Dynamic Process Support based on Users' Behavior

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***Abstract*—Nowadays there is a gap between the possibilities and the massively existing data on the one side and the user as main worker on the other side. In different scenarios e.g. search, exploration, analysis and policy-modeling a user has to deal with massive information, but for this work he usually gets a static designed system. So meanwhile data-driven work-processes are increasing in its complexity the support of the users who are working with these data is limited on basic features. Hence this paper describes a concept for a process-supporting approach, which includes relevant aspects of users' behaviors in support him to successfully finish also complex tasks. This will be achieved by a process-based guidance with an automatic tools selection for every process and activity on the one hand. And on the other hand the consideration of expert-level of a user to a single task and process. This expert-level will be classified during each task and process interaction and allow the automatically selection of optimal tools for a concrete task. In final the user gets for every task an automatically initialized user-interface with useful and required tools.**

Keywords: process support, process management, process adaptation, user-centered interaction

I. INTRODUCTION

In the today's information society we consume most of the required information from the internet. In huge data-sources it is possible to search for needed or interesting information, no matter if that information will be just text or multimedia elements like videos. Furthermore it is possible to contribute to those data-sources. But the work with these rapidly growing data-sources becomes more and more difficult to find exactly that kind of information, which is really required. To allow a more efficient use, the research community developed various approaches for dealing with these existing massive data. Most of these approaches were well applied and allowing and effective and sometimes more interactive data usage. But for the users it is often difficult to use these different tools with its different user interfaces and different interaction metaphors. In consequence a user invests often more time in learning to use a tool than in working with it to solve tasks.

Therefore some established methods exist to reduce the gap between required learning times to use this tool. One of these methods is the implementation of the workflow visualizations. Workflow visualizations give an overview about the steps to finish a task. Another approach by supporting the user is to use adaptive visualizations, which changes the visual presentation of the visualized data elements in dependence to the user's behavior or in dependence of the data. The current existing approaches are reduced on a limited number of these supporting features and are static implemented. Whether an expert is using the system or a novice, the supporting tools are enabled for all these users in the same way. Also the selection of adequate tools becomes critical, an expert needs often more functions for working with the data than beginners. But the current approaches are not focused to combine the users' behaviors including their personal profile, with the actual to performing tasks to automatically select the required supporting features and the adequate fitting tools.

In this paper we present an approach and its implementation for a dynamic process support. In dependence of the user's behaviors and the user's background (like his expert level), the user gets conducted through a task-process, supported by automatically switched supporting features and the automatically selection of the most adequate tool for finishing the task successfully. The underlain task-process will be identified autonomously by activity recognition. So for instance, if a user tries to annotate a picture, the system detects the annotation process and the user's behavior from system interactions in the past. So it automatically detects that the user do not need the workflow visualization as orientation, because he is an advanced user and in fact he needs the expert annotation tools, too. So the conceptualized system adapts the user interface in dependence to the user and the current task.

II. RELATED WORKS

In the past decades several approaches were published with the goal of supporting users through their work on computer systems. One of the biggest changes towards useable computer systems for normal consumers was the introduction of graphical operating systems. This novel approach allows further spaces in supporting users through their tasks.

But the main challenge for system architects etc. is to understand the users' behaviors and furthermore what tools or approaches will help them to finish their tasks successfully and easier. To understand a problem or tasks in its complexity and the required supporting features, we have to categorize it first. Helquist et. al. [6] introduces two similar existing classifications (see Figure 1). Because of the analogy between the quality characteristics between business processes and software process, Gucegliogłu and Demiros [5] summarize that the measurable characteristics are valid vice versa.

This work has been carried out within the project FUPOL 287119: Future Policy Modeling, partially supported by the European Commission. The FUPOL project proposes a comprehensive and new governance model to support the policy design lifecycle. The innovations are driven by the demand of citizens and political decision makers to support the policy domains in urban regions with appropriate ICT technologies. The foundation of the visualization work is the SemaVis visualization framework develop by the Fraunhofer IGD (http://www.semavis.com).

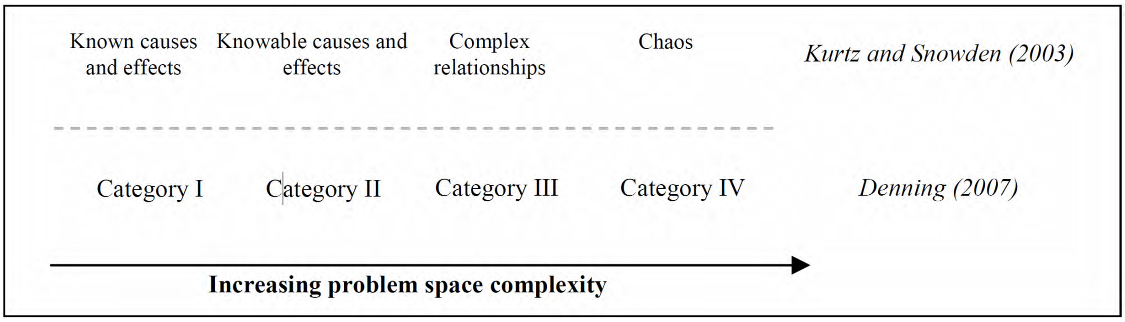

Figure 1. Illustration about the different classification for the complexity space (top) divided by Kurz and Swoden [10] into several named groups and (bottom) divided in categories numerically by Denning [3] (adapted from Helquist et. Al. [6]).

A. Processes and Workflows

A couple of process definitions exist, but most of them are focused on business processes only. But in scope of support users through software processes, we need a more technical one. In the past the application processes were in scope, because they differ not in their single activities and the entire goal, even more because of different orders of these activities. One of the areas where process-based approaches are used is during multimedia annotation. The annotation of multimedia elements can be performed with a set of tools, but often they have a different process with a different tasks order, so that many researches about workflows and process were applied in this area. One of the most influencing coalitions in this domain is the Workflow Management Coalition which often orients on annotation processes and they define processes as follow [16]:

"The representation of a business process in a form which supports automated manipulation, such as modeling, or enactment by a workflow management system. The process definition consists of a network of activities and their relationships, criteria to indicate the start and termination of the process, and information about the individual activities, such as participants, associated IT applications and data, etc."

Further they defined, that in general a process can be divided into a couple of sub-process. On the lowest level a process is defined through a number of activities, which the Workflow Management Coalition [16] defined as follow:

"A system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications."

Basing on these fundamental definitions it is possible to implement workflows in applications. The implementation of such workflow depends on the one hand on its level of specification. Therefore Bernstein [1] differentiates four categories between the range of highly unspecified and specified processes: (i) Providing Context, (ii) Monitoring Constraints, (iii) Planning Options Based on Constraints and (iv) Guiding Through Scripts/Directions. And it depends on the second hand of its planned implementations, e.g. is just a workflow visualization implemented or is there a fixed linking between a current activity and a for this activity enabled tool.

B. The User and the User's Behavior

In general we talk about human-computer-interaction, if a human work of action is coupled with the use of a computer [9]. So in fact next to the technical system with his technical elements and the software, the human as user plays an important role as well. In difference to technical systems, the users are able to think. So if a general tasks has to be solved, a human is able formulate it and also to define the required sub-tasks, where parts e.g. calculations can be performed by the technical system. To allow an effective splitting of work – in tasks which can be performed by the system, and in tasks that are required to be done by the user/human – the interface between user and system must be useful. To determine a useful interface, the behaviors of the users have to be understood. But these behaviors depending on the individual user, some of them are domain experts on the one hand, but novices in using computers on the other hand. To allow a general classification of users, Nielson [12] defined a cube in which the user's behaviors can be classified (see Figure 2).

Basing on this classification cube, it is possible to define requirements to the technical system, especially the user-interface (UI). If the target user group is similar in their behaviors, just a single UI has to be designed. It becomes more difficult, if the target user group consist of various user types with different behaviors. Therefore an approach is recommended, which adopts the UI (automatically or manually) to the current user type.

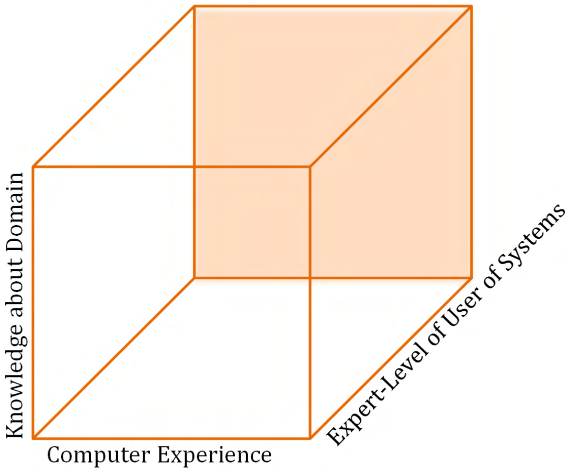

Figure 2. The users' behaviors can be categorized by the three dimensional model of Nielson [12], which considers the computer experience level, the level of knowledge about the domain and the experience level with the system.

C. *Interaction and Navigation Support*

To consider the different kinds of users' behaviors and different application and interaction processes it can be useful to use interaction and navigation supporting approaches. These techniques allow a more effective and efficient work with computers and reduce the risk to get "lost in data space". Especially in the work with massive data and a free interaction that is less restricted to a topic or limited in the provided tools it can become harmful, because of leaving the critical path to solve a task quickly. Predestinated scenarios are analytical tasks, e.g. finding gaps and problems in existing data or exploratory tasks like they are typical used in the semantic web for gathering an overview about certain domains or topics. To avoid such a divagation from the planned work, the user needs a kind of notification, which keeps him on track to his tasks. The approaches for that can be categorized and are listed in [2]. The usually used approaches are (i) Guidance and Wizards, (ii) Personalization and Adaption and (iii) Hints and Highlight.

Guidance and Wizards are appropriate to guide a user through difficult process steps. Wizards are an easy way to guide users through a process [14]. The idea is to collect required inputs and information on just one page in correlation to a specific theme. The process is mostly fix defined and allows no or just a minor variation. In general wizards are implicitly implementing a workflow representation internally. Workflows as a technical representation of business processes are a continuative approach, which usually also provide a kind of workflow visualization [7], where the goal of performing tasks is omnipresent for the user. Basing on the workflow, also the provided toolset can be adopted basing on the current step within a workflow.

Another possibility for supporting users in relation to the processes is using Personalization and Adaptation approaches. In focus to semantic technologies, these approaches can be subdivided into three types [15]. The first is Adaption of content and recommendation and aims to highlight entities which fit best to the user e.g. basing on the deviation of the entity names in perspective to a search query. The second option is Adaption of structure and presentation, which encompasses the customization of the data structure as a kind of menu. Therefore hierarchy of the structure can be changed by sorting, hiding, visualizing, enabling and disabling the existing concepts. The third approach is Adaption to support annotation, which is often realized by tagging and the user get the possibility to get content which is tagged by other users in correlation to his own often used tags.

If just a specific object or single information is relevant for a user, it can be focused to bring it in scope of the user by Hints and Highlight approaches.

III. CONCEPT FOR DYNAMIC PROCESS-SUPPORT

The approach we present aims to couple the existing process-driven with the user-driven approaches. This enables the users on the one hand to work more effectively and efficiently related to a process. On the other hand the human factors will be considered insofar as the users can work in an environment they understand and they can control. Most of today's existing systems possess a fair amount of functionalities, but the user is not able to find or use them, because they are not appropriately presented to the users so that he is unable to use it. On this account we have developed a concept which aims to consider the human factors in relation to the process-driven support.

A. *Process-oriented Approach*

Our process-oriented approach bases on an adaption of the required tools to a particular task within a given process. It is close to the general definition and the idea behind adaptive hypermedia systems as it is formulized by Jamson [8]:

"A user-adaptive system is an interactive system that adapts its behavior to individual users on the basis of processes of user model acquisition and application that involve some form of learning, inference, or decision making."

Zimmerman et. al. [17] defines it more general and categorizes the process aspects etc. as context factors:

"An adaptive system (contextualized or personalized or both) follows an adaptation strategy (e.g., pacing or leading) to achieve an adaptation goal (e.g., intuitive information access or easy use of a service). To achieve an adaptation goal, it considers relevant information about the user and the context and adapts relevant system components on the basis of this information."

To analyze the context aspects or more precisely the process status, we developed a system [2], which commits every event to a central place. This allows for observation through a workflow management module. Every event is internally allocated to a specific stage within a statically defined process – in most cases it is allocated to an activity, which is a stage that requires some interaction by the user e.g. text input. Based on the current task, the system automatically shows these tools, which are required to complete the task. In this phase the user's behaviors are ignored.

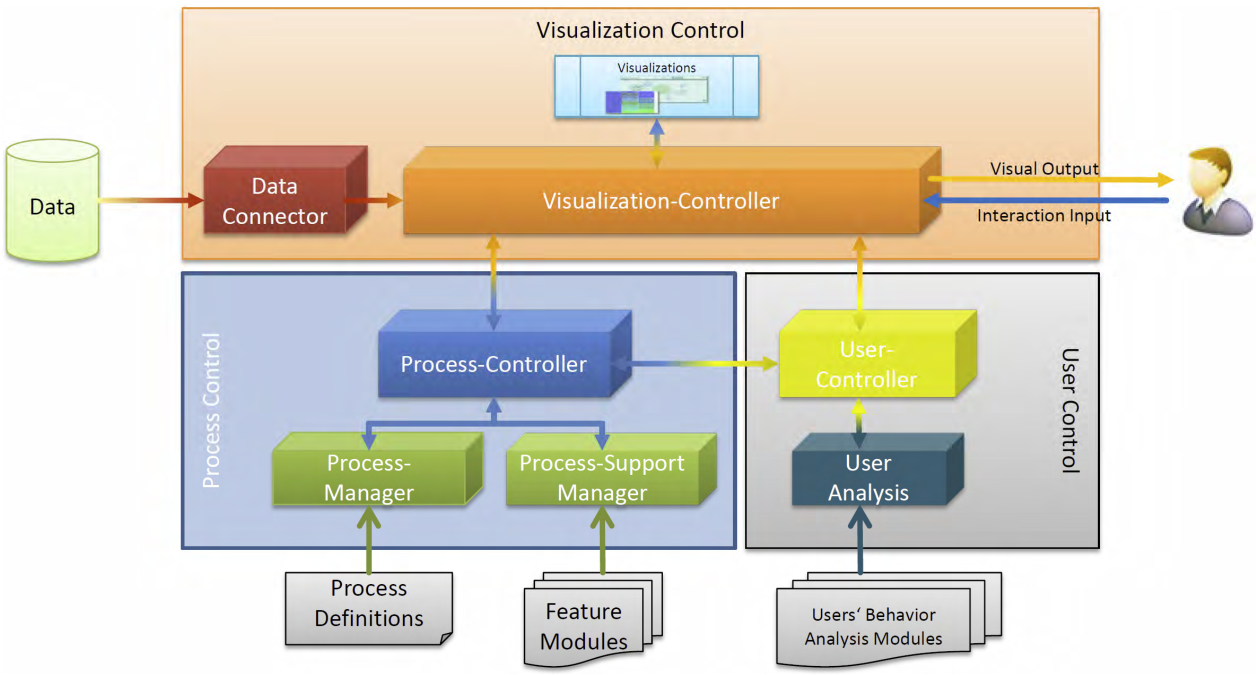

Figure 3. General Concept for an Dynamic Process-Supporting System based on the Users' Behavior. Therfore it allows the integration of Process Supporting Features, next to User Analysis Modules to achieve an user-driven process-support.

To improve the support of users, we extend our concept with rating-function of the user skills level.

B. The general Concept for a Process-Supporting System based on the Users' Behavior

The general concept consists of three main parts. The first is the visualization part, which main goal is to visualize incoming data. The second part is the process control part that organizes all issues around the definition of the process and the existing modules of process supporting techniques. In difference to our past presented approach in [2], we added a new part to allow considering the behavior of the users. Therefore, the user part is actively observing all interactions of the user and depending on the existing and enabled analysis modules the visualization will be adopted based on the users' behavior.

The main part for the visualization generation is the visualization control, which contains all issues to generate the graphical elements for the final view. The main components to compose visualization are (a) a data connector, which accesses the available data from a data-source - it can include a data transformation functionality to make the data compliant for the subsequent component. The second component, the visualization controller (b) organizes the mapping of the incoming data from the data connector to the visualization (c). To allow for an adequate processing it is recommended to implement a processing pipeline to ensure an optimal visualization of the data. The most established is the reference model for visualization from Card et al. [18], but there are also pipelines that support special kinds of visualizations and data e.g. the Semantics Visualization pipeline by Nazemi et al. [19].

The process support is than part of process control. This consists of two parts. The first is the process manager that is responsible for the organization of the existing processes. The processes need to be defined first, but it can also be integrated within a learning system, which empowers the process generation during use. All processes, the links between them, and also the activities of the processes need to be organized in this module. The second part is the process-support manager, which organizes all implemented process supporting features (an overview to the general techniques was given in chapter III). To support the user, the process-controller is collecting context information e.g. which is the current process and activity. Based on that information, the controller decides which process supporting type is appropriate for the current process, respectively the current task.

The third component, the user control, is a new part in the concept. The user controller's task is to observe all kinds of interaction from the user. The user analysis component includes the user analysis modules, in which the concrete algorithm implements the user's behavior characterization. The analysis algorithms aim primarily to identify the user's domain knowledge, the user's computer experience, or the user's expert-level for the system. These three main characterizations follow the user classification of Nielson (see chapter 2.B for Nielson's three-dimensional user classification). Through the user controller the analyzed behaviors will flow into the process-control e.g. to include them for the selection of an adequate process-support feature, or it can also influence the visualization directly e.g. if a color-blindness is identified, the color range is reduced to shades of grey.

For most scenarios, the adaption is above all, collaboration between process- und user-control. Furthermore, the primer adaption is processed in the process-control, because the adaption relating to a performed process is the main approach to guide the user more adequately through a given task. The influence of the user's behavior is an additional form to adapt the visualization and hence to also adapt to also personal requirements of the user. Just for a small number of exceptions it is also planned that the user-controller can directly influence the visualization processing. One of these exceptions is the adaption of the color range for color-blind handicapped users, because it is a strong restriction for the user and has a global influence among all available tasks and processes.

C. A User-driven Process Model

The challenge in modeling a user model is to define the relevant issues that influence the model in relation to the activity within a given process. Therefore we identified the expected processes for our software: (i) search, (ii) exploration, (iii) analysis, (iv) annotation, (v) data editing and (vi) policy modeling. All these expected tasks are designed for normal users so that no special domain-knowledge is required. In view of the user-model cube of Nielsen (see section 2.B) we can safely ignore the domain axis. Furthermore, we plan to integrate all required functionality into a single application, which allows us to focus on a single axis, namely the axis for the expert level in relation to the system itself.

Regarding the detection of the user skills level, we are orienting ourselves along the approach of Ghazarian and Noorhosseini [4]. For differentiating between novices and experts they evaluated a group of experts and novices for all available tasks. As task we can presume that they are very close to activities within a process and workflow respectively. After the evaluation, among others measures, the average time for a task and the number of interactions (e.g. mouse click sequence in specific time, total mouse move direction) can be extracted and a threshold between expert and novice group can be calculated. This gives the opportunity to classify new users and their interaction in one of these groups for every single task.

D. Adaptopting Tasks to the Users' behaviors

Under considering the trained user-model, it is possible to classify the user into three groups:

(i) A new user: This group encompasses all users who are using the system the very first time. Hereby the system has to create and train the user model. In general the new untrained model will automatically set as novice. After his first interaction under consideration of the interactions (e.g. total number of clicks) and in comparison to the threshold for a task, the user can be classified as expert or novice, but it will just has an effect, since the task will be performed a second time.

(ii) A know user, but a new task: In case that the user is performing just one task for the very first time, but in the past he had worked on other tasks, the classification results of the other tasks can be considered as initial classification status. In our concept and implantation we define the user as expert, if the most absolved tasks in the past were classified as expert level – if not, he will initially defined as novice. Then the analysis of the user will be equal to (i).

(iii) A known user and task: Hereby a user-model does exist for him and for the task he is working on. In relation to previous classification results, those kinds of tools to a task will be shown, which are fitting to the user-classification. If he is classified as expert, he will see the expert tools with many configuration possibilities. If not, he will just see the simple tools with just a limited number of configuration possibilities. The interaction results will flow into the user-model to improve it.

In all the presented scenarios, the user will always get the possibility to switch manually between the expert and novice task-solving tools. This guarantees that the user will have total control about the system.

E. Adaptopting Processes to the Users' behaviors

Similar to the adaption of tasks, we also adapt the process to the users' behaviors. The idea is to reduce process with tasks, which will not be required in focus to the expert level of a user. Usually novices are not able to handle complex task like they are existing in topics of policy-modeling [13] and data editing. Thereby to complex task can be run over. But it can also be useful to split a task, which can help novice users to haven a better overview about several steps. In contrast to novices, these split of a task can be confusing, so for them it could be better if the task will presented just as a single one.

We realize it by simply analyzing the ranking of the expert-level of the tasks within a process. If the major tasks are ranked for experts, then the process will be shown for experts. The adaption of the process will only be applied if all contained tasks were ranked, because it is harmful to adopt the entire process, if just a small number of performed tasks are ranked.

F. Additional Supporting Features

Next to the descried approaches, the system also supports additional supporting strategies, which can be enabled for the supported tools. In default the system decides for every task between experts and novices and selected that kind of tools, which will fits best. But it is also possible to select the same tool, but with a different setting. For instance, if the user is searching for special information he can use our technologies to comb through the data source – normally there is no difference between novices and experts. But for novices we developed an adaptive-visualization system [11], which can adapt the graphical primitives in the visualization to highlight entities in relation to the user's interaction history.

In general it is possible to add further process supporting techniques in dependence to the process, a single activity and to the user and his behaviors.

IV. USE-CASE: FUTURE POLICY-MODELING

The presented approach will be used to support decision makers in the creation process of policies in the domain of eGovernance. The policy modeling process counts as heterogeneous process, because such a process can be initialized at very different starting points. Some of these processes were launched by a suggestion from some political motivated stakeholders, but there are also starting points because of some kind of crisis e.g. high unemployment rate; in this connection the problem is that just the implication is known, but not the reason for it. Next to the different motivation for the need of a new policy, the analysis of the problem and expected solutions is complex and time consuming, and if the tools for performing that information foraging step are not adequate, the analysis can fail on the real issues.

In the European project FUPOL (more information about the project can be found at http://www.fupol.eu) the goal is to support decision makers in the policy modeling process with novel technologies that will help to identify challenges, risks and solution in a better way. To allow an adequate data analysis the tools needs many expert analysis functionalities to ensure the best extraction of knowledge of the data. However, this makes the use of such tools sometimes very difficult, so that users can feel an overload without an adequate support strategy. Therefore the presented approach in this paper addresses this aspect. But the decision makers who are going to use these tools are not experts in all possible analysis domains. Therefore it was required to develop the dynamic process supporting concept, which allows to consider e.g. the expert-level for a specific technique and allow a kind of personalized support.

V. CONCLUSION

In this paper we descripted an approach how the user-interface can adapted in relation to a current process-task and under consideration of the user's behavior. Additionally it is possible to extend the conceptualized system with additional supporting features like adaption or hints and highlighting techniques. We name it "Dynamic Process-support", because we enable to support the user in multi-dimensional way, but with the minor focus in process-orientation und consideration of the user's behaviors. However auxiliary dimension like the user's interaction history or the data characteristics can be integrated, too. In sum the users get personalized guided through complex application processes. It enables also to provide different degrees of interaction freedom, which allows an expert to do his job like he wants to do it, in contrast to a novice, who would be overstrained and requires a more stringent guidance through the process.

VI. FUTURE WORK

Currently we see a gap in providing the possibility to enrich the system with further functionalities, and the required effort for changing the process information in the background, because the editing of the process-data can be difficult, if all possible task-routines should be supported. But it is difficult to consider all scenarios where a function in an existing process can be useful. We expect that a generic process model which semi-automatically learns new processes and possibilities for combinations of tasks and tools can generate an important benefit. However, it allows that users can also contribute their expected opinion of what tasks are to do in which preferred order.

REFERENCES

[1] Bernstein, Abraham. "How can cooperative work tools support dynamic group process? Bridging the specificity frontier," in Proceedings of the 2000 ACM conference on Computer supported cooperative work (CSCW '00). ACM, New York, NY, USA, pp.279-288, 2000.

[2] Burkhardt, D., Ruppert, T., Nazemi, K. "Towards Process-Oriented Information Visualization," In Proceedings of ICL-Conference 2012, 2012.

[3] Denning, P. J. "Mastering the mess," In Communications of the ACM, 50(4), pp.21-25, 2007.

[4] Ghazarian, A., Noorhosseini, S. M. "Automatic detection of users' skill levels using high-frequency user interface events," In User Modeling and User-Adapted Interaction 20, 2, pp.109-146, 2010.

[5] Guceglioglu, A.S., Demiros, O.W. "Using Software Quality Characteristics to Measure Business Process Quality," In Business Process Management (BPM 2005), volume 3649, Springer-Verlag, Berlin, pp.374–379, 2005.

[6] Helquist, J. H., Deokar, A., Meservy, T., Kruse, J. "Dynamic collaboration: participant-driven agile processes for complex tasks," In SIGMIS Database 42, 2, pp.95-115, 2011.

[7] Hofmann, C., Burkhardt, D., Breyer, M., Nazemi, K., Stab, C., Fellner, D.W. „Towards a Workflow-based Design of Multimedia Annotation Systems," In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications, Chesapeake, VA: AACE, pp.1224-1233, 2010.

[8] Jameson, A. "Adaptive interfaces and agents," In: J. A. Jacko and A. Sears (eds.): Human-computer Interaction Handbook. Mahwah, NJ: Erlbaum, pp. 305–330, 2003.

[9] Johannsen, G. „Mensch-Maschine-Systeme". Berlin, Springer-Verlag, 1993.

[10] Kurtz, C. F., Snowden, D. J. "The new dynamics of strategy: Sense-making in a complex and complicated world," IBM Systems Journal, 42(3), pp. 462-483, 2003.

[11] Nazemi, K., Burkhardt, D., Breyer, M., Kuijper, A. "Modeling users for adaptive semantics visualizations," In Proceedings of the 6th international conference on Universal access in human-computer interaction: users diversity - Volume Part II (UAHCI'11), Vol. Part II. Springer-Verlag, Berlin, Heidelberg, pp.88-97, 2011.

[12] Nielsen, J. "Usability Engineering," New Ed. Boston, Mass. [a.o.]: Academic Press, 1994.

[13] OECD. "Citizens as Partners: Information, consultation and public participation in policy-making". OECD, 2001.

[14] Silingas, D., Pavalkis, S., Morkevicius, A. "MD wizard - a model-driven framework for wizard-based modeling guidance in UML tools," In International Multiconference on Computer Science and Information Technology (IMCSIT '09), IEEE, pp.609-615, 2009.

[15] Torre, I. "Adaptive systems in the era of the semantic and social web, a survey," In Journal of User Modeling and User-Adapted Interaction, Vol. 19, Is. 5, Springer, Netherlands, pp.433-486, 2009.

[16] Workflow Management Coalition. "Workflow Management Coalition Terminology & Glossary", 1999.

[17] Zimmermann, Andreas, Specht, Marcus, Lorenz, Andreas. "Personalization and Context Management," In User Modeling and User-Adapted Interaction 15, 3-4, pp.275-302, 2005.

[18] S. K. Card, J. D. Mackinlay, B. Shneiderman, "Readings in Information Visualization: Using Vision to Think," Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 1999.

[19] K. Nazemi, C. Stab, A. Kuijper, "A Reference Model for Adaptive Visualization Systems. HCII'11 Proceedings of the 14th international conference on Human-computer interaction: design and development approaches, pp. 480-489, 2011.