Tangible or Not Tangible – A Comparative Study of Interaction Types for Process Modeling Support

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Abstract. Many organizations loose potential for optimizing their operation due to limited stakeholder participation when designing business processes. One of the reasons is that traditional modeling methods and (interactive) tools are not suitable for domain experts who neither want to struggle with complex or formal notations, nor with the respective modeling tool. Tangible modeling interfaces are a significant move towards stakeholder inclusion. We review their respective capabilities not only with regard to modeling, but also to implementation and execution of business processes, setting the stage for improving the effectiveness of interactive Business Process Management support, and thus, stakeholder participation in organizational development.

Keywords: Tangible user interface, process modeling, model documentation, model execution, Subject-oriented BPM, multi-modal interaction.

1 Introduction

Modeling is a crucial activity for successful Business Process Management (BPM). Eliciting process knowledge of stakeholders by modeling requires adequate methods and (interactive) tools. To meet this requirement tangible modeling user interfaces have been developed, e.g., [12], complementing traditional intangible ones, e.g., [11]. Having a mix of interaction modalities allows supporting target groups with different capabilities. In this contribution we present different approaches to interactive process modeling support, and discuss their impact on the suitability for the task.

As process models serve as means for documentation, blue print for work behavior and origin of computer-based workflows we look at the consequences different styles of interaction and user interfaces have for modeling, persistent documentation, implementation and execution of business processes. Validation and optimization of business processes can be subsumed by execution, as they also require executable, thus intangible model representations. For intangible interaction several approaches have been developed, in particular for structuring the user interface of Workflow Engines (controlling the execution of process instances at runtime), e.g., [3]. However, the potential of tangible interaction styles and their recognition in terms of multimodal interactive or collaborative modeling support still needs to be explored.

M. Kurosu (Ed.): Human-Computer Interaction, Part II, HCII 2014, LNCS 8511, pp. 544–555, 2014.

The paper is structured as follows: After this introduction we present the framework we have used to analyze different interaction approaches. In section 3 we document the evaluation according to this framework. We conclude and sketch future work in section 4.

2 The Framework for Description and Analysis

In order to analyze different approaches to support process modeling the framework refers to their BPM background, usefulness and usability:

Way of Modeling and Methodological Background. This aspect refers to how the approach works and modeling is supported. The partially interdependent items to that respect are:

- *Nature of interaction*: What is the origin of the approach justifying the nature of interaction? It refers to the elements used for modeling, how they are utilized in the course of the modeling, and whether the interaction is driven by a specific methodical approach, such as Business Process Model and Notation (BPMN), Petri-nets, or Subject-oriented Business Process Management (S-BPM).
- *Ease of Use and Learnability*: How difficult is it to handle? What is the learning effort? The questions allow reflecting on how difficult it is to grasp the modality of interaction in the context of the supported BPM method(s). The latter could depend on the degree of formality and complexity of the notation, and expressed in terms of parameters like number of symbols, or similarity to natural language structures.
- *Stakeholder Participation*: How intense is stakeholder participation in the course of modeling? The quality of process design depends on how the approach supports involving stakeholders, leveraging their knowledge, expertise and creativity.
- *Collaboration and Distribution*: Is collaborative and distributed modeling possible? This question aims on how the approach supports joint designing of processes by modelers at different locations at a time.

Sustainability of Documentation. Process models are subject to change - created models need to be stored and accessible in a straightforward way, as in agile environments they need to be adapted continuously. It is of interest how a modeling support feature, by its nature, supports preserving or converting models for future revision and reuse. This aspect is closely related to the following.

Implementation and Execution. Process modeling no longer aims at merely depicting processes graphically enabling communication and optimization. It is rather of importance to execute models minimizing transformations, whereby execution refers to both completely manual work procedures, and automatically generated workflows. The latter align IT systems with work tasks and stakeholder needs. However, approaches might differ in transforming permanent formats used for modeling into executable ones to run generated workflows.

3 Evaluation

Using the description scheme presented in section 2 we have analyzed approaches that refer to established tools, or are increasingly used in BPM practice, thus promising candidates to become common use.

3.1 Brown Paper

Way of Modeling and Methodological Background

Nature of Interaction. A brown paper approach usually consists of a pin board covered by brown paper and a set of cards of different shapes and colors, being attached to the board during modeling and complemented by hand-written annotations, arrows etc. (for an example see http://www.metaplan.us/approach/ID/34). The elements can be used for many purposes like brainstorming, domain structuring or modeling of business processes.

The brown paper approach is not bound to a specific process modeling method or language. Modelers can use any notation for which they define the semantics of cards or drawn symbols representing the language elements, e.g., Event-driven process chains (EPC), Business Process Model and Notation (BPMN), Subject-oriented Business Process Management (S-BPM).

Learnability and Stakeholder Participation. Brown paper modeling is technically easy. There is no tool overhead, people just need to label symbol cards, pin them to the board and eventually use a marker pen to add information. The selected modeling language determines the learning effort users as business domain experts need to invest to be able to design processes. The effort increases with the number of language elements and the freedom of use. A list of modeling conventions might help, but cause overhead for modelers. Providing different cards representing key symbols also could help, but it does not reduce complexity. The latter can be achieved by limiting the language vocabulary to subsets of elements. However, they could cause interoperability problems with computer-based modeling tools which process different subsets, and with the transformation to executable procedures.

Due to its ease of use the brown paper approach applied by a well-trained moderator enables intensive stakeholder participation, and is only limited by applying it in specific method context, depending on the complexity of the method.

Collaborative and Distributed Modeling. Collaborative modeling is possible. 5-7 participants work together at one pin board. There are examples for virtual and digital moderation with virtual boards via video or web conferencing (see for example http://metaplan.de/moderation/), the applicability of the traditional brown paper approach for distributed modeling is poor though.

Sustainability of Documentation. The common way to save results from modeling is a photo protocol, with the models being stored as images (sometimes the brown papers are kept, too). Reuse is only possible by displaying or printing the images.

Alternatively, the wall papers can be transformed to computer systems, using the graphical user interface of modeling software (see section 3.4), taking the risk of errors when redrawing them.

Implementation and Execution. Brown paper models neither can be executed automatically, nor serve as work descriptions for manual execution of processes. In order to implement and execute them they need to be redrawn using modeling software (see section 3.4).

3.2 Tangible BPM

Way of Modeling and Methodological Background

Nature of Interaction. T-BPM stands for Tangible BPM (see [7, 8], www.t-bpm.de). It is based on the Business Process Model and Notation (BPMN) standard 2.0. The major elements of the interface are four different building blocks representing activities, events, documents and gateways as notation elements of BPMN. The modelers label building blocks using erasable whiteboard markers and put them on a table in order to lay out a process. Edges between elements are also drawn with markers. Elements can easily be removed and relabeled.

Learnability and Stakeholder Participation. Modeling with T-BPM is technically easy, but complexity increases according to the extent BPMN language elements are used. Although there are only four shapes to remember for modeling, the user needs to know a lot more about BPMN to use them correctly, e.g., the standard offers 8 types of gateways and more than 60 types of events (see http://www.bpmb.de/index.php/BPMNPoster and [11]). Hence, modelers first need to identify the right type and mark the building block, respectively, e.g., as a throwing event, caused by a message, before they can label it with process-specific information, e.g., invoice sent. If they do not specify the type precisely, the process description might be not sufficiently detailed for later use, e.g., for developing software. As a consequence, domain experts need at least basic know how of BPMN, and likely the support of a method expert to capture complex situations.

Similar to the brown paper approach, stakeholders can easily participate in modeling because the technique is technically easy-to-use. The haptic experience with the movable building blocks motivates and helps lowering barriers. However, the complexity of BPMN, if used comprehensively, causes higher cognitive effort for users, or requires a method expert guiding the design process.

Collaborative and Distributed Modeling. T-BPM offers several possibilities to collaboratively model processes in a group of 5-7 people around a table. Distributed design of process parts can be organized using several tables at different locations. Integrating the parts and coordinating the interfaces afterwards may cause high effort though.

Sustainability of Documentation. T-BPM models laid out on the table can be photographed and stored as images like brown paper processes. In order to have them stored in formats that make further electronic processing possible they need to be put into modeling software (see section 3.4).

Implementation and Execution. Implementation and execution conditions of T-BPM are similar to those of the brown paper approach (see section 3.1.3).

3.3 Comprehand

Way of Modeling and Methodological Background

Nature of Interaction. Comprehand is a tabletop interface that provides a digitally augmented modeling surface and graspable color-coded building blocks [9] [12]. People can model a process by placing them onto the table. Different from T-BPM, all movements and positions of the elements are filmed by a video camera from below. Using ReacTIVision and JHotDraw, the results are instantly interpreted, projected by a video beamer from below and displayed on an auxiliary screen. Building blocks can be labeled via a computer keyboard and connected by just touching each other. Again the system immediately shows the results of the respective user interaction on the table screen, like labeled blocks and arrows linking them. While most of the modifications are enabled by physically repositioning, removing or adding elements, other tangible tools like an 'eraser' serve to remove connecting lines from the screen. Figure 1 depicts the Comprehand interface.

The technology in general is open for any modeling language once their semantics are assigned to the building blocks. For capturing processes it has been configured to support modeling according to the subject-oriented approach. This approach captures both, the interaction of process participants, which orchestrates their collaboration, and their individual behavior, which describes the way they contribute to accomplishing a process. The modeling method is based on natural language structure with subject, predicate and object. Its graph-based notation gets on with only five symbols for representation: subject, message (including business objects), and the three action types do, send and receive [4]. Once modeling blocks are available for these concepts, no additional type specification is necessary, e.g., compared to T-BPM. One more reason to tailor the interface for S-BPM is the method's capability to automatically generate executable code from the model (see section 3.3.3).

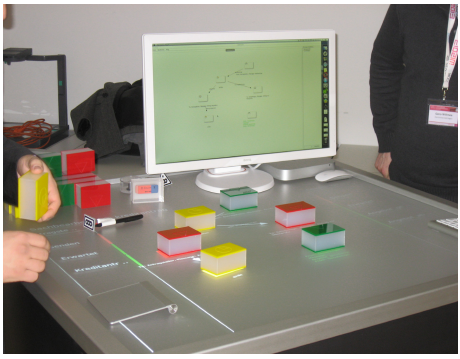

Fig. 1. Comprehand tabletop interface (see also `http://www.metasonic.de/touch`)

Learnability and Stakeholder Participation. Modeling with the interface is easy and does not require lengthy introduction. Typically, users quickly figure out how they need to apply the building blocks and the whole setting. In combination with the method properties described above the environment empowers domain experts to intuitively express their process knowledge in a straightforward way, without being hampered by some tool or method overhead.

S-BPM, and thus, the S-BPM instance of Comprehand, explicitly includes the stakeholders as it starts describing the process from their perspective when modeling their work (subject behavior) as a sequence of actions (function state), sending messages to other participants (sending state) or receiving messages from others (receiving state). The graspable modeling tools increases their motivation and fosters the focused elicitation of their knowledge [5]. In this way, stakeholder participation is facilitated, an objective often articulated in the context of Social BPM [1, 2, 10].

Collaborative and Distributed Modeling. The digitally augmented tabletop interface allows subject representatives to jointly model subject behaviors and interactions. It supports a variety of scenarios for collaborative and distributed modeling, such as the one detailed in the following (for further details see [9]): Initially, all participants involved in a process are assigned to a part of the surface for modeling subject behavior. To specify an interaction a message element is placed on the subject space, named, eventually annotated, and then moved to the area of the receiving subject (see left part of figure 2). Once the message exchange is completely captured, each representative of the different subjects model his/her respective (individual) behavior step-by-step, using the entire surface and placing state elements for function, sending or receiving states as required for task accomplishment (see right part of figure 2). Message ports for all other subjects serve to create receiving or sending states by placing a state element on incoming or outgoing messages shown in the ports and then dragging them to the desired position in the behavior model. The set of available messages has been defined in the previous step, i.e. interaction design. The system always tracks what happens on the table and displays the representation on an additional screen. Similar to the brown paper and T-BPM approach 5-7 people are a reasonable size for groups working at a single table.

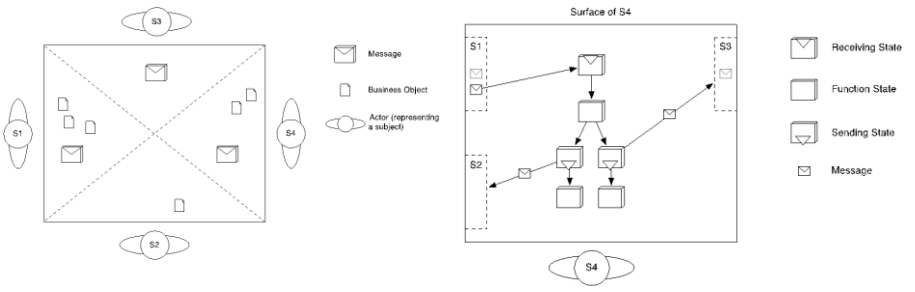

Fig. 2. Modeling surface for subject interaction (left) and behavior (right) – see [9]

Another set of typical use cases is based on distributed or co-located multiple tabletops. Using multiple tabletops facilitates both the modeling of subject interaction and the simultaneous or asynchronous behavior development for various subjects, either at the same place or spatially distributed (see fig. 3). For that purpose tables can be interconnected via a communication network. Synchronization is handled by an XMPP server, connecting to model clients and/or computer-based communication channels (like social networks, chat or videoconferencing) (see section 3.4). In this scenario representatives of each subject work at a specific table and can instantly notice incoming messages from subjects being modeled at other tables. They then can design the subject behavior at hand according to the actions they consider adequate following the receipt of those messages. Crosswise they can include sending states into their behavior specification causing message transfer via the ports to other subjects in order to trigger their reactions.

In any scenario the participants can discuss and negotiate while designing interaction and behavior, either face-to-face or via electronic channels. Due to the auxiliary display they can instantly follow their modeling procedure, and thus, check the results of their own design work in line to those of other subject representatives. In addition, they might check the overall coherence of the model based on the overall set of specified subject interactions. As each stakeholder can experience his/her behavior locally and from the overall organizational perspective at the same time, such an approach increases the probability to come up with an agreed-upon and well-accepted process model. In this way, effects like spamming co-workers (subjects) through broadcasting information become transparent immediately, and can be handled at design time. In case of S-BPM design time encapsulates build and runtime when executing SBDs automatically.

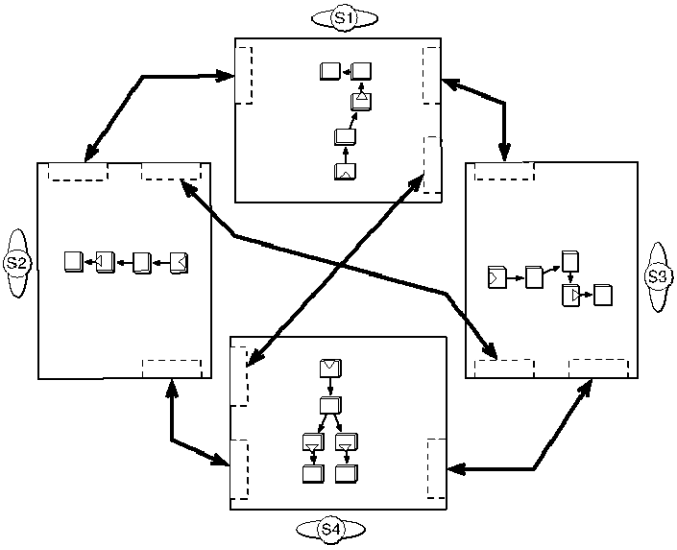

Fig. 3. Multi-surface setup for distributed modeling – see [9]

Sustainability of Documentation. For documentation the interactive system offers two options, as described in the following. As the system records all model states filmed and interpreted during the design phase in a repository, it facilitates user support for physically reconstructing former versions of current or previous sessions. The software, e.g., indicates where to put shapes on the surface, in order to rebuild a recorded state of the tangible model.

In order to persistently save models and make them available for electronic processing the system provides an automatic transfer facility. It transforms model information into the internal format of available modeling software following S-BPM, e.g., the Metasonic suite (www.metasonic.de). This transformation does not lead to any reduction or loss of information. Hence, there is no (manual) effort required for processing, as for the brown paper and the T-BPM approach.

Implementation and Execution. The models built with the tangible user interface described above and automatically transferred to the S-BPM software environment can be elaborated, validated, implemented as a workflow and brought to execution without programming. Enabler of the latter feature is the correspondence of the S-BPM modeling language to a process algebra with a precise formal semantics. It allows automated code generation and makes subject-oriented process descriptions executable and in this way, empowers process stakeholders to instantly validate the model and model changes without having IT specialists involved [4].

Variations. Technically less sophisticated tangible modeling support tools, also based on S-BPM, are Rural Comprehand and Buildbook. The first works with (magnetic) cards to be laid out on a surface and drawing lines to connect them when constructing diagrams. Buildbook consists of a letter case, representing a subject, and color-coded plug-ins encoding function, receiving, and sending states of the S-BPM notation as well as edges [6]. In both cases modeling results can be saved as photos, and transformed to the modeling software via image processing. From that point on, further processing is possible as described in section 3.3.3.

3.4 GUI-Based Modeling

Way of Modeling and Methodological Background

Nature of Interaction. Graphical User Interfaces (GUIs) are part of software tools that provide modeling features according to the implemented BPM method. The variety ranges from drawing tools like MS Visio, e.g., mainly offering stencils for EPCs or BPMN, to systems tailored ones for one or more particular methods, sometimes part of a business process management suite, also including a workflow engine. Examples are the ARIS Toolset (EPC, org charts etc.), Tibco, bizagi, Signavio (all mainly focused on BPMN), and Metasonic Build (S-BPM). In the following we do not further consider pure drawing tools.

In most cases design tools are used by method and tool experts who model processes according to information they have obtained before, either in interviews and

workshops with process participants (domain experts). The results are presented to others, discussed and modified in follow-up sessions.

Learnability and Stakeholder Participation. Modeling requires sound literacy of the implemented method and software tool environment. As mentioned before, ease-of-use is closely related to the complexity of the method, a fact that often limits active participation of stakeholders [1, 10].

Collaborative and Distributed Modeling. As modeling is performed at a computer-based work place usually a single user is involved. Jointly working on models is limited to workshop settings where the modeling screen is projected on a wall, so that participants can discuss what they see, and guide the modeler developing the process on the computer system. GUI-based approaches only support distributed modeling when using corresponding virtual communication and information sharing spaces. There are approaches to leverage social software (communities, micro blogs, chat etc.) in order to jointly design processes (e.g., ARIS Connect), a model can only be manipulated at a specific location at a time.

Sustainability of Documentation. Software-based modeling tools support storing models and artefacts in databases and repositories, according to internal formats, and thus provide access for future (re-)use.

Implementation and Execution. In many cases modeling results can be printed out and exported in HTML format, and in this way, serve as paper-based or online process guidelines for manual execution. It depends on the applied method and utilized tool, in how far implementation and execution as computer-controlled workflow is possible and a straightforward task. For instance, bringing ARIS EPCs to execution requires programming, e.g., using Business Process Execution Language (BPEL). The extent to which BPMN can be automatically mapped to BPEL and interpreted by a process engine at runtime depends on the match of the BPMN subsets of the modeling and execution component. There might differences from case to case, although BPMN is defined as a standard. Many software vendors only support a subset of the standard, mainly not identical, causing interoperability problems and additional transformation effort.

S-BPM models are executable on the fly (see section 3.3.3) - the Proof component of the S-BPM suite (www.metasonic.de) enables stakeholders experiencing and iteratively improving the modeled work procedures in a computer-based role play without having IT experts involved so far. Once the validation is finished the model can be implemented into an organization, and finally, executed by the Flow component to handle process instances in daily business. Programming is only necessary if it comes to the integration of existing applications into the workflow, such as ERP systems.

3.5 Comparative Analysis

Although the presented approaches reveal a variety of formats and modalities, they are closely coupled to the method context, either encoded in software or tangible hardware, or being part of skill deployment or social facilitation. Figure 4 depicts the

main results of the comparison. The table structure takes into account the type of interaction and relevant phases of BPM and required process support (application context).

The table entries reveal media discontinuity of the tangible modeling approaches with respect to seamless processing of modeling results, except for those based on the S-BPM approach. The latter allows the combined use of different modalities to create a coherent business model. The model representations, even when accomplished in distributed sessions, can be integrated, elaborated if necessary, and brought to execution, all with minimal manual effort.

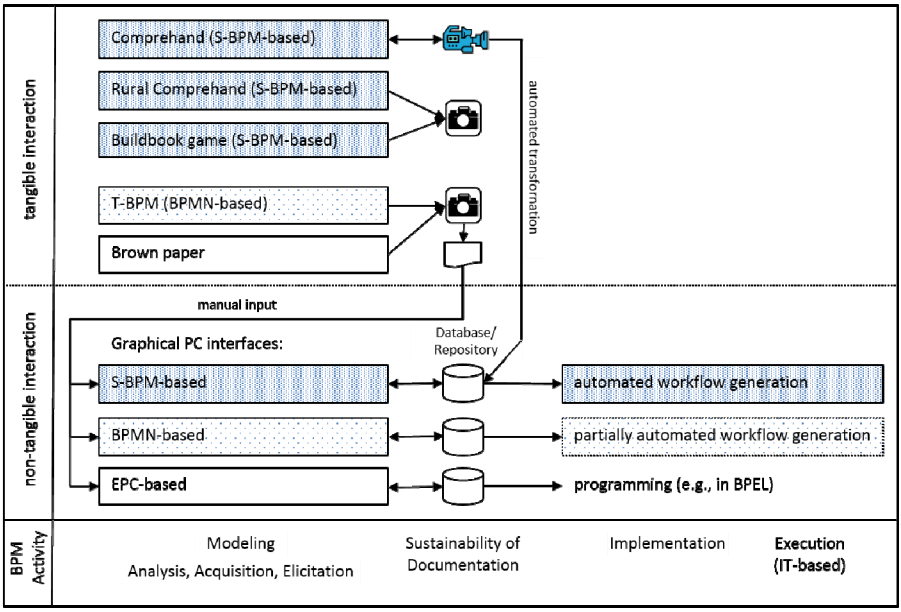

Fig. 4. Tangible and non-tangible modeling support

4 Conclusion and Future Work

As stakeholder participation turns out to be essential for business processes, modeling methods and (interactive) tools need to become suitable for domain experts. They should keep notations and utilization of features simple. In this contribution we have questioned the usefulness and usability of tangible modeling approaches as they promise a significant move towards stakeholder inclusion. We have reviewed their respective capabilities with regard to modeling, implementation and execution of business processes.

When contrasting tangible interfaces with non-tangibles they turn out to be beneficial in case the major modeling purpose is the description, explanation, discussion, and development of mutual understanding of business procedures. In case the main objective is to bring a model to execution, a seamless method approach, such as

S-BPM causes the least effort and workload. Corresponding tangible features not only offer the benefits of attracting stakeholder engagement, but also ensure coherence of representations on the organizational process level.

The support of collaborative and distributed modeling besides immediate an automatic generation of executable models reduces iterations that might be required due to different models of work. Hence, the acceptance of results, in particular achieved through coupling modeling with execution ('what you model is what you execute') can better leverage the potential for continuous improvement provided by concerned stakeholders.

As the user experience of tangible systems seems to be essential, next steps in research should be field studies of collaboration support. In terms of enhancing the palette of interaction features it might be worthwhile to look at ways to model processes also with gestures. Hereby, the S-BPM approach with its lean yet expressive notation seems to be a promising candidate for a respective approach.

Acknowledgements. The authors are grateful to the development teams of Comprehand and Touch, in particular Stefan Oppl, Matthias Neubauer, Florian Krenn, Dominik Wachholder, and Thomas Rothschädl.

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