



Team Hobbes - Spring Final Report

SAP Project | HCI Project | Spring 2007

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1 Executive Summary

The SAP NetWeaver platform is designed to integrate business processes by composing web services within the existing IT infrastructure to create new applications, crossing the boundaries of the isolated legacy systems in place today. Currently, application functionality does not fit with business processes. As a result, users are forced to adapt their work practices to the software instead of the other way around. Thus, a gap is created between how business users work and what development organizations deliver. For SAP to bridge this gap, it is important to create composite application design-time tools that allow business users to participate in a more meaningful manner in the development of their applications. To further explore this approach, SAP has teamed up with a team of Master's students in the Human-Computer Interaction Program at Carnegie Mellon University (CMU) to make SAP's NetWeaver design-time tools more usable for business users with minimal IT know-how.

This project spans over a period of 9 months and has been divided into two phases. During Phase 1, we aim to choose a design direction by conducting research to identify user needs. Our analysis included a usability evaluation of the NetWeaver design time tools, literature review of various academic and scientific papers, study of the competing products, user interviews and an extensive design ideation process. During Phase 2, we aim to develop design concepts for user evaluation and interactive software prototypes on validated concepts. This report details our research findings and design opportunities, and marks the end of Phase 1.

Our usability evaluation revealed that the NetWeaver design-time tools are largely catered towards developers. Extensive jargon is used throughout the interfaces and often requires the user to be knowledgeable on technical concepts such as software patterns and HTTP error codes. Moreover, complex tree structures are used to display elements of a business process thus making it very difficult for users to locate their desired options. We have also found that particular use cases such as adding a property to a view is taking too many steps to be easily recalled or even recognized.

Competitors who offer development tools for composite applications all achieve business process orchestration through service-oriented software architectures. We found that a set of core features related to interoperability, security and extensibility is common to all products. Another common denominator is high system complexity tailored to the needs of IT developers. Thus, we learnt that as we design a solution, it would be important to retain these core features and at the same time allow the tool to be used by a broader range of users.

We interviewed a broad spectrum of users ranging from technology oriented to business users to understand their work practices and to gain insights related to business process design and implementation. We found that the need for change of business processes can originate either from internal business modules or external customers. However, change in business process, which affects both work practice and work culture of an organization, is often invoked top-down from management. Hence, tacking progress on initiatives becomes a challenge for the management.

We also found that business process design in practice is naturally collaborative and requires participation from many people sharing knowledge in their own domain of expertise. Such need is attained mostly by ad-hoc methods including extensive meetings, use of whiteboard, and shared documentation. Visual models of the business processes are also often used to assist communication and are drawn in flow diagram style with standard notations using Microsoft Visio or IDS Scheer ARIS. However, these models tend to fail in providing concise information required for process implementation. In general, challenges arise in managing and digesting input from multiple sources, articulating appropriate information to different sets audiences, and being aware of the complexity of the problems and the resulting consequences of proposed solutions.

A rich set of design opportunities was identified from our research. We want to enable our users to monitor and analyze business processes. The users should be able to quickly understand business process semantics from simple visual representations and should also be able to participate in prototyping and sketching of composite applications. Everybody involved in business process design have the need to share documentation of requirements and technical specifications, which motivates us to provide an intelligent document management system that maps document artifacts and business process components to simple business process visualizations. In our designs, we will also try to foster shared mental models on tasks and teamwork to increase effectiveness of interdisciplinary teams.

These design directions will be the start point into the second phase of our project, when we validate design concepts and develop interactive software prototypes.

2 Introduction

This report describes our activities, methodologies and findings from the first phase of our capstone project with SAP Germany in spring 2007.

The reader is first introduced to the project scope in chapter 3. Not only does this chapter describe how we chose project focus, but also introduces the stakeholder model which summarizes the important participants in design and implementation of composite applications.

To learn more about composite applications and to become familiar with the problem domain, we selected a number of promising readings as background research. We included guidelines and tutorials related to the NetWeaver tools, technical articles related to composite application development and scientific papers on shared mental models and end-user programming. Chapter 4 presents summaries of readings and design implications.

In chapter 5, we present the findings of a competitive analysis of products from Oracle, IBM and BEA which are similar to the SAP NetWeaver Design-Time Tools.

We also analyzed the user interfaces of the SAP NetWeaver Design-Time Tools. The results from our heuristic evaluation can be found in chapter 6.

A large portion of our effort was directed at contextual inquiry in companies which either develop composite applications or model business processes. We had initial difficulties in getting in contact with people who fit in our idealized stakeholder model. But we demonstrated both patience and persistence and finally gained access to 14 users including IT managers, business process experts and developers in large-size organizations which operate world-wide. Chapter 7 contains findings from individual interviews and presents consolidated workflow, cultural influences, sequences and artifacts.

Finally we analyzed our findings from heuristic evaluation, literature review and contextual inquiries. We formed an affinity diagram of insights, breakdowns and design ideas. Based on this data, we synthesized eight consolidated design directions which can be found in chapter 9.

The final goal of our project is to create an interactive prototype which incorporates the functionality needed by business users to participate in the creation of composite applications. The insights gathered during our first project phase will inform design and prototyping in the upcoming project phase as outlined in chapter 8.1.

3 Project Scope

3.1 Project Overview

SAP has been a provider of software solutions for businesses of various sizes for more than 30 years. They had their biggest success with the rather monolithic SAP R/3 Enterprise Resource Planning (ERP) software platform, which included modules for business domains such as Human Resources, Customer-Relation Management (CRM), Finance, Supply Chain Management, etc.

Even though leader in the ERP market in Western Europe [1], SAP faces strong competitors such as Oracle and IBM, which also offer complete ERP solutions in the same market. As a result, in order to stay as independent as possible from a single software vendor, enterprises use different products from a multitude of software vendors. These legacy enterprise applications often operate isolated from each other.

Composite Applications are used to integrate isolated enterprise applications to support companies' business processes. SAP NetWeaver Design-Time Tools are used to design and implement such Composite Applications. Currently, these tools are catered to software developers and are difficult to use by other stakeholders involved in business process design.

Therefore, our goal is to create concepts and an interactive software prototype for business oriented users who want to actively participate in Composite Application design.

3.2 Focus Setting

We held two focus-setting sessions on February 4th, 2007 and March 2nd, 2007. After gathering input from accessible stakeholders, we arranged these in a hierarchical order in the form of an affinity diagram. Affinity diagramming is used to “sort large amounts of data into logical groups. Items identified by individuals are written on sticky notes, which are sorted into categories as a workshop activity” [43].

This activity helped our team in working at a creative level to address difficult issues that were beyond our understanding and scope. Moreover, using this technique we were able to understand the big picture of this project by interacting with teams with diverse experiences and in an unfamiliar domain. Table 3-1 is a summary of the participants and their roles in the focus setting sessions.

3.2.1 Focus Session Participants

Name	Position	Role during session	Session participation
Jonathan Gordon	SAP	Stakeholder	1
User 11	Consultant Company B	Stakeholder	2
User 2	Consultant Company B	Stakeholder	2
User 3	Consultant Company B	Stakeholder	2
User 6	Consultant Company B	Stakeholder	2
Ekta V. Shah	HCI Masters Student at CMU	1. Protocol 2. Moderator	1 & 2
Jonas Hinn	HCI Masters Student at	1. Moderator	1 & 2

	CMU	2. Diagramming	
Dongwhan Kim	HCI Masters Student at CMU	1. Diagramming 2. Protocol	1 & 2
Zoe Ouyang	HCI Masters Student at CMU	1. Diagramming 2. Protocol	1 & 2
Annie Zhao	HCI Masters Student at CMU	1. Protocol 2. Diagramming	1 & 2

Table 3-1: Focus Session Participants

3.2.2 Focus Setting: SAP Perspective

We had the opportunity to conduct a focus-setting meeting on campus with Jonathan Gordon, our SAP contact for the whole duration of the project. Discussions with Jonathan helped us significantly to set an initial scope for the effort in the first quarter of the spring term. The scope gathered from this session was very broad and we had a number of directions that we could focus on. Figure 3-1 is a snapshot of the resulting affinity diagram from this session.



Figure 3-1: Affinity Diagram: SAP Perspective

3.2.3 SAP Perspective: Grouping of questions and concerns

Table 3-2 is a summary of the initial foci gathered from the focus setting session with SAP.

1 st level groups	2 nd level groups
User Related	Learnability and documentation of tools Who uses which applications and how? How does SAP collect feedback from users?
Related to Tool Integration	What tools can be integrated to make NetWeaver easier to use? How do tools support change of business

	processes?
	How to integrate tools in work process (bottom-up or top-down approach)?
Abstraction of concepts and Simulation	How to prototype CA user interfaces?
	How to simulate business processes?
	How to test composite applications?
Collaboration among tool users	Any physical artifacts needed to be digital?
	Who needs to communicate with whom?
	How does the workflow of users without NetWeaver look like?
Assessing the value of tools	How to measure quality of results?
	SAP branding
	Who is SAP's customer, what is the value of SAP to them?

Table 3-2: Focus setting session with SAP

These initial foci were not prioritized, as they represented the view of a single stakeholder. They served the purpose of giving the project team an initial setting to start investigation. We kept these foci in mind as we spoke to potential or actual users.

3.2.4 Focus Setting: Consultant Company B Perspective

The second focus setting session was conducted at a consulting company. Four consultants participated in this session. The participants were technical in nature and very well versed with the SAP NetWeaver tools. We introduced this group to the Contextual Design process and gathered their questions and concerns related with the SAP NetWeaver system in an affinity diagram. Stakeholders then exchanged their results and formed groups of concerns in the affinity diagram. Once our team returned from this visit, we consolidated the affinity diagram to create higher-level categories of the areas pointed out by our participants. Figure 3-2 is a snapshot of the resulting affinity diagram from this session.



Figure 3-2 : Affinity Diagram: Consulting Company B Perspective

3.2.5 Consulting Company B Perspective: Grouping of questions and concerns

Table 3-3 is a summary of the issues, concerns and questions gathered from the focus setting session with Consulting Company B.

1 st level groups	2 nd level groups
Collaboration	Features of knowledge management
	GP design time locks objects for single user
	Nice tool for process collaboration
	Need to have version control for GP
Integration(Internal + External)	CAF GP should be integrated with NetWeaver Development Infrastructure (NWDI)
	Good Integration with Web DynPro and CAF
	Integration with other external applications
	Integration of GP and JSP
	Integration with third party API
	Read process flows from other tools
	Role Integration to action steps outside of GP
	Make external services implementation intuitive
	Integrate CAF core and GP with other document management systems
Browsing/Organizing/Search/Easy Retrieval/Deletion	Search capabilities in callable object
	Increased filtering activities
	Search capabilities while attaching Web DynPro components
	Deletion process of CAF GP complication
	Cascade deletion of rows not supported
	Cannot delete a folder of GP objects
Testing	Unit testing tool integration in CAF core
	Test from CAF core rather than browser
	Testing early in the process
	Problems with deleting and re-adding an operation during Gamma testing
Customization	CAF GP process structure requires flexibility
	Expand on composite callable object type
	Support maintaining transaction
	Contextual based
	Flexibility on role definition
Business User Centric/Usability	CAF GP not intuitive

Problems	Action Steps should be role based not user based
	Toolset not for business user
	Need more robust design between business and technology users
Documentation	Specifications to connect to different middleware
	Detailed documentation for CAF Tools
	Publish testing strategy

Table 3-3: Focus setting session with Consulting Company B

3.2.6 Choosing project focus

After gathering the vast amount of data from the affinity diagrams, both from SAP and Consulting Company B perspective, we chose focus areas that were in the interest of all stakeholders and validated by them.

We decided to focus on business users who were involved in business process modeling. We wanted to provide a platform for seamless communication between these users and other teams involved in the implementation of business requirements. These “business user enabled” composite application design time tools would allow users to participate in a more meaningful way in the development of “their” applications.

In order to design these tools, we wanted to explore the tools they use to model business processes as well as the collaboration and coordination needed in order to implement a process change. Our team hoped to gain a better understanding of how the need for process implementation is initiated and the different entities that participate in this process.

3.3 Stakeholders Model

The challenge we faced in this project was to understand the context of use of composite application design-time tools. There is a broad range of current and prospective users of these tools. Figure 3-3 below is an overall simplified diagram of the different users involved in the process of designing and implementing a process change and their influences on one another.

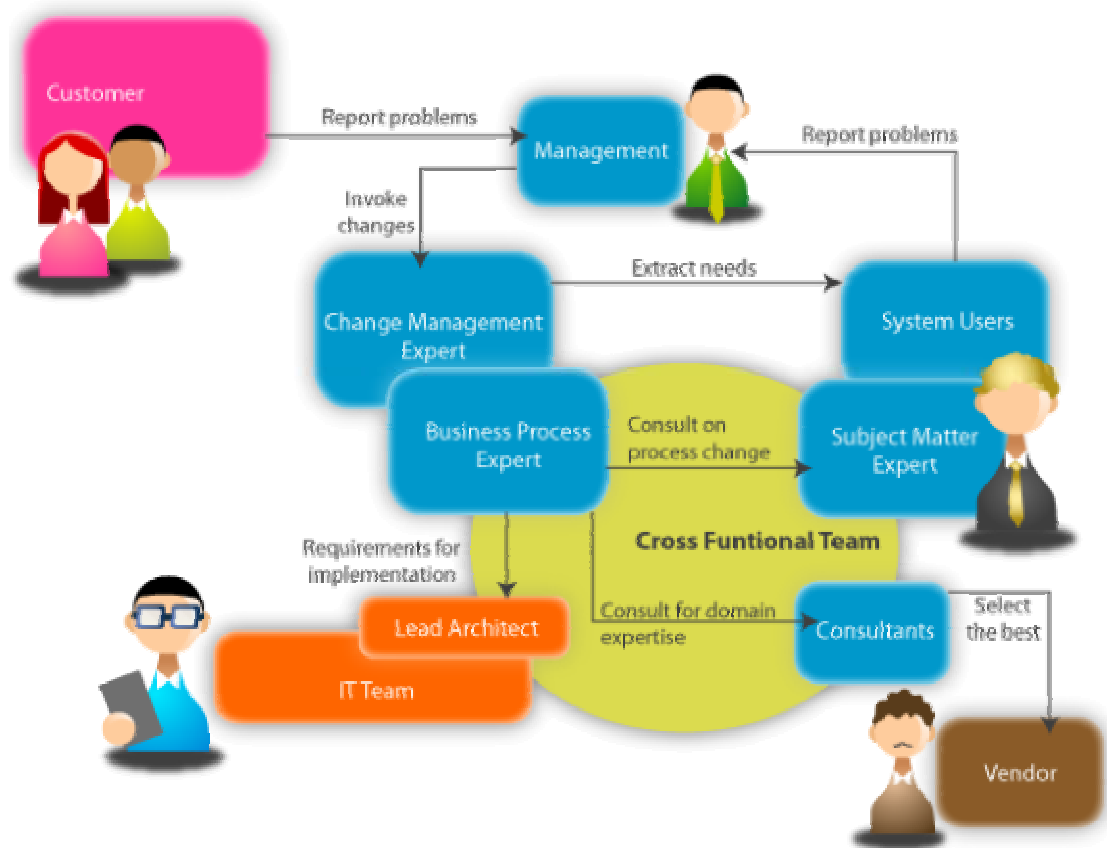


Figure 3-3: Stakeholder map showing influences

The need for a process change is mostly initiated by mid-level managers or system users within the company. Alternatively, the request might initiate from the customer when they report their problems to the management. The management directs this request to the change management expert or business process expert who investigates this request further and extracts needs from system users. They collaborate with a subject matter expert who is aware of both the as-is state and the to-be state of the business processes. Together, they design new processes and create functional specifications. Consultants help in this process by providing domain expertise on implementing and configuring the system. The business process expert then sends the functional specification to the IT Team who creates a technical specification and is responsible for implementing the process. In this manner, the business process expert acts as a broker between the IT Team and the business user by speaking their language and thus helping them achieve a common understanding.

Various tools are used throughout this cycle starting from project initiation to implementation. Figure 3-4 below highlights the tools used by the different user groups.



Figure 3-4: Stakeholder model showing tools

The customer uses various file sharing repositories to share their requirements and review requirements documents created by the cross functional team. All other stakeholders also use these repositories as a standard mechanism for sharing and reviewing documents.

The business process expert, subject matter expert and consultants work in collaboration to design business processes and understand user requirements. In order to do so, they use various business process modeling tools such as Visio and ARIS.

Once the business processes have been implemented using the SAP NetWeaver development tools, management and the change management experts use various tracking and analysis tools to create models that measure the cause and effect of these process changes.

4 Literature Review

4.1 Methodology Overview

We chose to review a mix of business readings, scientific papers and tool guidelines. We picked a number of recommended readings related to the domain of composite applications published by Microsoft, Gartner Research as well as SAP. We also read guidelines to gain a better understanding for the NetWeaver tools. Finally, we picked some readings recommended by faculty, specifically the ones on shared mental models, mixed-initiative approach and end-user programming.

4.2 What are Composite Applications? [28]

Microsoft Developer Network (MSDN) has published a series of articles [27] on Composite Applications. In the article “What are Composite Applications” [28], the author Atanu Banerjee explains that there is a gap between packaged ERP solutions and real-world business processes. He introduces Composite Applications as a solution to close this gap because they can be adapted to changing requirements in a cost-effective way and help to align stakeholders. The author explained that Composite Applications are enterprise software solutions which are assembled from pre-built components. They include personalization and customization abilities, so that users can easily and quickly modify specific functionality.

The failure that packaged ERP solutions do not meet real-world requirements is called the results gap. Custom solutions have to be built when packaged applications are not available. “The implications and benefits for both business users and solution providers can be summed up in three words: agility, adaptability, and alignment” [28].

There are four tiers of composite applications that target flexibility:

- Presentation Tier (Assets to present business information to workers)
- Productivity Tier (Assets to manage rhythm of the business-document management, collaborative support, information sharing)
- Application Tier (Assets to manage business transactions)
- Data Tier (Integration, Reporting and analysis of data)

Users of ERP and CRM solutions access business information and documents through web portals. These portals present a perspective into the enterprise depending on the user’s role. Altering business information or documents within the portal’s space is always part of a larger business process. Such a business process coordinates the activities of people and systems. “The activities of systems are controlled through process-specific business rules that invoke back-end line of business applications and resources through service interfaces. The activities of people plug into the process through events that are raised when documents that are specific to the process are created or modified. Then business rules are applied to the content of those documents, to extract information, transform it, and transfer it to the next stage of the process.” [28] Today, most packaged ERP and CRM solutions have pre-defined business processes. The author suggests that such enterprise solutions should be broken into collections of services which can be assembled into composite applications.

4.2.1 Design Implications

It is crucial for our team to understand composite applications as it helps organizations in being efficient. It helps organization map their business processes to the underlying architecture, and thus plays an important role in bridging the gap between the business user and the developers.

4.3 A Mixed initiative approach to semantic web discovery and composition [29]

Service Oriented Architectures permit the development of applications which are composed of services which encapsulate enterprise functionality. Attempts have been made to automate the composition of such services. They turned out to be unrealistic because many business processes are not accurately annotated.

The author of this paper [29] introduces a mixed initiative approach to service composition, which leverages existing service annotations but also involves the user to make decisions. The author has developed a framework for SAP's Guided Procedure Design-Time Tool to help users in discovery and composition of services:

- **Semantic discovery** enables users to search service repositories based on both functional and non-functional attributes.
- **Semantic dataflow** consolidation assists users by automatically suggesting ways of mapping input and output parameters of services as they are being composed.
- **Semantic control flow consolidation** suggests to the user in which order services are executed.
- **Users always have the flexibility** to selectively revise and complete existing annotations. Moreover, users are able to refine the control and data flow of selected services.

4.3.1 Design Implications

This paper [29] reveals to us that users of Guided Procedure Tool are confronted with a high degree of complexity when they try to compose services to build Composite Applications. We can also learn from this paper [29], that a service composition tool should hide the technical complexity of service composition, while maintaining the user's flexibility to look at technical details.

4.4 ARIS: Business Process Modeling Tool [30]

To implement their business requirements, organizations need an efficient way to map existing and new business processes. ARIS for SAP NetWeaver [30] enables organizations to define business management requirements from a business process perspective. Requirements are mapped using business process models and can be enriched with necessary additional information. "The two-way interface to SAP Solution Manager enables the models to be constructed based on SAP reference content for a process-based SAP solution" [30].

"ARIS is an important aid in making business decisions, while also ensuring that the required processes can be implemented in the SAP system" [30].

Highlighted below are the key features of ARIS for SAP NetWeaver:

Use of SAP reference content during the blueprinting phase

ARIS for SAP NetWeaver enables users to analyze SAP scenarios and processes which are available in SAP Solution Composer. Additionally, configuration processes from SAP Solution Manager can be integrated into this analysis as well.

Linking of process and configuration content

“The process content provided by SAP Solution Manager is imported into ARIS for SAP NetWeaver, where it is transformed into complete end-to-end processes that reflect the business management view. Content that relates purely to configuration is enhanced to include business information, such as manual operations and their description, executing roles, and data and information used. This process-based requirements analysis is the starting point for the subsequent blueprint” [30].

Synchronization between ARIS for SAP NetWeaver and SAP Solution Manager

“Synchronizing ARIS for SAP NetWeaver with SAP Solution Manager ensures that all the necessary process information is available for the implementation or upgrade project. Scenarios, processes, and process steps, along with the associated SAP transactions and SAP system landscape, can be imported into ARIS for SAP NetWeaver from SAP Solution Manager. It is also possible to reuse the relevant organizational and master data, as well as all documentation in ARIS for SAP NetWeaver” [30].

Wizard-supported creation of custom SAP scenarios

“A special wizard is available in ARIS for SAP NetWeaver to guide users through the creation of SAP-based process models. This makes it easy to get started with SAP-compliant process modeling and ensures adherence to specific conventions” [30].

Transferring the blueprint documentation into the process structure

“The business process models can be used in SAP training courses for all process participants. The ability to initiate transactions and access blueprint documents directly from ARIS gives users a process-based insight into the SAP system. The ARIS process models can also be integrated into the SAP F1 help system” [30].

Process-based planning of SAP enterprise Service Oriented Architecture (SOA)

“Since SAP communicates existing and future enterprise services using SAP Solution Composer, this information can be compared with the process models in ARIS for SAP NetWeaver. The enterprise services to be implemented can then be analyzed based on the process architecture. ARIS for SAP NetWeaver therefore provides a decision-making aid that is rooted in business reality, helping organizations to choose the correct enterprise services” [30].

4.4.1 Design Implications

ARIS is a business process modeling tool and thus is of significance to our project. We aim to enable business users to contribute in the implementation of their business needs. Thus, understanding the current mechanism used to model such processes and identify the strengths and weaknesses of this tool were crucial in order to better inform our design. The biggest strength of ARIS is that it helps users to integrate existing process definitions and documentations into an easy to understand process structure. It is also strength of the tool that it provides a number of wizards to guide the user in the creation of new processes. However, a weakness of this tool is its integration into the existing SAP tool landscape. It does not comply with the SAP look and feel and requires extensive configuration to be useful.

4.5 Semantic Business Process Management [31]

This article [31] highlights the challenges of Business Process Management (BPM) and suggests “to manage the execution of IT-supported business operations from a business expert's view rather than from a technical perspective” [31]. The author describes Business Process Management as being insufficiently abstracted which prevents business experts from seeing “the process space of an organization as a whole” [31].

“There is a bottleneck between the business perspective on operations and the actual execution of operations on IT systems. The fundamental problem is that traversing from one sphere to the other requires manual labor in any of the two directions, i.e. both for querying and manipulating the process space” [31]. Semantic BPM provides a high-level perspective on business processes inside an organization. However, the whole business process space of an organization is seldom accessible to business experts on a semantic level.

4.5.1 Design Implications

Our team learned from this article [31] that current database systems are not capable of interpreting abstract commands as needed by non-technical business experts. The concept of a semantic mediator can help to relate business goals to abstract database queries, and thus makes the actual process space more accessible to the user.

4.6 Introduction to Business Process Modeling Notation (BPMN) [32]

The author of this article [32] introduces the Business Process Modeling Notation (BPMN). The primary goal of BPMN is to provide a formal notation for business process modeling that is easily understandable by everybody involved in design, implementation and monitoring of business processes. Thus, BPMN bridges the gap between informal business process design and technical process implementation.

BPMN defines a Business Process Diagram (BPD), which is based on a flowcharting technique tailored to the visual design of business process models. A business process model is a network of graphical objects, which are activities (software services or user interaction) and flow controls that define the order of activity execution.

The aim of such a notation is to provide elements that modelers can easily identify, but yet support complexity. Variations of elements can be incorporated to support more complex constructs.

Highlighted below are the basic categories of such graphical elements [32]. These elements are illustrated in the simple example of Figure 4-1.

- **Flow Objects:**
 - Event (circles for start, intermediate and end based on when they affect the flow)
 - Activity (rounded rectangle)
 - Gateway (diamond)
- **Connecting Objects:**
 - Sequence Flow (solid line with a solid arrowhead shows the order of activities that will be performed)
 - Message Flow (a dashed line with an open arrowhead is used to show the flow of messages between two separate Process Participants that send and receive them.)
 - Association (dotted line with a line arrowhead is used to associate data, text, and other Artifacts with flow objects.)
- **Swim lanes**
 - Pool: A Pool represents a Participant in a Process. It also acts as a graphical container for partitioning a set of activities from other Pools. It is used when a diagram involves two separate business entities or participants which are

physically separated in the diagram. Sequence Flow cannot cross over two pools but message flow should.

- Lane: A Lane is a sub-partition within a Pool and will extend the entire length of the Pool, either vertically or horizontally. Lanes are used to organize and categorize activities. No message flow is permitted between flow objects within lanes of the same pool. Sequence flow may cross the boundaries of lanes within the same pool.

- **Artifacts**

- Data: Shows how data is required or produced by activities. It is connected to activities through associations.
- Group: Documentation or analysis purposes
- Annotation: additional text

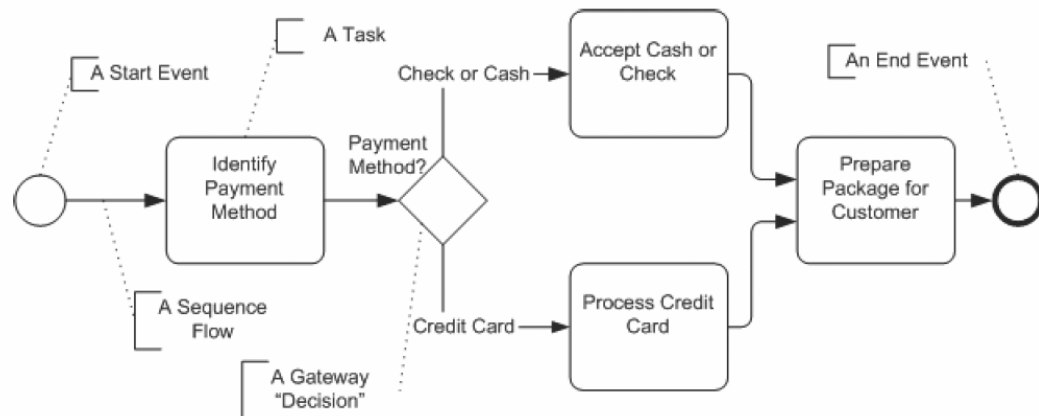


Figure 4-1: A simple business process model based on BPMN [32]

The general technique of modeling business processes is to start on a high level and then drill down to details. BPMN creates a standard for all modelers and also reduces the gap between business users and technical people who implement these models. “To help alleviate the technical gap, a key goal in the effort to develop BPMN was to create a bridge from the business-oriented process modeling notation to IT-oriented execution languages that will implement the processes within a business process management system. The graphical objects of BPMN, supported by a rich set of object attributes, have been mapped to the Business Process Execution Language for Web Services (BPEL4WS v1.1), the defacto standard for process execution” [32].

4.6.1 Design Implications

It was important for our team to understand this notation, as it is a standard in the industry and any design suggestions we make will have to take advantage of this. In addition, it helped in gaining a better understanding of the notation used in business process modeling and what are the important factors to be considered while designing them.

4.7 Improving User-Participated Requirements Analysis [21]

In this paper “Improving User-Participated Requirements Analysis in ERP Implementation: From the perspective of shared mental models” [21], Xuefei Deng analyzes the effects of shared mental models in the context of requirements analysis conducted by mixed teams consisting of IT consultants and application users. She believes that the overall software quality will be positively influenced when helping mixed teams to generate software requirements of higher quality.

To be successful in a team which analyzes requirements for implementing an ERP system, consultants must develop a sound understanding of the client's existing business processes while the user of the prospective ERP system must learn what functionality and customization a packaged ERP software can offer. Only by sharing their knowledge can they make the right decisions whether to change the existing business process, customize the packaged software or even de-scope requirements.

The author wants to apply the concept of shared mental models, first introduced to the team knowledge literature by Cannon-Bowers et al in 1990 [22] to help improve requirement team performance. She wants to determine under which conditions shared mental models (SMMs) are most beneficial. In addition, she wants to learn how task complexity and task size influence team performance when applying SMMs.

4.7.1 Design Implications

Shared mental models on teamwork have a positive impact on team efficiency. When designing for consultants, BPX and SMX, we should establish consensus among collaborators about their team process and their coordination with the application.

On the other hand, quantitative data did not support the hypothesis that SMM on tasks is positively associated with team performance. The author argues however, that the small number of observed teams might be the cause for this result. Nevertheless, we should design for helping collaborators to create a shared understanding of their task. For example, the elements of business process visualization should be recognizable by everybody.

Data also supported the hypotheses that shared mental models on teamwork have a positive impact on team efficiency.

When consultants and user representatives learned what to expect from each other, they were able to communicate and coordinate better, especially when they have to coordinate their effort on understanding complex requirements and on completing multiple requirements. [21]

These findings suggest that subject matter experts and user representatives should be trained on ERP software early in the development life-cycle, as it takes time to develop shared knowledge. Consultants should also prepare before working with subject matter experts and user representatives. The need is to be ready to communicate without jargon, to establish a shared view on common tasks and to establish team processes.

The author's final conclusion is that support for shared knowledge among consultants and users is an important strategy to improve the effectiveness and efficiency of requirement analysis teams.

4.8 End-User Programming (EUP) and examples in terms of Web Mashup

End-User Programming (EUP) describes non-professional programmer who writes programs in support of achieving their main goal [68]. Examples include accountants utilizing spreadsheets, analysts using MatLab, and general people creating web page and email filters.

Researchers have conducted many empirical studies focusing on how programming was learned, why programming is difficult to learn, and how people naturally express algorithms. Several consensus regarding EUP were reached [68]:

- Small syntax problems and typos that lead to catastrophic failure were often observed, while inappropriate formatting hinders code reading.
- Incremental rapid testing with good feedback is important to understanding.
- Appropriate metaphor helps the novice significantly.

Recently, many researchers make an effort to empower the end-user in creation of “mashup” through practice of end-user programming. A mashup is a website or application hybrid that draws content from more than one online source into a customized and integrated experience [38]. The emergence of mashup seems to be a promising solution for end-users to mix and match the tremendous amount of data and applications on the web into a form that supports their needs [34].

As we see a great degree of similarity between web mashups and composite application, we examined a few web mashup development tools below.

Yahoo! Pipes [36]

Pipes is a free online service provided by Yahoo! that lets the users aggregate and manipulate feeds to create mashups using a visual editor. As shown in Figure 4-2, a pipe is created by dragging pre-configured modules, which performs a single, specific task such as sort or fetch a feed, onto the canvas and wiring them together in the Pipes Editor.

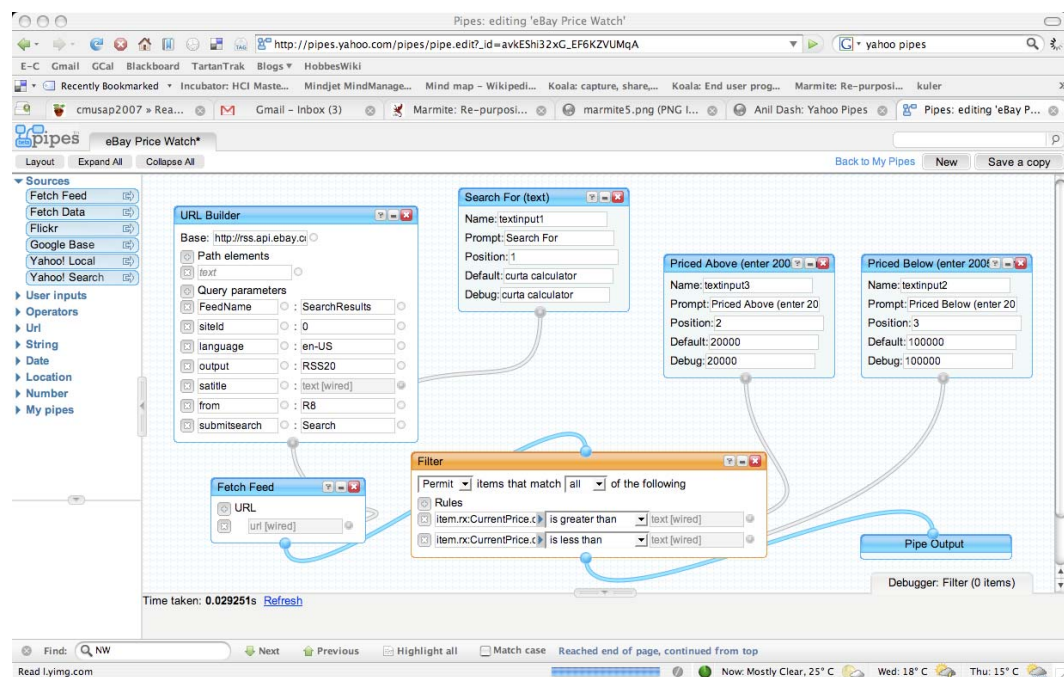


Figure 4-2 the user interface of Yahoo! Pipes and an example pipe [36].

Koala: Capture, Share, Automate, Personalize Business Processes on the Web [33]

Koala is a system that utilizes many popular EUP approaches such as programming-by-demonstration and sloppy programming. The abstract of the paper [33] provided a comprehensive description of Koala’s features:

Koala is a collaborative programming-by-demonstration system that records, edits, and plays back user interactions as pseudo-natural language scripts that are both human- and machine-interpretable. Unlike previous programming by demonstration systems, Koala leverages sloppy programming that interprets pseudo-natural language instructions (as opposed to formal syntactic statement) in the context of a given web page’s elements and actions. Koala scripts are automatically stored in the Koalescence wiki, where a community of users can share, run, and collaboratively develop their “how-to” knowledge. Koala also takes advantage of corporate and personal data stores to automatically generalize and instantiate user-specific data, so that scripts created by one user are automatically personalized for others.

Marmite [35]

Inspired by the Apple Automator, Marmite is an end-user programming tool which lets end-users create mashups in a data flow manner. Marmite's interface, as shown in Figure 4-3, consists of three major areas: the operator selection area, the data flow area, and the spreadsheet display. Users select operators from the operator selection area, place them into the data flow, and view the current state of the data at a particular operator, which shows what the data looks like after it has passed through that operator.

Marmite's design includes several attempts to solve common EUP problems in creating a mashup:

- Contextual suggestion of next actions guides the user in selecting next operators.
- The hybrid data flow/data view provides feedback about the state of the system between operations.

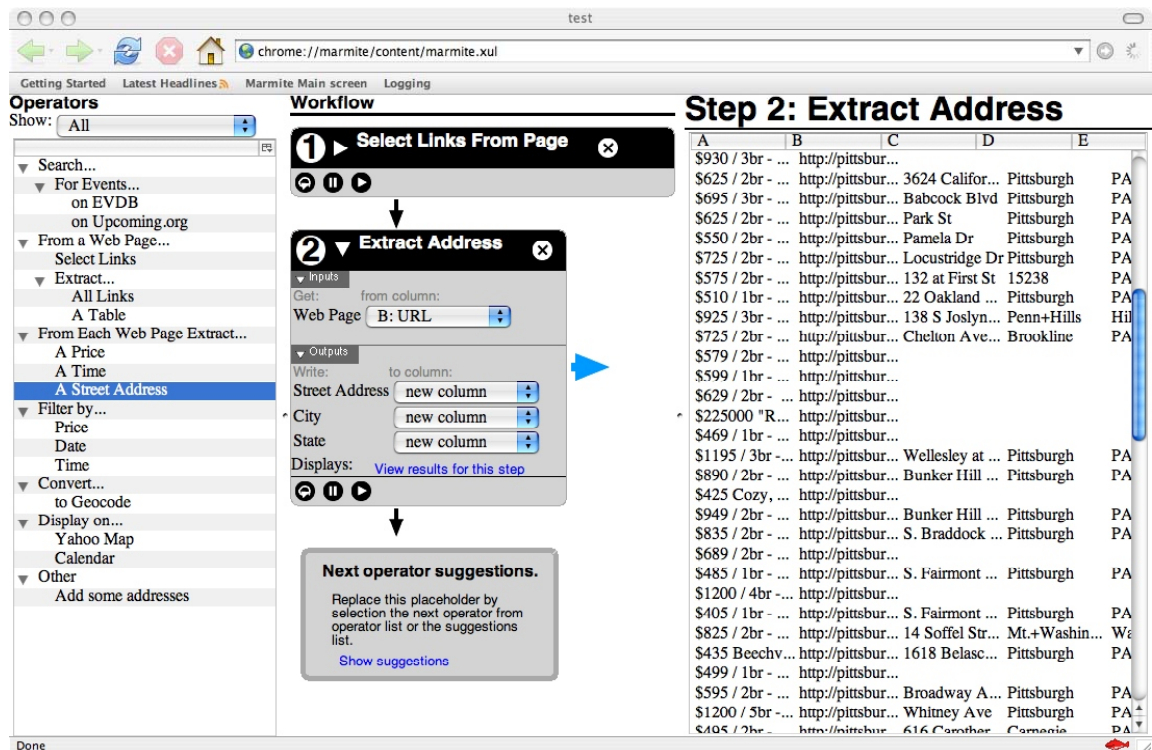


Figure 4-3: Marmite in action with a simple data flow and example spreadsheet view [34].

4.8.1 Design Implication

While we can draw a parallel between composite applications and web mashups, we also find a lot similarity between the business users who design composite applications and the end-users who compose mashups for their very own needs. Hence, it is important to consider the approaches utilized in the EUP systems when designing an application design-time tool for business users.

4.9 Guidelines to Specifying Composite Applications [37]

Aiming to provide a tool for product managers and business expert to communicate design specification of a composite application to the solution architect, this guide [37] consists of a series of forms and examples of how the forms can be filled out to provide all relevant information of a composite application. Below listed the forms in the order to be filled out:

1. General Application Information
2. Processes Overview

3. General Process Information (for each process)
4. Roles (for each process)
5. Visualization of Process Flow (for each process)
6. Step Data (for each process)
7. Exception Handling (considered for service calls)
8. Business Objects Overview
9. Business Object (for each Business Object)
10. UI Mockup (for each interactive step)
11. UI Description (for each interactive step)
12. Services (for each service)

4.9.1 Design Implications

This guide [37] provides us all the information that one would have to specify when designing a composite application that implements business processes.

4.10 Business Process Fusion: Enabling the Real-Time Enterprise [2]

The term “business process fusion” is defined by Hayward in Gartner’s research paper [2] as following:

Business process fusion is the transformation of business activities that is achieved by integrating previously autonomous business processes to create a new scope of management capabilities. A key driver for business process fusion is the competitive pressure to build a real-time enterprise, one that responds to market events and the general business environment as immediately as possible.

According to Hayward, the currently available business process fusion products are immature on one hand. He promises on the other hand that “cost will decline and profitability will increase through business process fusion because of greater efficiencies, visibility and control. It will allow for business processes to be modified without disrupting the supporting IT systems” [2].

4.10.1 Design Implications

We can learn from this paper [2] that business process fusion and composite applications will soon become wide-spread when business process fusion products become mature. SAP will soon be in strong competitive situation with their NetWeaver Platform, requiring them to have a strong competitive advantage. The cost of the product alone will not become a competitive advantage.

It is our insight, that SAP should focus on a strategy to reduce recurring expenses for customers of the NetWeaver Platform for software development and software maintenance. By tailoring the NetWeaver tools to business process experts and business users, the necessity for hiring expensive consultants might decrease.

4.11 Business Process Execution Language (BPEL) [6]

The author of this Oracle Developer Guideline [6] explains concise and precise what BPEL is and what it is used for:

The Business Process Execution Language (BPEL) is an XML-based language for enabling task sharing across multiple enterprises using a combination of Web services. BPEL is based on the XML schema of the Simple Object Access Protocol (SOAP), and Web Services Description Language (WSDL). BPEL provides enterprises with an industry standard for business process orchestration and execution. Using BPEL, business process can be designed to integrate a series of discrete services into an end-to-end process flow. This integration reduces process cost and complexity.

The BPEL language defines how to:

- Send XML messages to, and asynchronously receive XML messages from, remote services
- Manipulate XML data structures
- Manage events and exceptions
- Design parallel flows of process execution
- Undo portions of processes when exceptions occur

4.11.1 Design implications

We learn from this reading [6], that there is a need to share business process definitions among different types of users and applications. However, we consider this XML description as inappropriate for business users who are not tech-savvy. Instead, a business process modeling tool should be capable of generating such a standardized process description. A business process management tool can then use this description to execute a business process.

5 Competitive Analysis

5.1 Methodology Overview

Competitive analysis is an assessment of the features and their strengths and weaknesses of current and potential competitors. Our team performed a competitive analysis on the competitors of SAP in the field of composite applications design-time tools. In addition to becoming aware of the competitors, we were able to understand the scope and nature of the industry and determine the key factors of success. Our insights from this study will provide us an informed basis to develop concept ideas that will help achieve competitive advantage in the future.

5.2 Introduction to Competing Products

We found three leading vendors of business process management solutions: Oracle Fusion Middleware, IBM WebSphere, BEA AquaLogic BPM Suite. For each solution, we examined how the solution works as well as its key features and benefits from the vendor's point of view.

5.2.1 Oracle Fusion Middleware

Oracle Fusion Middleware (OFM) is a family of pre-integrated software products, which provide a coherent software infrastructure based on service-oriented architecture (SOA) [53]. OFM is based on a combination of standards, such as J2EE, XML, and Business Process Execution Language (BPEL), and “best-of-breed” services and stand-alone components spanning from portals and process management to application infrastructure, developer tools, and business intelligence. As opposed to SAP NetWeaver's “all-in-one” approach, OFM is packaged in various solution such as Business Process Management (BPM), Business Intelligence, Application Server, etc [54].

Particularly, the BPM solution is designed for “modeling, executing, managing, and optimizing” business process applications [66]. According to the Oracle Data Sheet [67], the BPM solution is comprised of the following components:

- Oracle Business Process Architect (BPA Suite)
- Oracle Business Process Simulator (BPA Suite)
- Oracle Business Process Server (BPA Suite)
- Oracle Business Process Publisher (BPA Suite)
- BPEL Designer (BPEL Process Manager)
- BPEL Console (BPEL Process Manager)
- Built-in Integration Services (BPEL Process Manager)
- Human Workflow Service (BPEL Process Manager)
- BPEL Server (BPEL Process Manager)

The Oracle BPEL Process Manager, as an integral part of the SOA Suite, provides “a framework for designing, deploying, monitoring, and administering processes based on the BPEL standard” [67]. The data sheet [67] explains that the product offers support for designing BPEL processes graphically either within Oracle JDeveloper IDE (Integrated Development Environment) or Eclipse IDE. These development tools allow visual editing of process model elements and eliminate the need to write BPEL XML descriptions manually. Also, wizards are provided to integrate workflows, transformations, notifications, sensors, and worklist task management with the process.

5.2.2 IBM WebSphere

WebSphere refers to a brand of more than sixty IBM software products that are designed to “set up, operate, and integrate e-business applications across multiple computing platforms using web technologies” [56]. The WebSphere family offers solutions to all different aspect of business IT, from application and transaction infrastructure, legacy application transformation, and business process management to e-commerce, mobile and speech middleware, and portals as well as software development and systems management [57]. The Business Process Management (BPM) solutions in particular offer tools to “model, assemble, deploy and manage processes” [58].

Among the BPM tools, our attention was drawn to the WebSphere Business Modeler which is specifically tailored to business analyst to "model, simulate, and analyze complex business scenarios" before they are implemented [59]. IBM's product page offers the following introduction to the product:

WebSphere Business Modeler products help organizations to fully visualize, comprehend, and document their business processes. Rapid results can be obtained through the collaboration functionality, where subject matter experts team to clearly define business models and eliminate inefficiencies. You can model business processes, then deploy, monitor, and take actions based upon KPIs, alerts, and triggers for continuous optimization.

We were also able to take a look at the user interface of the WebSphere Business Modeler from the online product help [61] provided on the IBM product website. Built on Eclipse's universal development platform, the user interface consists of multiple panes. The default 4-panes layout is set to have the Project Tree view, the Process editor showing a process diagram, Outline view, and Attributes view as shown in Figure 5-1.

The help page also explains the features of WebSphere Business Modeler. Some of the intriguing key features we found are listed below:

- Multiple business modeling modes allow users to view and develop models at different levels of detail.
- Association between business measures (key performance indicators and metrics) and process can be defined and used by WebSphere Business Monitor.
- Step-by-step animated simulation flows of real-time data enable the simultaneous viewing and examination of all cases in a virtual work environment. Simulation output on detailed information regarding resource utilization levels, cost, and cycle time calculations change dynamically as simulation runs.
- Predefined or custom reports can be generated automatically based on a wide range of process data.
- Project versioning and change tracking is available for the needs of large or distributed modeling team.

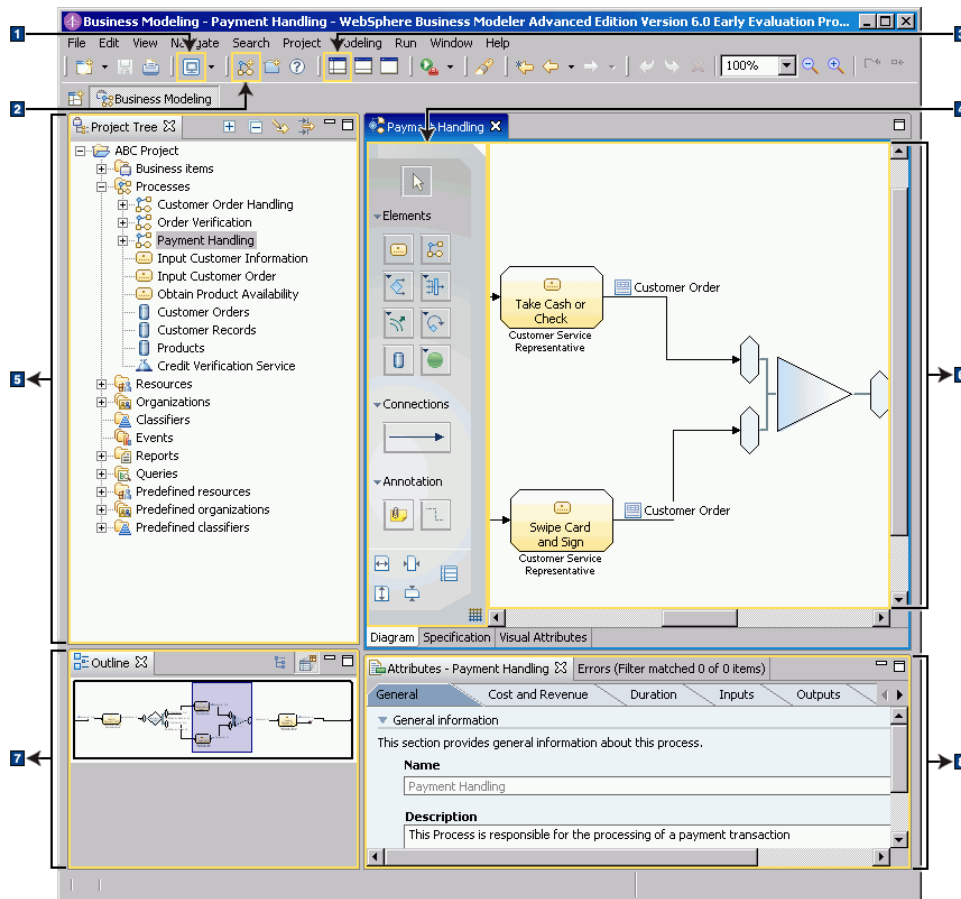


Figure 5-1: The user interface of WebSphere Business Modeler [61].

5.2.3 BEA AquaLogic BPM Suite

BEA AquaLogic BPM Suite is an integrated set of business process management tools from BEA Systems [62]. The suite consists of a number of specialized tools for different personnel participating in the process lifecycle as listed below [63]:

- BEA AquaLogic BPM Designer and BEA AquaLogic BPM Studio for process development
- BEA AquaLogic BPM Enterprise Server and BEA AquaLogic HiPer Workspace for BPM for process execution
- BEA AquaLogic BPM Manager and BEA AquaLogic BPM Dashboard for process optimization

In the ideal scenario described on the product website [63], business analyst would use AquaLogic BPM Designer to design and simulate business processes using business process modeling notation (BPMN) and UML modeling standards without writing any code. Completed project models are then directed to Aqua Logic BPM Studio, the workbench used by process developers to write business logic, connect to services, and assemble user interfaces. The completed process applications are deployed on the AquaLogic BPM Enterprise Server, where all resources that are part of each process can be orchestrated. Participants of the deployed process can access and manipulate tasks according to their assigned roles and responsibilities in the workspace provided by AquaLogic HiPer Workspace. Furthermore, real-time and historical process data are collected by the server and visualized through AquaLogic BPM Manager and AquaLogic BPM Dashboard respectively.

The product website [64] also claims a number of features and their benefits. Below, we list several points that interest us the most:

- Multi-language support for both development environment (English and Japanese) and deployed processes (up to 9 different languages) enables both internationalization and localization.
- ALBPM Designer and ALBPM Studio use one single integrated development environment (IDE), as shown in Figure 5-2, for “modeling, documentation, simulation, and testing” so separate components are not required for completing a full process lifecycle.
- Process templates repository is available for storing captured process best practices and for reusing across different BPM projects.
- The ability to define key performance indicators while modeling the business process allows business analysts to specify business activity data they want to monitor.
- Role based swim lanes allows the modeler to incorporate roles within the process design.
- Localized process documentation helps ease the creation and maintenance of up-to-date process reports.

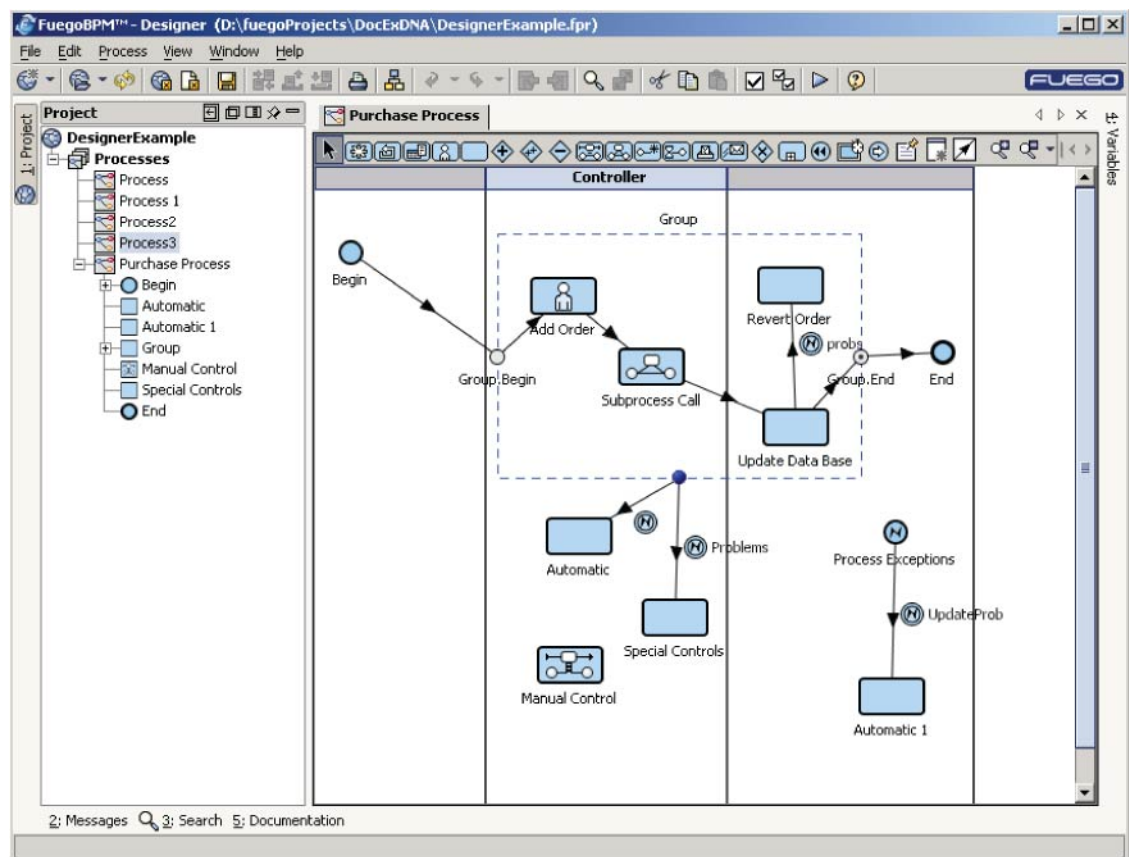


Figure 5-2: The user interface of BEA AquaLogic Designer and AquaLogic Studio [65].

5.3 Competing Products Review

Due to the limitation in gaining access to the competitors' products, we were not able to try out each product and conduct formal usability testing ourselves. Instead, we evaluated the strength and weakness about each product through examining online reviews written by various system

users and consulting firms. The data was valuable to us because the weakness revealed unaddressed user needs and the strength demonstrates valuable components that we should consider for our design. Table 5-1 summarized the findings of our competitive analysis.

Strength	Weakness
Oracle Fusion Middleware	
1. Code-driven development environment which supports agile methodology [45] 2. Support various mid-ware and database systems, such as PeopleSoft, J.D. Edwards applications and IBM DB2 Database [45] 3. Has very nice graphical tool which set to support business process execution language implementation. [45] 4. Allows users to deploy Fusion Middleware applications to any Java EE (J2EE)-compliant server. [45]	1. Weak on modeling and architecture tools, such as no data modeler for designers. [45] 2. Tutorials do not demonstrate good server-side development practices [45] 3. Calls to web services and similar cross-system communication are slow [45] 4. Provides good test environment, but do not scale to realistic production use because the main system focus too much on the standard service-oriented architecture technology which is extremely time consuming. [45]
IBM WebSphere	
1. The development tools suite is comprehensive and has strong team development features [46] 2. Has strong operational management features [47] 3. The directory strategy is strong and flexible [47] 4. Has strong integration features, including excellent tools for inspecting mainframe transactional systems [47] 5. Has strong support for Java and web services standards [47] 6. Provides built in search facility, users are also able to integrate with IBM's OmniFind or any other third-party FAST search engine. [49] 7. Allows integration with Microsoft products, which includes Word integration for authors and drag-and drop capabilities from Windows. [49] 8. Provides good UI development tool with tight Eclipse IDE integration [49] 9. Provides three UI views (basic, intermediate and advanced) for different level of users. [50] 10. Provides on-line error log which permit user/analyst to fix the syntax or grammar errors in the process model before deployment. [50]	1. Lack of a unified application server platform, which requires the users to work with two separate platforms (WebSphere Business Integrator Server Foundation and WebSphere Portal) [46] 2. Users need to integrate manually to create a single platform for composite applications [46] 3. Lacks a single development model for composite applications. Instead, it provides packages of tools for its two separate platforms, which raised the complexity of developing and managing composite applications [47] 4. Lacks unification in administration and management tools, although individually they both have strong clustering features for reliability and availability, but they are not yet integrated into a single administration framework." [47]
BEA AquaLogic BPM Suite	
1. Developers are able to create data services by	1. Weak on system securities [52]

<p>writing simple queries against a unified model, eliminating the need to write code to access, transform, and merge information from multiple sources. [48]</p> <p>2. Provides a single, unified administration console for data services which reduces training and management costs [48]</p> <p>3, Developers can save application development time and costs by utilizing data services. Data services provide a single, unified interface to all enterprise data regardless of where it resides, which simplifying application development. [48]</p>	<p>2. Lacks the integrated composition environment that will be required to provide unified toolsets so users can compose and manage a service or process from a central point rather than through separate SOA products.[51]</p>
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Table 5-1: Strength and weakness analysis on competitors' products

6 Heuristic Evaluation

6.1 Methodology Overview

Heuristic evaluation involves “having a product examined independently by multiple evaluators who understand the product's goals and have good knowledge of established usability guidelines” [40]. These evaluators develop a list of items that must be addressed, creating a structured format for the evaluation.

6.2 Purpose

SAP NetWeaver is composed of three tools - Visual Composer, Guided Procedures and Composite Application Framework (CAF) core. Team members conducted individual heuristic evaluations to evaluate these tools by using established usability guidelines [41]. On completion of individual reports, a consolidated report was generated that included all individual evaluations. Even though the focus and aim of this project is to look at the big picture and design a concept that addressed a bigger scope of problems, this evaluation served the purpose of helping us become familiar with the user interface. Moreover, this study also helped us overcome the barrier of limited access to users by enabling us to impersonate their roles and identify the problems they experience every day.

6.3 Table of breakdowns

This evaluation largely reflected the complexity of the system. Trivial tasks such as adding a new control to the user interface require the user to go through multiple steps and this can be expected to be annoying to most users. The interfaces use extensive jargon and this might intimidate novice users who are new to the system. Moreover, some controls and navigation were found to be unclear and no contextual help was provided in this regard. In addition, unclear error messages were observed during the evaluation. Table 6-1 summarizes our findings along with a severity rating (0-Not a problem, 1-Cosmetic Problem, 2-Minor Usability Problem, 3-Major Usability Problem, 4-Usability Catastrophe) [41] for each item. The severity rating in Table 6-1 is an average of individual evaluator ratings for each item.

Name of problem aspect	Severity Rating
Plus(+) button for adding a field is not visible	4
Two circles on top of the arrow from Start to GP Form in IView are not clear	1
No warning for invalid input in creating a new UI control	1
Check boxes do not inherit previous settings	2
Text lost without saving	3
In Content Administration, the screen should reflect the expansion of the tree menu	1
Menus are too small to read	2
Multiple steps required to add a UI control to the layout board	4

Use of jargon while adding a field	3
Unclear understanding of different tabs	2
Use of unclear controls	2
Error message not easily visible	4
Use of nested tree structure	3
Unimplemented feature	3
Unclear navigation between controls	3
Text field controls within layout view are only selectable within the textbox area	2
Controls shown in design view disappear after deployment to GP	2
Selections within Design view are not shown in Browse model	3
Browse model side bar does not show controls of design components	3
Unusable/unidentifiable icons in the Layout view	2
Error 500 upon creating a new process	4
Non-smooth horizontal slide and inconsistent view	2
Use of VC within browser leads to confusion	3

Table 6-1: Consolidated Heuristic Evaluations

Detailed descriptions of the problems identified can be found in the usability aspects reports (UARs) in Appendix A.

7 Contextual Inquiries

7.1 Methodology Overview

Contextual inquiry is “a user-centered research method in which focused field interviews are conducted with users. The goal of this research method is to explore the context of where business process design would occur and to understand users' approaches towards their work while identifying users' needs, so the product can be best designed to accommodate or improve current practices” [42].

Due to the intermittent, lengthy, and collaborative nature of business process modeling, it was impossible for us to observe the user's real work in the short time available to us. Thus, we elicited retrospective accounts as a method to overcome this constraint. During the interview, we probed the users' roles and involvement in business process design, the problems and challenges they dealt with, the applications and tools they used, whom else they worked with, and how they communicated with their collaborators. We also asked our participants to walk us through relevant documentation they created in their work process.

For each interview conducted, we used the contextual design method developed by Hugh Beyer and Karen Holtzblatt [42] and created the four work models described below to capture information gathered during the interview.

- **Sequence model** represents the steps by which work is done, the triggers that kick off a set of steps, and the intents that are being accomplished.
- **Flow model** defines how work is broken up across people and how people coordinate to ensure the whole job is completed. It also records down all instances of passing an artifact, communicating information, or coordinating to do the work regardless of the formality.
- **Cultural model** captures the invisible mindset that people operate within and that plays a part in everything they do.
- **Artifact model** extends the information on the tangible things people create or use to help them get their work done to show structure, strategy, and intent.

Following completion of individual models, we then aggregated all the individual models into one or two consolidated models for each of the four types of work models. From the consolidated models, we were able to gain a good generalization of the problem spaces and identify trends and common practices across different context.

7.2 User Recruitment

For our contextual inquiries, we are interested in understanding the practice of business process design and modeling from diverse perspectives. Given our project scope, we recruited stakeholders that fall in the following three user groups:

- **Current SAP tools users** who can provide us insights into the current state of the composite design-time tools. In order to adapt the tools to extended user groups, we have to understand the current system, retain its strengths, and remove its breakdowns.
- **Business users (BU)** are our original target user group for this project. We have to understand the business user's involvement within the context of business process modeling and look for design opportunities.
- **Business process experts (BPX)** have expertise in both the business and IT field. This user group often emerges as people's skill set evolve, and they tend to stand out as the broker

between business users and IT. Understanding their approach and strategy on enabling co-ordination between these disparate groups will help us discover design opportunities.

We have been recruiting through SAP partner consulting firms and attempting to connect with local Pittsburgh companies. In the initial phase of our user recruitment process, we encountered an unexpected challenge in gaining access to the right users. Such a challenge is particularly because business process modeling is not a common activity outside large corporations and that the business users involved in the business process modeling activities tend to be high up in the management hierarchy. Connection to the companies and contact information to these people are often protected from the public. Fortunately, towards the end of the given research time we had, we were able to gain access to more users via our personal networks.

In the end, we conducted fourteen contextual inquiries. The figure below maps all the users we have interviewed onto the spectrum of the skill set. The map in Figure 7-1 shows the spectrum of diverse users we recruited, ranging from technology oriented to business oriented. The business process experts (BPX) lie in the middle of this spectrum.

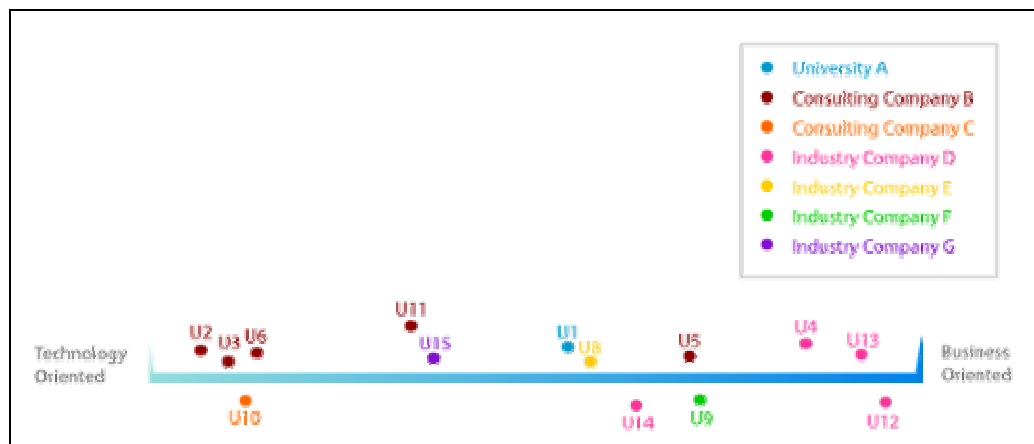


Figure 7-1: User Recruitment Map

7.3 Individual Contextual Inquiry Findings

7.3.1 University A

U1

Summary and design opportunities

For this contextual inquiry, we visited a financial system director's natural working environment, and we were able to understand how a business process expert communicates with system users and technical teams to improve business processes for the benefit of the university. We learnt that there exists a need to be able to maintain documents efficiently in regards to business process design.

Important insights

The daily activities of a Business Process Expert (BPX) center on communication (via email), meetings, and documents creation/review.

“Business requirement gathering is incredibly important.” Currently, most of this effort was done in the fashion of observing and talking with the system users to recognize the changes that have to be made. The important things to be captured include how the current system works, the system user's wishes and preferences, frequency of the needs, etc. Then cost, time, and trade-offs are taken into consideration when designing solutions.

Many meetings between the user and the consultants were to get advice on the business process changes. Part of the responsibility of our participant includes coordinating user acceptance testing, communicating the plan of deployment of the system, and training users on the new system.

7.3.2 Consulting Company B

U2

Summary and design opportunities

For this contextual inquiry, we interviewed a developer experienced in using the SAP composite application design-time tools. We were able to examine how he collaborates with other team members and how he approaches composite application development. Our team recognized the need for the detailed technical specification before developing the composite application.

Important insights

Communication between different roles is mostly done via emails, meetings (with phone conference), and documentation. The flow of communication very much relates to the sequential phasing of the project itself.

The central repository of documentation serves as a key communication point. The shared documents formalize the understandings to the project members, as well as provide a unified guideline to implement business processes.

The following are some of the documents we observed were used in the process of business process modeling: Business requirements, ARIS business logic models, Functional Design Specification, UI field metrics, objects model, Technical Design Specification. The business requirements, functional specification documents, technical specification documents, and UI field metrics were comprehensive and lengthy in Microsoft Word format. Tables are often used to create a clear mapping between different modules or functions and their specifications. The object model and ARIS business logic models that illustrated the relation and connection between different modules were in Microsoft Visio format.

The functional specification document specified the business process in terms of flow, logic, requirements, dependencies, and other details while the technical specification document specified the application architecture, object entities, UI pattern, and other implementation details.

During composite application development, it is extremely crucial to follow the guidance specified by the Technical Design Specification.

U3

Summary and design opportunities

In this contextual inquiry, we interviewed a developer who is responsible for creating web user interfaces for composite applications in his currently assigned project. He uses both Composite Application Framework and Guided Procedures Design-time to implement the user interface, which is entirely based on the Web DynPro Framework. During the interview, we were able to observe him using SAP NetWeaver Developer Studio to create Web DynPro components for Guided Procedures.

Important insights

The developer depended heavily on the development infrastructure including NetWeaver Development Infrastructure and NetWeaver Development Studio (NWDS). In order to share his work with other developers, he has to check-in the user interface components to the Catalog.

Moreover, service entities created within CAF core also need to be created in Guided Procedures Design-time, which introduces unnecessary steps in the observed context.

Data models from legacy back-end databases have abstract representations within NetWeaver Design-Time Tools. No compelling visualization of the abstract data model or the mapping between the databases is available in the tools, causing a lot of manual work when implementing the abstract data model.

Breakdown highlights

The user constantly lost connection when trying to connect to the server. Whenever a process took longer than expected, the user opened a Windows Console to ping the needed server resource. Since development of Web DynPro components requires the NetWeaver Development Infrastructure (NWDI), it is critical for a developer to be able to stay connected.

U5

Summary and Design Implications

This contextual inquiry was a phone call with a business user who is responsible for leading the creation of a composite application. Several design implications arose from this session:

- There is a need to market the composite application by showing how it fits on the SAP solution map. This helps in marketing the composite application.
- There is a need to create a set of testable requirements early on in the process to avoid requirements that cannot be tested.
- There is a need to organize business processes and measure the impact of business processes based on metrics of performance.
- There is a need to view business processes as an end-to-end process rather than as individual transactions.

Important Insights

ARIS is used to model business processes. Solution Manager is a mature tool that is used to organize business processes and enables the creation of a business process hierarchy early in the project. Moreover, it is important to know where a composite application fits in the value chain and what are the inputs and outputs of the value chain. Additionally, it helps to work closely with SAP to create a united front to the client.

Important Breakdowns

Clients are often intimidated by Service Oriented Architecture (SOA) as it is perceived as being expensive and time consuming in development.

U6

Summary and design opportunities

In this contextual inquiry done through a conference call, we were able to examine how a developer and his team worked on a composite application that will apply to multiple industries. Several design opportunities emerged as follows:

- There is a need to support extensive collaboration between multiple developers.
- There is a need to support easy interactive mapping between the visual business process model and the Guided Procedures (GP) implementation.

Important insights

Converting business process models into Guided Procedures (GP) models, and mapping between real world objects and GP callable objects, requires better documentation and standards.

A .NET application that manages the hierarchical assignment between an ARIS model and a callable object is being developed. In the application, one will be able to drag-and-drop the action to the callable object to create a guided procedure layout.

It relies on the developer's own reasoning to know whether the implemented model fulfills the needs. Usually Web Dynpro makes it obvious what should be in one screen, and each layer has very specific strengths to keep the components there.

Breakdown highlights

Version control in Web Dynpro is not well supported to allow more than one user to work on the same component at the same time.

Visual composer seems to be good for quickly prototyping their ideas, but it does not tie back to the rest of the Composite Application Framework (CAF) work. The lack of version control also prevents them from using it.

The mapping between ARIS model to callable object is not one-to-one. For example, if there are four steps in the ARIS model, it may really make sense to have just one callable object in Web Dynpro.

Jumping back and forth between Excel sheets and Word documents to tabulate all the specifications into a number grid does not provide a good visual representation of how the program will end up looking.

U11

Summary and design opportunities

In this contextual inquiry done through conference call, we were able to examine how a technical lead and his team worked on a composite application that will apply to multiple industries. Several design opportunities emerged as follows:

- There is a need to support extensive collaboration between multiple developers and business s process orchestrators.
- There is a need to ease the effort in soliciting business requirements.

Important insights

In terms of how to coordinate a team effort:

- Two people are assigned to develop one module: One person is responsible for the User Interface (UI) layer; the other person is responsible for GP modeling and implementation of web services.
- Communication tools used includes email, desktop sharing conference, requirement tracking system and an online document repository.

Requirements and processes are solicited using iterative whiteboard sessions with subject matter experts. These subject matter experts are consultants dealing with the client in the target industry on a day-to-day basis, thus making them the best source of in-depth knowledge, general pattern of the business processes and the pain points. The whiteboard session covers everything about the process, from the overall flow to details of each individual sub process and system level use cases. Pseudo design and steps are often drawn out to ensure that the vision from the subject matter expert is captured.

All the design details should be captured in detail in the functional design specification before moving into implementation. Having the specification done properly and validated by all stakeholders is important to avoid problems at a technical level.

The basic idea of composite application is to leverage and reuse as much back-end functionality as possible, so that there are no redundancies between the back-end system and the composite application.

Breakdown highlights

Understanding what is there and what needs to be built is challenging. Getting this information from subject matter experts is difficult as they tend to be not technical and do not understand object models. Moreover, Visual Composer (VC) does not support very complex user interfaces.

7.3.3 Consulting Company C**U10****Summary and design opportunities**

In this contextual inquiry using a telephone conference call, we talked to employees from a leading global provider of strategic consulting services such as software development, process management and business intelligence. There were three participants from the users' side. They have been grouped as one for the purpose of this report, as it was difficult to distinguish their different opinions and made best sense as one collection. Below are their different roles in the company:

- Facilitator at Consultant Company, manager of the remaining participants.
- Developer 1
- Developer 2

During this phone conference, the two developers reported about their last project involving the migration of a Field Service Report application from a legacy system into SAP NetWeaver Portal. Both developers have extensive experience in Web Dynpro web application development using NetWeaver Developer Studio (NWDS). The application being migrated is used worldwide and was difficult to change, which led to this project with the aim to implement the same functionality within NetWeaver Portal.

Important insights

Both developers were very technical oriented and did not participate in business process design activities for this project. However, they participated in the definition of the technical design specification, which was an important driver for the implementation of the new application.

Unit testing was used during development. Such practice is made possible by following the Model-View-Controller (MVC) design pattern when implementing the Web Dynpro user interface. Implementing Web Dynpro according to MVC pattern is directly supported by NWDS as shown in Figure 7-2.

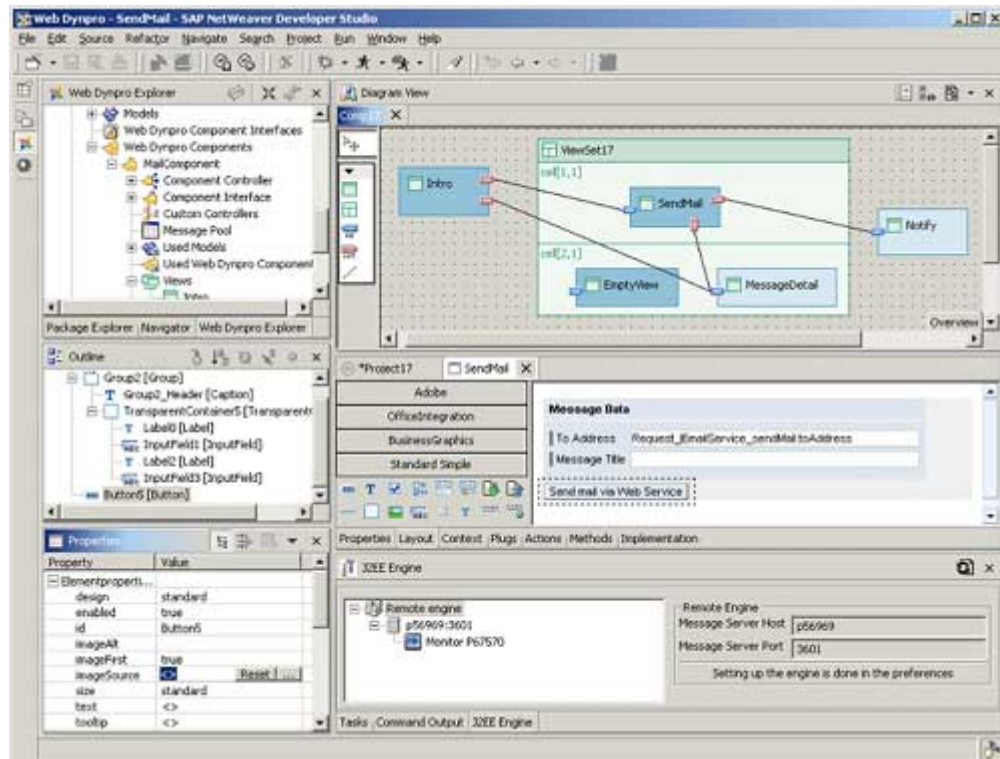


Figure 7-2: NWDS showing diagram view and user interface view of model view controller (MVC) pattern

The screens for SAP NetWeaver Portal have been completely implemented from scratch. The demonstrated use cases were implemented in wizard-style application control. A tiny preview maps the current visible screen into the overall flow. The application features progress bars and tabbed views, which are ready-to-use Web Dynpro components.

At the end of the project, both stress testing and user testing were conducted. However, only a little feedback resulted from the user testing as it was conducted offshore and was out of scope for the developers.

Breakdown highlights

It has been mentioned that the NetWeaver Mobile Platform did not satisfy their needs as field service workers need to work offline for longer periods of time.

The existing screen flow overview found in the field service report application is tiny and does not help the user to understand up- and down-stream process context. This tiny view could be expandable to show details of the process step and the pre- and post-conditions relevant to the overall business process as an error prevention mechanism and to foster awareness of the business process.

There is no easy transition available from showing flows of screens to showing the high-level business process.

7.3.4 Industry Company D

U4

Summary and design opportunities

In this contextual inquiry done through a conference call, we were able to examine how a business user worked as an internal business process consultant to drive improvement to a rapidly growing company. Several design opportunities emerged as follows:

- There is a need for the consultant to be aware of all relationships between each isolated module to prevent unexpected issues upon changes to individual modules.
- There is a need to document and keep the knowledge of current processes with the company rather than with individual employees.

Important insights

The consultants collaborate heavily with the resident expert team for each process cycle. The resident expert team has an executive owner for each process cycle. While the consultant team can provide assistance in reviewing and improving the processes, they first need the resident expert to provide in-depth understanding of their own process cycle.

It is important for the consultants to consider long-term strategy (5 to 10 years ahead) and envision the future state as a goal to lay out a roadmap towards the goal.

The consultants also work as bridges between all the individual process cycles. They have to move a level up and prioritize initiatives and projects across the entire company.

Below are examples of the kind of problems that the business process consultant encountered:

- Entitlement process is how they ensure a specific customer is entitled to a specific service. The current entitlement system is tied to the serial number attached to a computer. Therefore, when a customer buys a computer, the serial number signifies what level of service customers are provided. However, it is problematic to decide where this serial number should be placed.
- Sales order process – The current order processing system is implemented in Oracle. However, there is a need for this process to be more agile. Currently, when a customer places an order with multiple options, the system is unable to handle the wide variety of configurations. Because of this, 70% of the orders require manual intervention and dealing with this makes the process non scalable, especially in large companies.

Breakdown highlights

Isolation of modules lead to issues in other modules upon process changes: "The decision engineering makes in engineering process causes issues for sales force, operation group, service group, marketing process because engineering is isolated."

Lack of central documentation process: "Current process is not documented, so when people leave the company, all the existing processes are lost."

Too many different software products that do not talk to each other: "The software we use includes Oracle, SAP, Agile PLM (Product Lifecycle Management), Siebel CRM, PeopleSoft HRM. It was not a smart choice because they duplicate or overlap the technology." These software tools served different purposes and no one at that time looked ahead 5 years to foresee the current problems faced.

U12

Summary and design opportunities

In this contextual inquiry done through a conference call, we were able to learn how the user creates and applies changes to processes, and helps people adapt and see the benefit of the change at the company level. The user also conducted Conference Room Prototype (CRP) and User Acceptance Testing (UAT) with users and gets business processes validated.

There is a need for supporting simple artifact sharing with access control.

There is a need for a document format that can be understood by the public.

Important insights

The company is implementing CRM (Customer Relationship Management) in SAP, and the user spends a lot of time trying to figure out how to leverage existing processes that do not work well with SAP's out-of-the-box functionality while redesigning business processes.

Tibco is middleware software between Oracle ERP (Enterprise Resource Planning) system and Ventis CRM system, and is a business integration and process management software. It moves transactions through a heterogeneous environment.

When the user cannot create a process that makes everybody happy, he makes sure to bring in stakeholders so they see the benefit of the change over the company level.

The user project team shadowed system users to understand the business process. Generally, development process is a very iterative process and communication is required.

The participant had the business processes design validated with users. He conducted Conference Room Prototype with 25 users and implemented the prototype for the second round of testing. User Acceptance Testing was conducted after problems were fixed. Full-blown transactions were then tested by real users. Go or No-Go decision is then made whether to put the system live.

The company had administrators who kept track of who made changes and what is changed in documents on SharePoint.

Breakdown highlights

The customer was not satisfied with the level of service from the company: Customers expected the company to know everything about them. So when the company could not provide appropriate services, the customer got frustrated.

Process design automation software was useless: People who used the process design automation software got only a minimal amount of help since the problem definition was too variable. Therefore, the software generally spit back out a lot more information than what a white board or Visio would yield.

Business requirements document is too complex to look back: Once the design phase is done, the business requirements document was no longer referenced since it was simply too complex. Moreover, the user admitted that the company was not good at documentation.

U13

Summary and design opportunities

In this contextual inquiry done through a conference call, we were able to explore how a business user worked as a departmental process change facilitator. Several design opportunities are emerged as follows:

- There is a need to be aware of human dynamics involved in the process change.
- There is a need for a business process modeling tool that is easy to train on, integrates well with common office tools, and allows creativity with guidance.
- There is a need for prototypes to encourage people to embrace process change.

Important insights

Facilitating process change is all about managing human dynamics - being able to see inefficiency in other people's work, tackling with people's inertia against change, persuading them that the change will be good while making people feeling worthwhile, and gaining support from the managers.

People make small process changes on a daily basis in their individual tasks.

The need for larger scale process changes can arise from a combination of one or multiple different motives listed below:

- Significant inefficiency in current process noticed by mid-level managers
- Customer demands which grabbed top-level executive's attention
- Rapid changes in market, especially in responding to emergence of new technology
- Catastrophic events such as change in industry regulation or missing product deadline

A non-rigid template allows people to be creative to document in their style.

Visio is perfect for less tech savvy users. It is easy to train on and integrates with all the other MS Office tools.

Prototyping is an effective means to help people deal with change. Being able to play with prototypes makes people comfortable with possible upcoming changes.

Breakdown highlights

Extensive coordination with the suppliers is required when changes are made in the system. Small problems tend to arise even when connection is tested constantly. Many previously tests are run again to confirm things still work.

U14

Summary

For this contextual inquiry, we interviewed a change management expert who just joined the company and was able to provide important insights on change management in general along with business process modeling and simulation. The following design opportunities emerged through the inquiry:

- There is a need for support in standard Office tools for process change documentation, as this is the standard documentation tool supported across the company.
- There is a need to not only to visualize business process flow but also simulate it.
- There is a need to support root-cause analysis within business process modeling tools.
- There is a need to allow modeling in multiple sessions by multiple people asynchronously.
- There is a need for a quick start guide for any packaged software.

Important insights

A change management expert must maintain many ties to people in the company to gather feedback on process redesign. The participant used these contacts to convince people to accept changes. The change management expert must also be highly agile to react quickly to problems that infer process change.

Every change management Initiative starts off with business process modeling.

A swap out of a system or a new system will always cause a process change in the company.

The participant used the ADKAR Prosci [44] methodology to assess the company's awareness, desire, knowledge, ability and reinforcement towards change. He also uses a Fishbone Diagram to help him to find the root-cause of problems.

It depends on the work culture how to effectively invoke change in a company. A business process workbook is not as powerful to communicate to other people as PowerPoint presentations. Another good way to communicate business process change is going on road shows to demonstrate detailed screen flows.

Showing different levels of granularity of the business process helps to develop awareness of up and down stream processes among business process participants.

High-level views of business process flows are visualized using Visio, but the real value does not come in until the real implementation is shown to users and is close to what they expected. If people do not see what the process looks like, they will not entirely understand – which is the nature of the beast.

Packaged ERP software should be shipped with easily accessible documentation: prefer posters rather than books!

The business process solution should be shipped with large process diagrams available in large format.

Business process modeling within functional teams is often done using the whiteboard. This metaphor should inform application design.

Breakdown highlights

SAP's documentation is too complex to understand the built-in business process flows.

Documentation of built-in business process flows is not easily accessible.

It is very challenging to use Visio to map existing business processes inherent with packaged ERP solutions.

7.3.5 Industry Company E

U8

Summary and design opportunities

In this contextual inquiry, we were able to observe how the director of information technology exercises a business transformation program by implementing SAP modules to drive the business value and competitiveness of the company. Several design opportunities emerged as follows:

- There is a need to have the two different user groups share the same mental model and collaborate towards the common goal.
- There is a need to be able to test the new process before deployment.

Important insights

SAP modules are not only a business tool, but also an opportunity to revisit the way in which they do business.

It is common practice for the parental company to enforce their subsidiaries to align their business processes in accordance to their own processes.

The 12-months business transformation project consists of the following steps:

- Overall workshop with consultants mapping sister companies' SAP into the company
- The Core team of SAP project is created
- Established process workshop by breaking processes into pieces
- Focused workshop is conducted at the procedural level, touching the system
- Integration workshop is done for the final system testing

The user ensures the best practice for the company by learning how other companies create processes.

Gap analysis is the matrix that shows the existence of a gap in issues and areas. The business decision is made on how the existing SAP processes for sister companies could be modified to map the business process blueprint of the company.

SAP is valuable in terms of learning a full business cycle: after implementing SAP that offered a real time integrated system, employees have appreciation for what is upstream and downstream. If any employee hands others low quality data, they should know the consequence of the bad data.

Breakdown highlights

Language difference with European consulting companies is challenging: The user is currently working with four different consulting companies and three of them are based in Italy. The language difference makes collaboration harder. One US-based consultant is brought in to solve this translation problem.

Tight workshop schedule demands each stage be done on time: The schedule for the process transformation core team is very tight. Each meeting session can only begin after the previous one is done. When the need for extending one session period arises, the user is faced with the challenge to stay longer in one period without affecting the later sessions.

Lack of testing before full implementation of SAP: The only way to know whether the system is configured right and satisfies the requirements is by testing at the end. The system seems to support the blueprint, but "you don't know what you don't know". The user discovers that the system does not support how they work only after they have gone through a full cycle with SAP.

Changes in master data cause problems in other SAP modules: Change in the master data of an employee's status from part-time to full-time by HR department caused the entire SAP module (which pulls the employee status data from database) to be malfunction. This is because there is no integrated testing used during development.

7.3.6 Industry Company F

U9

Summary and Design Implications

This contextual inquiry was a phone call with a business process expert who undertook the role of a broker between the business users and the IT team. Several design implications arose from this session:

- There is a need to enable efficient co-ordination between the system users and the business process expert to reach a shared mental model.
- There is a need to support informal business process modeling notation.
- There is a need to abstract complexity of the system from the user and only provide them easy access to the data they require.

Important Insights

When system users have problems, they create reference documents to report the problem in the form of screenshots that show the operational flow of the system.

System users often do not have the ability to grasp complex tool related concepts and all they need is their required data from the system.

The notation used to model business processes is very informal and is often recorded as boxes and arrows on a composition book. Formal documentation of processes is only done for large-scale projects.

Problems reported from system users are put into a system that generates a tracking number and helps in tracking all the problems reported to the business process expert. This is then forwarded as an email to the IT team along with the user requirements.

Company nomenclature is used when communicating requirements. However, the business process expert is responsible for removing jargon in language when communicating with business users.

Over time, a manager develops intuitions on where the efficiencies lie in a business process and how they can be optimized.

Breakdown Highlights

Sharing processes as screenshots is weak as these often do not make sense to the business process expert and a conversation has to take place to understand user requirements. Thus, it takes substantial time to collaborate and this takes time away from actual work.

There is often a mismatch between what the users want and what is developed. Users sometimes leave out a certain step in the process that they think is implicit. However, developers lacking the domain knowledge take requirements literally, thus resulting in a mismatch between what users want and what is developed.

7.3.7 Industry Company G

U15

Summary and Design Implications

This contextual inquiry was a phone call with a business user who is involved in business process modeling. Highlighted below are the important design implications we gathered from this inquiry:

- There is a need to decide the design methodology for the business process and select the implementation platform before specifying the processes.
- There is a need to be aware of implementation details of processes other than one model. Moreover, it is also important to see the project progress through its different phases and see how it succeeds.
- There is a need to distinguish the usage of the business process modeling tools – whether it is used to model high-level processes or whether there is a need to model detailed processes.
- There is a need for ideal collaboration between the IT team and the business user, which can be accomplished when they both are brought under the same environment.

Important Insights

Different tools are used for different purposes. ARIS is used for modeling high level corporate processes, whereas Visio is used for detailed divisional processes.

Vague and high level models are created in the beginning and then more models that are detail error conditions, exceptions and cost are created.

It is not just the process that is important but also the relevance of the process for the company as a whole and relationships between processes.

It is important to have an understanding of the roles related to the process so that requests can be processed faster by directing it to the right person.

A tool used to collect ideas in an unstructured manner is used in the early phase of the project to generate ideas. These ideas are then given structure and meaning by incorporating them in the functional design specification.

Breakdown Highlights

ARIS has been found to be useful to model high-level processes but is not a good for detailed processes and creates an overhead because of imposed regulations. On the other hand, Visio is useful for creating detailed flows as it gives the user substantial freedom to model processes.

There is a break between process design and implementation environment due to the different stakes of the business user and the IT team. The IT team requires information on servers and back-end information, which is out of the scope of interest of the business users. Moreover, processes can be changed after implementation is complete and this creates an overhead for both the teams.

7.4 Consolidated Model Findings

7.4.1 Sequence Model and Findings

Sequence models for individual contextual inquiries can be found in Appendix B and the consolidated sequence models can be found in Appendix C.

Approach:

We identified 3 major sequences, which recurred in contextual inquiries:

- Designing and implementing a new business process
- Changing the business process
- User Acceptance Testing (UAT)

Designing and implementing a new business process

We interviewed two developers, a business process expert (BPX) and a manager which together collaborated in an effort to take advantage of a new business opportunity by creating a business process implementation. The BPX and the developers used SAP's NetWeaver Design-Time Tools to implement the business process.

In the beginning, a business process was presented to the team for further analysis whether the process was marketable at all. Once a decision was made to take advantage of the opportunity, they started to model the business process together with subject matter experts in multiple iterations. Their deliverable was an ARIS business model and a functional design specification. Figure 7-3 is an excerpt from this model and depicts the business process modeling sequence. Thereafter, developers and BPX worked together to design use cases and CAF core business objects constituting a technical design specification based on the requirements from the functional design specification. Once the technical design specification was created, the project moved into the proof-of-concept implementation phase. They used the NetWeaver Design-Time Tools to create Guided Procedures and also conducted informal testing. They applied the lessons learned to revise the functional specification and business process models. They finally implemented the application for production, according to the final technical design specification. Figure 7-4 is an excerpt for implementing a new process.

Breakdowns:

Testing during implementation with CAF core was challenging as SAP does not provide a testing strategy and also does not support unit testing integration into their framework.

The business object model that is created in the beginning of the process is the specification for implementation. However, the developers were not able to derive source code directly from the ARIS definitions. Instead, they had to carry the object model description through both functional and technical specification to guide the entity implementation within CAF core. When finally

consolidating the application in Guided Procedure Design-Time, they had to manually implement callable objects for each entity again.

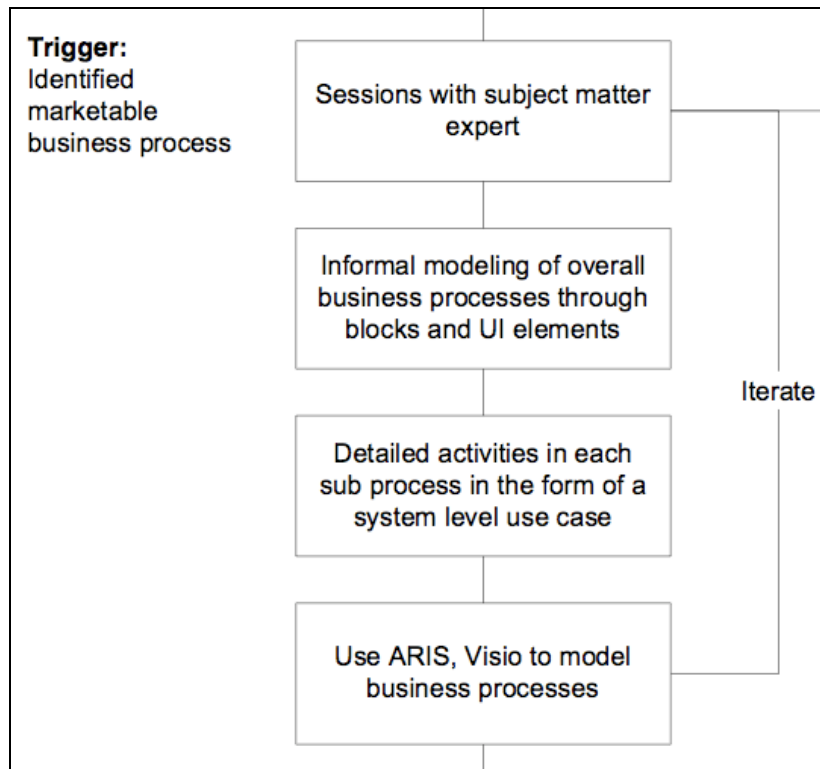


Figure 7-3: Business modeling sequence (excerpt from consolidated sequence model in Appendix C)

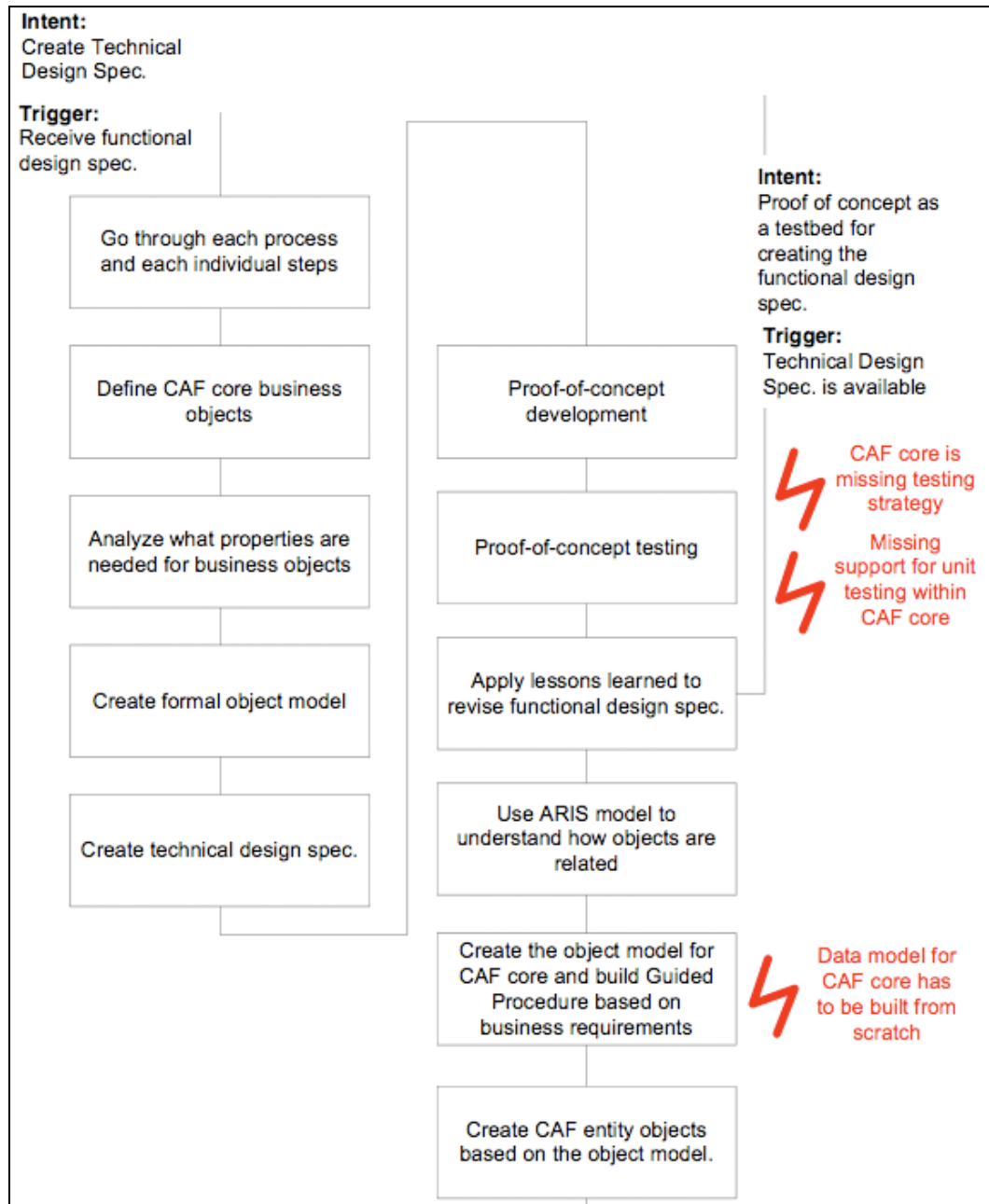


Figure 7-4: Implementing a new business process (excerpt from consolidated sequence model in Appendix C)

Change of an existing business process

Once inefficiency or breakdown in a business process is discovered, the users, Subject Matter Expert (SMX), Business Process Expert (BPX), and IT representatives meet to discuss the issue. They look at current processes using documentation, presentations, and whiteboard. They verbalize together a business requirement that addresses the problem and make an updated version of a requirement specification available through document management system. Involving a consultant, they define to-be processes and generate a roadmap or a project plan. They collect feedback from stakeholders to refine the design of the to-be process description before they hand the process over to developers for implementation. Figure 7-5 is the sequence model for the steps involved in changing an existing business process.

Insights:

Cross-functional teams sometimes employ shadowing to observe the user work as it happens.

They conduct gap analysis to identify differences between their vision and the business process description.

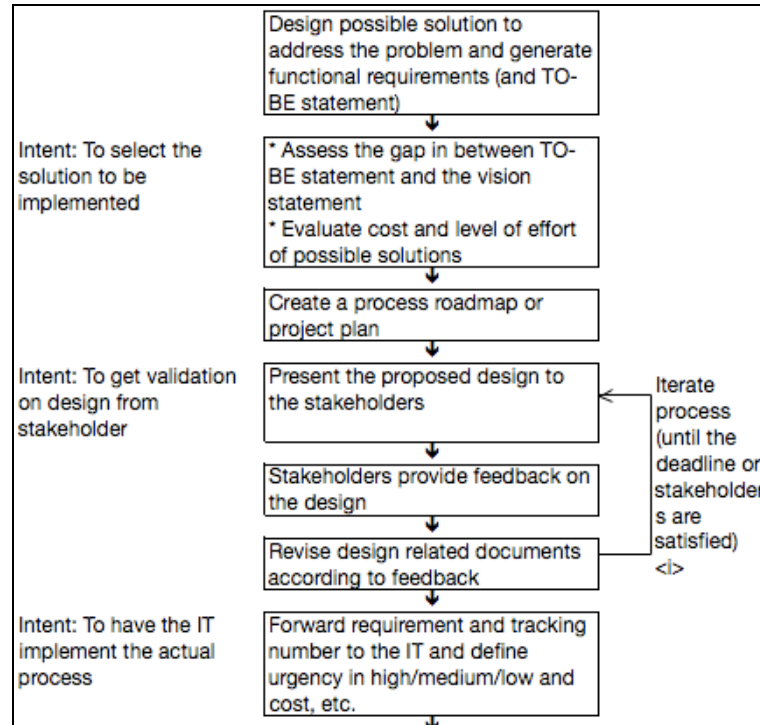


Figure 7-5: Change of an existing business process (excerpt from consolidated sequence model in Appendix C)

Testing

Three interviewees reported about testing strategies while implementing and before deploying an ERP application. They all conduct more or less unit testing while developing components of the business process as shown in Figure 7-6. Integration testing is conducted once components are readily implemented. Before a system is put live, user acceptance testing is conducted to test full transactions. It is our insight that user acceptance testing is both functional and usability testing, because software bugs are identified and users suggest modifications of the user interface for improved usability.

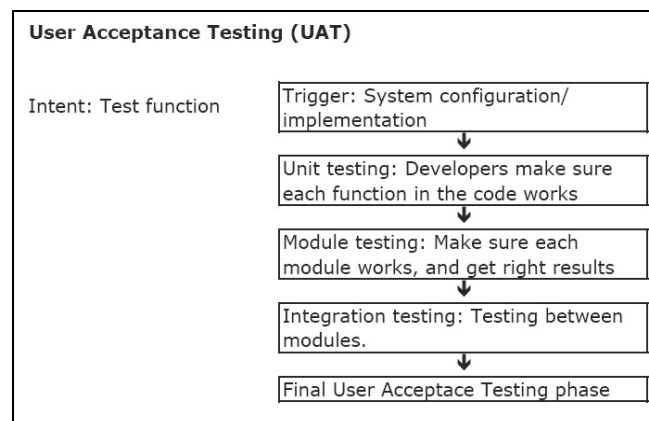


Figure 7-6: Testing sequence

7.4.2 Flow Model and Findings

Flow models for individual contextual inquiries can be found in Appendix B and both the consolidated flow models can be found in Appendix C.

Approach:

The approach we used for consolidating the individual flow models was one grouped by organization type. Different types of organizations have different workflows and differ in their role assignment. Thus, our consolidation was done in a manner to preserve this richness and diversity in our collected data.

Consulting Company B, Consulting Company C

Summary:

This consolidated flow model [Appendix C – Page C3] depicts the workflow from the initiation of the need for a composite application to the development and testing of this application. Various industry clients are responsible for running their businesses efficiently and propose a business case to the management when they recognize inefficiency. The management requests subject matter experts from the industry business units. They also direct the client requirements to the orchestration team that is responsible for analyzing and designing business processes.

Through several iterative whiteboard sessions with the assigned subject matter expert to understand the system level use-cases to design business processes, the orchestration team seek to validate business process flows and generated ARIS models. Additionally, the orchestration team is also responsible for creating test cases and scripts and conducting integration testing. The output of these sessions is a validated functional specification that is directed to the development team.

The development team creates a technical specification for creating the composite application and use Guided Procedures (GP), Web DynPro/Visual Composer and Composite Application Framework (CAF) to implement the business processes.

Breakdown Highlights:

Highlighted below are the breakdowns that have significant design implications:

- Collaboration between the Orchestration Team and the subject matter expert is a problem because the subject matter is complicated and creating a shared mental model between the two entities is challenging. Thus, multiple iterations are required, which is time consuming and labor intensive. Additionally, the functional specification contains the object model, which is difficult to be validated because of the non-technical nature of most subject matter experts. Figure 7-7 is an excerpt from the consolidated flow model and depicts the above breakdowns in collaboration.

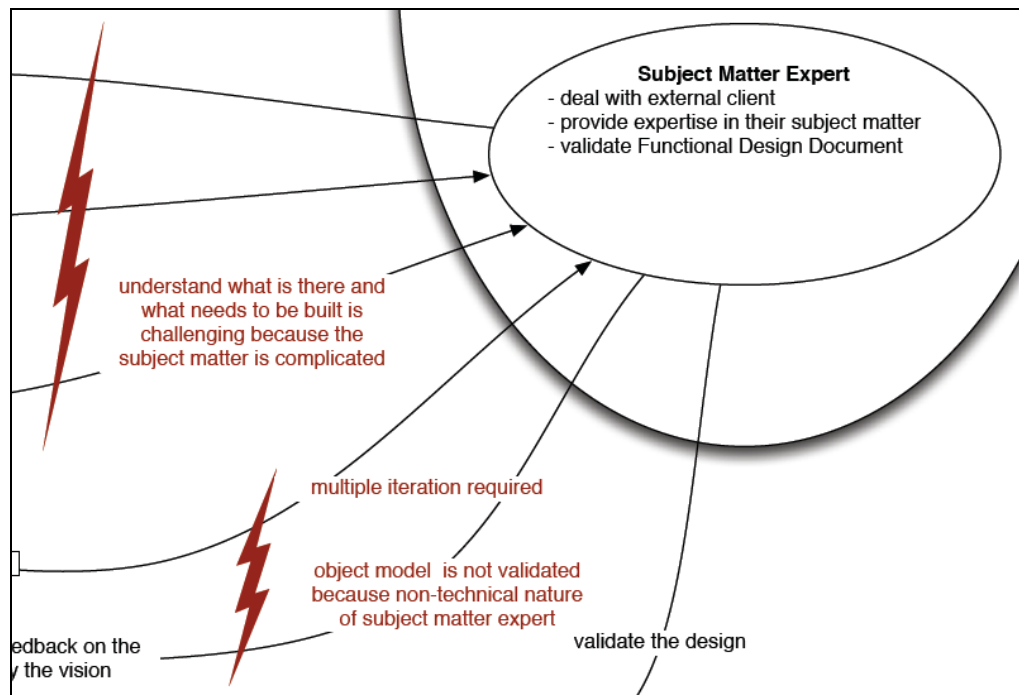


Figure 7-7: Breakdown in collaboration

- Another breakdown is in translating the ARIS model into a Guided Procedures (GP) model. Mapping the smallest unit in the ARIS model to callable objects in Guided Procedures is not one to one and thus poses a significant challenge to users. Figure 7-8 below shows the problem in mapping ARIS models to GP models.

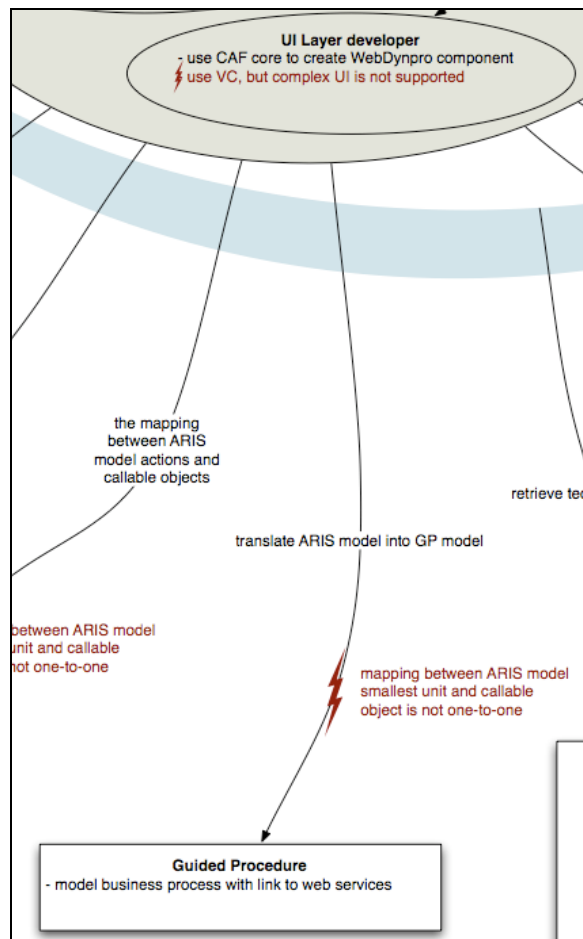


Figure 7-8: Breakdown in mapping ARIS to GP

- The final breakdown concerns tool usage. Our data reflected that using Visual Composer does not support creating complex user interfaces and thus does not support user needs. In addition, users criticized the wizard in the NetWeaver Development Studio (NWDS). Moreover, it was revealed that changes in NWDS are not reflected until synchronization is done manually.

University A, Industry Company D, Industry Company E, Industry Company F, Industry Company G**Summary:**

This consolidated flow model [Appendix C – Page C4] depicts the workflow and the passing of artifacts from the customer registering a complaint or the change management expert recognizing inefficiency to the IT team implementing a solution to optimize business processes.

The request is routed to the change management expert from system users or the top-level executor. The change management expert identifies the high-level needs of system users and holds discussion sessions with the cross functional team to optimize the user's business processes. The cross functional team which consists of the business process expert and the subject matter expert work in collaboration with each other to come up with a functional specification. The system users prepare reference documents that include screenshots of their current process to share their needs with the business process expert. The business process expert is then responsible for thoroughly understanding user needs, assessing the feasibility of changes and mapping the flow of business processes to address user needs. In addition, they are also responsible for creating test cases and scripts and recruiting users to participate in the testing phase. The gathered business requirements, reference materials and the generated functional design specification are directed to the IT team. The documents are also stored in a shared repository.

Upon receiving the requirements, the IT team works in partnership with IT consultants who are experts on configuring and customizing the system, to implement and deploy the change.

Once the application is deployed, the change management experts create models such as the Fishbone diagram and ADKAR Prosci [44] model to analyze the effect of the change.

Breakdown Highlights:

The data gathered revealed several breakdowns in the workflow. Highlighted below are some of the observed breakdowns:

- The mechanism used to transfer knowledge on problems from the system users to the business process expert was observed to be inefficient. System users created screenshots of their current process to reflect problems. However, these made little sense to business process experts who were unable to understand the context of these reference documents. This led to an overhead because of the need of multiple follow up sessions to understand precise user needs and inefficient business processes. Figure 7-9 is an excerpt that depicts the problems experienced in knowledge sharing and achieving a shared mental model.

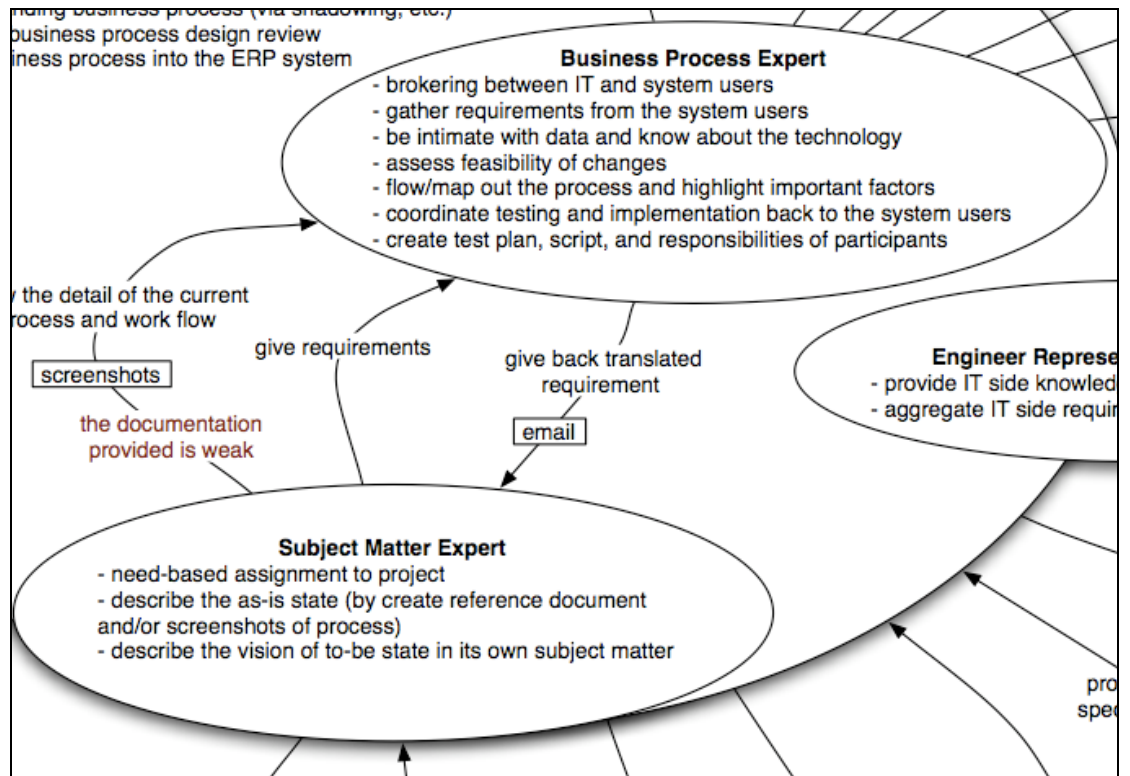


Figure 7-9: Breakdown in knowledge sharing

- Document management was observed to be challenging in this extremely collaborative environment. The business process requirements document was found to be too complex for communication after the design phase. Figure 7-10 below is an excerpt that shows the difficulty experienced in document management.

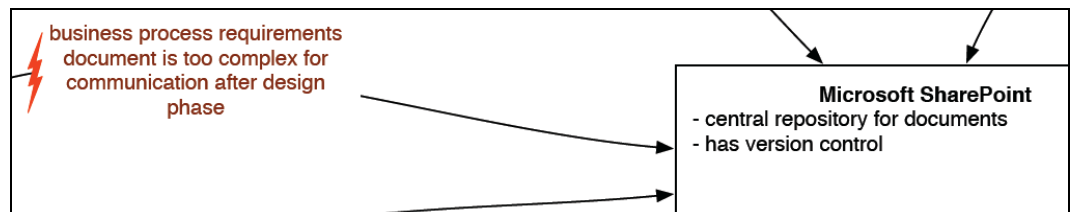


Figure 7-10: Breakdowns in document management

- Business process modeling tools were often found to be too abstract for the user to understand the implications of process change. Figure 7-11 is an extract that depicts the problems faced by users in tool usage.

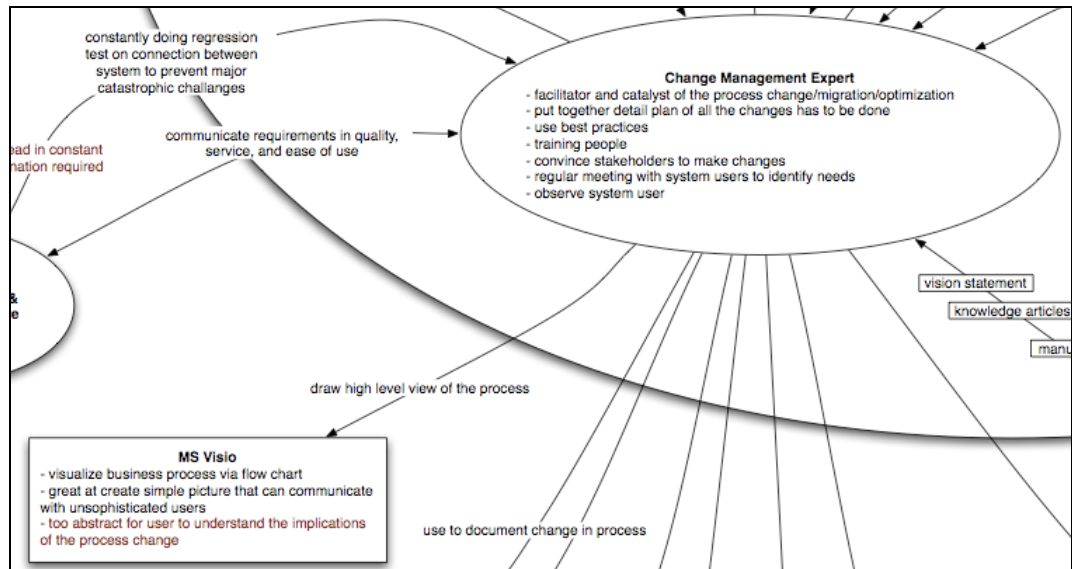


Figure 7-11: Breakdown in tool usage

- The top-level executor, who has no understanding of what it takes to make a process change, finds the constant need to be aware of the status of the request and this led to a significant number of meetings, which keeps people away from doing actual work. Figure 7-12 is an excerpt that shows the difficulty faced when people have different skills.

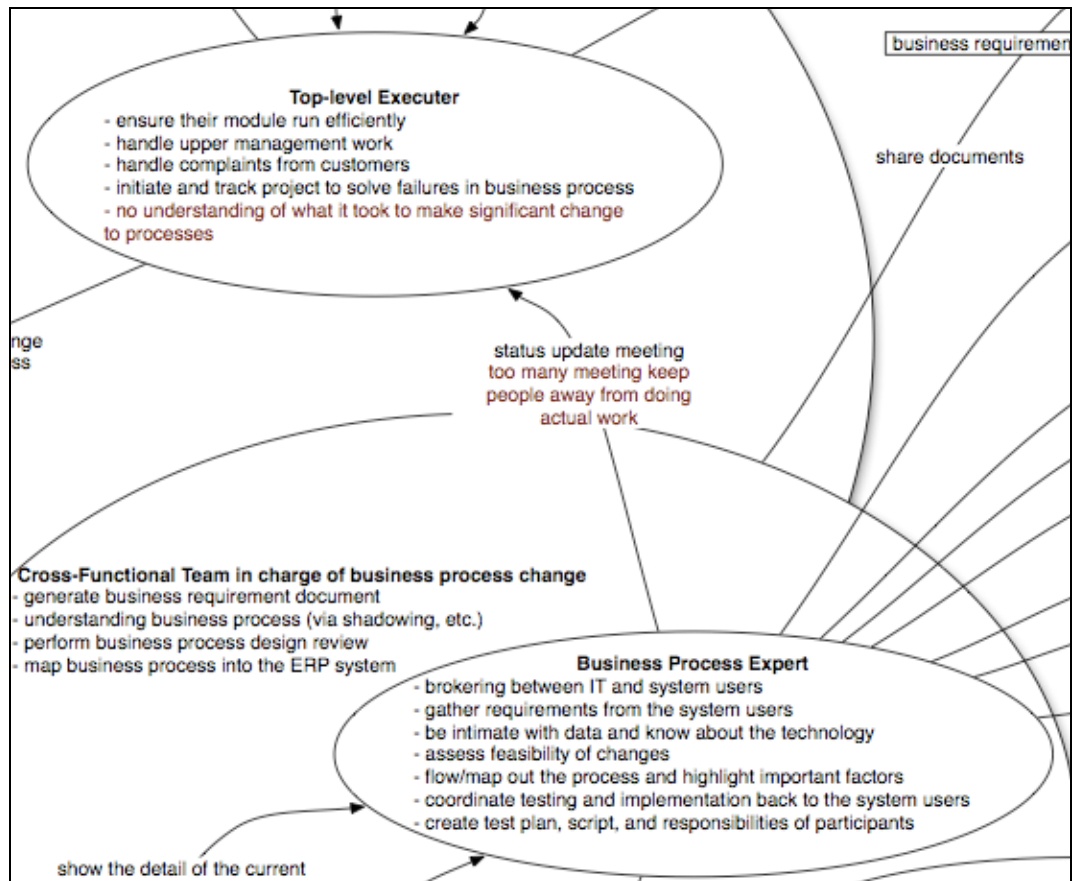


Figure 7-12: Breakdown in skill set

- Constant coordination is required within internal teams and with external teams such as third party suppliers and contract manufacturers, which creates an overhead for the different entities involved in this extreme coordination. Figure 7-13 below is an excerpt that shows the breakdowns in co-ordination.

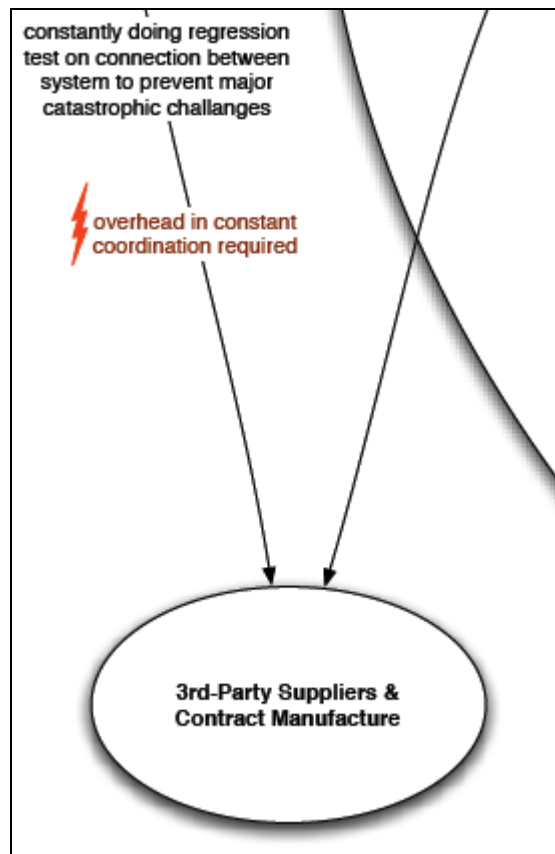


Figure 7-13: Breakdown in co-ordination

7.4.3 Cultural Model and Findings

We aggregated individual cultural model into two consolidated cultural models based on two distinct work environments - Industry Corporation and Consulting Firm. Cultural models for individual contextual inquiries can be found in Appendix B and both the consolidated cultural models can be found in Appendix C.

Industry Corporation Cultural Model

In the industry corporate environment, we focused on the influences over process changes. The followings are some highlights on the influences captured in the model:

- Corporation value: The Corporation values running business efficiently with best practices. Such a policy is passed down to executives, managers, and general employees.
- Distributed drive in process changes: As the facilitator of the process change, the change management expert has a major influence on individual business module and the system users within, to accept and adopt the changes in the process. The change management expert also encourages the system users to report inefficiencies and problems. Hence, the mid-level managers and system users also have influence on triggering a process change as they discover opportunities to change.
- Top-down drive in process changes: Company-scale system and processes changes often require influences from the CxO level executives or company-wide consultants. That influence is then carried down to the entire company through IT directors and other top-level executives.
- Influence overload on business process expert: When designing new business processes, the business process expert acting as the broker is vulnerable to all the influences, preferences and requests cast by multiple people from the business and IT side. Breakdowns arise when requests for meetings overwhelm the business process expert's time to do actual work. There is also a breakdown in the influence from the subject matter expert when the communication fails due to the technical nature of the material which is out of the scope of understanding of subject matter experts.
- Customer demands: Customers have expectations to receive first-class support and understanding from the corporation. Frustration arises when expectations are not met and there is an interest conflict.
- External influence: System vendors and IT consultants together have the influence on suggesting the best platform to the corporation through the business process expert.

Consulting Firm Cultural Model

In the consulting firm environment, we focused on the influences in collaboration between the Incubation Team and Industry Business Unit. The Incubation Team is responsible for finding new opportunities that can apply to general industry clients, hence working hand-in-hand with the Industry Business Unit is important to ensure the needs of the market are captured. The followings are some highlights on the influences captured in the model:

- Team value: The Incubation Team is responsible for finding new business opportunities in arising technology that can be applied to general industry clients. Hence, a great amount of value lies in keeping up with system vendors like SAP as well as collecting business requirement from various sources.
- Request for intense collaboration: There exists strong internal influences between each member of the team to ensure coordination over the tasks, information, and documents are carried out smoothly.

7.4.4 Artifact Model and Findings

Artifact models for individual contextual inquiries can be found in Appendix B and the consolidated artifact models can be found in Appendix C.

Throughout the contextual inquiries, out of the huge number of variety of different documents used by various stakeholders in the effort of making a process change, we discovered the universal existence of a functional design specification. Used both by the business process experts in the industry and the consultants in the consulting firms, the functional design specification serves as a means to thoroughly document the business requirement and acts as the key artifact used to communicate between the process designer and developers.

In the consolidated artifact model, we identified a number of common features shared across different functional specifications we analyzed. Following are some findings that may lead to design implications:

- Objective of the document defines the audience of the document
- Document version control and approval is standard to all documents
- High-level view of the process is presented when the process is relatively large in scale
- Related entities tend to be identified with or within the business process flow diagram
- Glossary of acronyms is necessary as the use of acronyms within the document is prevalent.
- Use of tables is pervasive even when it is not the best way to present the information.
- The differences in the style of functional specifications are mainly due to different needs for the audience. The ones made by the consultants tend to be more professional and carry more explanation and detailed information, while the ones made to be used for internal purposes often omit explanations on the context.
- The level of technical details provided by the functional specification depends heavily on the intended audience.

8 Design Implications

8.1 Design Ideation Process

Immediately after consolidation of the models from contextual inquiry, we started the design ideation process, preparing for the contextual design phase of our project.

We first systematically scanned data from contextual inquiries for breakdowns, design ideas and important insights. We transferred this data to sticky notes and formed an affinity diagram [42]. We built the diagram slowly during the course of one week. Team members divided up stickies and added them to a gradually growing picture of design opportunities.

At the end of the week, a moderator walked the team through the design opportunities. He was well prepared, presented the various clusters in the affinity diagram and answered clarifying questions from team members. This process helped us to gain a shared understanding for the design opportunities discovered during the various contextual inquiry sessions.

8.2 List of design implication

Upon this walkthrough, team members went out of the office to reflect on the design ideas to create a new set of design ideas, which stem from our initial findings but also support individual creative thought processes. We gathered the resulting design ideas from team members anonymously and sorted them into large categories, which are presented below.

Business Process Monitoring and Analysis:

We learned from business process experts and process change experts that it is valuable to monitor processes at run-time and to analyze process breakdowns based on the business process model, which reflects the current process implementation.

We developed a set of ideas related to interactive visualization of breakdowns, change progress and also cause and effect within a business process model for analysis and monitoring of business processes. The same visualization could be further used to simulate process flows to analyze performance or security quality attributes of business processes.

Intelligent Business Process Documentation:

We learned from users that documentation of packaged business process implementations are difficult to understand and are not easily accessible. In addition, business process experts and change experts have reported that initial design documentation is seldom kept up-to-date after implementation.

An intelligent business process documentation tool could provide templates of functional and technical design specifications, which could be used to automatically generate software components such as entities or callable objects. Changes to these software components could be automatically reflected in the pre-defined documentation. Automating the generation of process models and documentation might help both business process experts and change experts. Additionally, we could envision automatic notification of stakeholders when documents change.

Tool to support awareness and collaboration in cross-functional teams:

The effectiveness of cross-functional teams is essential for an organization which implements new business processes or changes existing ones.

We envision a collaborative online community of members in a cross-functional team, which helps to capture modeling artifacts, best practices and design patterns in a wiki-like environment.

We would foster a shared mental model on both task and team process to facilitate collaboration among team members and also allow for the creation of social ties to IT departments and user groups.

Contextual Help

Developers and users of SAP systems complained about missing help functionality within tools.

We suggest the addition of contextual help to NetWeaver Design-Time Tools based on a user task model to predict what users (e.g. BPX, CMX, SMX, etc.) want to do to provide accurate help. Such a system could also implement interactive guidelines for the tools.

Rapid user interface prototyping tool

We learned from an experienced change management expert that many users buy in to new processes only if they see concrete screen flows instead of high-level process diagrams. We learned from developers that visual composer is not flexible enough, which is why the use more sophisticated web user interface frameworks such as Web Dynpro.

We suggest the integration of rapid user interface sketching tools for creating mock-ups and screen-scribbles to demonstrate process change. We can also imagine a sketching tool, which allows re-using existing screens to create sketches of new ones.

Business process visualization

We consistently discovered that all actors in business process modeling sooner or later use Visio for informal process modeling. This is widely used tool, which is why artifacts created in Visio can be shared with anybody. We also learned that ARIS requires the specification of too many parameters, making the tool too complex to use for many users, which are not developers.

We created a long list of ideas related to business process modeling. We developed creative ideas reaching from zoomable user interfaces to modeling tools, which are used to align screenshots to define business processes. We also want to support ad-hoc modeling of process islands, which do not necessarily relate to a bigger picture. Instead, such process islands could be organized on a scratch pad to be used as pieces of an organizational process puzzle.

Mapping of artifacts to business process visualization

All stakeholders in business process modeling use file sharing to exchange documents. This is an important way to create a common understanding for the design artifacts and business processes.

We envision a business process visualization to structure the artifacts related to different parts of the business process which are created throughout the business process development life-cycle, including documents (Excel, Word, Visio), diagrams (UML, AKDAR, Fishbone), and informal text and picture annotations which are gathered in a whiteboard session.

The same visualization could be used to indicate either the progress of documents (Draft, Approved, or Reviewed) or the progress of process implementation. Functionality could be added to support automatic update of artifacts (esp. documents) due to change of the process implementation.

Multiple perspectives on business process models:

Today's NetWeaver Design-Time Tools do not support different perspectives for different user roles. Users have different goals and needs which requires user interfaces, which adapt accordingly.

We envision the idea of perspectives to be applied to all Design-Time tools to support different user goals and needs.

9 Next Steps

The completion of consolidating all models and synthesizing design directions marks the end of the spring semester. Our next steps are to filter and prioritizing our vast number of design ideas by assessing their feasibility. Thereafter, we plan on doing a concept validation with stakeholders before we start prototyping selected design ideas.

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