Changing Concepts in Human-Computer-Interaction in Real-time Enterprise Systems

Introducing a Concept for Intuitive Decision Support in SCM Scenarios

Christian Lambeck[1], Dirk Schmalzried[2], Rainer Alt[3] and Rainer Groh[4]
[1]*Technical University Dresden, 01062, Dresden, Germany*
[2]*OR Soft Jänicke GmbH, Geusaer Str., FH, 104, 06217, Merseburg, Germany*
[3]*University Leipzig, 04109, Leipzig, Germany*
[2]*Technical University Dresden, 01062, Dresden, Germany*

Keywords: Visual Business Intelligence, Business Analytics, Real-time Supply Chain Management, Decision Support, Radial Basis Functions, Scheduling.

Abstract: In current research, Enterprise Information Systems (EIS) are increasingly based on In-Memory-Technologies, resulting in extremely fast response times for a multitude of typical system requests. In addition, up-to-date hardware configurations apply multi-core processing units, which lead to an availability of immense computing power. Instead of a single result value, a whole result set is calculated within the same period of time. Because of these dramatic changes in technology, many business processes, currently still characterized by mask and dialog oriented user interfaces, will change to interactive and simulation based approaches. This allows for the introduction of innovative, interactive and simulation based business processes instead of conventional batch oriented ones. In the combination of the described interaction concept in this contribution and the handing of result sets as described above, the authors expect a fusion of operational (e.g. supply chain management) and analytical (e.g. business intelligence) application systems. To achieve this goal, the usage of assessment functions for weighting results, multi-dimensional result space folding based on similarity measures and visualizations using 3D-landscapes based on radial basis functions is suggested.

1 INTRODUCTION

Latest research on Enterprise Information Systems (EIS) and their underlying production methods has been manifold and primarily focused on performance and real time issues (Plattner and Zeier, 2011), Service-Oriented Architectures (SOA) (Ollinger et al., 2011) as well as sensor technologies. Especially the consistent vertical interoperability of these services and standards across the levels of automation (ISA, 2012) and the application of the *Internet of Things* to the production domain are current challenges (Kortuem et al., 2010). New production methods like modular 3F factories (Buchholz, 2010) as well as increasing complexity and dynamic of supply chain processes themselves reinforce the desire for extensive simulation enabled supply chain planning with a focus on varying input parameters and resulting outcome.

As a consequence of these changed conditions in production logistics and new objectives in the field of SCM a fundamental redesign of upcoming SCM systems is required. Especially rapidly alternating influential factors such as volatile raw material and transportation costs, volatile exchange rates and other volatile cost-influencing parameters have to be taken into account. In order to derive a reliable and suitable business conclusion, simulative "What-if"-scenarios are more important than ever and have to comprise these volatile parameters comprehensively.

By these risen claims, users demand for extensive simulation based planning tools. Their ability to vary input parameters and examine their effects on the resulting outcome reveals a powerful potential. Although simulative approaches in EIS exist, current state of the art systems fail to fulfill those requirements sufficiently. Since they were designed in the middle of the 90's, stringent hardware limitations had to be considered. In contrast, future RAM-based

Lambeck C., Schmalzried D., Alt R. and Groh R..
Changing Concepts in Human-Computer-Interaction in Real-time Enterprise Systems - Introducing a Concept for Intuitive Decision Support in SCM Scenarios.
DOI: 10.5220/0003984201390144
In *Proceedings of the 14th International Conference on Enterprise Information Systems* (ICEIS-2012), pages 139-144
ISBN: 978-989-8565-10-5
Copyright © 2012 SCITEPRESS (Science and Technology Publications, Lda.)

computers with Multi-core support enable the user to generate whole result sets instead of a single value in a fractional amount of contemporary time consumption. This trend allows the combination of operational and analytical processes. As a result, sophisticated answers for a variety of complex SCM problems can be given in almost real time.

Attendant to the increased possibilities in handling complex information sets, related user interface principles have to change accordingly. Nevertheless, user interface design principles in the field of EIS have been rarely subjected to research within the last years. While multi-touch devices and corresponding interface concepts are widespread in other domains as illustrated in (Lima, 2012), enterprise applications – especially in the upper levels of automation – are still dealing with transactional interfaces that consist of forms, tables and dashboards and are meant to be controlled by mouse and keyboard (e.g. SAP R/3 UI- History in (SAP AG, 2012)).

Due to the novelty of visual and explorative simulation and interaction techniques in EIS, related research on human-computer-interaction can be rarely found. This contribution proposes a user interface concept for the exploration of a three dimensional landscape consisting of sampling points. These “Data Landscapes” indicate a production plan’s objective fulfillment through *Key Performance Indicators* (KPI). Relevant challenges such as aggregated information presentation, real time interaction and their preliminary considerations on performance and algorithms are also addressed.

2 RELATED WORK

Nowadays, production and simulation related Enterprise Resource Planning Systems (ERP) – particularly in Small and Medium Enterprises (SME) – are customarily supported by Excel-sheets and are limited to textual or diagram output (Elizandro, 2008; Gissrau and Rose, 2011). The majority of these tools visualize the production plan as a Gantt-Chart, but direct interaction is rarely supported at all. In addition, adequate presentations which give an insight to complex correlations - like the simultaneous planning of material flows and the related resource consumption - are often missing. In general, offered visualizations are subjected to reporting in most cases, whereas wide parts of the business process remain textual. This might be one of the reasons for current usability problems as described in (Topi et al., 2005).

The research project Mind Map APS (DLR, 2010) assumed an upcoming fundamental change in the handling of enterprise applications within the next years. Therefore, the three aspects *Search Engine based System Access*, *Interactive Business Process Modeling* and *Zoomable User Interface Design* were taken into account to investigate their potentials. As a primary goal, users should be able to interact with the system more intuitively through map-based, interactive and scalable process visualizations. Although the estimated breakthrough could not be fully achieved, several prototypes were conceived which deal with 3D visualizations in oil industry, mobile process assistance for healthcare scenarios or semantic search paradigms to ease the user’s system access.

Real-time EIS based on In-Memory technologies allow response generation, which is faster by speed decades. Therefore, many business processes, currently characterized by sequential and iterative dialogs, are changing to simulated ones with parallel computations (Karnouskos et al., 2010). While ERP systems facilitate the concept of simulation insufficiently, additional Advanced Planning and Scheduling (APS) applications have been introduced (Stadtler and Kilger, 2008, p.109). The involved deficiencies that result from the split system landscape are different data models and potential import/export problems, time delays or problems while merging simulation alternatives with real plans.

3 BUSINESS PROCESS

The proposed design causes some challenges in the practical implementation. This primarily derives from the vast amount of data to be processed (storage issues), requirements on short response times (performance issues) and finally the novel interaction and its resulting user acceptance (interface issues). In the following, challenges regarding condensed data as well as real-time interaction on these consolidated information are discussed.

3.1 Benefits of Planning Processes based on Simulative Result Sets

To bridge the before mentioned gap in current systems, standard and sequential ERP processes could be redefined in a real-time EIS as follows:
After the adjustment of initial parameters for an overall optimization objective in a first step, the system generates a whole set of results at once. For the step of computation, optimization methods as

well as heuristics are applicable. The emerging planning alternatives are presented in a summarized visualization instead of a series of individual results in a sequential user dialog. The major benefit is an explicit and direct comparability of the suggested planning solutions.

The parameter variations in a production scheduling task might reach from different objective functions (e.g. maximized profit margin; minimal profit margin with restocking, meeting delivery dates) to additional restrictions (stock clearance, enforcing batch clearance). Thereby a combination of these restrictions is also possible, so that a composite and complex schedule optimization task is formed. Finally, specific production schedules arise which would be typically presented as Gantt-Charts. However, comparing those Gantt-Charts – or even a subset – is a challenging task for users and constitutes the sequential and iterative dialog structure mentioned before.

3.2 From Gantt-Charts to Key Performance Indicators

A more convenient way than traditional Gantt-Charts is the comparison of summarizing *Key Performance Indicators* (KPI) for each generated planning alternative, which again can be used to evaluate SCM objective satisfaction (e.g. quality, due dates, margins, flexibility and demand fulfillment). In most cases it is sufficient to choose the best fitting schedule out of the sample space and proceed with the business process. In other cases of composite result evaluation functions it might be helpful to investigate each component's impact on the composite KPI separately.

If none of the resulting production schedules satisfies the business needs or if all resulting objective functions are not satisfying, it could help to start a new simulation run with better parameterization. Therefore users have to slightly vary the parameters specifically in those regions where already promising schedules have been found. In consequence, the level of detail for this region would be increased by any of these iterations until the identified result is satisfying. To receive further reference points for regions of favorable schedules and to fully use the interactive and simulative potential of real-time EIS, a suitable visualization technique is required. In the following section, the established concept of Data Landscapes is presented and gets adapted to the field of EIS and SCM in particular.

3.3 From Key Performance Indicators to Data Landscapes

The authors suggest a projection of the generated schedules into a plane using folding algorithms based on similarity criteria. This plane uses T*ime* as one dimension and R*esource Utilization* as the other. Contrary to Gantt-Charts that use time and resource allocation as well, this plane cannot provide a specific time or resource predication. Instead it is able to illustrate the neighborhood and therefore the similarity of production schedules. Hence, similar schedules are projected closely to each other onto that plane which is caused by the multidimensional folding algorithm.

One appropriate method for neighborhood preserving multidimensional folding of production schedules are Self-Organizing Maps - so called Kohonen Maps (Kohonen, 2001) - known from neural networks. Each production schedule is uniquely defined by the set of contained production orders, which again define an unambiguous temporal allocation of resources and material flows. Thus, the proposed folding delivers reproducible nodes in the map.

This plane layer can be extended into a third dimension by applying an evaluation function on top of these nodes. The evaluation function typically results in KPIs to be used for measuring the fulfillment of the SCM targets. The resulting sampling points can be joined using radial basis functions, for example, to form three dimensional Data Landscapes (see (Carr et al., 2001)). Despite the suggested radial basis functions, equivalent construction techniques for Data Landscapes are also applicable, of course.

Besides a uniform evaluation function, the use of "*mountain stacks*" might be suitable, in which different parts of the evaluation function (e.g. separated by margin, demand fulfillment, deadlines) are added consecutively. This allows for weighting certain input parameters and also considering particular thresholds (e.g. all schedules reaching a certain margin).

3.4 Exploring Regions of Interest

In regions around a local maximum, probably more interesting production schedules can be found. By recalculating with slightly modified parameterization, the resolution of this designated area can be increased and the user might detect more interesting production schedules that are even closer to the current objective. Due to the suggested method, additional nodes will be located closely to the existing one with a high probability. However, the folding of those multidimensional schedules into a two dimensional plane cannot avoid the partial placement of sampling points outside the current region of interest. The following example illustrates the effect that might occur:

The proposed method as described above would create a landscape with 16 different sampling points (16 CPUs could deliver those simultaneously), which are distributed non-equidistantly across this map. We assume that there are two sampling points in region A and that their evaluation function (KPI) has a significant maximum here. Hence they represent promising schedules and deserve closer attention. A next recalculation run on the same region with slightly changed parameterization generates 16 additional sampling points. Due to the marginal modification of the input parameters, the majority of them would reside in this region, but some of them, as a result of the folding, might reside in a totally different region of the map. The resulting resolution has increased again and would allow for a third iteration. After three runs, 48 sampling points are distributed across the Data Landscape where most of them reside in the region of interest.

4 USER INTERFACE CONCEPT

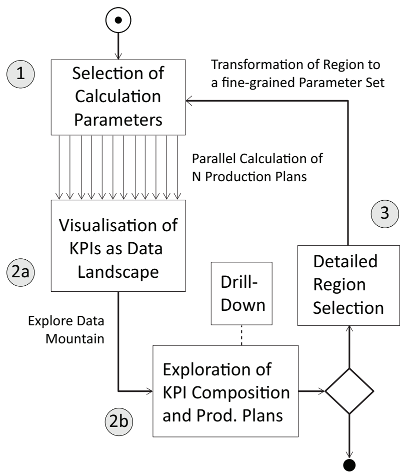

Figure 1: Business Process Dialog Model.

The preceding sections focused on the suggested business process with its benefits compared to the conventional approach. In this section, a concrete user interface concept is described, which is meant to be used on a touch-sensitive tabletop system. The described process is split into four steps as illustrated in Figure 1.

In contrast to most existing applications, the whole business process is controlled by a single view to avoid usability problems as described in (Topi et al., 2005) (identification of and access to the correct functionality, transaction execution support, overall system complexity etc.).

4.1 Selection of Calculation Parameters

As a first step, the user has to set the initial parameters (see section 3.1) which affect the selection of the simulation algorithm and adjust it according to the optimization objective. Therefore, parameters are selected in the lower left area of the screen (see Figure 2). On the right of the selection buttons, users are able to adjust the influence of a selected item by sliding the value between a minimum and maximum. Because the parameters partially affect each other, their final composition is depicted below the current slider. This way, users are always aware of the consequences during their direct manipulation. Once the parameters are selected and set as desired, the system generates the result set as described in section 3.1. Finally, a Data Landscape consisting of several sampling points gives a first overall impression of the result set's potential to satisfy the objective.

4.2 Result Presentation

Whereas conventional systems usually illustrate the simulation results in a textual 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 which is positioned according to the axis *Resource Utilization* and *Time*. Therefore, plans with similar properties in utilization and time can be found within the same region. The height of the peak as an indicator for the achievement of objectives is build upon the sum of its *Key Performance Indicators* (KPI, see section 3.2). This means, that each KPI corresponds to a particular SCM objective and represents its partial fulfilment. Hence, the parts for quality, due dates, flexibility et cetera add up to final height and form the overall KPI for that designated production plan.

4.3 Region Selection and Drill-Down

In a next step, users might want to explore a promising area in more detail – a so called *Drill-Down*. Therefore, a top view of the Data Landscape is illustrated in the middle part of the lower control view. To select a region, users simply create a rectangle

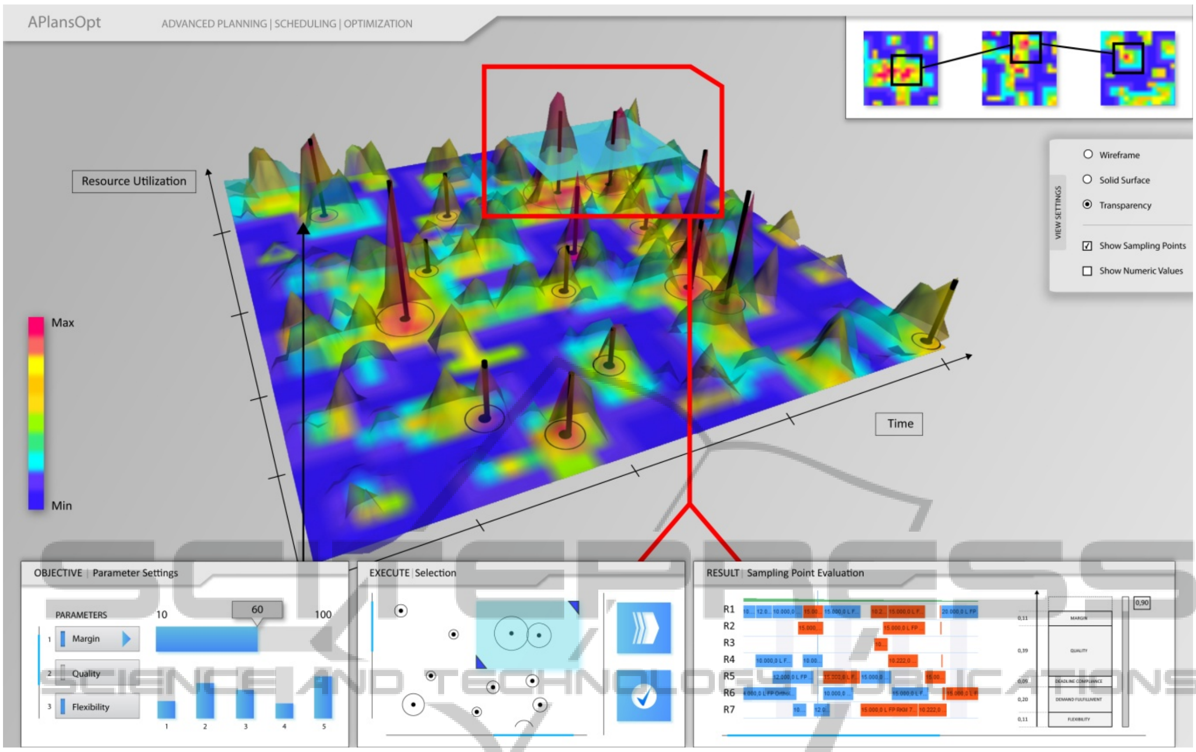

Figure 2: Suggested user interface concept with control views for parameter settings (bottom left: Objective), region selection with next iteration calculation (bottom centre: Execute) and Drill-Down with Gantt-Chart and KPI composition (bottom right: Result). The overlay indicates the Drill-Down from a selected peak to its KPI composition and the related production plan. The upper right series of snapshots illustrates the iteratively zoomed in regions in the manner of a detail-and-context. View settings (e.g. wire-frame, solid, transparent) can be adjusted in the options menu at right of the screen.

SCITEPRESS SCIENCE AND TECHNOLOGY PUBLICATIONS

and size it to the desired dimensions. Simultaneously, a plane with same dimensions is placed in the 3D model to highlight the current area and its included peaks. However, the selection of several independent regions is not possible at present. The details of the current selection are illustrated in the lower right part of the screen, where the KPI composition and the corresponding plan's Gantt-Chart are visualized. After having examined the area peak by peak, the former selection plane might be adjusted again to restrict or enlarge the amount of included sampling points accordingly. Once the identification of valuable production plans is accomplished, a further iteration can be started which is primarily focused on the selected area. As described in section 3.2, the initial parameters are getting slightly adjusted for the next run and influence the upcoming iteration. Although not all of the computed results might be located in the area due to the parameter adjustment, its resolution is permanently increased by each iteration. In the end, the selected region gets more and more fine-grained in detail whereas the surrounding region remains widely coarse-grained. If a satisfying production plan is found, the recursive workflow ends up by applying the final production plan.

5 CONCLUSIONS

The suggested user interface concept with its related adapted business process allows for the intuitive presentation of different production schedules and their corresponding KPIs. In addition, the comparison of these schedules as well as the iterative approximation to more promising production plans is supported in a visual way.

Changing the conventional usage concept of Enterprise Applications as described in this contribution could exploit the potential of novel real-time EIS. Business analytics, business intelligence and operational design would fusion and could form a comprehensive insight into simulative information spaces. The concept of planning is transferable to other domains of operational systems, such as blend optimization, make-or-buy decisions, variations on raw material costs as well as the strategic simulation of material portfolios, geographical locations or capacity extensions. For those domains, different simulative derived variations can be compared very rapidly and with ease. The approach of increasing a result area in resolution and its further exploration is therefore widely applicable.

6 FUTURE WORK

Although the described concept is still in a prototypical status, its potential benefits are already obvious. In further research and development, considerations on appropriate touch-sensitive hardware as well as user studies are planned. Especially the paradigm of Drill-Down with the help of multi-touch gestures on a tabletop system will be subjected to research in the future. Concerning the projection type for the 3D Data Landscape, a comparison of the current perspective projection and an isometric perspective seems to be reasonable. To support the comparability of peaks even more, the isometric projection might be more suitable. The upcoming user studies will evaluate the introduced concept by a survey with experienced users to state the major deficiencies. Due to the great demand for mobile solutions in EIS in general, further research will also have an eye on possible scenarios on mobile devices. With their numerous built-in sensors, new interaction metaphors are imaginable. One example might be the use of G-sensor abilities for suitable Drill-Down or refinement interactions.

ACKNOWLEDGEMENTS

Europa fördert Sachsen. ESF Europäischer Sozialfonds

Gefördert aus Mitteln der Europäischen Union

Christian Lambeck would like to thank the European Union and the Free State of Saxony, Germany for supporting this work. Special thanks are due to Thomas Lambeck and Frank Förster for their enthusiastic participation.

REFERENCES

Buchholz, S., 2010. Future manufacturing approaches in the chemical and pharmaceutical industry. *Chemical Engineering and Processing: Process Intensification*, 49(10), pp.993–995.

Carr, J. C. et al., 2001. Reconstruction and representation of 3D objects with radial basis functions. In *Proceedings of the 28th annual conference on Computer graphics and interactive techniques*. SIGGRAPH '01. New York, NY, USA: ACM, pp. 67–76. Available at: http://doi.acm.org/10.1145/383259.383266.

DLR, 2010. Mind Map APS - Project Fact Sheet. Available at: http://www.pt-it.pt-dlr.de/_media/ Infoblatt_MindMap_APS.pdf [Accessed December 12, 2011].

Elizandro, D., 2008. *Simulation of industrial systems : discrete event simulation using Excel VBA*, New York: Auerbach Publications.

Gissrau, M. & Rose, O., 2011. A DETAILED MODEL FOR A HIGH-MIX LOW-VOLUME ASIC FAB. In *Proceedings of the 2011 Winter Simulation Conference*. Winter Simulation Conference 2011. Arizona, pp. 1953–1963.

ISA, 2012. ISA | The International Society of Automation. Available at: http://www.isa.org/ [Accessed February 14, 2012].

Karnouskos, S. et al., 2010. Real-world Service Interaction with Enterprise Systems in Dynamic Manufacturing Environments. In *Artificial intelligence techniques for networked manufacturing enterprises management*. London; Heidelberg: Springer.

Kohonen, T., 2001. *Self-organizing maps*, Berlin; New York: Springer.

Kortuem, G. et al., 2010. Smart objects as building blocks for the Internet of things. *IEEE Internet Computing*, 14, pp.44–51.

Lima, M., 2012. visualcomplexity.com | A visual exploration on mapping complex networks. Available at: http://www.visualcomplexity.com/vc/ [Accessed February 10, 2012].

Ollinger, L., Schlick, J. & Hodek, S., 2011. Leveraging the Agility of Manufacturing Chains by Combining Process-Oriented Production Planning and Service-Oriented Manufacturing. In *Proceedings of the 18th IFAC World Congress. World Congress of the International Federation of Automatic Control (IFAC-2011), August 28 - September 2, Milan, Italy*. Elsevier Science Ltd.

Plattner, H. & Zeier, A., 2011. *Desirability , Feasibility, Viability – The Impact of In-Memory*, Berlin ; Heidelberg ; New York : Springer.

SAP AG, 2012. SAP Design Guild - R/3 History in Screen Shots. Available at: http://www.sapdesignguild.org/resources/r3_history.asp [Accessed December 2, 2011].

Stadtler, H. & Kilger, C., 2008. *Supply chain management and advanced planning concepts, models, software, and case studies*, Berlin : Springer,.

Topi, H., Lucas, W. T. & Babaian, T., 2005. Identifying Usability Issues with an ERP Implementation. In *Proceedings of the International Conference on Enterprise Information Systems (ICEIS)*. ICEIS'05. pp. 128–133.

SCITEPRESS SCIENCE AND TECHNOLOGY PUBLICATIONS