to the underlying manufacturing process. Current and upcoming tasks for selected machines are visualized in the interactive Gantt-charts beneath. On top of these views, and in addition to standard touch gestures, tangible objects on a tabletop system are used for selection and adjustment tasks (see figure 3, no. 6).

As soon as the user starts dragging a process in the Gantt-chart, he or she needs all relevant information about the resulting consequences immediately. The user's increased awareness of the

impacts is a crucial prerequisite for subsequent and expedient planning decisions. To prevent the user from constructing inconsistent states, the application supports the user by highlighting conflicts.

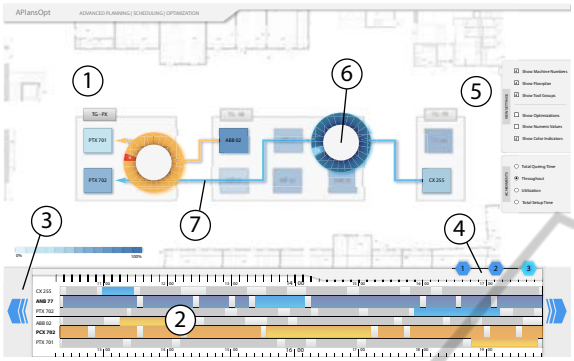

Figure 3: User interface consisting of floor plan with machines and tool groups (1), Gantt-charts of the selected machines (2), dialog control (3), dialog step indicator (4), visualization settings (5), tangible object (6) and material flow (7) (Lambeck, Kammer, et al., 2012).

2.4 Touch-enabled Mobile Dashboard

This concept originates from a workshop with an international car manufacturer and has focused on mobile business intelligence in the field of sales and marketing. To be successful in an oligopoly which competes for market shares, the financial provider has to differentiate its services. With the help of mobile business intelligence, service processes can be treated more flexible to meet the demands of a fast changing market and corresponding customer needs.

In this specific scenario, field managers are coaching their car dealers according to available contract types and disposal strategies. To assist the communication and to ease the traceability of the presented data (e.g. quarterly figures) a mobile solution has been prototypically implemented. It combines information from customers, contracts, staff and social communities to valuable mobile services. These services cover meeting preparation, performance analysis, forecast simulation, coaching and protocol management. In addition, peripheral services allow for status tracking and route management. All services are accessible through the start screen, which shows the main functional categories.

A first main function is the retrospective investigation of the business performance by revenue. The application starts to present the sales of the car dealership for a period of 12 month. If the user performs a zoom gestures, the resolution adapts to a more detailed presentation of several weeks. By zooming in again, a list of contracts for the selected week is shown. By clicking on one of the contracts, all details are presented.

The second main function is the simulation of a contract setting in a “what-if”-scenario. Herein, contract mixtures can be composed and templates for bonuses can be selected by directly interacting with the visualization illustrated in Figure 4. During the setting of interest rate, contract runtime and given bonus, the visualization is adapting and presents the final revenue. The solution is conceived for Tablet devices which seem to be appropriate in their dimensions to suit the needs of the scenario. In addition, the application uses multi-touch interaction with zoom, pan and slide gestures.

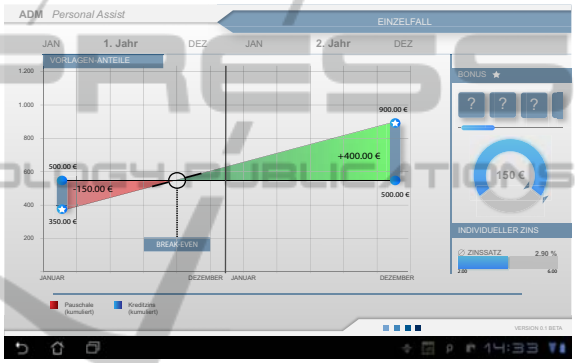

Figure 4: Screenshot of the sales and bonus simulation interface illustrating the effect of a bonus and the interest rate on the revenue according to the contract runtime (Lambeck, Jung, et al., 2012).

3 SUMMARY AND CONCLUSIONS

The enormous number of industry branches and users that are affected by usability problems in the ERP domain has illustrated the importance of this research. First motivated by insufficient research concerning the graphical user interface in the field of enterprise applications, relevant and related work focusing on usability and user satisfaction has been presented. In the subsequent section on promising case studies, we introduced prototypical concepts that aim to resolve at least some of the aforementioned usability problems. The benefits of the presented concepts cover:

- iteratively developing result presentations
- direct-manipulative visualizations
- tangible interaction for the simultaneous selection of objects and the adjustment of parameters

- topological object placement instead of tables with textual attributes
- strong visual correlation between topological and temporal information
- strong visual correlation between user actions and resulting consequences

The presented concepts are varying in their mentioned usage scenario, interaction modality and additional aspects. Figure 5 summarizes the prototypes according to their addressed user need, scenario, modality and UI capabilities. These examples give a first impression of innovative user interface solutions in the field of enterprise systems. Especially concepts addressing the *identification of and the access to the right functionality* as well as the *overall system complexity* (Topi et al., 2005) are fundamental to increase usability. As users are facing several barriers as briefly summarized in this paper, especially the methodology of accessing enterprise information should be renewed by appropriate concepts. Whereas most of the experienced users learned to use their ERP system by attending time and cost consuming trainings and their daily work over the years, especially inexperienced users are still facing those problems. In addition, primarily small and medium-sized enterprises are affected, as they often have less knowledge in application usage and cannot afford a dedicated expert in this field. By utilizing visual metaphors and reactive interfaces prior to textual tables, forms and menus, a significant improvement in ERP usability could be achieved.

However, multi-touch and tangible interaction have been stated as less important in our local survey (see section 2). One of the reasons for this result might be that users are familiar with keyboard- and mouse-based interaction and do not have exhaustive experience in handling touch-enabled devices. Hence, the resulting benefits of such a technology can be hardly estimated by the users themselves and might be misunderstood. Therefore, it is increasingly important to offer concrete and adequate prototypes, which are able to illustrate the additional benefits and support the confidence building in the new interface design. With the help of the presented prototypes, the usefulness but also the inadequacy could be identified in a user study by qualitative and quantitative methods

4 FUTURE WORK

Since our regional usability study from 2011 demonstrated that interface-related problems in ERP still exist (cp. section 2), we currently conduct an extended survey which is focused on the graphical user interface and its interaction modalities. Our major research questions are dedicated to mobile devices, user guidance and the habits of private IT-usage. To obtain a broader insight and deduce more significant results, the study will focus on multiple European countries, which currently involves Austria, France, Germany, Latvia and Poland. Thus, regional differences could be taken into account to

	User need	Scenario	Modality	Drill-down capabilities	Visualization capabilities	Guidance capabilities
1 **Graph-based Scheme**	Task-oriented Visualizations Detail and Overview	Manufacturing in ERP systems	Desktop Mouse & Keyboard	3 Levels: - condensed - prouct. steps - details	Graph with enriched status nodes with filling and color scheme	Implicit / random - nodes can be selected to display the details (related ERP form)
2 **Spatial Data Landscape**	3D Views on Processes and Facilities	Decision Support & RT-SCM	Desktop Mouse & Keyboard	2 Levels: - data mountain - production schedule	Free zooming data landscape with color scheme to indicate optimum	Explicit / sequential - stepwise from parameter input to schedule presentation
3 **Tangible Floor Plan**	Task-oriented Visualizations Multi-touch Devices	APS & Manual Scheduling	Desktop & Mobile Multi-touch & Tangibles	2 Levels - floor plan - production schedule	Floor plan with color scheme to indicate objective fulfillment	Explicit / sequential - stepwise from parameter input to schedule presentation
4 **Touch-enabled Mobile Dashboard**	Detail and Overview Multi-touch Devices	Mobile Business Intelligence for Sales and Marketing	Mobile Multi-touch	4 Levels - year - month - week - contract	Direct-manipulative diagrams for interactive and visual drill-down	Explicit - categories as entry point on start screen - breadcrumb

Figure 5: Classification of the presented concepts according to their user need, scenario, modality and UI capabilities.

offer enhanced and region-tailored solutions. The presented prototypes can make a valuable contribution to illustrate the potentials of new interface and interaction paradigms.

The findings of future user studies combined with the approaches presented so far have to converge to an integrated concept to ensure the adequate consideration of usability concerns in the software development workflow. By offering a concrete usability standard or guideline for ERP, that goes beyond abstract engineering standards such as (ISO, 2013), the sustainability of usability concerns in the field of ERP can be improved.

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