

# Drawing Services: Towards a Paper-Based Interface for End-User Service Orchestration

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## ABSTRACT

One of the challenges end-users face in order to maintain and enhance their IT infrastructures is the simplicity and ease of use of the configuration/design-time interfaces. In this paper we describe our approach of using existing technologies for paper-based interfaces to allow end-users to orchestrate services in a Service-Oriented Architecture (SOA). We gathered first experiences with paper-based interfaces for IT configuration by developing an end-user-developable paper-based remote interface for interactive TV applications. Further we conducted a workshop to evaluate how end-user can orchestrate services. Here, we discuss the usefulness of a paper-based interface for the orchestration of services, from an end-user perspective and how the experiences from our prototype and the workshop can inform the design of a paper-based orchestration prototype for SOA.

## Categories and Subject Descriptors

H.1.2 [Information Systems]: User/Machine Systems – *Human information processing*; H 5.2 [Information Systems]: User Interfaces – *User-centered design*; I.6.5 [Computing Methodologies]: Model Development – *Modeling methodologies*

## General Terms

Design, Experimentation, Human Factors.

## Keywords

Service-Oriented Architectures, End-User Development, Haptic Interfaces, Paper-based Interfaces, Service Orchestration.

## 1. INTRODUCTION

End-User development (EUD) is a paradigm to make computers and software more useful by creating systems that are not only “easy to use” but especially “easy to develop”. The research on EUD provides according to Lieberman et al. (2006) “a set of methods, techniques, and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create, modify, or extend a software artifact.” [1] This framing of EUD leaves a spectrum of potential end users

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who can be addressed with concrete EUD approaches. Fischer [2] described a continuum of end user types with different degrees of affinity with information technology, other describe end users in professions that – like programming – require certain abilities in abstract thinking (e.g. scientists).

For the domain of Enterprise Resource Planning Systems (ERP) we have to consider end users that may be highly specialized in their application domain, but do not have the necessary abilities or the desire to “invest” into programming skills. Those different skill levels may result in intra- and inter-organizational delegation patterns, as we have discovered in one of our recent studies [3]. In this case, the adaptation of ERP infrastructures becomes a collaborative process, in which different shades of end-user-developers/programmers are involved. The need for EUD implies the need for highly flexible software infrastructures, which have always been a central design aspect of ERP systems. Therefore it is no surprise that Service-Oriented Architectures (SOA) – being the latest trend in software flexibilization – became the new design paradigm for ERP systems. This shift towards process-oriented thinking and flexible service infrastructures offers new opportunities and challenges to address EUD in ERP systems.

In our current research we are interested to explore how (digital) paper – as one of the most familiar medium for collaborative interaction and creative sketching – can be utilized to integrate end users with little IT affinity tighter into end-user driven development processes by providing a digital paper-based service-oriented process modeling environment.

In our first conceptualization of the challenges and opportunities, we refer to several prior experiences that we describe in this paper: In chapter 2 we address research issues for EUD in SOA, in chapter 3 we briefly describe first experiences in end user business process development, in chapter 4 we refer to a first paper-based EUD prototype, all to inform the discussion of first design implications we see in the concluding chapter 5.

## 2. END-USER DEVELOPMENT IN SERVICE-ORIENTED ARCHITECTURES

### 2.1 SOA and BPM

SOA is a type of software architecture that has evolved from component-based development and distributed Internet architectures and gains rapidly importance for organizational infrastructures. By providing platform-, vendor- and language-independence and the ability to build highly flexible and loosely coupled architectures, SOA promises to ease the use of system

functionality in heterogeneous architectures and provide reuse of distributed system functionality. Its concept is nowadays tightly coupled with the idea of Business Process Management (BPM), which has its origins in workflow modeling. This combination promises to bridge the gap between IT and business: processes are modeled by business modelers just through composing services and then implemented by developers. In case of web services, the most wide-spread implementation approach to SOA, orchestration tools allow users to do the composition by graphical process modeling based on BPEL (Business Process Execution Language) and visualized by BPMN (Business Process Modeling Notation).

Although there is a great interest in using BPM in SOA, there is only little documented empirical research about it. A good example is the study of Brahe and Schmidt [4]. They researched the implementation of BPM in SOA in the financial industry. In an analysis phase a business developer defines together with user's business process requirements at high level terms. This is the only phase where the end-users are involved. Afterwards a solution architect defines a so-called solution model, where all tasks of the previously designed process are described. In a specification phase the model is further detailed with references to existing and new services. This model is used by a process developer to implement the process.

## 2.2 Challenges of EUD in SOA

The focus of EUD is to provide end-users with tools and approaches providing a manageable use-time flexibility of software infrastructures. One way to address the problem is to use technology flexibilization approaches intended for code reuse and improved application management, and exploit them for EUD. We did some research in flexibilization approaches and systems that are "easy to develop" in the context of tailoring component-based systems [5]. In a similar way we are now approaching SOA. Organizational infrastructures increasingly rely on these concepts, and among them are ERP systems maybe the most fundamental applications. There are a number of EUD approaches that can be used, among them the "Gentle Slope Of Complexity" [6] and "Domain Oriented Design Environments" [7]. First approaches to the ERP application domain aim towards enabling end-users to particularly manage and create agile workflows and business intelligence applications [8]. But as a result of the complexity of the domain, EUD is likely to become a collaborative enterprise of users with different roles and expertise. It becomes an important challenge to integrate EUD aspects in existing development processes (and as a consequence elicit design requirements for EUD measures therefore not only from the use context but also from the existing technical environment and from the organization of software development [9]), but our focus remains on collaboration issues in the field of application.

To be able to create flexible EUD applications for SOA several challenges have to be considered. Wulf et al. [5] provide some end-user oriented concepts and interfaces. As the SOA concept was designed without end-users in mind, service interfaces remain only technical and do not provide non-functional information. Neither end-user oriented process modeling interfaces nor appropriate mechanisms to discover services and to understand their functionality are available. As end-users are typically unskilled in programming/modeling they must be supported to gradually acquire necessary skills for tackling development challenges [6]. However, current SOA techniques have only a

weak support for different complexity levels and no possibilities to express unknown concepts. As there is no communication support available, issues like learnability, reuse of tailoring artifacts as well as delegation patterns are not regularly supported.

## 2.3 Use of paper-based interfaces

Existing orchestration environments have "typical" graphical user interfaces. An alternative approach to those, especially for EUD purposes, is the emerging paper-based user interface concept (PBUI). PBUIs bring together physical and digital artifacts to utilize the use tradition of paper and the processing capabilities of modern PCs. First attempts to integrate these worlds go back to Wellner's DIGITALDESK [10] connecting the physical and the digital desktop with digitalization technologies. Creating PBUIs requires having a close look at the affordances of paper and its digital counterpart to combine them complementary. Affordances of paper are especially easy grabbing, moving, turning, transporting and annotating. Furthermore paper affords collaborative activities, undisturbed creative thinking and sketching, low formal claims and a low cognitive workload. Nevertheless there are also some problems with paper. Sellen and Harper point out symbolic, cost-related and interaction problems [11], whereby emerging digital paper applications mainly have to deal with interaction problems (e.g. feedback). Nowadays PBUIs are used to capture paper-based form filling, to digitalize handwritten notes, to enrich paper documents with digital means and to enable paper-based sketching in CAD applications. There are also upcoming approaches to design interfaces creatively by the use of a digital pen-and-paper technology.

Closely related to PBUIs is the research on electronic sketching and low-fidelity visualization, which mainly base on e-whiteboard and tablet-PC technology. Several approaches try to enhance CASE tools with sketching support (e.g. the KNIGHT tool [12]) or to enable end-users to create interfaces based on sketching and managing low fidelity prototypes (e.g. the SILK project [13]). Focus of these approaches is especially the recognition of gestures and components as well as the visualization and beautification of sketched prototypes.

## 3. PRESTUDY: END-USER BUSINESS PROCESS PLANNING

In this section, we will describe what we have learned from a Business Process Planning (BPP) workshop with end-users, which we used as a pre-study for the design of our digital pen-and-paper-based orchestration approach. Since our intention is a design environment for end-users, we confronted our workshop attendees with the task of designing business processes by using pens and paper mock-ups as design tools.

### 3.1 Methodology

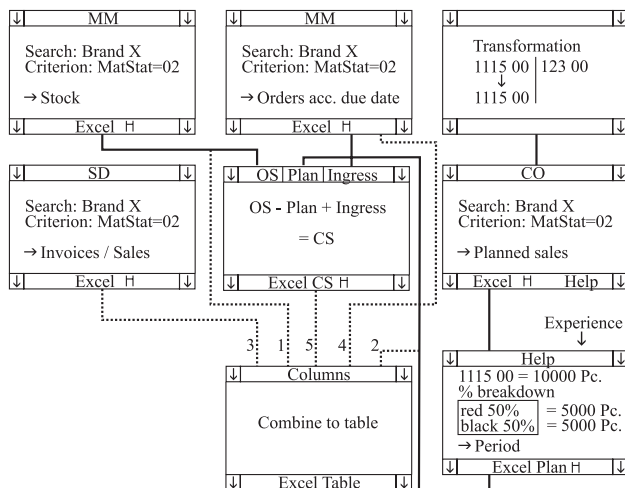
The workshop was held at an "in-between" region, as Muller [14] puts it, which contains attributes of the common environments of both participating groups, software developers and end-users. The users were not experienced in designing business processes, but in the customization of the companies' SAP system. Users were asked to translate a domain scenario to a "business process" to find out how end-users intuitively use the process design elements and what semantics seem to be "natural" to them.

### 3.2 Workshop setting

In the BPP workshop participated six researchers and three users from a mid-sized enterprise from the production industry. All three users were technically skilled – but no engineers – and had the formal role of “Key Users” of the company’s SAP system. One of them was the head of the IT-department. On the researchers’ side there were each two developers, moderators and observers. Working materials such as papers of different formats, Post-it notes, different color pens and a blackboard were provided. At the beginning of the workshop, a scenario from the working context of the users was chosen and specified. As a prerequisite for planning of product order quantities, an overview is needed showing diverse processed stock information which has to be selected and extracted from three different modules of the used SAP ERP system, before it has to be consolidated using Microsoft Excel. After the scenario was set, possible design entities – boxes (small slices of paper) and wires (pen strokes between the boxes) – were introduced to the users. Through connecting the output port of one box with the input port of another box a dataflow was defined. A huge blank paper, accessible by all users, represented the design space. Users could write inside the boxes to specify their content or function, arrange the boxes on the design space, and connect them. Annotations might be used to specify special operations or the semantic meaning of the connecting lines used. Additionally the software engineers could be asked for help and the moderates ensured an understanding and that discussions were kept focused on the question.

### 3.3 Results

The users started the design process with discussions about what result they actually want to achieve. They sketched a table with the desired result and where the data should be taken from. The design artifact used to specify this desired outcome is depicted in a simplified way in Figure 1.



**Figure 1: Solution design created by workshop participants**

The actual design process was started through a discussion by the end-users how to specify the boxes. They decided to introduce a box for every SAP module, from which data was needed. If necessary, the center of the box was annotated with a selection criterion, to get the subset of the data. At the bottom of the box a short explanation of the data of interest was added. The output port of a box was labeled with the desired output format (e.g. “Excel”). The input port of one of the boxes was also connected

to a specially colored box labeled with “experience”. Users wanted to express the semantics that planning is done with an input of experience. How planning is done was described exemplarily in the center of the box, whose input port is labeled with “help”. Some were also connected to the input port of a special calculation box. Its input port was labeled with the abbreviated names of the data that should be delivered by the other boxes and its center contains a formula, representing the calculation this box should perform on the input parameters. The output ports of all boxes, which should contribute columns to the desired resulting spreadsheet, were connected to the input port of a box labeled “combine in table”. The connecting lines ending in the input ports were especially colored (red) and annotated with numbers, which should describe the ordering of the columns.

## 4. PRESTUDY: A PAPER-BASED END-USER-MODIFIABLE REMOTE CONTROL

In this section we will describe our pre-study, which we used to gain a deeper understanding of the advantages and potentials the digital pen-and-paper technology provides for end-users. After a short overview to the basic technology, we will present the concept of the pRemote (personal Remote) and show first results from an evaluation of the pRemote designer.

### 4.1 Digital pen technology

The pRemote input concept is based on Anoto’s digital pen technology ([www.anoto.com](http://www.anoto.com)). Their main components are a thickish ball-pen equipped with an integrated camera and memory and a paper with a fine dot-pattern printed on. By reason of dot-recognition by the camera it allows to not only digitally capture writing and drawing, but also to identify uniquely every single location on every single sheet of paper that is being drawn upon, which can be exploited for new ways of paper-based interaction. The pen can be used asynchronously (via USB) as well as synchronously (via Bluetooth).

### 4.2 Concept

To gather a deeper understanding of the advantages and potentials the new technology provides, we developed a paper-based remote control which allows the input of text and the control of media centre functionality. The basic idea is to enable end-users to design remote control interfaces individually. Therefore we developed an Acrobat stamp plug-in. The user can choose between different stamp templates (e.g. broadcast stations, control functions, letters, keypad layouts) from a list and layout the icons individually on an Acrobat design drawing area. By saving the layout, its elements are mapped to the paper and are correlated with the specific position on the paper. Afterwards the layout can be printed on Anoto paper and is ready to use. By pointing on a region the digital pen will trigger the corresponding function synchronous on the media centre. Additionally the user can write text on a template which automatically will be identified by using a handwriting recognition system.

### 4.3 First results

An evaluation of the pRemote prototype was conducted with 7 users in the age of 22 to 32. The handling of the pen was easy understood by all participants. All users had a positive attitude to the interaction concept. One of the main interests was the user experience of the designer plug-in. Participants were requested to modify the remote control layout to their own needs. Three

participants had demands for improvements and created therefore their own template, but the potential for designing own layouts was mentioned as positive by all users. Using a hand drawn interface to control the system was seen as kind of sceptic by the participants. Most of the users mentioned that they couldn't draw well enough. So a stylish interface (e.g. nice symbols) is not realizable with this method. However, one participant decided to sketch a first draft of the layout on paper (see interface "D" in Figure 2), as designing the layout with the pen was easier for him. Thus by supporting the user to design layouts on paper first, they could gain more creative freedom. These interfaces should then automatically be transferred to a computer for refinements.

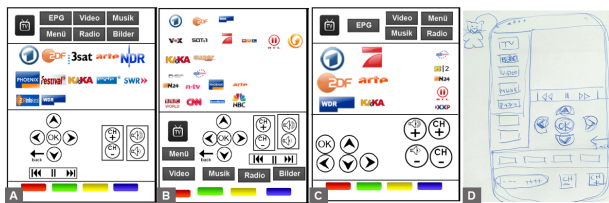


Figure 2: Different pRemote interfaces designed by users

## 5. TOWARDS PAPER-BASED END-USER SERVICE ORCHESTRATION

Drawing from the experiences described above, we now are able to discuss first design implications for our planned prototype.

### 5.1 Paper-based EUD in SOA: General Issues

Particularly in the field of business process management there is an open field for a wide involvement of the business users, both from an EUD perspective as well as from a BPM perspective. The users should be able to initiate as well as participate in process development. As stated above, users often are only involved at the very beginning of process development and do not actively take part in modeling activities. But as we saw in the BPP workshop, users are able to understand and apply the concept of process modeling in SOA, especially when they get simple tool support and they can make up their own sense on the process modeling. Formality and complexity of available BPM tools that state to bridge the gap between business and IT may hinder users' participation. Current end-user approaches on SOA pick up this aspect (towards "simple" tools), but are restricted to an orchestration of simple processes only.

As several projects make use of PBUIs and electronic sketching interfaces for design tasks, it has been shown that paper can provide significant advantages (collaborative and creative) to create design sketches and to develop low-fidelity prototypes. This was confirmed by the results of our pRemote pre-study, where users approved paper-based modeling as a first design sketch. The easy and creative sketching and the possibility of annotating elements were considered as very helpful. However, there are so far no approaches that make use of the flexibility and the haptic character of digital paper and enable a quick and smooth integration in further modeling steps. Approaches like KNIGHT, SILK and other projects head towards this direction by supporting creativity and collaboration. However, they are less flexible than real paper and seldomly situated in the work practices of end-users. We think that the digital paper technology provides not only the potential to integrate first process sketches, but also to enable simple orchestration and moreover to empower

end-users to participate in these development processes within their usual work practice.

### 5.2 Paper-based orchestration process

Based on the findings from the pre-studies (chapter 3 and 4) as well as from further interviews we sketch our idea of an exemplified paper-based orchestration process:

1. One or more end-users create a first process sketch on paper and describe what it does. Existing sub-processes/services are referenced directly if known.
2. In the next step other end-users may refine and amend the graphical process model. Additional notes and aspects of unknown process concepts are annotated or sketched with informal annotations.
3. During the next step, the process is completed together with professional solution modelers on the basis of the existing sketches. By observing sketches and annotations of more skilled modelers the end-users can also enrich their knowledge about process sketching.
4. In a last step, the paper model is transformed into a digital graphical process model, which can be used in a BPM tool. Formal aspects are transformed directly into the process model, while informal aspects and annotation are kept to document process emergence and the reasoning behind it.

During the first three steps the users are assisted by contextualized interaction methods using a connected computer. Interaction methods could be e.g. searching existing services, showing details of services and feedback methods to verify formal input.

### 5.3 Requirements for a paper-based orchestration tool

Two main aspects have to be considered in the development of a digital paper-based orchestration tool for end-users: (1) Provide a *modeling notation* that could be used to capture relevant aspects of services orchestration, appropriate for end-users and applicable for paper-based modeling. (2) Develop an *interaction concept* to digitally enrich and support the modeling on and the interaction with digital paper(s). In the following we want to highlight some important findings that arise from analyzing our pre-studies and experiences and from general affordances of paper-based interfaces.

**BPM in SOA:** Due to the affordances of paper, process modeling on it can't replace standard modeling tools completely and has to be seen as a pre-phase to computer-based modeling. The "paper-modeled" process must be transformable to standard BPM tools. To integrate the paper modeling smooth in current work practice the paper-based notation should be similar to current orchestration concepts (e.g. BPMN/BPEL). To make use of an existing service repository the notation and the interface have to provide mechanisms to reference existing services on the paper and to adapt their properties (especially how to access the service). To meet complexity concerns of modeling and to avoid hard media breaks between modeling on paper and computer, the paper-notation should not be restricted to simple modeling aspects, but also enable the user to sketch more complex aspects. As business processes are typically modeled collaboratively the systems has also to support multiple modelers at once.

**EUD is SOA:** The BPP workshop showed that the chosen visualization (box-and-wires metaphor) could with little help be understood by end-users. However, they used the center of one of the boxes for different semantic information. To enable an even more formal modeling the center of the boxes could be more differentiated. Besides the structured aspects of composition the users also used annotations (e.g. column order) and informal extensions (e.g. "experience" as input) in a fluent way. The *modeling notation* must take care of these informal aspects in an appropriate way. In the workshop setting, revising the boxes and wires was identified as helpful in modeling and enhancing the process and should be considered for the *interaction concept*. Although the users understood the core concept of boxes-and-wires, some inconsistencies in the use of the boxes could be noticed (e.g. sorting rules as functions and not as input parameters). This could be reduced by assisting the users through contextualized support.

**Paper-based Affordances:** PBUIs have to deal with three main problems: Paper is static, it provides no further feedback than its strokes and, with current digital pen-and-paper technology, once drawn content can't be removed. Otherwise, Anoto's location awareness enables affordances that go beyond the traditional use of paper. Different sheets can be digitally related by physically connecting them with a stroke. Copies of papers with identical location information may be considered as "paper types" with certain assumed semantics. Because the semantics of paper-sketches can only be interpreted to a certain extent. The *modeling notation* has to exhibit such a clear structure that imprecise or revised sketches can also be interpreted correctly. It must also be analyzed which process aspects can be adequately modeled on paper and which orchestration activities should be supported by a computer (e.g. feedback and end-user assistance). The design of the *interaction concept* is heavily affected by the affordances and characteristics of the digital pen-and-paper technology. Because of the static character of paper and the complexity of an orchestration process, should some aspects, whenever possible, be supported synchronously with a computer. To recognize different input content (e.g. model elements, annotations and commands) the system must be able to distinguish between different input types (e.g. gestures and handwriting) and sketching contexts. Since paper provides no dynamic feedback, additional techniques (e.g. tactile, auditive and visual feedback) have to be utilized. Thereby the continuous paper-use-process must be undisrupted (as far as possible). Further interactional aspects to consider are collaborative use with several pens, online and offline use, selection of commands and providing a reliable input recognition. In the end, the paper-based process representations may also be an interesting (persistence, haptics, familiarity) anchor for further process-related in-use interactions of end users.

## 6. Conclusions for the design

Summarizing the most important design criteria for the development of a paper-based end-user oriented orchestration interface are (1) a modeling notation that is easy understandable for end-users but also capable of even more complex modeling aspects, (2) an integration of formal and informal elements, (3) support for collaborative modeling, (4) digital enhanced modeling support, (5) design for fluent interaction and modeling (especially reliable recognition, feedback design and undisrupted use), (6) the integration of existing orchestration practices and (7) to deal with

the static character of paper. These criteria provide a good basis for detailed further discussions of design aspects and tradeoffs (e.g. on basis of the cognitive dimensions framework [15]), which are needed to make out the concrete design concept. However, we strongly believe that a system that meets these design criteria enriches the traditional orchestrations process and empowers end-users to actively participate in process modeling and orchestration.

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