

Process-mediated Planning of AEC Projects through Structured Dialogues

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To Ilse

Cathedrals come in many shapes

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As I'm laying the final stones of this structure, now is an appropriate moment to look back, reflect, and enjoy the panoramic view from the top of the cathedral. A beautiful view unfolds. A view of a life on top of the world!

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GLOSSARY

ADF	Activity Decision Flow
A/E	Architect / Engineer
AEC	Architecture, Engineering and Construction
AGC	Associated General Contractors of America
AI	Artificial Intelligence
AIA	American Institute of Architects
API	Application Programming Interface
APM	Association for Project Management
ASP	Application Service Provider
ASTM	American Society of Testing and Materials
B2B	Business-to-Business
BAFO	Best And Final Offer
BFC	Building Futures Council
BOMA	Building Owners and Managers Association
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
BPR	Business Process Reengineering
BSI	British Standards Institute

CAD	Computer Aided Design
CCTA	Central Computer and Telecommunications Agency
CDM	Collaborative Decision Making
CGL	Commercial General Liability
CIB	International Council for Research and Innovation in Building
CM	Construction Management (at risk or advisory)
CMPU	Campus Master Plan Update
CO	Change Order
CSAV	Computer-Supported Argument Visualization
CSCW	Computer Supported Collaborative Work
CVE	Collaborative Virtual Environment
DB	Design-Build
DBIA	Design-Build Institute of America
EJCDC	Engineers Joint Contract Documents Committee
E&O	Errors and Omissions
ESP	Engineering Service Provider
e-HUBs	e-Engineering by Holonomic and Universal Broker services
ERP	Enterprise Resource Planning
FM	Facility Management
GC	General Contractor
GT	Georgia Tech (Georgia Institute of Technology)
GUI	Graphical User Interface
HCI	Human Computer Interaction

HTML	Hyper Text Markup Language
HVAC	Heating, Air-Conditioning and Ventilation
ICT	Information and Communication Technology
IFB	Invitation For Bid
IFMA	International Facility Management Association
ISO	International Standardization Organization
IT	Information Technology
JaWE	Java Workflow Editor
KM	Knowledge Management
KWS	Knowledge Worker System
LST	Lease-Sale-Transfer
MCM	Milan Conversation Model
MEP	Mechanical, Electrical and Plumbing
NSA	Negotiation Software Agents
NSPE	National Society of Professional Engineers
NSS	Negotiation Support Systems
OA	Owner-Architect
PBB	Performance-Based Building
PM	Project Management
PMBOK	Project Management Body Of Knowledge
PMI	Project Management Institute
PP	Project Planning
PPMM	Project Planning Meta Model

PPP	Project Planning Platform / Project Planning Process
PPPM	Project Planning Process Model
PRINCE	Projects in Controlled Environments methodology
QA	Quality Assurance
QBS	Quality Based Selection
RFC	Request For Clarification
RFI	Request For Information
RFP	Request For Proposal
RFQ	Request For Qualifications
RIBA	Royal Institute of British Architects
SME	Small or Medium-size Enterprise
SSL	Secure Socket Layer (encryption)
URL	Uniform Resource Locator (Weblink)
VCE	Virtual Collaboration Environment
VDT	Virtual Design Team
WBS	Work Breakdown Structure
WF	Workflow
WfMC	Workflow Management Coalition
WFTAO	World Federation of Technical Assessment Organizations
WPDL	Workflow Process Definition Language
WRD	Workflow Relevant Data
XML	eXtensible Markup Language
XPDL	XML Process Definition Language

SUMMARY

Project planning in the Architecture, Engineering and Construction (AEC) industry at present relies heavily on individual skills, experience and improvisation. In an attempt to increase predictability and efficiency, and to improve knowledge retention across projects, this thesis proposes a more systematic approach to project planning. It does so by introducing the notion of a meta-process model that embodies and cultivates the logic and intelligence of incremental and collaborative planning activities in a given domain. Planning tasks are encoded and enforced as a set of structured dialogues between project partners. To make this possible, a taxonomy extension to current workflow modeling technology is introduced. The concept of the chosen approach can thus be classified as process mediation through structured dialogues. It is applied to the particular example case of Design-Build project delivery for which a detailed workflow model was created. This model serves as a partial instantiation of the larger Project Management Body Of Knowledge, an abstract framework put forward by the US Project Management Institute. A prototype system architecture is devised as an extension to an existing collaborative virtual environment developed in the European e-HUBs research project. This experimental Web-based platform supports the enactment of workflows that are expressed in the standardized syntax of the neutral process definition language XPDL. The functional richness of the structured dialogue extensions is demonstrated through a dialogue management prototype developed as a separate MS Access database application.

CHAPTER 1

INTRODUCTION

Project planning in the Architecture, Engineering and Construction (AEC) industry requires much experience from individual planners. Existing planning software tools typically provide many features to list and organize needed design and construction activities, to optimize resource allocations, to visualize expected project schedules, to coordinate project execution, and so forth (see for example Figure 1.1, which shows a user interface in Primavera). But in order to arrive at a meaningful project plan in the first place, tool users must possess project and domain specific know-how, with anticipation and improvisation skills that are not provided or supported explicitly by the offered planning environment. Even the user's complete familiarity with the software functionality provides no guarantee for the quality of a generated project plan, and whether its content is actually sensible, reliable and comprehensive. Moreover, most planning tools are not collaborative in the sense that they do not specify who is responsible for generating what planning data, and when. Instead it is often a single project manager who assimilates the project plan. A lot of embedded planning knowledge is thus unscripted, undocumented and preserved only in personal memories or in scattered documents, making its transfer and enrichment over time limited to interpersonal contacts and people's direct project involvement.

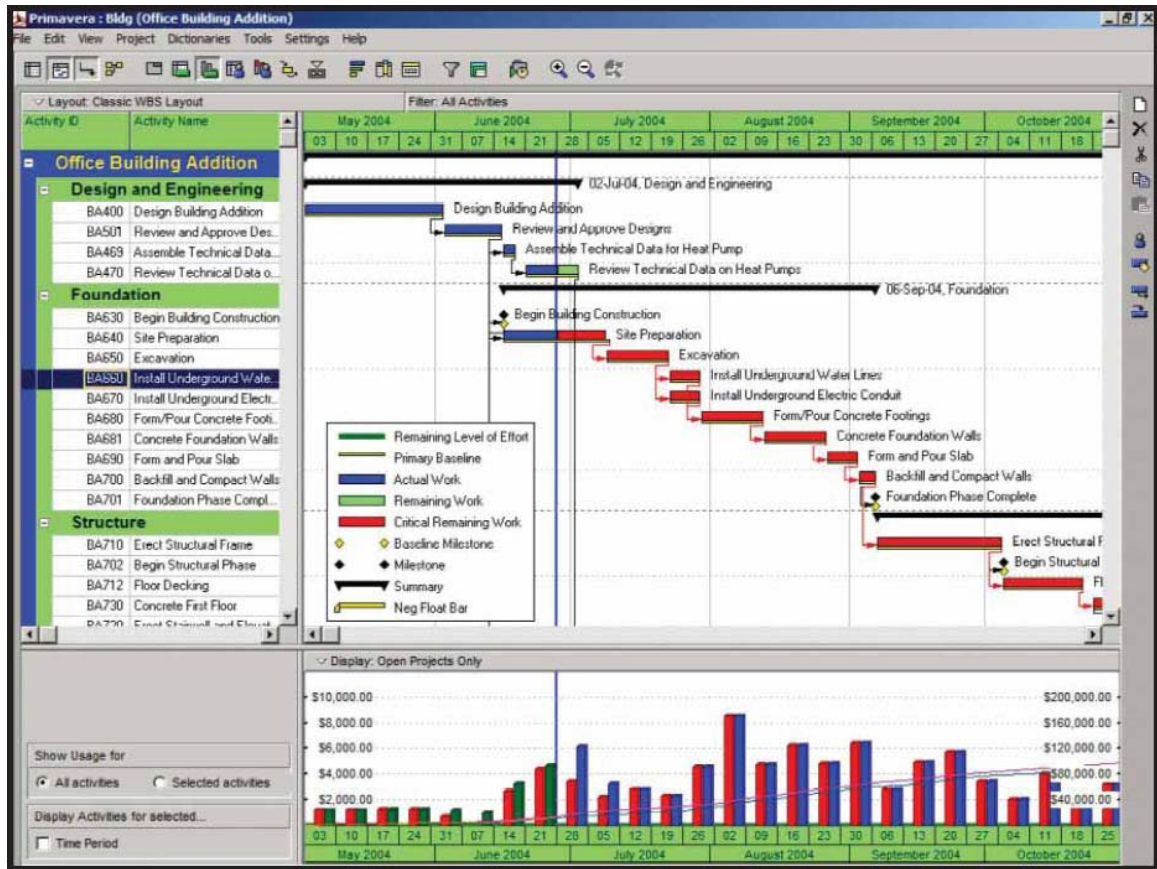


Figure 1.1: Typical Screenshot of an existing Project Planning Tool

This dissertation proposes a more methodical approach to project planning by introducing procedural steps for project partners to systematically work towards a solid project plan. The applied mechanism to realize such a process-driven project planning is the execution of a planning workflow. However, traditionally workflows tend to be rather mechanistic, dispatching individual rather than collaborative activities, with assigned tasks that still require from the performer some prior know-how of how to handle the job at hand.

Therefore the concept of workflows is expanded in this thesis to include the notion of so-called “structured dialogues”. A structured dialogue not only assigns consecutive tasks according to a predefined logic, but it is designed to also support the cooperative nature of some planning activities by “ushering” project partners when needed into (virtual) meetings, in an attempt to structure the interaction and make the dialogue productive and efficient.

The main hypothesis of this dissertation is that project planning in the AEC industry would benefit from process mediation, and structured dialogues in particular.

This hypothesis rests on the three premises that:

- i) A planning process and its implicit knowledge can be modeled with workflow technology, where
- ii) The more collaborative aspects of the planning process can be expressed in structured dialogue extensions, and
- iii) The execution of such a dialogue-enabled workflow would indeed add value to existing planning practices.

The foremost assumption is tested in this dissertation by modeling a particular planning process. First, available research is explored that could serve at a meta-level as a process planning process model. A particularly useful framework is provided by the Project Management Body Of Knowledge (PMBOK), put forward by the US Project Management Institute. The PMBOK defines an ordered abstract set of high-level planning sub-processes that are interconnected by required inputs and outputs.

For the purpose of this thesis, the PMBOK framework also has some shortcomings however, in that it is not AEC-specific, its intermediary deliverables and process timing have not been stated in detail, and it is not collaborative in the sense that it does not specify between construction project partners *who* should do what and when. In order to mitigate these shortcomings, a smaller slice within the larger planning framework was selected that could be worked out into a convincing (detailed, collaborative and AEC-specific) example case.

The selected focus is on the early planning stages of a construction project where the delivery method is selected. Traditionally, AEC projects are first designed by architectural firms before bids for construction are solicited from general contractors. Since many parties in the industry are still relatively unfamiliar with innovative forms of integrated design and construction, or so-called Design-Build (DB) project delivery, supporting the planning process for this type of procurement variants makes for a suitable candidate to demonstrate the potential value of planning process mediation.

Technically, the objective is to have groups of project planners – e.g. companies or project teams – execute workflows in which the system prompts participants for each activity to access, submit or edit deliverables that were generated upstream or that are needed downstream (as will be illustrated in Figure 5.1 on page 65). The data templates that are thus incrementally populated, together are intended to form a comprehensive project plan that addresses issues like risks, rewards, responsibilities, arbitration, deadlines and quality assurance.

Workflows are expressed in the neutral XML Process Definition Language (XPDL), a standard put forward by the Workflow Management Coalition (WfMC) in an effort to stimulate interoperability between workflow software vendors / execution engines. Although every process modeling effort inherently involves a degree of subjectivity and creativity, the PMBOK process steps were used to systematically generate a representative workflow for Design-Build project delivery. The roles involved as participants in this planning process are the building's Owner with his Criteria Consultant / Owner's Architect, and the DB entity consisting of the Contractor(s) and the Architect-of-Record. By starting at the last DB activity and tracing back where necessary inputs were produced as output of upstream activities, a network of so-called Workflow Relevant Data (WRD) is reverse engineered for the DB planning process.

Since existing workflow technology does not explicitly support the notion of enhanced structured dialogues as explained earlier ("ushering" participants into predefined gatherings), the XPDL taxonomy had to be expanded to cover aspects that are relevant to conduct and capture controlled meetings between project participants. A dialogue must be supported in all phases preceding, during and following an actual conversation – respectively through resources, propositions and decisions. Based on a literature and research analysis of dialogue theories – such as ActionWorkflow, Speech Act Theory, the Milan Conversation Model, and Graphical Conversation Capturing – a set of entities and attributes is determined that may serve as information containers in the back-end database of a dialogue support application.

A prototype system was configured to be able to demonstrate the envisioned process-guided DB project planning. In order to keep the research effort feasible and decrease the steepness of the development curve, the prototype is built on the substrate of an existing collaborative virtual environment (CVE) developed in the European e-HUBs project, which focused on the brokering between clients and providers of e-engineering services. This EU-funded research project not only provided the advantage of a full-featured online collaboration platform ready-for-use (e.g. with built-in communication, community and document management), but it also came with a customized process modeler and an embedded workflow enactment engine.

Unfortunately, the use of an available process modeler coupled with an operational enactment platform, both compliant with *existing* XPDL syntax, inevitably excludes the possibility to have the system launch controlled meetings that are modeled according to the taxonomy enhancements proposed in this dissertation. Hence the support for structured dialogue extensions is effectively realized through a separate mocked-up Microsoft Access prototype that now needs to be launched manually during task execution. The second part of the earlier stated hypothesis – that more collaborative aspects of the planning process can be expressed in structured dialogue extensions – is addressed by modeling a sample dialogue for some of the activities within the larger DB process. A use scenario shows how the relational database would be incrementally populated with predefined resources on topics (*pre*), additional run-time information, consecutive statements and reached decisions (*during*), and a per-participant-and-topic resolution status (*post-conversational*).

The overall prototype configuration thus composed, though working, finds itself in a development stage which is too early for extensive and reliable field testing, since the used workflow execution platform – a prototype in itself – is rather slow and unstable, the extended dialogue support tool is a separate trial application requiring manual launching, and the various user interfaces have not been submitted to usability refinements yet. The third and last part of the hypothesis – that execution of a dialogue-enabled workflow would indeed add value to existing planning practices – can therefore only be partially addressed at this point. The objective of this thesis is rather to provide some proof of concept by addressing in subsequent chapters the main hypothesis and its three constituting suppositions, as stated in the beginning of this section (page 3).

This summarizing introduction will conclude on the next page with an outline of the organization of this dissertation.

The structure of this dissertation is as follows:

The next chapter (2) starts with a problem statement, based on observed procedural shortcomings of current project planning practices. Chapter 3 explains the proposed solution concept of process guidance through structured dialogues. It also reiterates the hypothesis that project planning in the AEC industry would benefit from process mediation, and structured dialogues in particular. The broader theoretical context is sketched in Chapter 4, which describes general research roots of this thesis, and builds the case for better, facilitated and Web-based project planning. Chapter 6 elaborates on the system architecture of the implemented solution. But first, Chapter 5 outlines the methodology that is followed in the remaining chapters for prototype development and consecutively testing the three parts of the stated hypothesis. The first premise – that a planning process and its implicit knowledge can be modeled with workflow technology – is tested in Chapter 7 by modeling a Design-Build process in detail. The second premise – that more collaborative aspects of the planning process can be expressed in structured dialogue extensions – is addressed in Chapter 9, after Chapter 8 takes an in-depth look at existing dialogue theories and R&D, on which to build an extended discourse taxonomy. Based on that analysis, a prototype dialogue support module is developed (9) and applied to some of the planning dialogues that would occur in the previously introduced DB process. The third and final premise – that execution of a dialogue-enabled workflow would indeed add value to existing planning practices – is discussed in Chapter 10, which summarizes the hypothesis testing achieved thus far. The dissertation concludes with an overall evaluation (11) and potential directions for future research (12).

CHAPTER 2

PROBLEM STATEMENT

This chapter addresses in more depth the shortcomings of existing planning practices in AEC. It starts (2.1) by defining Project Planning in order to indicate where the approach of this thesis differs from the broader existing research and technology in this field. The next section (2.2) provides a brief analysis of some typical state-of-the-art planning tools. The conclusions drawn from this analysis are summarized into a problem statement (2.3); whereas current support typically focuses on the efficient management of final planning deliverables, such as project schedules and budgets, the argument is made that a more systematic approach is needed to arrive at such deliverables and to intelligibly achieve a comprehensive project plan.

The next chapter will outline the fundamentals of the proposed solution concept on which this dissertation is built.

2.1 Definition of Project Planning

Project planning can be defined in general as the projection of the realization or achievement of a plan (Webster). More precisely, project planning within project management can be defined as the process to quantify the amount of time and budget it will cost to undertake a temporary endeavor to create a unique product, service or result. The purpose of project planning is creating a project plan that a project manager can use to track the progress of his team (Wikipedia). A carefully planned and organized strategy is needed to accomplish the specified objectives. The strategy includes developing a plan which will outline the goals, explicitly set the tasks to be completed, determine how they will be accomplished, estimate time and resources (both human and material) needed for their completion. How projects are planned and managed will seriously impact the profitability of the ventures that they are intended for and the quality of the products or services they generate.

The US-based Project Management Institute defines project planning as the development and maintenance of formal, approved documents used to guide both project execution and project control. The primary uses of the project plan are to document planning assumptions and decisions, facilitate communication among stakeholders, and document approved scope, cost, and schedule baselines. A project plan may be anywhere between a high-level summary or a detailed work plan (PMI 2000a).

A couple of well known techniques are typically associated with and used for the purpose of planning and scheduling the different tasks in project management: Work Breakdown Structures (WBS), Gantt charts, the Critical Path Analysis (CPA) and the Program Evaluation and Review Technique (PERT). A WBS is a list of tasks ordered as a tree of activities that take into account their lengths and contingencies. Gantt charts (named after the social scientist Henry L. Gantt) arrange the different events in synchronism and associate each task with its owner and its estimated beginning and ending time. The chart shows a WBS with tasks owners and needed resources on the y-axis, while having a timeline on the x-axis. It displays activities as timed bars and graphically visualizes the sequence of the events. The CPA focuses on the timing by more explicitly taking into account the interdependence of critical tasks. It identifies the tasks that need to be completed on time to meet the intended project deadline (the critical path), while considering the possibility of parallel tasks, and wait and slack times for every activity. The Program Evaluation and Review Technique (PERT) is a variation of the CPA in that it follows a probabilistic rather than a deterministic approach, taking into account the likeliness of activity durations.

Project planning applications typically tend to be measured by their ability to support the intricacies of the traditional diagramming techniques listed above, while basically ignoring that they only reflect the final outcome of a long and disordered planning process that still depends heavily on the vast and largely undocumented knowledge, improvisation skills and assumed experience of individual planners. The systematic build up of meaningful and comprehensive planning data is not supported.

2.2 Analysis of Current Planning Software

The previous section defined project planning as the process to quantify the amount of time and budget it will cost to undertake a temporary endeavor to create a unique product, service or result. Although hardly any tools are available to explicitly support the procedural part of this definition (the systematic process steps and logic needed to arrive at a comprehensive project plan), many software applications exist to aid in the operational part of the definition (management of projected temporal and financial aspects of projects).

In the latter arena, a wide range of project planning applications is available today, ranging from stand-alone software to Web-based products, from generic to AEC-specific (see Table 2.1), from academic to commercial, and from simple to highly complex tools.

Table 2.1: Categorized Examples of Project Planning Applications

PP Application	Generic	AEC-specific
Stand-alone / Web-enabled	MS Project	Primavera
	MILOS	COSMOS
Web-based	PlanOnTheNet	Construction extranets
	Thumbprint	(Constructware, Citadon, etc.)

This section will deal with some relevant commercially available applications, whereas Chapter 4 will describe some research projects and prototype tools that have been developed by the academic community.

Stand-alone or Web-enabled applications may use the Internet to exchange data, but they require an initial installation of application-specific software on every work station that needs to run the tool. Web-based applications on the contrary only require an active Internet connection and the installation of a current Web-browser. The latter offers an appealing proposition since it reduces the costs of IT staff and maintenance by taking away from clients the continuous burden of having to install software upgrades. Application Service Providers are software providers that operate according to this business principle. ASPs that offer Web-hosted project spaces with collaboration and information sharing functions dedicated for the building industry are called Project Web Sites, or construction extranets. Major players in this constantly evolving arena are companies like Buzzsaw, eBuilder, Constructware, and Citadon. Most of these applications focus mainly on the operational project management aspects during the execution phase, such as accounting, project communication and document management. They are not aimed at project planning as a collaborative negotiating procedure with legally binding consequences between potentially remote project partners, let alone project planning through a managed meta-process.

PlanOnTheNet (www.planonthenet.com) is a general purpose planning service that allows collaborative editing of work plans, yet it is aimed more at internal collaborative

planning – within one legal entity, instead of between companies or organizations. So instead of allowing members to freely create plan versions, in order to serve as a mutually acceptable process modeling tool it should always generate time-and-person stamped new (object) versions when modifications take place, with possible "solid" (contractually agreed upon) objects like deadlines. Thumbprint (www.cyntergytechnology.com) is an interesting tool because it focuses on collaborative program management i.e. on recurring projects that are similar but different. Based on predefined sets of project variables, projects can be launched with customized Work Break-down Structures (WBS) adapted to the selected parameters. Microsoft Project is a stand-alone project planning tool for generic business purposes with limited functionality. Primavera is widely used in the AEC industry, though it is a stand-alone application and not in the first place a collaborative (multi-user) project management tool. Knowledge Worker System (Schmidt 1998) is an interesting group management tool, originating in the academic community, which allows the parameterized reuse of business processes.

The tools described so far offer typical conventional project planning functionality like the graphic expression of estimated task durations on a timeline, with task dependencies and associated resource allocations. However, the knowledge of how to go about gradually and logically populating these tools with reliable planning data, while guaranteeing its quality and completeness, remains largely uncharted territory. Although some of the tools described may offer project templates, none of them provides an elaborate and collaborative separate process to customize those templates. This thesis aims to address the void of process driven project planning.

2.3 Problem Identification

Project planning applications tend to emphasize the efficient visualization of time schedules with optimized resource allocation, rather than focusing on the methods and process of arriving at a solid project plan. Current planning practices incorporate little systematic effort to capture and reuse the implicit domain knowledge of experienced project planners as they make preparatory decisions. The lack of stored procedural information leads to a rather ad-hoc approach to project planning, an enduring over-dependence on individual experience, and constant reinvention of the wheel on each new construction project.

Existing collaborative virtual environments instead mainly strive to accomplish a more effective communication between project planners, with any-time/any-place access to planning data. Where actual processes are supported, they typically involve low-level, rigid and execution-phase oriented workflows, such as the aggregation of some Change Requests from the Contractor into an eventual approved Change Order from the Owner. The project planners themselves usually have little or no direct control over the modeling, customization or adjusting of any offered workflows, if provided at all. Consequently, current Web-facilitated planning services fall short in cultivating essential process embedded knowledge; at best providing means but no roadmap to arrive at a comprehensive project plan.

CHAPTER 3

PROPOSED SOLUTION CONCEPT

The previous chapter identified a lack of procedural support for existing planning practices in the AEC industry. As solution to that problem, this chapter proposes the execution of a planning workflow, or so-called Project Planning Process Model (PPPM). Process steps to guide project planning are compared to a recipe for baking a pie (3.1). The idea is introduced (3.2) that planning between project partners takes place at a strategic, tactical and operational level, and that the project plan at the tactical level could be incrementally generated by applying a meta-process at the strategic level. Such a meta-process could be provided by workflows that are augmented with support for structured dialogues (3.3). A structured dialogue is meant to convene the appropriate people and streamline the agenda of their meetings, while also providing the resources needed to successfully complete their task. The reason for proposing these solution concepts is reiterated (3.4) with the hypothesis of this dissertation that project planning in the AEC industry would benefit from process mediation, and structured dialogues in particular. Finally (3.5), the limitations of the selected approach are addressed.

3.1 Project Planning: a Piece of Cake

Project planning could be compared to cooking; a cook (*project planner*) not only needs good ingredients (*planning data*), but also the recipe (*planning process*) to be able to bake an apple pie (*project plan*) from them. Without recipes (*planning steps to follow*), the quality of cooking (*planning*) remains heavily dependant on the individual skills and experience of the cooks, good as they may be. However, even the best cooks may not realize there are better or new methods to bake an apple pie (*e.g. innovative AEC procurement methods*), they may be lost in a different kitchen (*another AEC firm or unfamiliar geographic area*), they may not be able to make other types of pies – cherry, walnut (*other types of buildings*) – and they may not be able to handle baking multiple or as many pies simultaneously (*managing several projects*). Moreover, without a cookbook of recipes (*library of AEC processes*), transferring skills to junior cooks (teaching) remains a very time-intensive and error-prone process that is easily submerged in the time-pressed daily work of satisfying customers of the bakery (*AEC firm*) – counting on a low employee turnover rate.

This thesis aims to provide an impulse to the creation of a planning cookbook for the AEC industry.

3.2 Process Mediation Concept

Currently project planning methods in AEC have no clear status in the overall initiation and execution of projects. It is the stage where clients and potential providers of services find a way to create a process that fulfills the client expectations. This stage is dominated by the experienced “dinosaurs” in the industry. There is little recognition of the fact that project planning is the tactical translation of strategic objectives into project execution, as illustrated in the conceptual view of project planning in Figure 2.1.

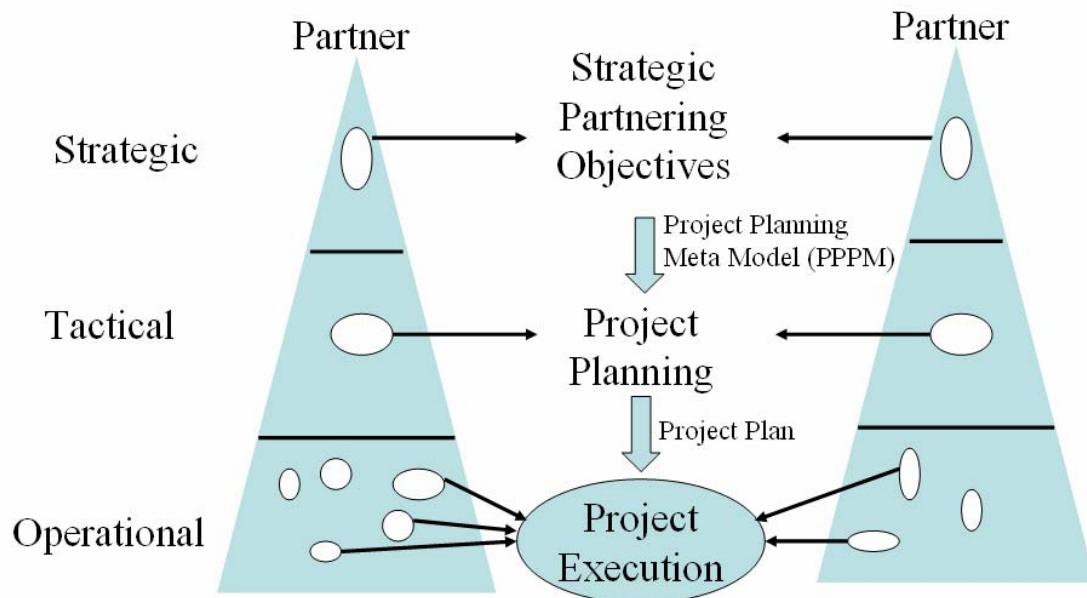


Figure 2.1: Strategic, Tactical and Operational Project Planning

Current project planning procedures are not explicit. Experienced “champion” planners bring partners together to form partnerships and create the more mechanistic descriptions of the project to be executed, such as extensive Work Break-down Structures and project schedules. Most of the knowledge behind the procedures is unscripted. The premise of explicit project planning support is that the procedures are made clear, thus increasing transparency, predictability and ultimately planning effectiveness (Allee 1997).

The figure positions project planning at the tactical middle layer between strategic partnering objectives and actual project execution. Strategic objectives are expressed as the business rules that govern how an enterprise wants to engage in a partnering dialogue. The rules are typically the result of strategic management decisions. They paint the broad brush strokes of the Project Planning Process Model (PPPM) which is consequently refined to show all the tactical negotiation steps and the dialogue templates that each step is linked to. The resulting PPPM governs the tactical project planning process, typically conducted by experienced project planners from all potential partners. The tactical process leads to a project plan which should be complete enough to guarantee the successful management of the actual project execution, conducted by designers, engineers and project managers from both partners.

It is important to note that the PPPM is not meant to impose a form of “process tyranny” on the project planners. Instead, participants may opt to start or abort any tactical process (represented in the PPPM) at any time, depending on the need to enter into improvisation or abort because of perceived lack of support from the system at a given instance (similar

to selectively using a “cookbook”). The process-mediation is intended to avoid information overload for participants at all times, presenting them only with the information needed at a certain point of the planning – as opposed to the overwhelming amount of random data, or lack of data, that may be present in an unstructured planning trajectory. In general, process guidance can increase predictability and knowledge retention across projects, thus positively influencing quality and productivity.

3.3 Structured Dialogue Support

Even with a meta-process that carefully assigns progressive planning tasks to project participants in accordance with a predefined logic, individual performers could still be at a loss as to how to go about executing their assignment. Therefore, this thesis aims to take process mediation one step further beyond “traditional” workflow support by attempting to also structure the interactions needed to complete a project planning activity. So-called “structured dialogues” can usher the appropriate group of people into a (virtual) meeting room, and focus their task execution on an organized sequence of topics that need to be addressed, thus increasing the efficiency and coherence of the overall planning process. A structured dialogue can preemptively offer resources needed to successfully handle a task, provide an audit trail of past and future interactions by capturing and scheduling communication events, document and clarify agreed decisions, and make explicit eventual consensus (or lack thereof) on the issues at stake.

For example, when a workflow engine dispatches a task to “issue a Request For Proposal” to an Owner, the owner organization may want to get system support on what information should be included in the RFP, how it must be incrementally composed and distributed, who to contact, what local and general regulations apply, etc.

A structured dialogue is not intended to affect participants’ flexibility in selecting communication means, but rather builds on people’s existing social skills, expertise and situational preference to use e-mail, phone, fax, face-to-face meetings, etc. It should be noted that the structuring may also involve a “self-dialogue” (within one entity), to add consistency to and rationally guide individual actions in an intelligible and organized manner.

Since current workflow technology does not support functionality for modeling and executing structured dialogues, a separate part of this dissertation will elaborate on this topic. In these chapters (8 and 9) the paradigm of a traditional workflow is compared to a “Task Manager” analogy, whereas a structured dialogue is referred to as an extended “Team Organizer”. The general idea is to go from document-centered workflows towards process-managed dialogues.

3.4 Hypothesis

As introduced earlier, the main hypothesis of this dissertation is that project planning in the AEC industry would benefit from process mediation, and structured dialogues in particular. This hypothesis rests on the three premises that:

- i) A planning process and its implicit knowledge can be modeled adequately with workflow technology, where
- ii) The more collaborative aspects of the planning process can be expressed in structured dialogue extensions, and
- iii) The execution of such a dialogue-enabled workflow would indeed add value to existing planning practices.

The validity of these premises will be assessed in part in – respectively:

- Chapter 7 (Design-Build Process Analysis),
- Chapter 9 (Prototype Dialogue Support System) and
- Chapter 10 (Hypothesis Testing).

3.5 Limitations of the Approach

The selected mechanism to achieve the objective of better procedural support for project planning, is the execution of a predefined planning workflow. With any system or research approach there are inherent discrepancies between means and ends. This does not pertain so much to desirable tool features that are still missing or additional future functionality (as will be addressed in Chapter 12 “Future Research”). It rather concerns impossibilities or inevitable shortcomings of the system or the research method that are of a more permanent and fundamental nature.

In this case, the expected value of the proposed system is partially derived from the assumed gradual evolution of planning process models to better reflect work practices, with increasingly valuable resources attached to activities and dialogues. This fine-tuning and enrichment of a process over time depends on a level of willingness by the process participants to share knowledge and experience, which may require some extra effort beyond just task completion (time spent documenting, explaining, generalizing, etc).

Even if the system makes this evaluation / “teaching” aspect very simple, it still requires the cooperation and some benevolence of users whose interest may rather be to secure their own jobs or their company’s competitive advantage by the exclusiveness of certain knowledge and expertise. The usefulness of the approach thus relies in part on a presumed progressive spirit of shared interest, ownership and understanding within the

industry that “each individual is stronger together than alone”, like in open-source software development.

On a smaller scale, the system won’t be able to replace the social environment that is needed for a successful collaboration on a project. Irrespective of the applied technologies, groups of planners will go through phases of team formation, where differences of work cultures, professional disciplines, and individual personalities may need to be bridged. These social processes are crucial for project success yet hard to structure or predict with workflow technology.

Also, the proposed system is not intended to copy or replace functionality typically offered by most “traditional” planning systems, i.e. to directly generate Gantt charts or cost sheets. It is rather aiming to organize and feed the timely and efficient use of such applications.

Some inherent technical shortcomings of the implemented prototype system result from the choice of applied components rather than from the selected approach in general. For example, the implemented workflow management system is not integrated with the applied module for structured dialogue support. Since such “temporary” issues could in principle be solved by upgrades, additional development work, or a different tool selection, they will be addressed in Chapter 12 (“Future Research”).

A shortcoming of the chosen testing approach is that articulation and formalization of the example test process (Design-Build project delivery) is implemented “top-down” by the system developer instead of “bottom-up” by the system users. Hence the ability by process participants to modify, or generate from scratch, their own customized work practices remains an open question for later experiments (see also Section 5.3.4 on this topic).

The next chapter will discuss the theoretical and research roots that underlie some of the claims made thus far.

CHAPTER 4

RESEARCH BACKGROUNDS

This chapter explores the basic fundamentals in research and literature of this dissertation. It sets out to describe Knowledge Management in the AEC industry (4.1) and how storing best practices in project planning provides a business value. It then continues to also place collaborative project planning in the broader context of Computer Supported Collaborative Work (4.2). Within these fields the chapter zooms in specifically on the European academic eLEGAL (4.3) and e -HUBs (4.4) projects. These research endeavors respectively focused on collaborative contract definition and e-engineering partnerships. The last section (4.5) will build the argument for enhanced project planning in the AEC industry by arguing successively why it should be better (4.5.1), facilitated (4.5.2), collaborative, and Web-hosted (4.5.3).

It should be noted that the research discussed is by no means intended to be a comprehensive review, but rather an indication of applicable issues. Additional, dedicated research will be described in the context of Chapter 8, which deals specifically with dialogues and their structuring.

4.1 Knowledge Management

As an area of research, Knowledge Management (KM) forms a broad umbrella dealing with the cultivation of various kinds of information within an organizational context. Wikipedia (www.wikipedia.org) defines Knowledge Management as the capturing, organizing, and storing of knowledge and experiences of individual workers and groups within an organization and making this information available to others in the organization. Knowledge can be explicit or tacit; explicit knowledge is codified or articulated (e.g. written down in manuals or archived in databases) and can be easily transferred and stored. Tacit knowledge relates to “knowing how” or “understanding” and is transferred through application, practice and social interaction between individuals. Allee (1997) states that knowledge is embedded in a social process that emerges in and travels through networks, communities, and webs of conversations. In that social process the Internet is advancing the network capabilities of organizations.

KM seeks to apply and improve the collective intelligence in a business setting, by easing the creation, organization, sharing and flow of knowledge, and by increasing awareness and understanding in the process. The introduction of a process model for project planning has the same objectives and therefore falls within the KM realm. As containers of best practices, stored process models can streamline activities and foster knowledge retention across projects, providing an organizational and procedural context to accumulated information.

Kamara *et al.* (2002) describe how Knowledge Management is also recognized as a core business concern in the AEC industry, with intellectual assets playing a key role in gaining competitive advantage, stimulating innovation and improving performance. Since the industry is very much project-based, a distinction can be made between KM within firms (across projects) and within projects (across firms), and also within stages of a project (e.g. translating a client's business needs into technical specifications). The authors state that "the definition of tasks and their interrelationships (workflows) together with a record of their actual execution, obviously adds to the knowledge base of an organization".

Based on a survey among AEC practitioners, the reasons for KM (*why*), the types of managed knowledge (*what*), and the applied methods of KM (*how*) were determined:

Why:

- R1 To deal with organizational changes due to staff turnovers and changing business practices (for example, from a hierarchical setup to 'virtual' teams)
- R2 To minimize waste, prevent the duplication of effort and the repetition of similar mistakes from past projects, and for improved efficiency
- R3 To cope with business growth and diversification of activities (e.g. to evolve from traditional General Contractor to Design-Builder and Facility Manager)
- R4 To effectively manage the supply chain in project delivery (e.g. the need for knowledge of suppliers and their capabilities)

What:

- T1 Knowledge of organizational processes and procedures, including knowledge of statutory regulations and standards, the management of interfaces between different stages (components) of a project, in-house procedures and best practices
- T2 Knowledge of a client's business and how to interpret business requirements into technical specifications for the construction team
- T3 Knowledge of how to predict outcomes, how to manage teams, focus on clients, and motivate others
- T4 Technical domain knowledge (of design, materials, specifications, technologies), including knowledge of the environment in which the industry operates.
- T5 'Know-who knowledge' of people with the skills for a specific task, and knowledge of abilities of suppliers and subcontractors (knowing who to contact when there is a problem was considered to be a key aspect of any KM strategy)

How:

- M1 Strong reliance on knowledge accumulated by individuals, but without a formal way to capture and reuse much of this knowledge
- M2 Use of long-standing (framework) agreements with suppliers to maintain continuity (and the reuse and transfer of knowledge) in the delivery of projects for a specific client
- M3 Capture of lessons learnt and best practices in operational procedures, design guidelines, etc, which serve as a repository of process and technical knowledge (usually through post-project reviews that only involve the project's participants)

- M4 Involvement (transfer) of people in different activities as the primary means by which knowledge is transferred and/or acquired
- M5 Use of formal and informal feedback between providers and users of knowledge as a means to transfer learning/best practices, as well as to validate knowledge (e.g. site visits by office-based staff to obtain feedback on work progress).
- M6 Strong reliance on informal networks and collaboration, and 'know-who' to locate the repository of knowledge.
- M7 Within firms with hierarchical organizational structures, there was a reliance on departmental / divisional heads to disseminate knowledge shared at their level, to people within their sections.
- M8 Use of appropriate IT tools (such as GroupWare, Intranets) to support information sharing and communication

From the study by Kamara *et al.* (2002) it can be concluded that much knowledge (what) in the AEC industry is unscripted, and that the transfer mechanism (how) is mainly people-centered. Also, the driver for KM (why) is basically an expected efficiency gain in project delivery rather than in the creation of new knowledge. In general, most companies do not have a formal KM strategy, but rather a haphazard and people-based approach that leaves much space for improvement.

A process-driven project planning could contribute to all surveyed objectives (reasons R1 to R4), while it would primarily make procedural knowledge explicit (type T1). The method would fall into the categories of capturing best practices / IT tools (M3 and M8).

4.2 Computer Supported Collaborative Work

Joint project planning also falls within the broader context of Computer Supported Collaborative Work. Applications for cooperative work have been devised and studied in this research field for decades. With mixed success (Grudin 1988, 1999), CSCW has been addressing a wide variety of topics ranging from attempts to simulate co-located-ness and enhance awareness in virtual environments (Fitzpatrick *et al.* 1998, Okada *et al.* 1999) to studies of supporting dispersed group coordination (Jeng 1998, Kvan 2000).

In the latter category an interesting tool for the context of this thesis is the MILOS system (Goldman *et al.* 2000). Although developed for distributed process planning, it is more oriented toward "internal" distributed workflow definition; it is not intended particularly to suit the collaboration between different legal entities during the planning of mutual projects, e.g. by restricting modification of certain contractual obligatory tasks / deadlines, by "proposing" changes before applying them, or by requesting explicit approval from other parties for applied changes in a planned workflow. It does not provide versioning of plans and models (a negotiation audit trail) which is an important feature for negotiation; going back and forth between proposed changes. Also, for the execution phase MILOS expects participants to keep a centralized electronic personal calendar up-to-date, for the system to be able to check if individual schedules allow the assignment of processes – a rather unrealistic assumption, especially for projects carried out across multiple organizations.

In general, CSCW applications are often classified according to the 2-dimensional space-time dimensions of the collaboration they are aimed to support (see Table 4.1). Although a significant benefit of the project planning model proposed in this thesis is its applicability in asynchronous dispersed collaborations, it should be noted that the model in principle could also support the partnering process in the other quadrants (e.g. same time, same place collaborative project planning).

Table 4.1: CSCW Matrix of Space-Time Dimensions of Collaboration

Collaboration		Time	
		Synchronous	Asynchronous
Place	Co-located	A	B
	Dispersed	C	D

Nickerson (1997) added a third dimension to the matrix in an effort to develop a taxonomy of group computing applications that analyzed their systematic similarities and differences (Table 4.2). Besides the “when” and “where”, he proposed to include the “what” of collaborations; the form that the communication takes, being (combinations of) audio, visual, and document exchanges. The resulting classification provides 28 categories of communication – two whens by two wheres by seven permutations of whats (just audio, audio + visual, etc).

Table 4.2: Nickerson's Taxonomy of Group Computing Applications

Group Computing Application Type:	Communication						Example Product	
	Time		Place		Form			
	Synchronous	Asynchronous	Co-located	Dispersed	Audio	Visual		Document
Electronic Mail		x		x			x	Eudora
Instant Messaging	x			x			x	ICQ
Shared Database		x		x	x	x	x	SamePage
Audio Conferencing (computer telephony, VoIP)	x			x	x			Skype
Video Conferencing (room and desktop systems)	x			x	x	x		Intel ProShare
Electronic Conferencing	x			x	x	x	x	MS NetMeeting
Electronic Meeting Support	x		x	x			x	Ventana
Workflow Management		x		x			x	Livelink Intranet
Etc.								

Many research fields are related to CSCW and group computing applications. Two academic projects in the EU deserve special attention as “roots” of this thesis: eLEGAL and e-HUBs. Both of these research projects aim to facilitate AEC partnering processes.

4.3 eLEGAL

eLEGAL is a recently completed research project to specify legal terms of contract in Information and Communication Technology, funded by the European “Information Society Technology” program, and carried out by a consortium of British, Italian, Finnish and German universities and companies (<http://cic.vtt.fi/projects/elegal/public.html>). The rationale behind the project was to address the issues faced by project-based businesses, such as construction and large-scale engineering firms, for which ICT based information exchange has become commonplace whereas it is not properly covered by contractual practice. Poorly defined responsibilities, overlapping communication techniques and mistrust hamper the full use of inter-enterprise ICT. eLEGAL set out to define a framework for legal conditions and contracts regarding the use of ICT in project business. The objective was to specify requirements, implement legal support tools and promote an enhanced business practice in which the use of ICT in inter-enterprise information exchange was contractually stipulated.

Current legal practices related to ICTs and the operation of the construction industry were reviewed for the four participating countries, as well as emerging ICT support, related Research & Development efforts, and standards for information sharing in Virtual Enterprises. A number of online services for the AEC industry were identified: information systems, directories and catalogs, pricing and estimating systems, and collaboration and project management support. Usually username-password

combinations serve to identify users of these services, although in principle several other methods for user authentication are available, like smartcards, biometric systems (fingerprints, iris and retina patterns, voice patterns, handwritten signatures), digital signatures and digital notaries for time stamping services. Although not so much for identification purposes, certification authorities like trade organizations provide further means to guarantee authenticity and quality by improving trust between contract parties.

Findings suggested that, although the Internet is rapidly changing the way engineering professionals communicate and trade goods and services, current contractual practice seems to preserve the traditional methods for achieving legal admissibility in business. Construction contracts, even for large and technically advanced projects, contain few or no references to ICTs, except maybe for an occasional specification of CAD software to be used by project partners. Official documents are still formally submitted mostly on paper. The use of ICT seems to be intended solely to speed up the transmission process, but effectively has no legal validity. Legislation to support technology may exist, but the construction industry has not adopted it within its contractual practices.

eLEGAL aimed to implement an online contracting service for all aspects of an electronic business transaction, such as partner selection, contract negotiation and service execution. The resulting COSMOS Editor application was developed for e-engineering parties to draw up a comprehensive online contract, select clauses and conditions from a clause library, sign the contract, and monitor its execution (<http://www.econtracting-zone.org/downloads.html>). It provided a model of an electronic contract with clauses that

are structured with XML technology, an Internet markup language that allows automatic processing of data (see: www.w3.org).

Nevertheless, COSMOS basically only supports the selection of certain contract clauses. Despite the available contract ‘wizard’, the system does not provide its users thorough support in selecting appropriate contract provisions, in negotiating conditions or in planning interaction during the project. The initially envisioned functionality of partner finding or ensuring contract adherence are in fact not supported. From a technical perspective, COSMOS is a stand-alone application instead of a Web-based service, which decreases its applicability for collaborative contract formation between remote business partners. Also, the contract editor provides no user-specific editing rights or change tracking – let alone role or user-dependant change tracking – which would be key features for collaboratively drawing up contracts in iterative negotiation cycles.

A more practical and usable research substrate in the context of this thesis is provided by the European e-HUBs project discussed in the next section.

4.4 e-HUBs

According to market analysts from Gartner (www.gartner.com), it is very likely that e-engineering will become the next wave of Business to Business (B2B) trade on the Internet. The EU-funded e-HUBs project, “e-Engineering enabled by Holonomic and Universal Broker services”, introduces a new addition to the arsenal of tools that support this growing area of collaborative commerce. It focused on the process-driven planning of outsourced mechanical and construction engineering services.

The emphasis on “Broker services” signifies the importance that is given to an impartial web-hosting entity that provides service to clients who seek, and providers who offer, a certain engineering skill. “Universal” denotes the project’s objective to make the environment flexible enough so that it can be configured for any particular engineering domain, such as construction. “Holonomic” underlines the idea that the system, although a part, cannot be seen as just another trivial feature or add-on to the whole arsenal of tools already available to the engineer. Instead it reflects the central role of the engineer in a business setting, where project planning is just one of many activities going on in parallel. Project planners are multi-threading, improvising, multi-channel, reactive, and sensitive human beings. To be successful, a project planning platform should acknowledge this, and place the human in the center of its universe rather than the software system. This is especially true in highly creative and expertise-driven activities such as new-product-design and engineering.

The e-HUBs project aimed at introducing a new breed of technologies and support environments, for the project planning phase of global engineering partnerships. e-Hubs are intended to help companies engage in e-engineering faster, with increased quality control, with less risk, and with better oversight and project management control. The focus was on partnerships that exist within a relatively short time frame, requiring agile and secure planning. The project extended from 2002 to 2004, involving a consortium of nine partners from Europe and Latin America, hosted by Delft University of Technology and led by professor Augenbroe from Georgia Tech. It consisted of a mix of academic institutions and Small to Medium Enterprises (SME-s).

The effort responds to an observed need to plan projects rigorously before they are executed. This is deemed especially important if projects are executed with remote partners, for example projects that are run in Web-hosted work spaces. An examination of current practices revealed that tactical and collaborative project preparation were a very important phase of an e-engineering project, requiring better understanding and new forms of procedural IT support, as the ultimate success of a project depends on good project preparation. The e-HUBs consortium developed a configurable environment for remote, collaborative project planning. A platform was envisioned through which e-engineering partnerships could be formed and projects planned rapidly and effectively. The e-Hub would act as a two-way collaboration and integration broker to establish e-engineering partnerships on a project-by-project basis, matching demand and supply for specialized expertise, for example to check building code compliance, or seismic structural analysis.

Reasons for project consortiums to go through e-Hubs for outsourcing services might be:

- The large number of dedicated services needed in a construction project (where the fragmentation of the industry might have negative scale effects)
- The uncertainty and management overhead involved in contracting services on a one-by-one basis (selection, certification, pricing, contracting, monitoring, coordination)
- The lack of available options for increasing competitiveness and optimizing efficiency, cost and quality once engineering project consortium partners are bound to their pre-established contractual relations and provisions.

It should be noted that the expected advantages for a particular firm might not be obvious within just one project, but rather during management of multiple projects or a program with an increasing number of subcontractors.

The world of engineering is becoming increasingly global; products are designed in one place, engineered in another and manufactured elsewhere. In order to stay competitive, the product development of companies requires a broad spectrum of expertise in new materials, new manufacturing tools, dynamic simulation, testing procedures, and advanced engineering disciplines. This list is expanding almost daily as new technologies enter the picture. Product development organizations, particularly SME-s, cannot invest enough to keep up with all knowledge domains. For them it is impossible to cultivate within their company borders the deep expertise needed for using all advanced software

tools, so their strength and survival will instead rest on their ability to focus on their core expertise. This requires SME-s to form partnerships with parties whose specialized knowledge complements their own and adds to the current stage of the product development. Such partnerships will be project based, and therefore ad-hoc and volatile. Engineering Service Providers (ESP-s) are contracted to bring in expertise, which is needed for new product development but which is missing in the developer organization, such as the seismic analysis of a building design for an architectural firm. Instead of forming strategic long-term “service-level agreements”, as is current standard practice in mainstream outsourcing, e-engineering contracts are project-specific, governed by the tactical and operational circumstances of the project at hand.

e-Engineering partners must “fuse” their work processes. They need to do so rapidly, remotely and securely, while anticipating and dealing with all eventualities, and limiting project related risks to a bare minimum. Tools are required that enable partners to reach agreements about project requirements, work arrangements, process mediation, and anything else that a specific project might require. The success of project teams is strongly determined by their management, and by the expectations that drive project management. An explicit, mutually agreed upon, and complete project plan can avoid disconnects in expectations. Projects therefore require a clear set of planning documents that specify risks, roles, responsibilities, Quality Assurance methods, schedules and deliverables. Many of these negotiated outcomes would eventually be part of the e-engineering agreement, so the contract is obviously an essential result of the project planning phase, and is therefore explicitly addressed in the e-HUBs project. The lack of a

comprehensive project plan may later bring the project to a deadlock, especially in the case of remote partnering, where problems during execution often take much longer to resolve.

The recently developed e-HUBs prototype was envisioned to support the meta-process of collaborative design of a project model by client, provider and broker. e-Hubs can provide transaction scenarios that populate this project model, in a systematic process negotiation or by enabling a structured dialogue about tasks, dependencies, incentives, and penalties during workflow model design. Within the phase of project preparation stages could be distinguished like information exchange, quality assurance tests, actual execution, reporting and closeout. The brokering service intends to support definition of semantic project concepts as well as negotiation concepts, for example: projects, tasks, task logic, permissions, event(type)s, time, Requests For Information, rewards, penalties, requirements, contract clauses, document(type)s, amendments, decision moments, responsibilities, Requests For Changes, exceptions, procedures, provisions, resources, etc. Together these concepts provide a transparent environment consisting of overlapping (1) project preparation interactions, (2) workflow modeling and (3) enactment of generic (meta)process models. Eventually e-Hubs could be embedded in a broader context that supports partner selection (via prospects, online portfolios, expertise profiles) and knowledge retention after project partnering (via partner rating, process templates, or performance metrics).

Partner finding and selection, and project execution are already well supported by the current generation of B2B partnering sites. Therefore the focus of e-HUBs was on the project planning phase, where it can be argued that current platforms have yet to make a significant contribution. Planning functionality was envisioned that presents project partners with the opportunity to seamlessly merge procured engineering services into the overall project. Electronic workspaces - and more specifically: e-engineering workspaces – have been around for quite a while. They have revolutionized intra and inter-organizational work processes. But there are also significant problems associated with them.

Studies show that companies often get a lower Return-On-Investment than they expected to get from using these tools. Whereas existing commercial tools merely bring project planners together on the Internet, the e-HUBs platform intended to add intelligence to the planning process by structuring the dialogue between future project partners. This ambition was based on the notion that tools which simply allow users to make a work-breakdown or a project schedule, do not capture and cultivate the business logic of how to go about planning a project together. Instead, those tools were found to make planning heavily reliant on skills and experience that project partners may not actually possess. The current generation of electronic workspaces provides the means for project planners to be connected and to work together, but lacks the specific functionality to enhance their project planning effectiveness.

The e-HUBs project is relevant to the subject of this thesis since outsourcing services need to be planned concisely (and often remotely) in strongly asymmetric knowledge settings. The project also targeted the support of remote secure planning of projects that would be executed through a Collaborative Virtual Environment (CVE), based on the premise that project preparation during the partnering stage is underdeveloped, under-recognized and hence an obstacle between potential and actual partnering. Moreover, e-Hubs are meant to act as tactical partnering instruments independent of specific operational technologies or tools, in order to perform an additional, non-existent function preceding, not replacing, operational e-engineering workspaces.

The e-HUBs project is to some extent a parallel effort to the proposed research in this thesis, in that it also strives to support the project preparation phase by joint workflow definition between engineering firms. However, the project differs in that e-Hubs primarily focus on short-lived partnerships between an outsourcing project participant and an external service provider, engaged to obtain benefits of scale, expertise, and speed. e-Hubs aim to broker a hybrid mix of generic (not domain specific) services, pertaining organically formed, fast track “point partnerships”. Although not excluded, e-Hubs in principle do not focus on long-term “vested” alliances, since these types of partnerships require complex adaptive strategies, with a management style that is more or less reformulated on a project-by-project basis in response to unique circumstances. Instead partnerships are targeted that are of a more repetitive nature within or across projects. Usually this entails well-defined tasks, with only a limited management scope and time span within the larger project. Those tasks are allocated to engineering

(sub)contractors that need no tight contractual relationship with the project consortium as a whole. This makes assigning task responsibilities rather straightforward, with up and downstream dependencies that are transparent and easily manageable.

The research in this thesis however, does not exclude longer-term, domain-specific partnerships, potentially between contracting parties within the core of a project consortium -- like AEC alliances. Nevertheless, longer-term relationships in construction projects might not render enhanced, collaboratively defined working agreements less necessary than in the e-HUBs' e-engineering domain. It may be argued that enhancing the current e-partnering practice with unambiguous collaboration modeling is most crucial for more complex, interdependent interactions that require process modeling beyond simply a clear definition of outsourced deliverables. Detailed project planning makes only sense within a certain time horizon, where the benefits of planning for anticipated change dynamics outweigh the potential re-planning efforts that result from inevitable and unforeseeable events. The relatively large costs involved in mitigating planning insufficiencies in construction projects quickly warrant a longer time horizon for project preparation. A plausible premise of this thesis is that collaborative project planning leads to better anticipation of the dynamics of change.

4.5 Research Justification

The following sections will build the argument for enhanced project planning in the AEC industry by arguing successively why it should be better (4.4.1), process-mediated (4.4.2), collaborative, and Web-hosted (4.4.3) based on documented findings of previous research.

4.5.1 Better Project Planning

Few professionals in the design and construction industry will dispute that better project planning will likely lead to better project deliverables in terms of time, cost and quality. An enhanced preparation ahead of time can reduce the amount of change orders, misunderstandings, budget overruns, litigation and delays later on during project execution.

Yates and Hardcastle (2003) describe two case studies from the Hong Kong construction industry where large numbers of claims due to – among others – contractual incompleteness, and consequent ex post adjustments, resulted in significant cost increases for the owners. The relatively high extra costs are explained from a transaction cost economics perspective; the complex, long-term and dynamic relationships in construction projects make for an environment where opportunism thrives. Transaction specific investments, or ‘asset specificity’ (site, physical or human), in the course of a design or

construction project creates a ‘monopoly’ power for contracted parties that inhibits the client from procuring additional goods and services according to free market principles once the design or construction project is underway. The authors state that if participants in the construction process – especially the client – would have a better understanding of the factors that cause conflicts and disputes, they could take appropriate avoidance measures.

It should be noted that contractual incompleteness on a ‘traditionally’ procured project usually falls into one of the following three categories:

1. Anticipated incompleteness; at contract formation stage in the form of Prime Cost Sums (PC Sums), Provisional Sums, Provisional Quantities, etc. -- which are adjusted during the construction phase to reflect actual requirements.
2. A contractual mechanism – namely, the right to instruct variations or changes – which allows the client or design team optimum flexibility in decision-making (either by leaving decisions as late as possible or by changing decisions previously made).
3. Unintended contractual incompleteness; ambiguities, errors or omissions in the contract documentation, which come to light after contract closure, necessitating clarification and adjustment. This latter category can be avoided or reduced by better project preparation.

The ‘Dispute Avoidance and Resolution Task Force’ of the American Arbitration Association comments in its February 1994 newsletter (AAA 1994):

“During the past 50 years much of the United States construction environment has been degraded from one of a positive relationship between all members of the project team to a contest consumed in fault finding and defensiveness which results in litigation. The industry has become extremely adversarial and we are paying the price... A positive alliance of the parties (involved in the construction process) constitutes an indispensable link to a successful project.”

New types of partnerships and alliancing contracts could reduce the litigious climate in construction projects and create a more synergetic atmosphere, but in order to improve the situation adequate vehicles are needed for empowering partnerships to engage in better project planning.

Recent research in Canada and the United States indicates that the general traditional practice of shifting project risks to the other contracting party by using disclaimer clauses in contracts, is a significant reason for parties to increase the total cost of a project (Zaghloul and Hartman 2003), with assessed premiums between 8 and 20%. Any improvement in the process and more appropriate risk allocation would deliver substantial savings for the construction industry. Research also shows that there is an important relationship between trust and risk allocation through contract provisions.

According to Zaghoul and Hartman (2003) the five most commonly used exculpatory clauses in construction contracts regard (1) uncertainty of work conditions, (2) delaying events, (3) indemnification, (4) liquidated damages, and (5) sufficiency of contract documents. Based on a survey among industry experts – owners, consultants and contractors – with more than 300 respondents, it can be concluded that a trust relationship between the contracting parties should exist first to reach a better risk allocation process.

Certain stages are proposed to achieve higher pre-project trust:

- A clear understanding of risks being born by each party and who owns and manages that risk;
- More time and effort in the front-end of a project and sufficient experience to manage or mitigate the risk and administrate the contract;
- Adequate risk-sharing or risk-reward systems should exist to share the benefits if the risk does not occur during the project lifecycle; and
- A negotiation phase prior to the start of the contract should exist, this phase is required to build a trust relationship between the contracting parties, then this negotiation phase can be part of the contract itself.

4.5.1.1 Example Scenario: GT Campus Master Plan

About every 5 to 6 years, last performed in 2004, the Georgia Institute of Technology as a large facility owner wants a new master plan generated that serves as a guide to a wide

range of future institutional developments, like land acquisitions, quantities of student admissions, traffic flow, and capital construction / renovation projects. To generate the 2004 Campus Master Plan Update (CMPU), an outside consultant was hired: a remote architectural company from Florida (WRT, <http://wrtdesign.com>). In order to bring down the price, and increase the accuracy of new developments, Georgia Tech agreed to provide a large volume of data, regarding field surveys, transportation, parking, storm water management, utilities, building use, building conditions, athletic facilities, pedestrian safety issues, etc. This comprised a long list of deliverables from owner to architect. Within the owner organization, many employees across several departments worked for months to produce all this information, mainly in the Facilities, Capital Planning and Space Management departments, but also in Parking and Transportation, Real Estate Development, etc. Based on the gathered data, the architectural firm would eventually develop, simply stated, a "future campus map", after several rounds of iteration with many different (levels of) owner-representing employees, organizations and departments. To further complicate the process, certain information was sensitive, due to potential speculation on real estate values around campus, US Department of Defense research activities, and risks of terrorism on main utility pipes and facilities. Relationships within the project were longer-term, vested partnerships, involving allocation and outsourcing of design and engineering services to dispersed parties. Although some meetings were conducted face-to-face, day-to-day planning and operations mainly took place via remote collaboration (e-mail, phone, ftp-sites) between owner and architects, internal owner departments, and third parties, like aerial photographers. The master planning process clearly required a lot of upfront planning

involving the coordination of partner responsibilities, both internally and externally: how to exchange data, what data, when, privileges, data formats, accuracy, disclaimers, which coordinates to use, document layouts, fonts, logos, contracts, task sequences and dependencies, deadlines, contact info, responsibilities, and so on. For such a complex process, insufficient project planning and understanding ahead of time are bound to lead to later inefficiencies. These inefficiencies, attributable in hindsight to inadequate project preparation, indeed occurred during the CMPU project 2004, manifested in unclear deliverables, misunderstandings, wasted effort, redundancies, personal frictions, exchange of incompatible file formats, incorrect data, overtime, patchwork, rework and delays, to the extent where the project was eventually renamed from “CMPU 2003” to “CMPU 2004”. Although the master plan design process itself may be to some extent unpredictable, human-network-driven and fuzzy, explicitly modeling engineering work agreements around it could reduce uncertainty and inefficiency, and increase the quality of process output. Collaborative pre-execution definition of work statements would be a helpful part in the partnering process between project parties.

The CMPU example shows that a careful project planning is an indispensable step to streamline execution. Moreover, in a project like this, crucial points exist in the process – such as the kick-off, and the hiring of external consultants at some point – where things can easily start to break down because there is no predictable and well managed way in which partners plan their tasks and responsibilities systematically. Adding a more methodological approach to the planning will take a lot of uncertainty out of the equation. This thesis thus targets a step that is well recognized as crucial in the total project life cycle, yet it is under-recognized and under-supported in the team collaboration space.

4.5.2 Mediated Project Planning

Project planning in AEC involves multiple partners where a service is delivered by a provider to a client. Most of these services are managed by contracts between client and provider, in many cases as subcontracts of a bigger overall contract. The main business objectives for these services are to:

- Reach economies of scale,
- Spread risk,
- Create strategic alliances,
- Accommodate fluctuations in order portfolios, and
- Obtain external skills and expertise.

The last point denotes an inherent difference in knowledge between client and provider. Information asymmetry also exists in the partnering process of a building owner and his AEC professionals. Since architectural design or construction is not the core business of most owners, they are likely to be less knowledgeable and experienced than their practiced counterparts in firms who deal with construction issues on a daily basis. On the other hand, smaller architectural or construction companies, start-ups or sector-inexperienced firms (e.g. in specialized fields like hospital or school design and construction) might be less well informed and powerful in contract negotiations with large institutional owners. In other words, many owners, contractors and architects would simply not recognize contract provisions or omissions that could potentially have a

negative or even harmful impact to them e.g. by an unbalanced allocation of risks or unreasonable performance requirements. Mediation by a brokering agent – human or software – can alleviate information asymmetries between negotiating parties by bringing in expert knowledge to either party, gained over many similar project negotiations. Every organization can benefit from a more controlled environment for managing projects, even for small projects where there is often more risk of cost overruns and missed deadlines than on larger projects (Bentley 2005).

Furthermore, facilitation of the partnering process by an autonomous computer or human agent may be inevitable for ensuring proper handling of the negotiation process and resulting intermediary agreements, e.g. by tracking changes, showing deviations from standard contracts, or locking end-results and attachments to avoid modification after contract closure. The rules and procedures for effective planning (best practices if you like) are not available. Stating them explicitly will lead to the definition of a meta-process, i.e. rules about the process of project planning. Managing the project preparation through such a meta-process that suggests or enforces planning events will make for a shared planning burden between project partners and for a clear, optimized allocation of planning tasks to the proper, most proficient resource in the organization of either the owner or the architect. The meta-process will guarantee both the timeliness of invoking planning events and the comprehensiveness of the planning outcome, by reducing the chance for errors and omissions. Also, it will avoid an ad-hoc approach to contract definition, and instead foster knowledge retention in recurring partnering processes (Allee 1997, Kamara *et al.* 2002). And finally, joint project planning through a mediated

process will increase transparency and mutual understanding of project expectations among the parties involved.

In summary, the objectives of mediated project planning are to:

- Alleviate information asymmetry between project partners
- Ensure proper handling of negotiation process and resulting intermediary agreements
- Share the planning burden between involved project partners
- Achieve a clear, optimized allocation of planning tasks to the proper, most proficient resource across organizations
- Guarantee timeliness of invoking planning events and comprehensiveness of planning outcomes
- Avoid an ad-hoc approach to contract definition
- Foster knowledge retention across recurring projects within organizations, and
- Enable industry-wide diffusion of best practices, thus increasing quality and productivity in AEC
- Increase transparency and mutual understanding of project expectations

4.5.3 Web-facilitation of Project Planners

The multilateral and remote nature that characterizes many partnerships in current construction projects, calls for a suitable partnering platform tailored to those circumstances. Reaching a detailed agreement is the result of an iterative selection and negotiation process that involves many participants who may well be dispersed in time and place for at least part of the project planning process. The Internet provides a connecting infrastructure for this situation. Apart from this mere practical aspect, Web-facilitation holds the promise of greater efficiency (faster, cheaper, repeatable processes), better quality (richer, more complete project preparation), and improved knowledge preservation in the project planning and negotiation process (El Sawy 2001), as will be explained in the subsequent sections on (successively) Business Process Reengineering for e-Business, and Web-facilitated negotiation.

4.5.3.1 Business Process Reengineering for e-Business

Moving the process of project planning and contract negotiation online, while managing it through a collaborative mediated meta-process, effectively means a fundamental reengineering of the process. In the domain of improving organizational performance by focusing on business processes, Business Process Reengineering (BPR) started out in the 1990s, more or less evolving from the Total Quality Management movement in the 1980s, which focused on continuous incremental improvements rather than radical process redesign through innovative technologies. BPR is in essence a performance

improvement philosophy that aims to achieve quantum improvements by primarily rethinking and redesigning the way business processes are carried out (El Sawy 2001). BPR for e-business requires rethinking and redesigning business processes at both the enterprise, supply chain and project level to take advantage of Internet connectivity and new ways of creating value. That means e-business is more than simply electronic commerce (trading via the Internet), or Web-enabling existing technologies; it also involves adapting traditional operating procedures and organizational change, building on the notion that in today's knowledge-intensive economy competitive advantage is often achieved through collaborative advantage (Platt 1996).

El Sawy (2001) lists ten tactical principles for restructuring and reconfiguring processes:

1. Squeeze out waiting time
2. Let swiftest and most able enterprise execute
3. Flex the process for any time, any place, any way accessibility for participants
4. Synchronize the physical and virtual parts of the process
5. Capture information digitally at the source and propagate it
6. Provide in-process visibility with fresher and richer information
7. Fit with vigilant sensors and feedback loops to prompt action
8. Augment interactive analysis and synthesis
9. Grow knowledge around the process through all who are involved
10. Make the process personalized with preferences and habits of participants

It should be noted that business processes that include intensive knowledge work – like capital project design, construction or new product development – are typically more difficult to tightly structure than more repetitive business processes that consist of mainly or completely clerical production work. Nevertheless, better supporting the project planning by AEC partnerships would contribute to many of the ten objectives for process performance improvement outlined above. When construction project partners can exchange better-structured information earlier, faster and more easily, work can be planned better, performed with more quality, and where it is done best across organizations.

4.5.3.2 e-Negotiation

Project planning contains a high dose of negotiated give and take, since planners may have different objectives and expectations of their partnership. Negotiation is therefore an important aspect that an effective mediated PP platform will have to reflect and support. One of the motivations for electronic negotiation lies in the expected process efficiency gains that result from a quantitatively and qualitatively higher-level information exchange. System support and advice to mediators and participants promise more informed decisions throughout the negotiation procedure and a faster emergence of negotiated agreements. e-Negotiation can involve negotiation support systems (NSS) or negotiation software agents (NSA) that replace human decision-making altogether. Hung and Mao (2002) define e-negotiation as multilaterally bargaining for mutual gain conducted by two or more agents, either human negotiators or computer programs, using

tools and techniques of information technologies in a cooperative problem-solving environment. Bichler *et al.* (2003) describe electronic negotiation as an iterative communication and decision making process between two or more agents (parties or their representatives) who:

1. Cannot achieve their objectives through unilateral actions
2. Exchange information comprising offers, counter-offers and arguments, via electronic media
3. Deal with interdependent tasks; and
4. Search for a consensus that is a compromise decision.

Effective e-negotiation in practice is still more of an art than a science, depending principally on creativity, negotiation skills and domain knowledge of individual planners. Nevertheless, four key approaches are identified as a possible basis for negotiation modeling: decision theory, game theory, negotiation analysis (a combination of the first two), and auction theory.

- Decision theory focuses on alternatives, conflicting objectives and uncertainty of decision outcomes as key aspects of negotiations.
- Game theory aims at predicting negotiated outcomes, with models that assume rationality of agents' decisions based on clear utility functions – as opposed to real human negotiating behavior.
- Auction theory entails a series of multi-dimensional negotiation protocols, like multi-unit auctions (involving prices decreasing with larger quantities, instead of

price-based-only negotiation), combinatorial auctions (involving multiple items or bundles of products and/or services) and multi-attribute auctions (involving negotiation of not just price, but also quantity and quality). Multi-dimensional auctions are limited in computability, due among others to the complexities of unpredictable and irrational negotiating behavior.

Many negotiation processes in the AEC industry have multi-dimensional characteristics that complicate or rule out automation (negotiation software agents), since construction-engineering agreements often involve:

- Complex combinations of products and services (a contractor offering a combined package of labor, material, equipment and subcontractors),
- Scale efficiencies influencing price levels (a contractor purchasing plywood in larger quantities for several construction projects),
- Preference elicitation based on multiple criteria (not just price as a measure of preference, but also utility, quality, risk, participants' experience, reputation, etc.)
- Mutual participant dependencies extending beyond the initial agreement (e.g. Change Orders becoming part of the contract documents after contract awarding)
- 'Irrational' human negotiating behavior (e.g. lower bids in expectation of future business with a customer)

Therefore, project planning support systems for the AEC industry should support – not replace – human interaction, allowing among others haggling, trade-offs, concessions, logrolling, and bartering when planning projects. Web-facilitated, mediated project planning through structured dialogues should thus allow and enable negotiation, but does not particularly require extensive systematic support for it, as human intelligence is best suited to find middle ground in construction projects.

CHAPTER 5

RESEARCH METHODOLOGY

In previous chapters this dissertation has thus far provided an executive summary (1), framed a problem statement (2), proposed a solution concept (3), and explained the motivations for this proposition in the context of existing research and literature (4).

This chapter outlines the steps that are followed in the remaining part of this dissertation for realizing and examining the conceptual solution proposed in the opening episode. Each consecutive section in this chapter briefly introduces or explains a later successive chapter of the dissertation. The two main steps are first the development of a working prototype system, followed by testing it, in a bid to systematically investigate the three partial suppositions that together make up the main hypothesis. This approach is further explained in the opening section on the next pages.

5.1 Overview

The objective of this research is to provide a proof of concept for the hypothesis (stated in Section 3.4) that project planning in the AEC industry would benefit from process mediation, and from structured dialogues in particular. It does so by assessing the validity of three underlying claims in consecutive chapters. Each of the sections in this chapter is a short preview of a more elaborate chapter on the same topic later on in this dissertation.

Before addressing the premises beneath the hypothesis, the next section (5.2) first explains the basic configuration of the implemented prototype system. This system architecture will be explained in more detail in the next chapter (6).

The first premise of the hypothesis is i) that a planning process and its implicit knowledge can be modeled with workflow technology, hence Section 5.3 describes the modeling of a project planning process (Chapter 7). An analysis of existing process models and methods in AEC (5.3.1) reveals that the so-called Project Management Body of Knowledge (PMBOK) provides a particularly useful and solid fundament for this process modeling (5.3.2). As a suitable project window to demonstrate the modeling of a planning process, the planning of a construction delivery method is selected (5.3.3). For this process – so-called Design-Build project delivery – an elaborate workflow model is provided in Chapter 7.

The second premise, ii) that more collaborative aspects of a planning process can be expressed in structured dialogues, is assessed by first exploring existing research and theories on dialogues (5.4). Based on this analysis (detailed in Chapter 8), a separate prototype module is devised to support the structuring of workflow-initiated dialogues. With this application (5.5) a structured dialogue is modeled in the Design-Build project delivery process introduced earlier. Chapter 9 provides technical details and dialogue snapshots of the dedicated prototype application.

The third and final premise is iii) that execution of a dialogue-enabled workflow would indeed add value to existing planning practices, in terms of higher quality, lower costs, less omissions, better knowledge retention, faster execution, less litigation, fewer budget overruns, etc. This premise can be tested in various ways as will be explained in Section 5.6 (Chapter 10).

In summary, the methodology follows these sections:

– with corresponding chapters, and the part of the hypothesis they address (i, ii, and iii) –

5.1	Methodology Overview	Chapter	5
5.2	Prototype System Configuration	Chapter	6
5.3	Modeling a Project Planning Process (i)	Chapter	7
5.4	Analysis of Dialogue Theories	Chapter	8
5.5	Modeling a Structured Dialogue for Design-Build Project Delivery (ii)	Chapter	9
5.6	Concept Validation (iii)	Chapter	10

5.2 Prototype System Configuration

In order to prove the hypothesis that project planning would benefit from the proposed dialogue-enabled process mediation, an ideal test system would be comprised of some key components. It would entail both a custom process modeler that is capable of representing the enhanced concept of structured dialogues, and a mature execution environment that is able to run such innovative processes online between project planners, while providing enough “regular” features to not hamper the system’s credibility in a possible user evaluation.

However, it would be a dauntingly steep development curve to:

1. Expand existing workflow taxonomy to include syntax for structured dialogues
2. Develop a high-end process modeler customized to include that syntax
3. Develop a corresponding full-featured Collaborative Virtual Environment (CVE)
4. Model an example planning process in detail (e.g. Design-Build project delivery)
5. Extensively test and measure the implementation with performance metrics
6. Validate the concept of the proposed solution (separating ends and means)

In order to keep development feasible yet realistic, the approach has been followed to add functionality on top of an existing CVE that allows the execution of standardized workflow models. The e-HUBs project, introduced in Section 4.4, provided such a

platform with an integrated process modeler that generates workflow models in an interoperable format (see Section 6.2 and 6.3). Although this process modeler does not explicitly support the concept of enhanced structured dialogues, their added value is made plausible through a separate rapid prototype developed in MS Access, as described in Chapter 9. Though not truly integrated with the selected CVE, the prototype dialogue application, combined with the used skeleton functionality of the e-HUBs platform, can be envisioned to provide an initial prototype / test implementation for taking a first cut at a possible proof of concept. Hence the testing of the main hypothesis is subdivided in the assessment of the three constituting premises as introduced in Section 3.4.

5.2.1 Technical Concept

In order to achieve better collaborative project planning, a mediated partnering process is devised in which (groups of) participants carry out predefined sets of ordered activities (workflows). Process participants can be represented by individuals, groups, companies or cross-organizational project teams that play a role within the overall process, such as the role of the architect for the construction of an office building. Each of their activities requires the production and sharing of certain information items (Figure 5.1). This is supported by predefined data templates where items of concern, decisions, rationales, parameters, and documents (as described in Watson *et al.* 2002) are accessed (*read*) or submitted (*write*). These information items, together with the pre-defined process logic, guide the partners through the planning process, which is driven by a series of detailed workflows, such as the selected one for so-called Design-Build project delivery.

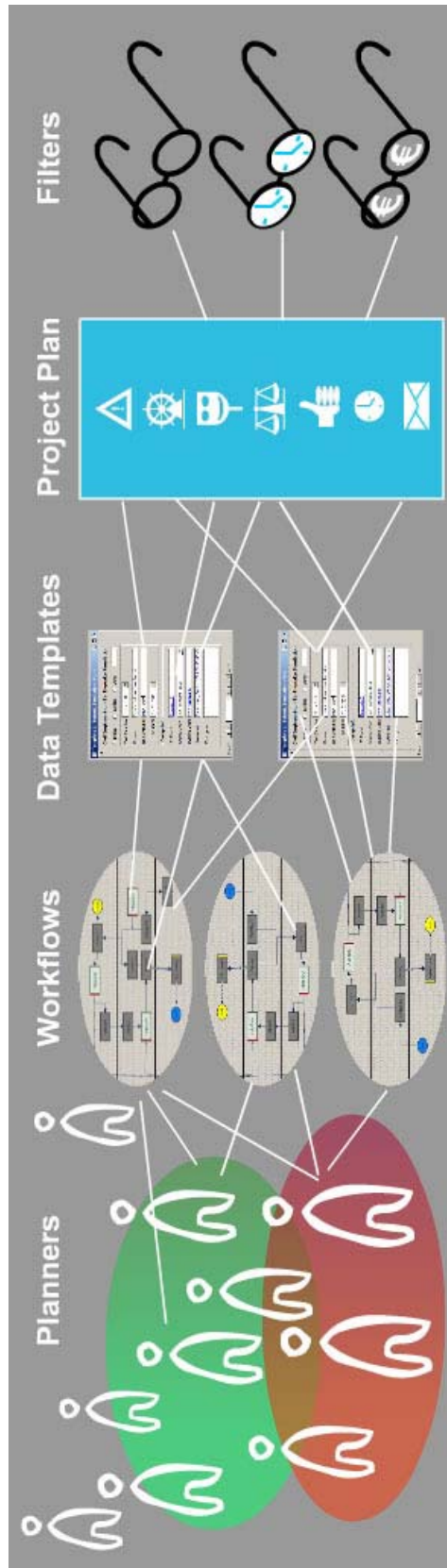


Figure 5.1: Technical Concept

When all workflows have been completed, the data templates will have been filled with information items that together form a complete project plan, containing the results of all activities and dialogues. This repository contains information with respect to all relevant issues such as risks, responsibilities, roles, rewards, arbitration, quality control, deadlines, deliverables, and so on. In this context, a role can be defined as a function that a human actor undertakes within a project. Filters can be defined to process the information in the planning data repository for downstream use (Figure 5.1). These filters can be set up to separate final outcomes from the intermediary deliverables (the project's audit trail) that led up to those results. For example, they could be used to generate specific documents, such as the project's overall financial data or task schedule.

The next chapter (6) will expand on the technical details and intricacies of the applied system architecture for the prototype set-up.

5.3 Modeling a Project Planning Process

As part of the hypothesis testing, an example planning process will be modeled in Chapter 7. This section explains the motivation for selecting this particular example case. It starts with an analysis of existing process models and methods in AEC (5.3.1), lifts out the PMBOK framework (5.3.2), and then zooms in on the planning of a construction project delivery method (5.3.3) called Design-Build (DB).

5.3.1 Analysis of existing Process Models and Methods in AEC

Although each design and construction project is uniquely different, during the process of project planning and contract negotiation there are common and/or similar steps to be followed in every situation, spanning from feasibility studies to requirements gathering to permitting processes and beyond. Since the rules of the process are described on such a meta-level, it basically serves as the starting point of project planning. For various reasons and with varying success researchers have made attempts to develop comprehensive theoretical models that would describe and structure work-processes in the construction industry at a meta-level.

Some studies have been undertaken specifically to model and better understand architectural design processes. Significant examples are the Analytical Design Planning Technique – ADePT (Austin *et al.* 2002), the Process Protocol (Sheath *et al.* 1996), the RIBA Plan of Work for Design Team Operation (RIBA 1973), and Pugh's Total Design model (1988). Most of these design process models are either too narrow (e.g. focusing only on conceptual design), too general (e.g. focusing on engineering generically) or they are simply not useful to support mediated project planning. On top of that, research in business, cognitive and behavioral science shows that it is very hard to predict or model activities for the “creative” part of the design process (Ballard 2002, Heinz 2002, Kvan 2000, McMillan *et al.* 2002), partly because for unique, custom-designed products it is difficult to elicit user preferences (Terwiesch 2003).

Other efforts describe in narratives (rather than providing actual support systems) small slices of practices that can be more easily structured, such as the contract negotiation between owner and architect, for which the American Institute of Architects recommends five general steps (AIA 2003):

1. Establishing project requirements
2. Describing project tasks and responsibilities for each of them
3. Identifying schedule requirements
4. Adapting plan, budget and/or schedule if necessary
5. Determining the architect's compensation

A number of project management organizations have taken initiatives to put forward industry standards, approaches and techniques for improving performance of project organizations.

The British Standards Institute (BSI) has published BS6079 “A Guide to Project Management”. BS6079 is aimed primarily at small to medium sized organizations as a guidance document rather than a statement of requirements for formal project management conformance, and it includes the implementation and operational phases as part of the project lifecycle. Organizations who wish to adopt the BS6079 standard as a general framework for project management will still require detailed guidance on the processes, activities and products of their projects.

The Association for Project Management (APM) has developed a method which is used primarily as the basis for competency assessment of individuals in managing projects, but also as the basis of syllabi for training courses and for accrediting training companies in Europe. It identifies forty key competencies divided under four headings: project management, organization and people, techniques and procedures, and general management.

The APM is also running another industry standard of project management principles with a strong tendency to define best practices – called PRINCE2, which stands for Projects in Controlled Environments. It is a formal method developed in 1996 by the Central Computer and Telecommunications Agency (CCTA) of the British Government. It describes a framework for the organization and management of a project, recognized primarily in the UK as a standard in the public sector while it has also been widely adopted in the private sector (Figure 5.2). Whereas earlier versions of the method were designed specifically for IT project management, PRINCE2 provides a generic best-practice approach suitable for use on all types of projects. PRINCE2 consists of a set of processes covering the project lifecycle from startup to closure, and project management techniques such as product-based planning and quality review. It also describes a number of project management components such as risk management, quality, project controls, organization, configuration management, and change control. CCTA has established a training accreditation and consultant registration scheme which includes a PRINCE 2 examination (Bentley 2005). However, PRINCE2 does not include every aspect of project management. For example, team motivation and contract management are not

part of the method but are often critical to the success of projects. BS6079 and PRINCE2 can be used together within an organization to provide a more complete coverage of the various aspects of project management.

For establishing the theoretical fundamentals of a guided planning process, a particularly useful project management methodology is provided by the American equivalent of the APM, the US Project Management Institute (PMI), as will be explained in the next section.

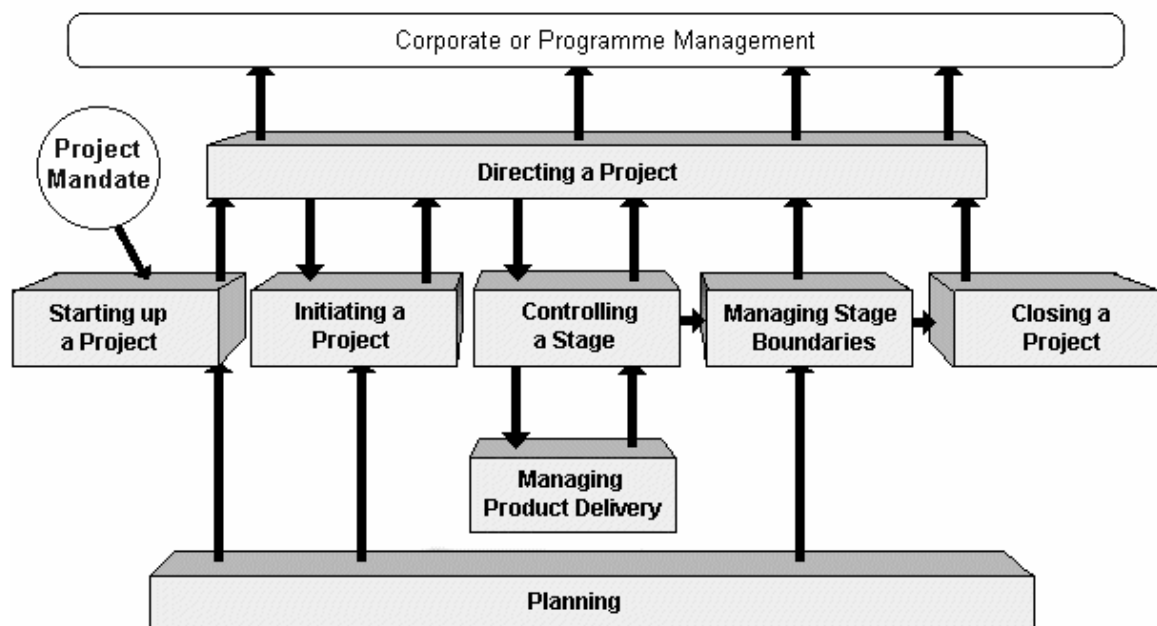


Figure 5.2: PRINCE2 Process Model

5.3.2 Project Planning governed by a Meta-Process: PMBOK

An elaborate but abstract series of project planning steps is proposed by the Project Management Institute in their Project Management Body of Knowledge (PMBOK) which represents the knowledge of over thirty years of project management experience spanning multiple industries worldwide (PMI 2000a, b). At the highest level the PMBOK describes project management as consisting of initiation, planning, execution and project closure, with a ‘controlling’ loop going back from execution to planning (Figure 5.3).

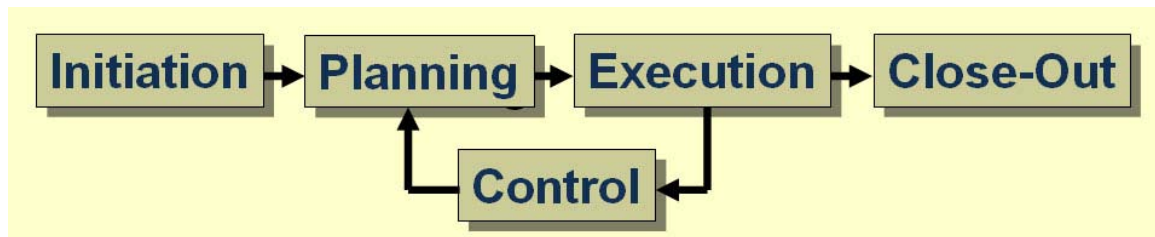


Figure 5.3: Top-level Phases of the Project Management Body Of Knowledge

During project initiation the recognition of the need for a project and the commitment of the (permanent or temporary) organization to it are assured by defining a project charter, an initial scope statement, project managers, stakeholders and the team composition, while assessing constraints and assumptions in the cultural context of the endeavor.

After completing project initiation, the PMI suggests a more or less consecutive development of a series of *core planning processes* – though recognizing the iterative nature of project planning – in parallel with a series of optional *facilitating processes* (Table 5.1). The latter are applied as deemed necessary based on the characteristics of the particular project at hand. Core planning processes are for example activity definition and schedule development, whereas facilitating processes could be risk identification and procurement planning. The various planning sub-processes should result in a consistent and coherent overall project plan to guide execution and control.

Table 5.1: PMBOK Planning Process Groups

1. Core planning processes	2. Facilitating planning processes	AEC-specific
1.1. Scope Planning	2.1. Quality Planning	2.12. Safety Planning
1.2. Scope Definition	2.2. Organizational Planning	2.13. Environmental Planning
1.3. Activity Definition	2.3. Staff Acquisition	2.14. Financial Planning
1.4. Resource Planning	2.4. Communications Planning	2.15. Claim Identification
1.5. Activity Sequencing	2.5. Risk Management Planning	2.16. Claim Quantification
1.6. Activity Duration Estimating	2.6. Risk Identification	
1.7. Cost Estimating	2.7. Qualitative Risk Analysis	
1.8. Schedule Development	2.8. Quantitative Risk Analysis	
1.9. Cost Budgeting	2.9. Risk Response Development	
1.10. Project Plan Development	2.10. Procurement Planning	
	2.11. Solicitation Planning	

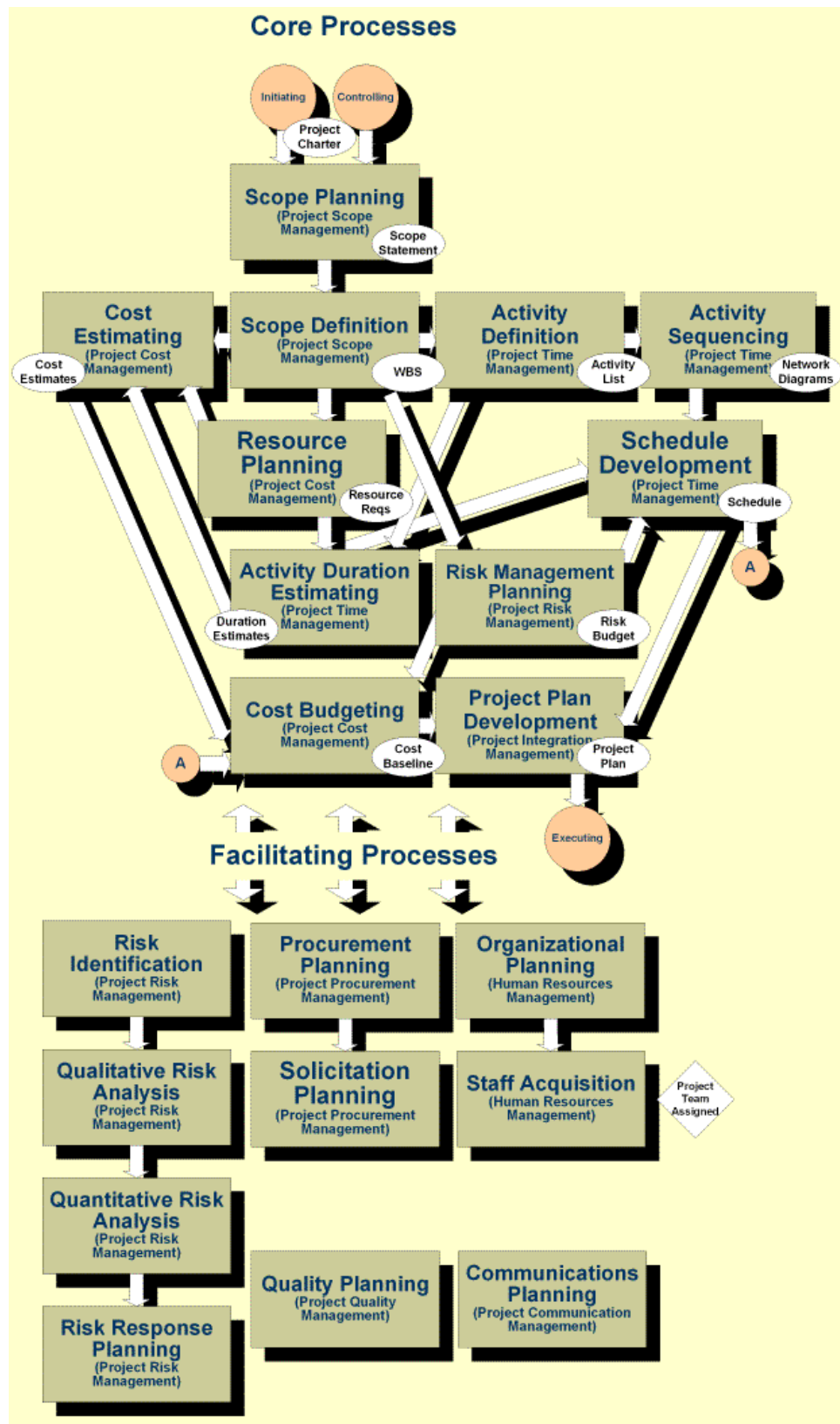


Figure 5.4: PMBOK Core and Facilitating Planning Processes

The process groups are linked by the results they produce; the result or outcome of one often becomes an input to another according to the dependency diagram in Figure 5.4. An example of such input and output deliverables is presented in Table 5.2, for the process group of Activity Sequencing.

Table 5.2: Inputs and Outputs of the Activity Sequencing Process Group

Activity Sequencing		
Inputs	Tools & Techniques	Outputs
<ol style="list-style-type: none"> 1. Activity list 2. Product description 3. Mandatory dependencies 4. Discretionary dependencies 5. External dependencies 6. Milestones 	<ol style="list-style-type: none"> 1. Precedence Diagramming Method (PDM) 2. Arrow Diagramming Method (ADM) 3. Conditional diagramming methods 4. Network templates 	<ol style="list-style-type: none"> 1. Project network diagrams 2. Activity list update

It is important to keep in mind that there is no single right answer in planning projects and the necessary level of detail; too much of it wastes time, money, and frustrates the project team, whereas too little of it introduces risk, confusion and extra costs. Different teams with same intentions may therefore produce very different plans to accomplish their goal. Even with a number of services predetermined at the outset of an AEC

collaboration, other activities might still become necessary once the building project is underway. Many of the owner's needs and expectations come into the focus only in the process of design, which may require revisiting and updating the original planning.

It should also be noted that the PMBOK only describes input and output deliverables at a generic level, without much detail of the actual procedures and required domain knowledge to complete activities, and without much detail at the level of applicable techniques. For example, the output of the "Scope Definition" sub-process is defined as the Work Break-down Structure, but implicit familiarity and experience are assumed as to how to arrive at a realistic project-specific set of phases. Moreover, the PMBOK does not explicitly define resource allocation in the form of activity assignments to parties or individuals involved in a construction project (who should do what), whereas the division and coordination of responsibilities and tasks between project partners is a crucial aspect of construction project management.

These deficiencies instigated the selection of a more narrow focus within the larger PMBOK framework, so that detailed deliverables and task assignments could be specified. A small project window, representing a sub-process out of the whole project planning process, was selected to test the hypothesis that a controlled, mediated planning process will result in better project planning.

5.3.3 Focus: Construction Project Delivery Method

The research has concentrated on a small but important “project window” of the total life of a construction project. The selected project window contains a representative but manageable component out of the larger PMBOK framework that:

- Can be implemented “stand-alone” while still being meaningful as a separate planning activity,
- Involves interactions between multiple project partners with different roles, responsibilities, strategic objectives, etc.
- Enables some basic means of comparing conventional uncontrolled planning practices versus process mediation, and
- Preferably provides support for a procedure that is otherwise ill-served by existing know-how of a majority of practitioners.

The latter is intended to increase the likeliness of convincing those practitioners of the added value of the proposed process guidance in an industry which has traditionally been skeptical of, and slow in adopting, new technologies (Lockley *et al.* 2002).

The selected project window zooms in on the project initiation phase and the sub-process of scope planning, by focusing on the selection and implementation of the project delivery method, in particular so-called Design-Build delivery, which is an important decision early on in the life of many construction projects.

Although many variations exist, the main delivery methods are (Hendrickson 2000):

- *Design-Bid-Build* – separate design and construction, with a fixed design before construction costs are known
- *Construction Management* – a method to guarantee early infusion of construction knowledge into the design process
- *Design-Build* – integrated design and construction, typically with an early fixed budget but a partly undefined design
- *Bridging* – a method to combine the fixed design of Design-Bid-Build with the early fixed price of Design-Build

The main advantages of applying the Design-Build delivery method versus conventional Design-Bid-Build, are that it is generally faster, it produces an early fixed price for the owner, it optimizes the integration of design and construction knowledge (traditionally dispersed across different disciplines and firms), and it internalizes design and construction trade-offs and potential adversarial relations between architect and contractor within the Design-Build entity (Beard *et al.* 2001). Disadvantages on the other hand are the lesser influence by the owner on design details, the quality that may be compromised over the early fixed price, and the effect that later design changes become Change Orders (which increase the project's cost).

In order to mitigate some of those disadvantages, the Bridging method was devised. Bridging incorporates the strength of competitive bidding with detailed drawings instead

of just performance requirements. A more or less fixed design is generated by the consultant / owner's architect, thus reducing the owner's exposure to later claims (Change Orders).

Most participants in construction projects are more familiar with the traditional Design-Bid-Build approach. Therefore they are often hesitant to apply potentially more innovative methods such as Design-Build variations, even though for certain projects these delivery approaches may offer significant advantages.

Chapter 7 will expand on the features of Design-Build project delivery in general, and of the implemented process model for it in particular.

The chosen window on the total project planning process provides a realistic case which fits the criteria set forth earlier. All AEC projects go through a planning stage where the choice of delivery method is one of the most important tactical decisions that have to be made. Moreover, it is a tactical planning effort that involves a series of potential partners and consultants, and it brings together different companies that have different strategic objectives. Modeling and enacting a structured dialogue for the neutral selection and correct implementation of the delivery method is expected to make the decision making process less biased, better informed, and more in the best interest of the project at hand (instead of just being based on tradition). It enriches tactical decision making by objectively presenting available options with the right background knowledge at the right time in the project's life cycle.

5.3.4 Process Formalization

Knowledge in the AEC industry resides in a wide variety of places; in manuals, books, drawings, on Websites, in document repositories, but most of all in the heads of people – as explained in Section 4.1, which among others lists observed types of knowledge. Hence a lot of knowledge of construction processes is unscripted. Understanding a process therefore basically requires a lot of study and/or experience. This knowledge can be made “visible” in various ways, for example by verbally describing work practices or by visualizing processes with workflow modeling tools. This latter process articulation requires both a formalized language in which to express workflows, and a methodology to systematically build up a workflow model.

A formalized workflow modeling language is provided by the Workflow Management Coalition (WfMC), an international non-profit organization of workflow vendors, users, analysts and university / research groups. The constructs of this formalized language will be explained in the next (technical) chapter on the prototype system architecture (in Section 6.2).

A methodology to systematically build up a workflow model is provided by the PMBOK framework just described in Section 5.3.2. It not only supplies a meta-level project planning framework, but also serves as a road map to methodically generate workflow models through its respective steps of Activity Definition, Resource Planning, Activity Sequencing, Activity Duration Estimating, etc. – as will be explained in Section 7.2.

The process logic of Design-Build project delivery in this dissertation is derived from study of literature and documented processes that identify cardinal project planning activities and their deliverables. Irrespective of the used methodology, the design of a workflow model is an iterative and creative process with an inherent degree of subjectivity and interpretation (PMI 2000a). Increasing the accuracy and usefulness of the devised DB process model must be possible through evaluation, customization, and adaptation over time as a result of continuous use. The generation of data templates for each of the activities is based on the available technological features of the selected combination of a process modeler and its associated executing environment, described in the next chapter.

With the PMBOK modeling steps and the developed prototype system described in the next chapter, project planners in principle have all the means at their disposal to model as well as execute their self-created processes. Yet, the modeling (or modifying) of (existing) workflows by process participants themselves is not being studied explicitly as part of this research. This is primarily for the same reason why extensive field tests have not been undertaken yet – the implemented system is still a prototype in an early stage of development, not quite ready for end-users. For an experiment aimed at providing an initial proof of concept, using a predefined planning process model instead of a “blank page” shifts an otherwise extra level of complexity from the system users to the system developer. The size and scale at which process modeling should eventually take place might well be left to market forces and the initiative of stakeholders such as process participants themselves, communities of practice, researchers, or trade organizations.

5.4 Analysis of Dialogue Theories

The planning process model for DB project delivery described in the previous section is expressed in the neutral XML Process Definition Language (XPDL), which is a standard developed by the Workflow Management Coalition (WfMC), outlined in Chapter 6 (on the technical aspects of the prototype system architecture). This workflow technology offers only limited functionality when it comes to having a running planning process model dispatch more collaborative activities or convene efficient meetings between process participants. The constructs of the XPDL workflow modeling language do not provide for support of the structuring of dialogues between workflow participants, hence its taxonomy had to be expanded.

An analysis of existing research and theories on dialogues was undertaken (Chapter 8), in order to derive a meaningful set of representative entities and attributes, that could serve as containers of information in a relational database application for structured dialogue support. The analysis respectively evaluates the ActionWorkflow paradigm (8.3.1), Speech Act Theories (8.3.2), the Milan Conversation Model and its conversation handler (8.3.3), workflows augmented with group interaction techniques (8.3.4), computer-mediated Collaborative Decision Making (8.3.5), and finally graphical conversation capturing with the Compendium tool (8.3.6).

5.5 Modeling a Structured Dialogue for Design-Build Project Delivery

Based on the findings from the analysis of dialogue theories, a conceptual structure for the database of a dialogue support application is composed (Chapter 9). This structure is then translated into the back-end database of an actual Microsoft Access application, with a mocked-up graphical user interface to the database of dialogue entities.

In order to demonstrate that collaborative aspects of a planning process can be supported by this application, an example structured dialogue is modeled for some of the activities of the process for Design-Build project delivery, introduced in Chapter 7. A system use scenario describes how the overall planning workflow would mobilize so-called dialogue initiators to commence a structured dialogue between system-suggested participants on a predefined series of agenda topics with embedded resources. In advance of the actual discourse, participants would open the dialogue module to streamline their meeting (a phone call, threaded discussion, face-to-face or cyber meeting, etc). Snapshots of the user interface demonstrate how recorded interactions, additional resources and decisions would be added gradually during the dialogue. Viewing and access rights to entities (e.g. topics or resources) can be defined through their scope attribute. Moreover, they can be marked to be recurring for every consecutive process instance, or even to be publicly accessible (to serve as a shared knowledge entry for the community at large).

5.6 Concept Validation

While Chapters 7 and 9 mainly address the first two premises on which the hypothesis of this dissertation (3.4) is based, Chapter 10 summarizes earlier findings and takes on the third and last premise to provide a proof of concept that the proposed approach actually adds value to, or even has benefits over, existing planning practices in the AEC industry. This overall concept validation is based on qualitative evidence gathered through various means, such as an analysis of the process model by a domain expert, internal system comparison against derived design guidelines, a survey among experienced AEC project planners, and evaluation by experts in academia and industry practitioners. As directions for quantitative testing, comparative system evaluation is proposed in an educational setting, before measuring possible efficiency gains through field tests in industry practice.

The final chapters of the dissertation end with conclusions (11), remaining issues and recommendations for future avenues of research (12) in the field of process-mediated project planning with structured dialogue extensions. The next chapter (6) starts with the technical system architecture of the implemented prototype configuration, before consecutive chapters will attempt to incrementally provide a proof of concept for the constituting premises of the stated hypothesis.

CHAPTER 6

SYSTEM ARCHITECTURE

This chapter treats the technical aspects, tools and components that together make up the functional architecture of a working prototype system application devised for process-controlled planning, respectively through:

- 6.2 A standardized workflow modeling paradigm (XPDL)
- 6.3 The Java Workflow Editor (JaWE)
- 6.4 Enactment through an existing Collaborative Virtual Environment (CVE)
- 6.5 The customized e-HUBs Process Modeler
- 6.6 Integration of these applications and components with the CVE

An additional, separate module for structured dialogue support will be discussed in Chapter 9. The next section (6.1) will briefly introduce the various components and provide a high-level overview of the overall system architecture before treating some aspects in more detail.

6.1 Overall functional Architecture

Figure 6.1 illustrates the overall configuration of the prototype application for process-mediated project planning (PP), particularly for the example case of Design-Build (DB) project delivery. A separate module for structured dialogue support would be launched for joint activities by a running process (not depicted here, but in Figure 9.3 on page 255).

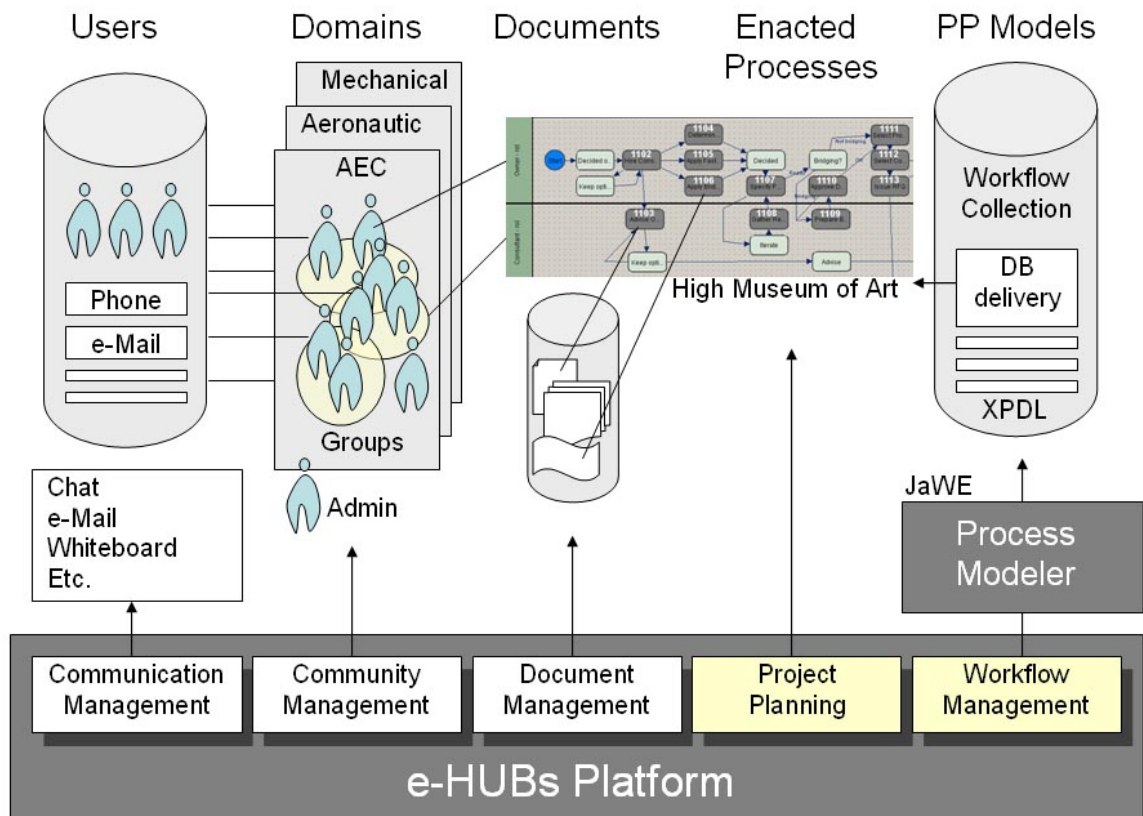


Figure 6.1: Overall Configuration of the Prototype System

The application is build on the substrate of the e-HUBs platform, an existing CVE that contains not only all the typical functionality like community and document management, but also the special two modules of workflow management and project planning. The former module provides a customized process modeler with which PP workflows can be generated in a standardized format (XPDL), while the latter module enables the launching and enactment of particular process instances from the library of available abstract workflows. An example of an offered workflow is the process model for Design-Build project delivery that will be presented in the next chapter. The process model contains horizontal bars assigned to roles (e.g. in a construction project these might be the owner, architect, or contractor), where each role is played by an individual or group (company or organization). The various activities in the process model (represented by boxes in the horizontal bars) are linked to files in the document management module of the e-Hub. These links are established through data templates which will pop up when the user accesses the task online in the CVE. Documents may serve as inputs to an activity, or they may be required as an (edited) deliverable for a downstream activity. The e-HUBs administrator can create new engineering domains as needed (aeronautic, mechanical engineering, AEC, etc), and appoint dedicated domain administrators with the privileges to manage their community (users and groups). Individual users can become registered community members by signing up online for the desired domains. With the e-HUBs process modeler they can make and run their own workflows, or adapt available ones.

The next sections will describe the intricacies of the depicted components, starting with an explanation of the selected workflow modeling paradigm.

6.2 A standardized Workflow Modeling Paradigm

Workflow modeling is defined as the computerized facilitation or automation of a business process (WfMC 1999a). By applying workflow management, documents, information or tasks are passed from one participant to another in a way that is governed by rules or procedures. Ideally, the meta-process to guide Design-Build procurement should be expressed in a common, standardized workflow modeling representation, so as to allow both creation and execution in a broad variety of adhering software packages.

6.2.1 eXtensible Process Definition Language (XPDL)

The Workflow Management Coalition (WfMC), founded in August 1993, is a non-profit, international organization of workflow vendors, users, analysts and university / research groups. The Coalition's mission is to promote and develop the use of workflow (WF) through the establishment of standards for software terminology, interoperability and connectivity between workflow products. When developing a collaborative workflow model, taking the body of knowledge of the WfMC as a base is a rational starting point, since the WfMC represents one of the most comprehensive and state-of-the-art standardization efforts in the field of process modeling.

A variety of different tools may be used to analyze, model, describe and document a business process. In order to provide a common method to access and describe workflow

definitions, a workflow process definition meta-data model has been established; the Workflow Process Definition Language (WPDL). This meta-data model identifies commonly used entities within a process definition (Figure 6.2). A variety of attributes describe the characteristics of this limited set of entities (Table 6.1). Based on this model, vendor specific tools can transfer models via a common exchange format. One of the key elements of the WPDL is its extensibility to handle information used by a variety of different tools.

The WPDL may never be capable of supporting all additional information requirements in all tools. Based upon a limited number of entities that describe a workflow process definition (the “Minimum Meta Model”), the WPDL supports a number of differing approaches. In order to be WPDL-compliant, a vendor needs to enable both import and export of workflow definitions as a character stream into or from its internal representation (WfMC 1999b).

The WPDL also has a version specifically aimed at Internet applications: XPDL, which stands for XML Process Definition Language. XPDL uses eXtensible Markup Language (XML, see: www.w3.org) schemas as the mechanism for process definition interchange. The XML language allows the workflow model to be expressed in computer-interpretable data entities, independent of any particular implementation mechanism such as programming language, modeling software, data transport mechanism or Operating System / hardware platform (WfMC 2002).

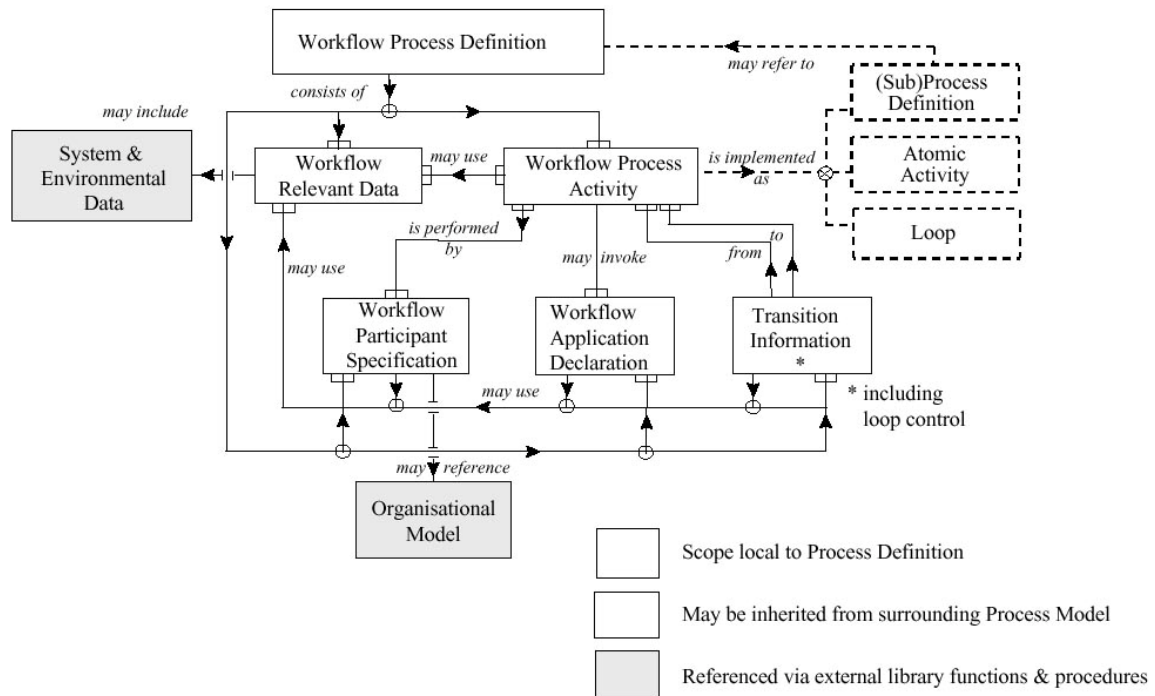


Figure 6.2: WfMC Workflow Meta-Model Top-level Entities

The WfMC classifies the following process definition entities as generic ‘building blocks’ of workflows:

- | | |
|----------------------------------|------------------------------------|
| 1. Activities | (Items of work) |
| 2. Participants | (Executing activities) |
| 3. Applications | (Executing activities) |
| 4. Transitions | (Relations between activities) |
| 5. Workflow relevant data | (The input / output of activities) |
| 6. System and environmental data | (Situational information) |

Table 6.1: Overview of Entities and Attributes of the WfMC Workflow Model

Workflow Model Definition	Workflow Process Definition	Workflow Process Activity	Transition Information	Workflow Application Declaration	Workflow Relevant Data	Workflow Participant Definition
- Id - Name - Description	- Id - Name - Description	- Id - Name - Description	- Id - Name - Description	- Id - Name - Description	- Id - Name - Description	- Id - Name - Description
- WPDL-Version - Source Vendor ID - Creation Date - Version - Author - Characterset - Codepage - Country Key - Publication Status	- Creation Date - Version - Author - Characterset - Codepage - Country Key - Publication Status - Valid From Date - Valid To Date - Classification	- Characteristic - Automation Mode		- Tool Name	- Type	- Type - type related information
- Extended Library - Conformance Class	- Extended Library	- Split - Join - Loop - Inline Block				
	- Parameters		- Condition	- Parameters	- Value	
- Responsible - External Model Ref - Access Restriction	- Responsible - Access Restriction	- Participant assignment - Implementation - Application assignment - Access Restriction	- From - To			
- Documentation - Icon	- Documentation - Icon	- Documentation - Icon				
- Priority Unit - Cost Unit - -	- Priority -Cost -Duration Unit - Duration - - Waiting Time - Working Time	- Priority - Instantiation -Cost - Duration - Waiting Time - Working Time				- Strategy - Capacity-Cost - Prepare Time
...

A workflow package can contain multiple processes, each consisting of the listed components. Table 6.1 gives an overview of entities and attributes defined within WPDL. Bold typed attributes are mandatory, all others are optional. Italic typed attributes indicate relations to other entities. The triple dot “...” indicates the potential usage of extended attributes, the rows delineate different categories of attributes (WfMC 1999b).

6.2.2 Collaborative Workflow Modeling

Although the selected narrow project window – Design-Build project delivery – does not involve the specific negotiation between project partners of the process design itself, many situations may exist where the modeling of the workflow (needed activities, dependencies, timing, etc) is a direct topic of their structured dialogue. In fact, it is interesting to note that the core planning processes of the PMBOK show considerable overlap with the steps needed to populate a workflow model, as reflected in the consecutive process groups of Activity Definition, Resource Planning, Activity Sequencing, Activity Duration Estimating, and Schedule Development. Therefore, the collaborative modeling (or adaptation) of a workflow by future project partners can be a significant part of defining a clear and comprehensive work statement.

Although workflow models are typically describing activities and their dependencies for multiple actors, paradoxically they are often defined by a single project manager, analyst, supervisor or consultant – not collaboratively. Joint workflow definition could allow organizations or project teams to tap into their collective knowledge, to actively engage

the process participants involved ahead of time, and to mitigate the problem of unilaterally designed – and thus potentially misrepresented – process models, with underestimated resources, end-user resistance, bias towards the business interests of the modeler, and so on. Collaborative workflow modeling in AEC project planning can lead to more comprehensive, mutually understood agreements, a better process of reaching such agreement, and consequently a better implementation of agreements.

Both the collaboratively defined workflow model and the meta-process to guide its definition (the project planning) could be expressed in XPDL format to facilitate ultimate execution with some level of platform independency.

6.2.3 Possible XPDL Extensions to support Collaborative Workflow Definition

In order to support collaborative workflow definition between remote project partners at the semantic level, the WPDL model would need some additions and refinements, covering a range of negotiation aspects like (random, not detailed here):

- Process definition entities need to be accessible in a shared repository with version control and change tracking at object-level (who modified what, when, and why). The current model only allows for defining the author, date and version of the entire workflow process. Process participants may want to redline, comment on or inquire about objects (e.g. via Requests For Information) when defining a workflow asynchronously.

- Workflow participants must have specific viewing, modification and acceptance (see next bullet) permissions for process definition entities. This will enable such features as third party reviewing, and private or semi-transparent sub-processes, e.g. for subcontracting or internal project-planning purposes.
- The entire process definition and individual new entities have a ‘proposed’ state with a requesting process participant. The state can be elevated to ‘accepted’ by authorized process participants of the other negotiating party, potentially with a descriptive conditional approval. The current WPDL model only supports states ‘under_revision’, ‘under_test’ and ‘released’ for the entire workflow process definition, and basic states ‘notStarted’, ‘running’, ‘suspended’ and ‘completed’ for process instances.
- Once officially approved by all parties, process definition entities and associated documents must be time-stamped and locked ‘read-only’, while being overwritten or succeeded only when all parties have approved a next modification. A partnering process can thus leave an audit trail of frozen process snapshots, while being constantly updated, e.g. by adding approved Change Orders to originally agreed upon documents.
- The workflow definition language should support levels of detail and abstraction – like Activity Decision Flow diagrams (Mentzas *et al.* 2001) – to allow, among others, project partners to understand the logic of complex work agreements by

switching between overview and details. Zoomed out to the top-level the main objectives of an agreement must be immediately apparent, whereas zoomed-in, sufficient detail must be available to clarify project specifications and exclude ambiguities.

- The collaborative workflow model must enable process definition entities to be grouped as sub-process and marked as alternative or contra proposal to other sub-processes. Process participants may also want to import sub-processes (e.g. ‘best practices’), or single entities, from other stored processes.
- Process definition entities can be externally linked or nested in networks of related workflows e.g. in supply chains or subcontracts. A mechanism is needed for exporting, negotiating or propagating changes to other dependant workflows or contracts.
- Quality:
The workflow model should support explicit definition of Quality Assurance entities for activity outputs, in which the consequences of non-compliance can also be specified e.g. as optional workflow paths or as links to related narrative contract provisions. Project participants or deliverables could be required to meet industry certification (e.g. ISO standards) or satisfy certain performance criteria, measured or quantified with predefined verification methods.

- Time:

Similarly, in terms of time performance, the model must be able to represent milestones with – possibly types of – deadlines (e.g. hard, soft), and task dependencies beyond time or resource dependencies. Merely informative or planned entities must be clearly distinguishable from contractual obligations.

- Costs:

Even though the workflow model is not meant to capture data related to financial aspects such as accounting or bidding, compensation is a crucial and inevitable aspect of negotiating engineering agreements, and should therefore be represented in the model, e.g. as attribute of activities or processes.

- In the context of negotiating an agreement, workflow participants often fulfill specific roles, like buyer-seller, contractor-subcontractor, etc. These roles might have to be modeled explicitly when providing object-contextual negotiation support like tutorials, wizards, help functions, best-practices, tips, links to information sources or expert knowledge bases.

Although the above proposed XPDL extensions sketch a potentially relevant field of study, this research will not focus on extending workflow modeling semantics, but rather on supporting the meta-process of partnering and project planning through structured dialogues and existing technology standards.

6.3 The Java Workflow Editor (JaWE)

Enhydra's Java Workflow Editor (JaWE) is the first open source graphical Java workflow process editor fully according to WfMC specifications, supporting XPDL as its native file format and without any proprietary extensions (<http://jawe.objectweb.org>). The shareware application can be used to view, create and edit every XPDL file which conforms to WfMC specifications. Version 1.4.2 was released in February 2005.

The Enhydra community that developed JaWE consists of several entities including technology providers, developers, users, and community sponsors, with interest groups in Japan, Europe, China, Taiwan and the US. Users are reporting bugs, making feature requests for future releases, while contributors write code, documentation, and patches. The Enhydra.org venture encompasses a large range of projects with the aim to provide a blanket of open source technologies for e-business. Based on Sun's Java programming language as the de-facto language of Internet programming its projects are 100% Java. Since its inception, Enhydra has become accepted as a scalable and robust e-business application server, attempting to compete with more expensive and proprietary commercial application servers. It is similar to the Apache organization in the Web server market.

The Enhydra.org Web site is hosted by the international Objectweb consortium, which is an umbrella open-source software community created at the end of 1999 and hosted by

INRIA, the French National Institute for Research in Computer Science and Control (<http://consortium.objectweb.org>). Its goal is the development of open-source distributed middleware, in the form of flexible and adaptable components, which range from specific software frameworks and protocols to integrated platforms. ObjectWeb developments follow a systematic component-based approach. The consortium is an independent non-profit organization open to companies, institutions and individuals.

The middleware layer stands between the operating system and an application, and handles the communications between nodes. The concept of middleware appeared as networked systems became increasingly dependent on sophisticated protocols and architectures. Since distributed computing architectures are getting ubiquitous, this layer becomes pivotal to an ever growing number of applications. Middleware therefore is a key enabling technology whose dysfunction or deficiency may impact a wide range of applications and even whole distributed systems. The peer-review of the code that operates behind the scenes, as allowed by open-source, is intended to enhance reliability, performance, and eventually mutual trust.

The open source code of the Java Workflow Editor was used to develop a dedicated process modeler exporting XPDL files which could be parsed (interpreted) by the Web-based platform that was selected for running the Design-Build demo: the e-HUBs platform. The customized workflow modeler will be described in Section 6.5 of this chapter.

6.4 Enactment through an existing Web-based e-Engineering Platform

Using an existing external application for execution of the devised meta-process may serve multiple purposes simultaneously, by assisting to demonstrate a) the actual working, b) the practical efficacy and c) the inter-operability of the chosen approach. Moreover it avoids the distraction and overhead of having to develop an operational home-made engine from scratch. In principle any workflow engine could have been used to run the guided Design-Build process (as described earlier in Section 6.2 and as detailed in the next chapter), provided the chosen tool fulfills certain basic requirements, such as it being:

- XPDL-compliant – to enable import from the JaWE modeler's output
- Web-based – to allow distributed process enactment
- Fully operational – to avoid simultaneous debugging of process and engine
- Reliable – to facilitate extensive testing
- At low or no expense – to permit broad dispersion / avoid unnecessary user cost
- Etc.

The European e-HUBs project (www.e-hubs.org), introduced in Section 4.4, provided a convenient platform that not only fulfilled the listed general requirements, but also came with direct access to its developers through Georgia Tech's indirect involvement.

6.4.1 e-HUBs Platform Modules

The core functionality of the e-Hub is offered at the tactical level of the partnership through a web-hosted collaborative project planning platform, as depicted in Figure 6.1 at the beginning of this chapter (Section 6.1). The platform enables human project planners who are registered as e-Hub members – like the client, ESP or potentially other third parties – to make all tactical decisions about the execution of an intended e-engineering project. The prototype e-Hub was developed as an extension to an existing Collaborative Virtual Environment. This has the advantage that the web-hosted platform already offers all the normal functions that one typically expects in such an electronic collaborative workspace, for example community building, team communication, document management, notification and calendaring. However, the project planning platform has two additional modules: workflow management and project planning. Figure 6.3 depicts these latter two modules in a screenshot of the collaboration platform across the top menu bar, labeled as WORKFLOW and PROJECT PLANNING, while the more customary modules are labeled WEB, CONTENT MANAGER, USER MANAGER, MEETINGS, FORUM, E-MAIL, and SEARCH.

The workflow management component offers an XPDL-compliant workflow modeling tool, with which a Project Planning Model can be developed offline and uploaded onto the e-Hubs workspace in a specific engineering domain. The dedicated process modeler will be described in the next section of this chapter.

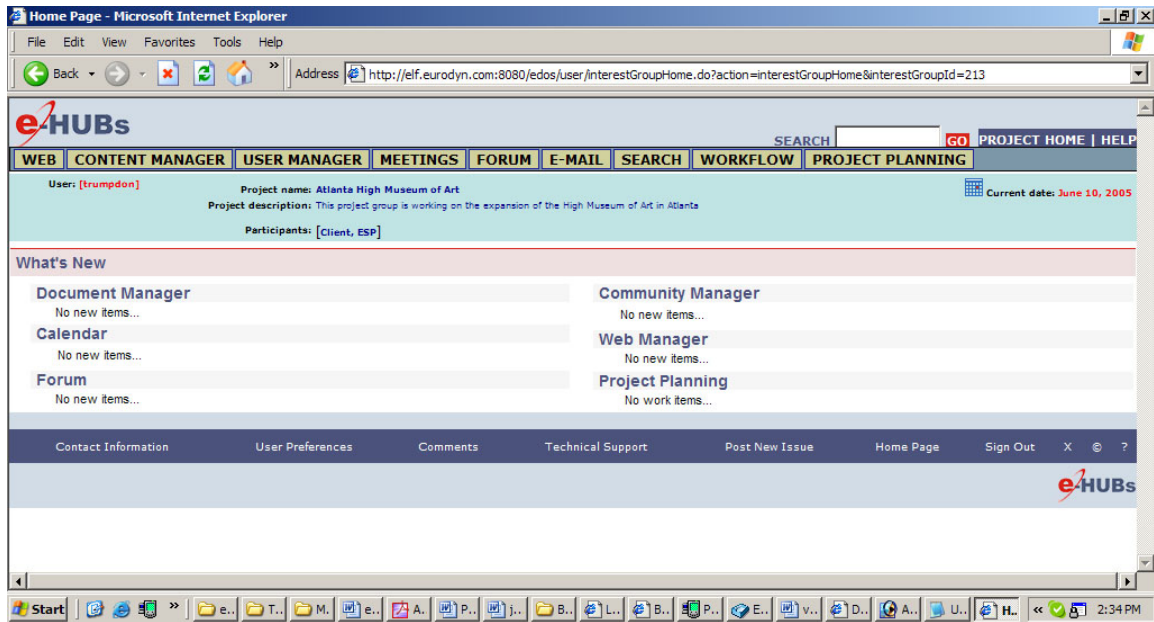


Figure 6.3: CVE Screenshot showing available e-HUBs Modules

The document library forms a central point for collecting and sharing project information among clients and ESPs. It is realized through the Content Manager, a structured hierarchy of sections and subsections that supports a wide diversity of file formats (such as .doc, .pdf, .zip, .exe, .txt, .xls, .html, .xpdl, etc).

With the project planning module, workflows are selected and instantiated in a given project space. Project planners control their activities by enacting appropriate workflows. They can start and abort any workflow at any time. When a workflow is complete, its results are gathered in workflow-specific information templates, that are embedded in the e-HUBs Project Planning module. These data templates, as described earlier, act as ‘containers’ of planning decisions, their rationale and their negotiation trail. The entries

in the templates contain links to relevant information, like other templates, web pages, correspondence, or stored documents. When a set of workflows has been executed, the collection of generated planning entities together form the project plan, which can be exported to downstream project activities in customized formats.

The Project Planning module consists of tabs for a user's activities, the already prepared deliverables (their status is appearing next to each document), the phases of the project, the document templates and project milestones (see for example Figure 7.7 in Chapter 7, page 179).

The e-HUBs Webmaster in Europe can create new engineering domains as needed, and assign administrator privileges to individuals for each domain, which might be called for example "Seismic Risk Analysis" or "Architecture". A domain administrator (the Industry Coordinator) then has the disposal of a range of functions to manage the given engineering community. He can grant access to users that have requested to become part of the domain for either outsourcing or providing domain-related services. Once registered (after signing up), a user has the ability to apply for a specific industry profile (i.e. client or ESP).

Users have to select their engineering domain(s) when logging into the platform (Figure 6.4), using Secure Socket Layer encryption (SSL). Once they have identified the most appropriate collaboration partners, the admin can create dedicated projects for them (a Project Space), for example the "Atlanta High Museum of Art expansion", and assign

registered domain members to the project on their request. Apart from individual project participants, the domain admin can also create roles for the project, and assign members to certain roles. For example, he might assign the individual user “Donald Trump” to the role of “Owner” on the “Atlanta High Museum of Art” construction project.

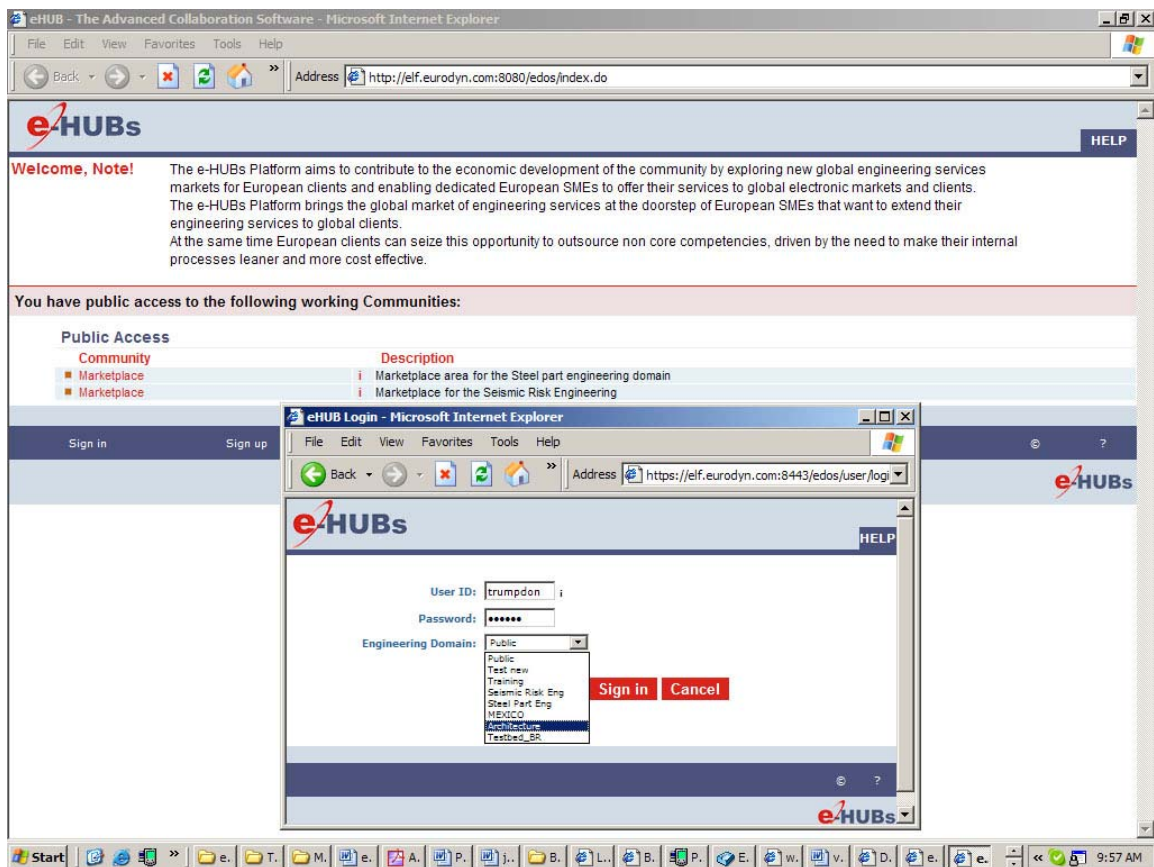


Figure 6.4: Graphical User Interface for signing into the Collaboration Platform

When modeling a workflow for a particular project with the customized e-HUBs Process Modeler (outlined in the next section), the human modeler can then select as process participants the project's roles and individuals as defined by the domain administrator. Therefore consecutively the domain, and project within the domain, have to be selected when connecting to (logging into) the online database of registered users to import process participants into the e-HUBs Process Modeler.

After laying out and saving the process, users can upload the resulting XPDL file onto the e-HUBs site in order to expand the collaboration capabilities among the parties. Once the XPDL is uploaded, the package with its processes can be selected for execution from a list of available workflows. By default a process is started with the settings contained in the uploaded XPDL file. Not only can users see the content of the file (the XML code) online, but they can also review and modify the parameters of the process (actors that participate, process description, deadlines, etc). One process can thus be (re)used multiple times, even simultaneously, with varying settings. Each time a process instance is initiated, the list of active tasks that have to be carried out (to-do items) includes additional tasks as defined for those actors responsible for the first activities. The assigned parties receive notifications regarding the steps that they will have to follow to complete their activities. Depending on the settings such notifications are sent by e-mail, but they will always appear in the main page that e-HUBs users see just after signing in to the service, and in the Project Planning section. A user may abort or suspend individual processes instances that they own, and delete their packages.

6.5 The customized e-HUBs Process Modeler

The e-HUBs Process Modeler is a stand-alone tool that provides a comprehensive graphical interface for creating, managing and reviewing business processes defined according to the XPDL specification, for further use on the e-HUBs platform or in any other WfMC standards-compatible workflow process execution engine. The application itself and its manual can be downloaded from the platform's Website. Although the tool looks similar to the JaWE editor described earlier (and is built on its source code), the e-HUBs Process Modeler is slightly customized as will be explained on the next pages.

The dedicated modeler can thus manage (create, edit, store and interpret) any XPDL file which conforms to the WfMC specifications. The WfMC specifications introduce the minimal meta-model that identifies the commonly used entities within a WF definition, their relationships and attributes, while describing their usage semantics in a standardized manner to ensure interoperability among different workflow systems. Furthermore, additional object attributes (so-called extended attributes) are provided to facilitate the extensibility of the standard. Such objects are included as extensions to the basic meta-model, in order to meet the specific needs of individual products or workflow systems. Through the use of this meta-model, the e-HUBs process modeler generates output that can be interpreted by various workflow engines, including the workflow module of the e-HUBs platform, for immediate execution and utilization by end-users.

6.5.1 Process Modeler Concepts

Since the e-HUBs Process Modeler operation framework is inherited from the WfMC specifications and XPDL definition, it is based on the following main concepts:

(See Figure 6.2, page 89, and Table 6.1, page 90 – WfMC 1999b)

- **Package:** The core element in any workflow definition is the package, which serves as a container for grouping together a number of individual process definitions and their associated data, which are applicable to all contained process definitions. Within a package, applications, participants and data fields have a global scope, meaning they can be referenced by any of its workflows if the entities were defined at the package level. The structure of each package definition may include a package header that provides descriptive information about the package itself, including information about the XPDL version used, the creation date, the tool that was used to create the package, further description of the workflow, etc. Once uploaded onto the e-HUBs platform, the header will be listed as a selectable set of processes available for instantiation (Figure 7.7 of Section 7.3, page 179).
- **Workflow (WF) / Process:** As described in the previous paragraph, each package contains the definition of one or more workflows, called processes, presented in the form of activities sequence that they consist of. The most basic building elements of a workflow model are its activities and transitions. Any

workflow definition may include a process header, to provide descriptive information about the process itself, similarly to the package header. For example, it can include a description of the process, creation date, priority, etc. Applications and participants may also be defined at the level of an individual process, but in that case they will only be available for that specific process.

- **Participant:** Participants represent performing e-HUBs platform entities, which can interact with the workflow, in other words, entities that handle work items. Available participant types include Roles, Human or System entities, a Resource set or Resource and Organizational Units. The system participant is represented by e-HUBs platform itself. Creating new participants for a process is done by connecting to the e-HUBs platform and importing (a desired selection of) roles and/or participants that have been defined online for the particular project for which the process is being designed. Roles abstract the involvement of humans in the workflow process. During workflow run time, this convention is evaluated and roles are assigned to specific human actors either manually (by the administrator or project leader) or dynamically (by the system, based on pre-defined rules / directives, such as optimized skill sets).
- **Activity:** Activities represent actions that are supposed to take place during the execution of a workflow. The most basic activities, performed by one participant, are the atomic activities. Activities may be started automatically or manually (on demand execution). Activities will often produce one or more work items,

handled by the assigned participants and may also be completed automatically (upon completion of all work items) or manually. In the former case the system is capable to specify which workflow items have been completed, while in the latter case the participant should manually specify that an item has been completed, updating its status within the system accordingly (i.e. from pending to completed).

- **Transition:** A transition represents a link from one activity to another. When an activity is completed, its outgoing transitions are executed. Activities can have one or more transitions both going into and out of the activity (except for the first and last activities which respectively can only have one in and one outgoing transition). Transitions can be constrained by dependency restrictions, which are defined individually in each activity. Every activity may include dependency restrictions for its incoming transitions (known as joins) and/or its outgoing transitions (known as splits). Two types of transitions exist: AND and XOR (eXclusive OR). Incoming AND transition sets require that all transitions must take the value 'true' for the next activity to start, while for the XOR transition sets one and only one transition taking the value 'true' is enough for the execution of the respective activity. Outgoing AND transitions designate that every path at a split will be executed, while an XOR transition indicates that only one path, which first evaluates to true, will be executed.
- **Application:** Applications represent the interface that is used to execute a software application or a procedure within a workflow environment. They can be

included as child of a package or of the workflow itself. The application interface is defined as a set of formal parameters (names and types of parameters), which are passed via an invocation interface (API) to an existing - declared within the workflow environment - software application to be executed. These parameters are eventually mapped to actual parameters within activity definitions. The declared applications can be generic or abstract tools (e.g. send_e-mail, save_document, etc). They invoke the enacting workflow engine to launch the necessary 'real' software applications, enabling for instance the uploading of submitted deliverables during an activity to a pre-specified folder in the e-HUBs Content Manager, accessible to other downstream activities.

Due to the many parameters involved this feature can get very complex.

- **Workflow Relevant Data:** WRD are workflow parameters that are typically used to maintain decision data (used in conditions), to pass on (intermediary) deliverables between activities or sub-processes, or to provide the activity's performer with relevant information, such as an applicable reference document or a link to an online resource. The names of WRD (their IDs) must be unique within a workflow. Type declarations define a set of types for the WRD, such as fillable text fields, clickable URLs, selectable comboboxes, or checkable boolean values. Those data fields are used for the end-users to create actual instances of the workflow relevant data when running the process. All the WRD of an activity together form a rudimentary task-specific data template as envisioned in Figure 5.1 of Section 5.2.1 (page 65).

6.5.2 Process Modeler Graphical User Interface

Most of the WF activities involve the filling of appropriate forms by the activity participants, thus setting the values of the process relevant parameters. An activity's form is launched during execution when a performer accesses the activity in the project planning module of the e-HUBs platform. Depending on the type of the workflow relevant data and its settings, the appropriate item of the Graphical User Interface (GUI) will be presented on the form during enactment:

- String, float and integer parameters are represented with edit boxes;
- A reference parameter is represented with a browse-for-file button;
- A date parameter is represented with a browse-for-date button;
- A Boolean parameter is represented with a set of radio buttons, true and false.

The properties of each form field can be defined through the Form Field dialog in the e-HUBs Process Modeler. The different attributes that can be defined for each parameter comprise:

- Name: defines the WRD name that is assigned to the field;
- Type: defines if the field is writable or just readable;
- Mandatory: defines if the field has to be filled or not;
- Order: defines the sequence of the field inside the form.

Packages constitute composite models of all workflows to be supported within a project. Figure 6.5 delineates the GUI for a package containing four processes. The package contains all the necessary workflows, associated tools, external applications and participants. However, it is also possible to define only parts of a process definition (e.g. a common list of workflow participants or external applications), or the common parts of several processes within one package (e.g. a repeatedly applied subflow), and then nesting processes by referencing them from other packages.

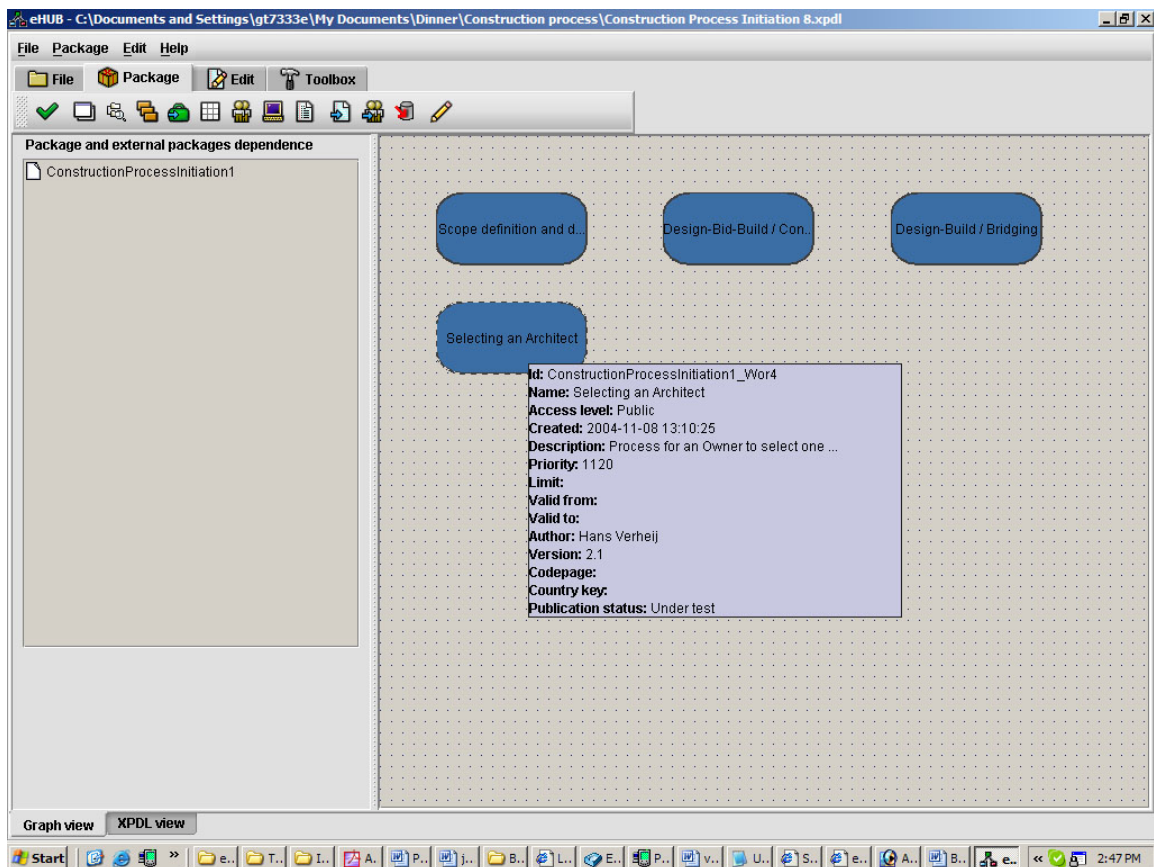


Figure 6.5: Customized Process Modeler at Package-level

The graphical representation of a workflow can be drawn after participants, applications, and WRD have been defined in forms. Participants are presented with a horizontal ‘swim lane’ across the design ‘canvas’ (Figure 6.6). Various elements such as events, activities, and flow controls can be created by dragging them from the toolbar onto the canvas, and by defining the various properties of the placed elements. Activities are assigned to actors by positioning them in the appropriate lane. The sequence and temporal dependencies of activities are represented by transition arrows.

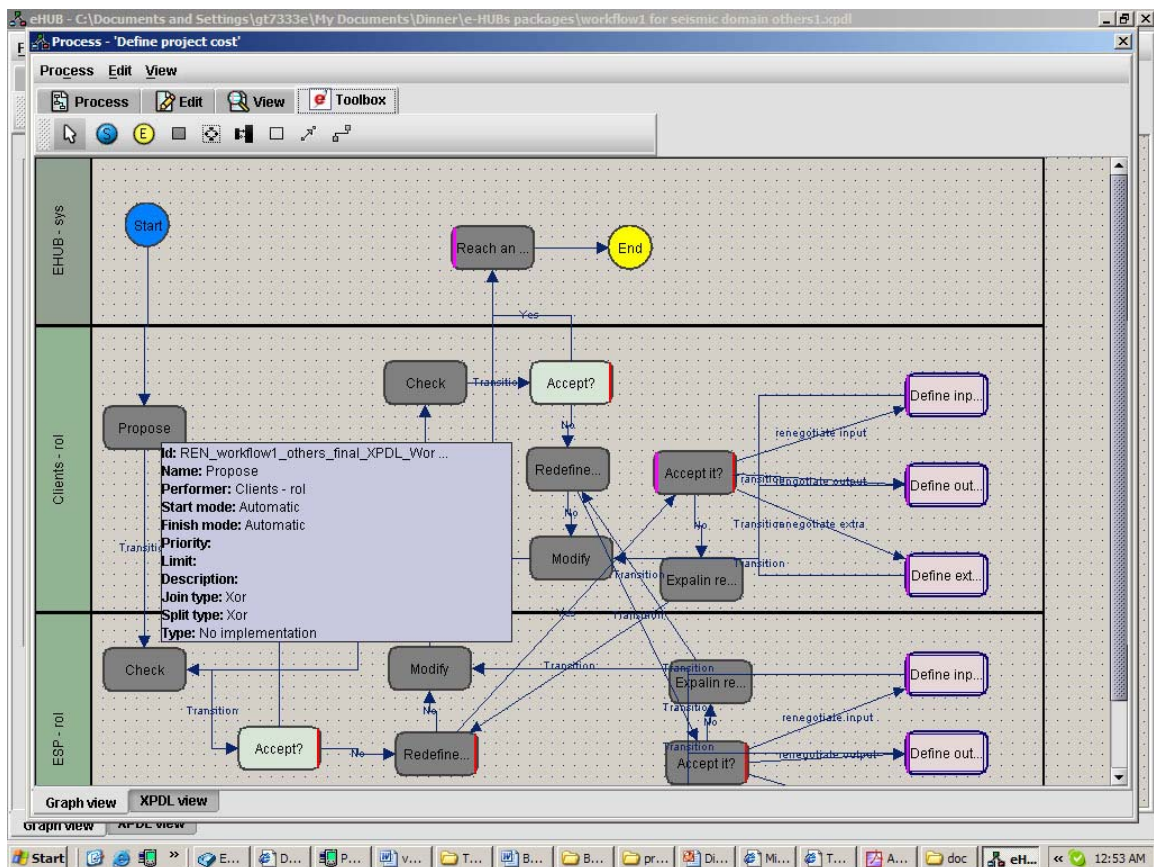


Figure 6.6: Customized Process Modeler at Process-level








To create a valid workflow the following steps need to be performed:

1. Create a package
2. Insert a process
3. Import participants from the e-HUBs Platform directory
4. Insert Participant on the process view canvas as swimlanes
5. Declare software applications that will be used by the process activities
6. Declare Workflow Relevant Data
7. Draw the WF
8. Define the activity forms (data templates) as presented run-time
9. Connect defined applications to activities
10. Save the package as an XPDL file

Both at the package and at the process level, the multi-view interface of the e-HUBs Process Modeler provides tabs (at the bottom) to switch between a graphical and a textual XPDL representation.

Table 6.2 (next page) provides a listing of available graphical entities. It shows that a group of consecutive generic activities can be assembled into a block, for simplification. The “Start” activity of a process will activate the system - in this case the integrated workflow engine of the e-HUBs Platform - and trigger it to launch the first assignment(s) while tracking the progress of submittals until the process instance is finished.

Table 6.2: Graphical Representation of basic Workflow Modeling Elements

Concept	Description	Notation
System Activity	When a System Activity is occurring, it affects the course of action in a process. Two types of system activities are defined: (a) those that trigger the start of the process, and (b) those that signal the end of the process.	Start 
		End 
Activity	Activities are divided into Generic Activities, Block Activities (a group of one or more Generic Activities) and Sub-Process Activities (WFs)	Generic 
		Block 
		Sub-Process 
Flow Control	A flow control is a point within a process where the process is split into two or more paths, or two or more paths join into one path. More complex flow controls exist that follow complex formal rules.	Route 
Sequence Flow	A sequence flow is used to show the flow from one activity (or flow control) to another activity (or flow control).	Transition 

The e-HUBs Process Modeler is customized from the JaWE editor in that it does not allow from-scratch creation of process participants but rather forces them to be imported from the online database of registered platform users for a specific project. Also, when creating Workflow Relevant Data for activities the tool prompts the user for the definition of extended attributes that describe the graphical lay-out of input fields once the process is run by its participants on the e-HUBs site, i.e. this may pertain the height of a textbox (one line) or text area (multiple lines with automatic scrollbar).

6.6 Integration of Applications and Components

The previous sections have laid out the technical aspects, tools and components that constitute the system architecture of the prototype service for controlled project planning. The combination of a customized Process Modeler - that generates workflow models in a standardized, interoperable output format - with an execution environment of an existing Web-based e-engineering platform, offers a powerful set of tools for a realistic implementation of a working prototype application.

Nevertheless, before proceeding, it should be noted that there are also significant disadvantages associated with the choice of the selected tools over other applications. Before describing the implemented Design-Build project window in the next chapter, this section will discuss some of the more pertinent drawbacks of the selected tool set.

Unfortunately the e-HUBs platform, as the outcome of a separate academic endeavor, is still a prototype in itself, which is rather slow in its operation. The Website's sluggish speed and response time may not prevent an otherwise fully operational and working system from proving the value of a guided project planning process, but it does complicate extensive testing both during development and during user validation.

Related to this issue is the questionable user-friendliness of the platform's user interface, which has not gone through the kind of extensive user testing one would expect from

similar commercially available services. Thorough testing and continuous user feedback on such tools over time gradually filter out errors and unclear functionality that may otherwise hamper the ability for researchers to separate concept validation from simple criticism on the implementation and user interface.

Furthermore the lack of a commercial backbone may raise concern for the platform's maintenance and future upgrading, and for the extensibility of its technology over time. The chosen direction should therefore be seen as a hybrid between a conceptual R&D effort and true system development.

Also, the current versions of both the e-HUBs Process Modeler and platform, offer few possibilities for customizing the appearance of data templates, other than some of the basic features described earlier in Section 6.5.2. To fully benefit from the potential power of a “structured dialogue”, more functionality may be required for process modelers to design task-specific tools and user interfaces. Chapter 9 will elaborate on this topic.

Finally, both the desirability of an actually working prototype for concept testing, and the requirement to keep process modeling complexity reasonably low for end-users, conflict with the need to enrich the semantics of the available minimal meta-model as provided by the WfMC to include universal WRD lay-out attributes in its XPDL model. This creates a catch twenty-two between the ability to validate / demonstrate and the need for theoretical syntax expansion first.

CHAPTER 7

DESIGN-BUILD PROCESS ANALYSIS

This chapter demonstrates the concept of process-controlled project planning through the implemented case of Design-Build (DB) project delivery, a procurement method which makes for a single-point responsibility for both design and construction in building projects. After a brief history and overview of the DB realm, Section 7.2 will detail the aspects of the developed process map, by tracing the consecutive steps for workflow definition suggested by the Project Management Body Of Knowledge; i.e. scope definition (7.2.1), activity definition and resource planning (7.2.2), activity sequencing (7.2.3), followed by a description of background knowledge (7.2.4) and deliverables (7.2.5) for each activity. An important aspect is what the data inputs and outputs are for each activity, and where and how each deliverable is handled during the DB process, upstream or downstream (7.2.6). Section 7.3 will demonstrate the resulting process model as it would be put into operation, including the task-specific online knowledge bases that would add a fundamental layer of evolving intelligence beneath the information processing. Finally, Section 7.4 will address some initial methods to validate the applicability and usefulness of the approach. In summary, the main steps are the systematic definition of the process logic, and then the addition of project planning data elements, that will eventually be meshed into structured dialogues in the next chapters.

7.1 Design-Build Overview

Design-Build is a construction project delivery approach aimed at integrating the responsibilities for design and construction within one legal entity. The principle of DB project delivery was briefly introduced in Section 5.3.3 (page 77). Since this dissertation is not dealing with particular construction management techniques, but rather uses one technique as an example case, this chapter will suffice with a brief overview.

Single-point responsibility helps reduce the adversarial relationships that often exist between designers and builders, and it can avoid the owner serving as manager or referee between parties, having to coordinate and mediate during construction. Instead, handoffs between design and construction become internal to the Design-Builder, shifting the focus from the contractor from simple cost reductions to optimized delivered value, and forcing the designer to more directly consider issues such as constructability and cost. Furthermore, DB project delivery gives the owner an earlier indication of costs, though the exact design may not be fixed at the time of setting the price. Integrating design and construction more closely has also proven to speed up the overall design and construction process (Beard *et al.* 2001) i.e. by condensing time-consuming design iterations, overlapping design and construction, and diminishing the number of needed Change Orders. Moreover, a Design-Build entity may be in a position to offer expanded services beyond just design and construction, such as financing, operation and maintenance.

Although DB has won renewed interest in the last decades, integrated design and construction is in fact an age-old tradition that dates back centuries. Cathedrals were devised and built under the supervision of one master-builder. The ever increasing diversity and complexity of buildings and building systems came with a gradual segmentation of professional skills and responsibilities. This breaking up into trades and specializations in turn led to undesirable side effects and inefficiencies in the life-cycle of facilities, such as the short-term focus on low initial costs for the builders instead of the long-term operational cost of facilities for the users, the absence of independent oversight on behalf of the owner on designer's errors and omissions, exploitation of the contractor's monopoly with overpriced change orders, and a lack of incentive for builders to optimize design solutions. It became evident to many facility owners that a "restructuring" of contractual relationships within the industry was necessary to improve efficiency and accountability in construction.

Figure 7.1 illustrates the conceptual difference in contract relationships between the various main procurement methods (Haviland 1994). The diagrams also show the main roles involved in the DB process: the building's Owner organization, its Consultant(s) (engineer or "Owner's Architect"), and the Design-Builder who hires, is led by, or consists of a (general) contractor, an architectural firm (AE) and potentially other specialized disciplines depending on the project at hand. Applying DB has important implications of which all parties must be aware. The reshuffling of responsibilities means for example that the Architect works for the Design-Builder, not for the Owner (only indirectly).

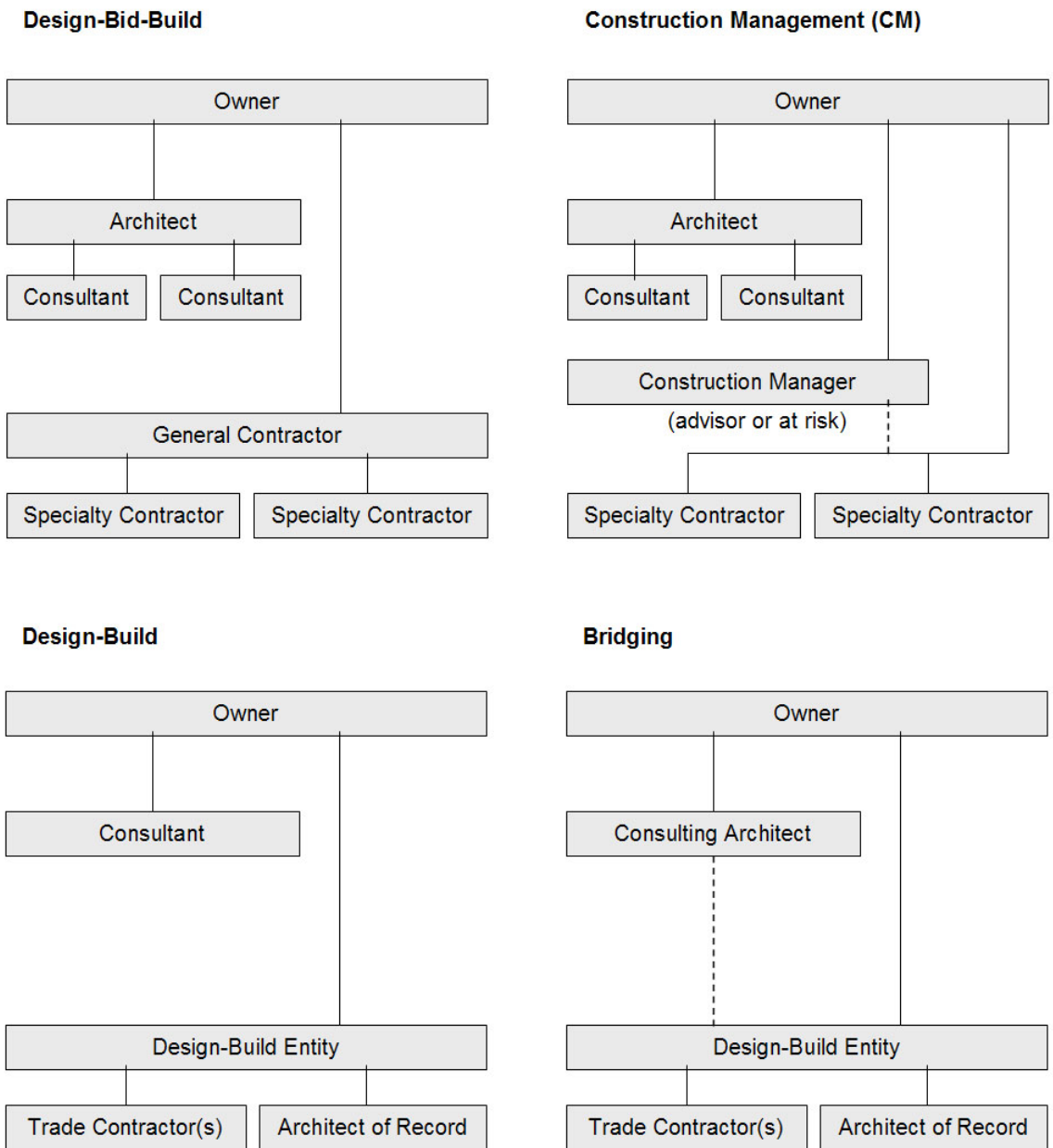


Figure 7.1: Contract Relationships in four main Project Delivery Methods

7.1.1 Trade Organizations representing DB Process Roles

Owner Organizations

The Building Owners and Managers Association International (BOMA) actively represents and promotes the interest of the commercial real estate industry, mainly in the USA, through collection, analysis and dissemination of information, and via advocacy and professional development. Founded in 1907 and based in Washington DC, the BOMA is an international federation with over 17,000 members in 84 U.S., 10 Canadian and 10 international associations (www.boma.org).

The International Facility Management Association (IFMA) is a non-profit association supporting the largest community of FM professionals in the industry, with more than 17,300 members throughout 55 countries, though mainly in the USA. Established in 1980 and based in Houston TX, the IFMA is dedicated to promoting excellence in the profession. Globally, IFMA provides certification and educational programs, offers networking opportunities, conducts research, spots trends and assists corporate and organizational facility managers in developing skills and strategies to manage human, structural and real estate assets of organizations. The combined purchasing power of IFMA's North American members equals \$81 billion (U.S.) annually (www.ifma.org).

Design-Builders

The Design-Build Institute of America (DBIA) is a membership organization with 16 chapters founded in 1993 to advocate and advance single source project delivery within the design and construction community. The DB method of project delivery embraces AEC services under a single contract, thereby re-integrating the roles of designer and constructor. DBIA members include practitioners from all project phases, plus public- and private-sector project owners. DBIA focuses its efforts on increasing the successful use of innovative design-build teams on non-residential building, civil infrastructure and process industry projects. Best practices are disseminated through educational programs and conferences, awards, publications and legislative efforts at the federal and state level.

Contractors

The Associated General Contractors of America (AGC), headquartered in Washington DC, is representing over 33,000 qualified construction contractors and industry related companies, which include general contractors, specialty contractors as well as suppliers and service providers. The AGC is the USA's largest and oldest construction trade association, established in 1918. Operating in partnership with its over 100 regional chapters, the association provides a range of services satisfying the needs and concerns of its members. The AGC's mission is to improve the construction industry by educating AEC firms, promoting the use of the latest technology, and advocating quality in building construction, while protecting the public interest.

Architects

The American Institute of Architects (AIA), founded in 1857 and headquartered in Washington DC (www.aia.org), is the professional organization for more than 65,000 licensed US architects and associated professionals in nearly 300 state and local chapters worldwide (AIA 2003). The AIA supports the practice of architecture and upholds quality standards for the profession, for example by licensing professionals, developing standard documents, and by way of continuing education requirements on its members. AIA documents, first developed in 1888, serve as standard forms of agreement that have been carefully reviewed, court-tested and modified over many years of practice by organizations representing owners, lawyers, contractors, engineers and architects. AIA documents are widely used by and accepted in the construction industry. The BOMA and IFMA for instance, do not make their own contracts. Architectural firms across the world exist in a wide variety of sizes and types. The average firm in the USA consists of 9 or 10 people, many companies are even smaller. Yet, there are also larger firms with staffs numbering over 100 employees. Some firms specialize in one or more services or project / facility types. Others offer in-house engineering (structural, mechanical, electrical, etc) or additional design disciplines (planning, urban design, landscape architecture, interior design, etc). Many architects integrate specialty disciplines into their projects through appropriate consultants. Each architecture firm brings its own combination of skills, expertise, interests, and values to the table, thus making every project unique while also introducing a certain complexity. Each situation is different in its people, programmatic needs, construction site, and financing and regulatory requirements.

7.2 Design-Build / Bridging Process Map

As illustrated in Section 6.2.2 on Collaborative Workflow Modeling (page 91), the PMBOK not only serves as meta-level project planning framework, but also provides a logical technique needed to systematically arrive at a process representation for Design-Build project delivery. A comprehensive DB process definition can be attained by following the prescribed consecutive (but potentially iterative) steps of Scope Definition, Activity Definition, Resource Planning, Activity Sequencing, Activity Duration Estimating, and Schedule Development (Table 5.1, page 72). Notwithstanding the devised methodology, modeling a workflow always involves a degree of creativity and subjective interpretation, so that different designers may model the same business process differently, as explained in Section 5.3.4 (PMI 2000a).

The subsequent sections will address and illustrate the above actions to arrive at a process model for Design-Build project delivery, ending in Section 7.2.6 with the identification of Workflow Relevant Data per activity.

7.2.1 Scope Definition

In line with the modeling steps outlined above, this section defines the scope of the selected Design-Build project window - as an embedded slice of a larger overall process - by identifying the system boundaries, and by determining a Work Break-down Structure of phases within the project window.

The WBS is defined as “a deliverable-oriented grouping of project components that organizes and defines the total scope of the project” (PMI 2000a). Work not in the WBS is outside the scope of the project. As with a scope statement, the WBS is often used to develop or confirm a common understanding of project scope.

The Design-Build process which is the main focus of this chapter, can be subdivided in the following main phases:

- A: Formation of the Owner’s team and the Design-Build team (if non-permanent)
- B: Selection of the most advantageous type of DB variant
- C: Identification of facility needs (program definition)
- D: Generation of preliminary design intentions (optional; if bridging is applied)
- E: Pre-selection of qualified offerers (optional; if multiple competitors)
- F: Proposal development and modification
- G: Proposal negotiation and selection
- H: Construction preparation

From this sub-division the system boundaries can be deduced; the process starts after the selection of Design-Build or Bridging as the preferred delivery method for a project, and it ends with the resulting construction commissioning. The latter is usually considered to commence with the official signing of the so-called Part 2 agreement, which governs the detailing and realization of the facility proposed under the Part 1 agreement, as will be explained in Section 7.2.4.

7.2.1.1 Potential Preceding Workflow

Section 6.5.1 explained that processes can be grouped in packages to form intertwined hierarchies of nested sub-flows and/or sequential parts that mutually refer to each other. The process leading up to the decision to use DB/Bridging could be managed by a workflow also, as part of the same XPDL package. Without going in much detail, this preceding process is described in brush strokes in the following paragraphs, and illustrated by Figure 7.2. It shows the graphical process representation called “Scope definition and delivery method selection” within the same “Construction Process Initiation” package.

This workflow basically is a “self-dialogue”, since the mere two swim lanes show the process is primarily performed by the (role of the) building’s Owner, although he may opt to engage a Consultant for advise on the important decisions to be made.

The Owner must first define the initial scope statement, which provides a documented basis for making future project decisions and for confirming or developing common understanding of project scope among the stakeholders. As the project progresses, the scope statement may need to be revised or refined to reflect approved changes to the scope of the project. The scope statement typically includes a project justification (business need), a brief summary of the intended end-product (the building), intermediary deliverables (design and construction milestones), and project objectives (quantifiable criteria to measure success, such as cost and quality).

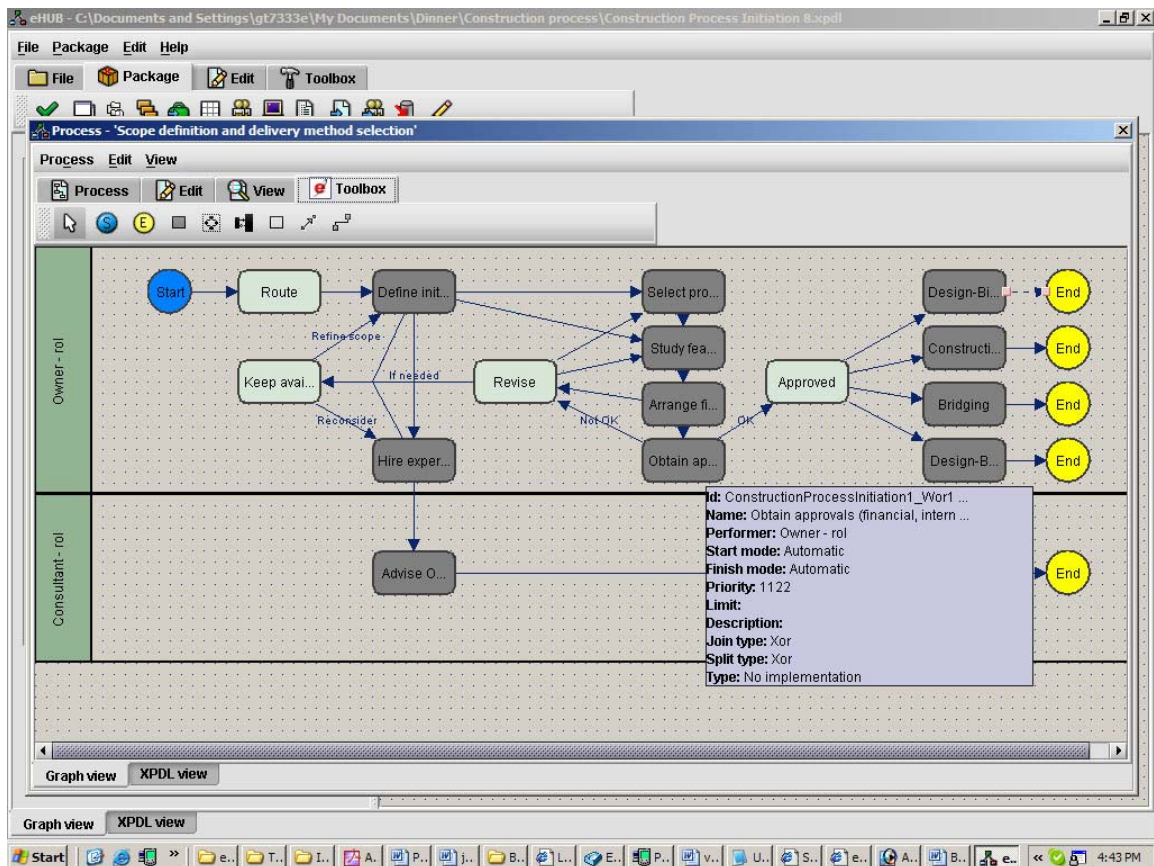


Figure 7.2: Process Model for Scope Definition and Delivery Method Selection

After scope definition, the Owner must consider hiring an expert in fields like feasibility studies, real estate financing, and/or delivery method selection (to fulfill the role of Consultant in the process). Next, the Owner must select the project delivery method. Although this may still seem a complex decision to make at this point, the decision could be supported by the expert's advise, dedicated tools and resources, and task-specific online knowledge repositories, as will be demonstrated (for the main process) towards the end of this chapter, in Section 7.3.1. Also, the Owner may still revise his decisions as the

current process progresses and more project information starts to solidify (e.g. exact user requirements, needed square footages, budgets, etc). The following two activities are respectively to study (or revisit) the project's feasibility and arrange its financing. If this leads to a revision of earlier decisions, process loops are available for their adjustment. The same applies for the next task: obtaining (financial, internal and external) approvals. If everything is approved and in order, the process may proceed to a dedicated last activity depending on the selected delivery method; one of Design-Bid-Build, Construction Management, Bridging, or Design-Build.

If the Owner opted to apply one of the latter two, this last activity may persuade the Owner to launch the subsequent process to support DB implementation – the process of which will be treated in more detail in the next sections, as it is the main focus of this chapter.

7.2.2 Activity Definition and Preliminary Resource Allocation

Table 7.1 presents a catalog of activities for the DB/Bridging process, with the WBS phase they belong to (as listed in Section 7.2.1), and with their initial resource allocation at the abstract level of roles. Each activity has been given a randomly assigned, progressive four-digit numerical key that is unique within the package for later identification purposes.

Table 7.1: Activity Definition for the Design-Build / Bridging Process

ID	Activity	WBS	Role
1102	Hire Consulting Architect / Criteria Consultant?	A	Owner
1103	Advise Owner	A	Consultant
1104	Determine Ownership Situation	B	Owner
1105	Apply Fast-tracking?	B	Owner
1106	Apply Bridging?	B	Owner
1107	Specify Performance Requirements	C	Owner
1108	Gather Facility Requirements	C	Consultant
1109	Prepare Bridging Documents (Schematic Design)	D	Consultant
1110	Approve Design Intent	D	Owner
1111	Select DB Procurement Methodology	B	Owner
1112	Select DB Contract Format	B	Owner
1113	Issue Request For Qualifications	E	Owner
1123	Set up Legal Entity	A	Design-Builder
1124	Select Architect of Record / General Contractor	A	Design-Builder
1125	Sign Contract between Architect and DB-er	A	Architect
1126	Sign Contract between Contractor and DB-er	A	Contractor
1127	Secure Bonds and Insurances	E	Design-Builder

Continued on next page...

Table 7.1 (Continued)

ID	Activity	WBS	Role
1128	Submit Qualifications	E	Design-Builder
1129	Hold Pre-submittal Conference	E	Owner
1130	Screen Qualified Firms	E	Owner
1132	Evaluate Qualifications	E	Owner
1133	Debrief Unsuccessful Submitters	E	Owner
1134	Issue Request For Proposal or Invitation For Bid	F	Owner
1135	Accept Proposal Contract (Part 1)	F	Design-Builder
1136	Hold Pre-proposal Conference / Q&A Sessions	F	Owner
1137	Generate Preliminary Design	F	Architect
1138	Revise Design	F	Contractor
1139	Submit / Present Proposal	F	Design-Builder
1140	Check Proposal	G	Consultant
1141	Evaluate Proposals	G	Owner
1142	Select Proposal	G	Owner
1143	Debrief Unsuccessful Offerers	G	Owner
1144	Revise Documents / Prepare Contract	H	Owner
1145	Sign Construction Contract (Part 2)	H	Design-Builder

7.2.3 Activity Sequencing

The temporal task dependencies between the activities from Table 7.1 are shown as connecting arrows in Figure 7.3, which is a graphic representation compiled from several screenshots of the main workflow as displayed in the e-HUBs Process Modeler. The Figure shows the overall process map, with arrows delineating the Activity Sequencing, and swim lanes for the five roles involved: Owner, Consultant (or “Owner’s Architect”), Design-Builder, Architect-of-Record, and General Contractor.

Figure 7.3 is similar to Figure 7.4, except that the graph is dissected in the main (WBS) phases of the Design-Build process as introduced in Section 7.2.1, with each phase more or less covering a vertical bar in the diagram against a faded-out background.

Figure 7.5a and 7.5b were derived from the respective left and right part of Figure 7.3 in order to increase the diagram’s legibility. Moreover, in these figures the IDs of the shown activities are added. This enables matching the graphical activity representations with their corresponding appearance both in Table 7.1, and in upcoming sections that describe the process and the Workflow Relevant Data for each of the activities.

The activities 1112 (Select Contract Format) and 1135 (Accept Contract) will be highlighted in Chapter 9, where they are discussed in more detail in the context of developing a more advanced structured dialogue at the level of individual tasks than supported by the current set of applications.

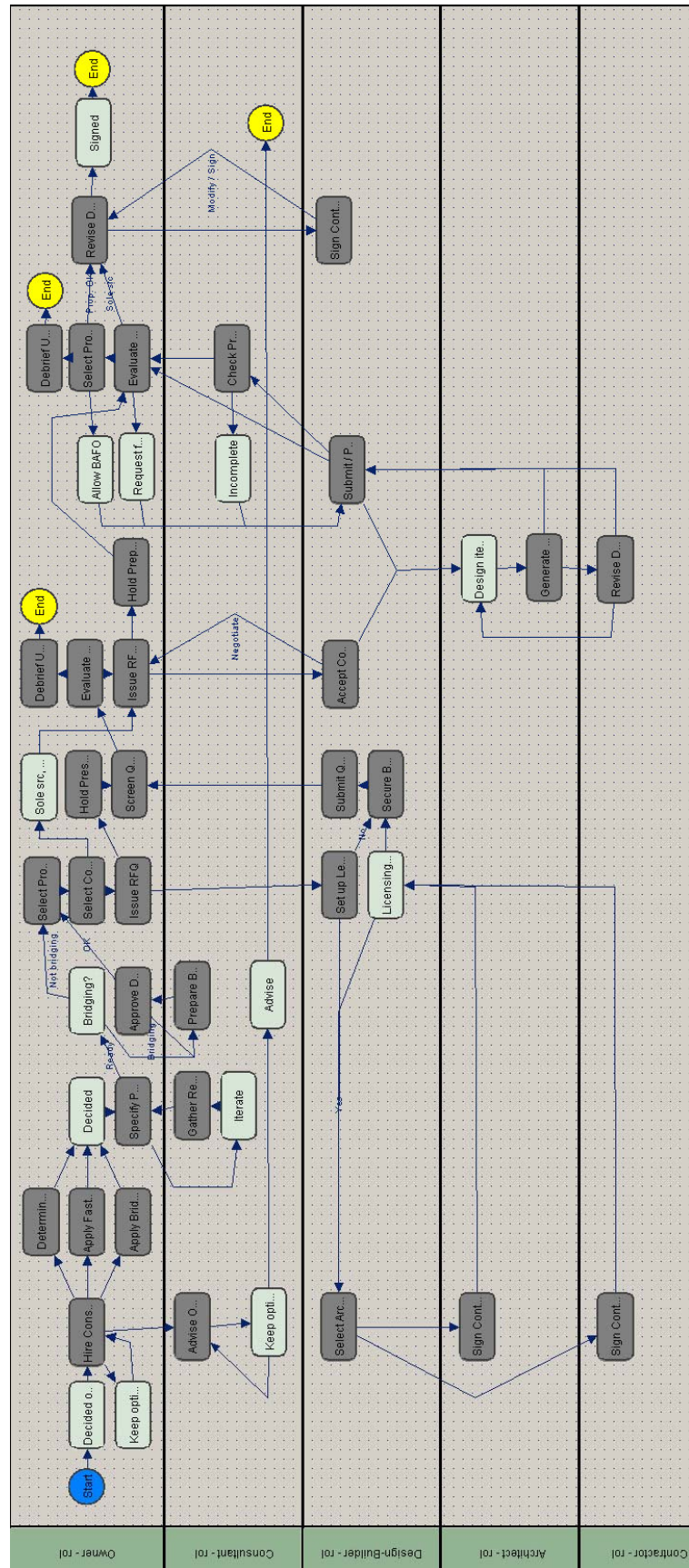


Figure 7.3: Design-Build Overall Process Map

- A: Formation of Owner's team and DB team E: Pre-selection of qualified proposers
- B: Selection of best type of DB variant F: Proposal development and modification
- C: Identification of facility needs G: Proposal negotiation and selection
- D: Generation of preliminary design intent H: Construction Preparation

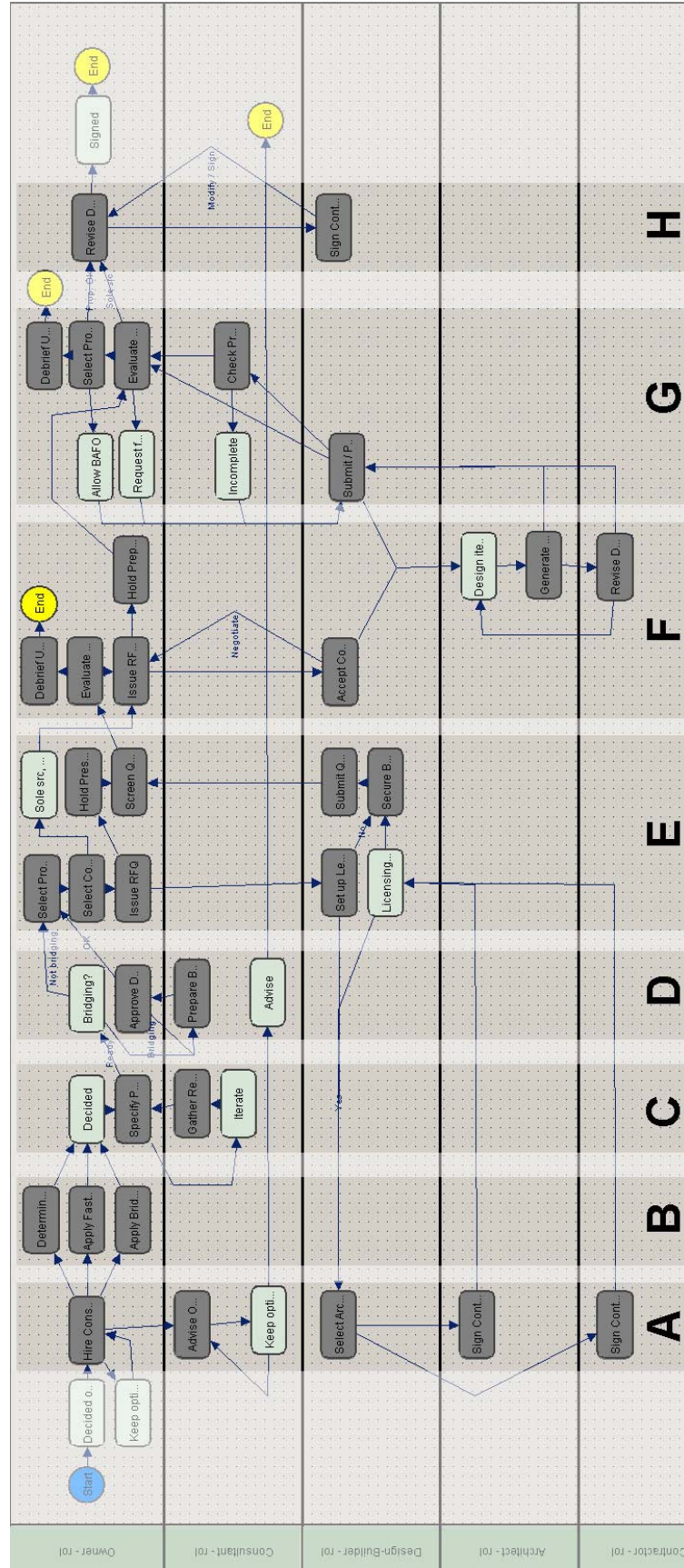


Figure 7.4: Main Phases of the DB Process

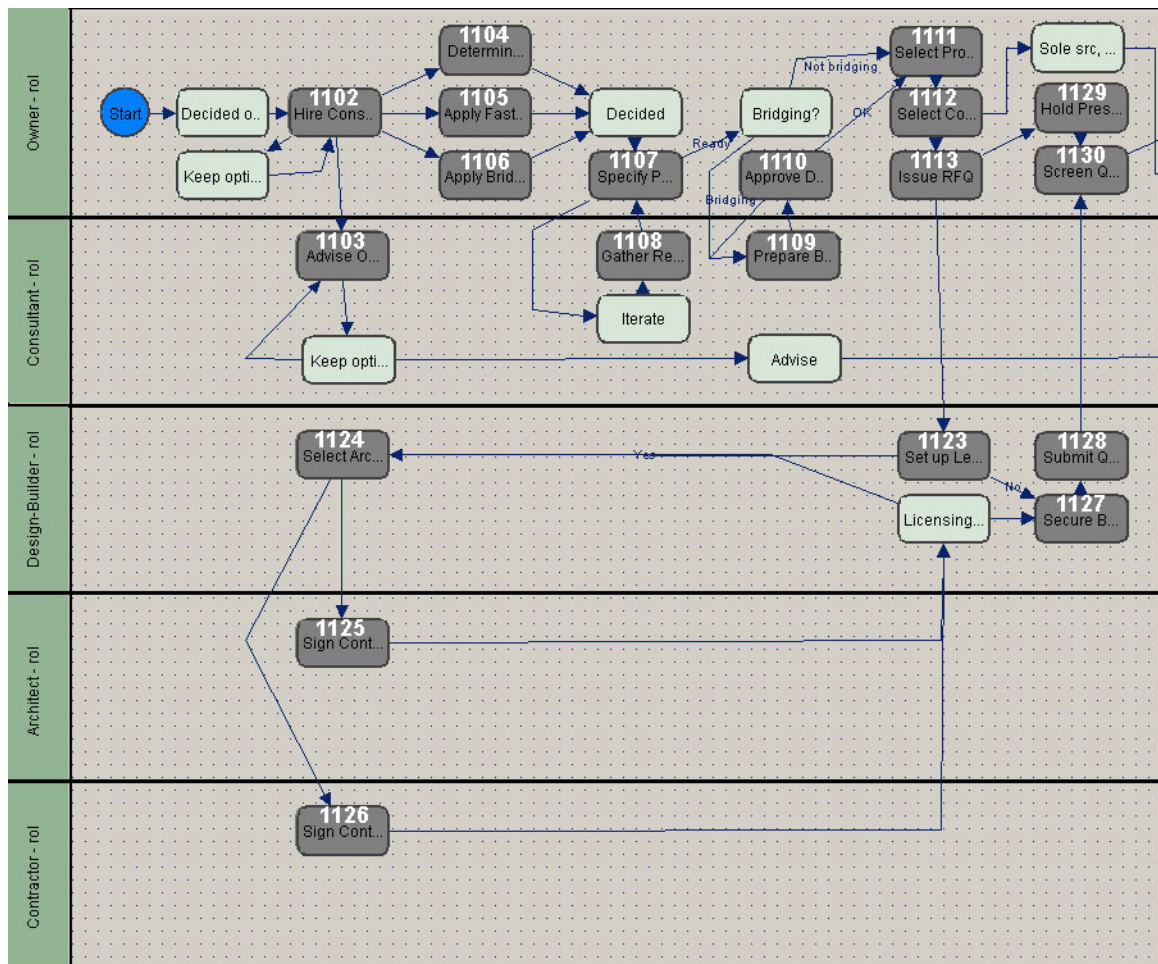


Figure 7.5a: Detailed Design-Build Process Map

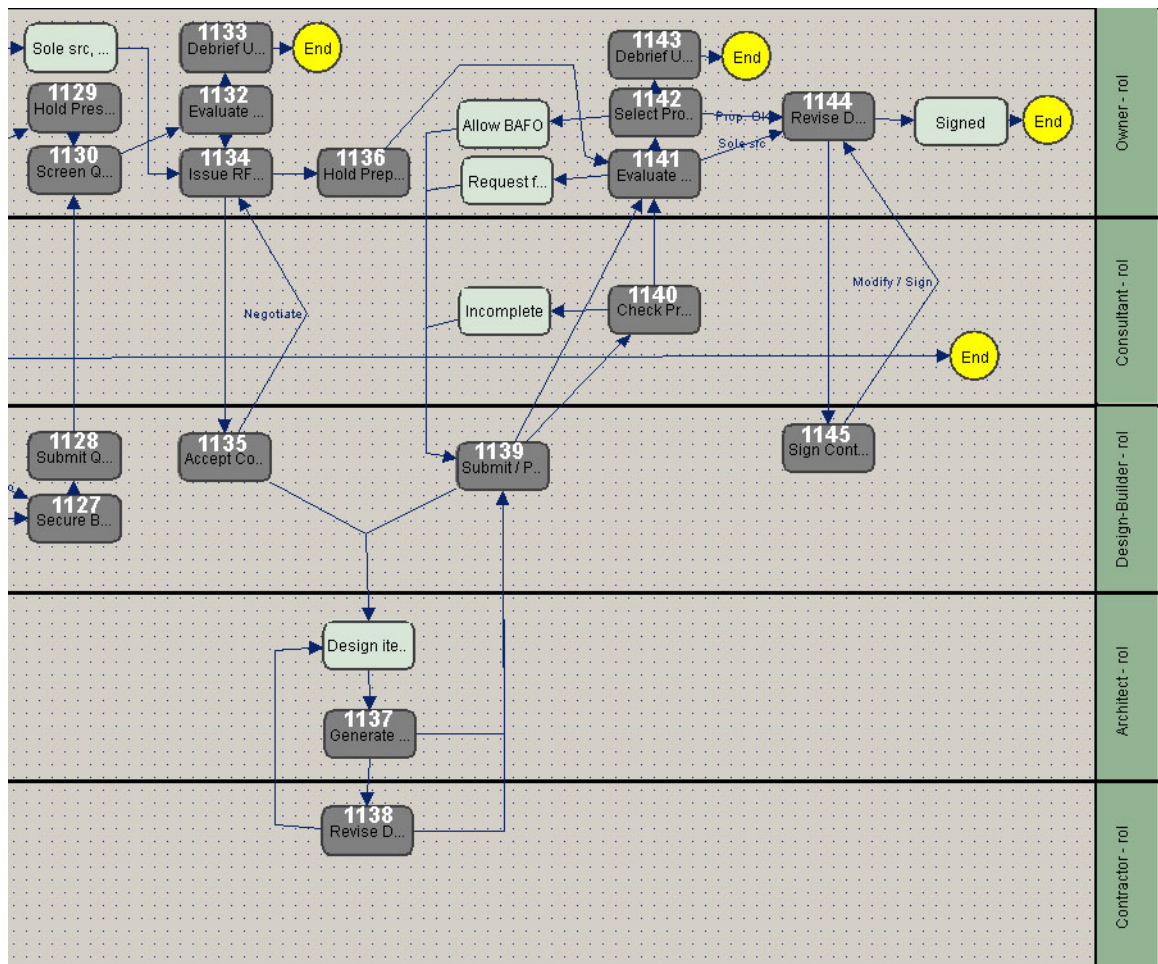


Figure 7.5b (Continued)

7.2.4 Description of Design-Build Activities

This section provides a short narrative that touches upon the main issues at stake for each of the DB process activities of Table 7.1 / Figure 7.3. Some knowledge of the principles and practices behind DB are crucial for understanding the functioning of the implemented process, although an in-depth analysis of all the particular DB intricacies for each task would be superfluous here. For that, each activity has a task-specific Web site to serve as an evolving domain knowledge repository, as will be explained in Section 7.3.1.

1102 Hire Consulting Architect / Criteria Consultant

[By: Owner]

Depending on the project's complexity, and the available man power / experience within the Owner organization, the Owner may wish to engage external expertise to:

- Support Owner's decisions (for example in selecting bids from Design-Builders),
- Assist the Owner in defining its building needs (requirements engineering),
- Generate an initial preliminary design, laid down in bridging documents, and/or
- Oversee the later work of the selected Design-Build entity.

These services are represented respectively by the Consultant activities 1103 (Advise Owner), 1108 (Gather Facility Requirements), 1109 (Prepare Bridging Documents) and 1140 (Check Proposal). Each of those activities are launched (or not) at the appropriate time by the workflow engine if the Owner decides to pre-activate them in 1102 by setting a mandatory Boolean value to true (or false) for each desired service. The peculiarities of

activity 1102 will be described in some detail when the task is treated as example in Section 7.3. Even when rejected by the Owner at first, activity 1102 remains available during the run-time DB process in case later Owner-decisions still require expert assistance after all.

1103 Advise Owner

[By: Consultant]

This activity remains available throughout the entire process and gives the Consultant write-access to a variety of deliverables and decisions that would otherwise have to be provided exclusively by the Owner.

1104 Determine Ownership Situation

[By: Owner]

Design-Build project delivery has the potential to offer its users a wide range of extended services beyond just design and construction, such as business planning, site acquisition, financing, operation, maintenance, and asset management. These tailored services are summarized under the name Design-Build-Plus, and includes:

- Turn-key projects; where the DB-er hands over the ready-to-use project when construction is completed after having financed the building and potentially even the land.
- Build-leaseback; where the DB-er retains ownership of the facility and leases it back to the client who commissioned it based on terms negotiated at the outset.

- Build-Operate-Transfer (BOT); where the DB-er operates (and receives fees) from the facility according to the requirements of the commissioning client.
- Build-Own-Operate-Transfer (BOOT); the DB-er may even own the facility during operation until transferring it after a specified period of time.
- Build-Own-Operate (BOO); for which no transfer of ownership is specified.
- Lease-Sale-Transfer (LST) variations; where innovative and complex combinations of leaseholds can be granted to consortia of developers, investors, owners, and DB-parties.

Some of these options are beneficial to clients who do not have the financial capacity to invest in initial project development, but who can write long-term lease agreements or guarantee a reasonably secure income from rent or regular user fees. Increasingly DB+ is used for large infrastructural projects such as highways, tunnels and bridges, but also for parking garages, correctional and health facilities, where local governments are short of construction funds but can obligate user fees or engage in long-term lease agreements.

Since ownership may be fluctuating in DB+ projects, in this case the “Owner”-label of the process model should be interpreted in broad terms as the “Client” who commissioned the building.

Obviously the exact ownership situation is an important factor for many downstream process activities, and a topic where process support could make an impact by serving owners to make informed decisions if they find themselves in unfamiliar territory. The ownership conditions may well reflect earlier decisions that were part of the preceding

process of scope planning, feasibility studies and financing (Section 7.2.1.1), in which case some of the deliverables for activity 1104 may be present already (since WRD parameters are defined at the package-level, accessible from multiple processes).

1105 Apply Fast-tracking?

[By: Owner]

Fast-tracking aims to cut back overall project time by overlapping design and construction, and it therefore fits well with DB project delivery. Even though detailed design documents have not been finished yet, construction contracts can be awarded early for portions of the work, in so called packages. Consecutive packages could comprise for example demolition and site preparation, foundations and structure, procurement of long-lead-time items, exterior closure, major mechanical systems, interior construction, casework, and/or finishes. The quantity and timing of packages may vary widely, but of course the coordination and integration of packages must remain manageable (and affordable) both on-site and on the drawing board. Moreover, commencing construction with an incomplete design carries a significant risk. The coordination not only between design disciplines but also between packages will likely bring additional costs and require the appointment of a Construction Manager.

If the project is split up in components however, a separate instance of the parameterized DB process could be launched for each major package, thus aiding the coordination of procuring multiple “sub-projects” simultaneously.

Bridging is a procurement method that combines the advantages of DB with those of competitive bidding with detailed drawings. The process is similar to pure DB except that the Owner first hires a design professional as Consultant to prepare bridging documents that communicate a certain level of design intent to DB offerers. The Owner may want to apply bridging as a means to gradually define requirements, because he has a long-standing relationship with a particular design professional, or because he wants to engage a specific signature architect on the project. Typically, functional and aesthetic characteristics are conveyed with drawings, whereas more technical aspects are expressed in performance specifications, thus leaving the exact specification of construction technology and methods to the architect-of-record of the DB-er. The bridging documents may serve as literal prescriptions or more as non-compulsory guidelines. Whereas traditional Design-Bid-Build results in a fixed product with an unknown price, and DB results in an early fixed price but an incomplete product, Bridging 1) produces an enforceable price early on, 2) allows architects to work directly with the Owner to create the right design, 3) yet it also places other architects close to the contractors and manufacturers to develop the best construction technology, and 4) it centralizes responsibilities for design errors and omissions, construction and post-construction faults, 5) yet it offers a professional Owner representative to protect the client's interest throughout the building process. The decision to apply bridging will trigger the activation later on of a process loop between Consultant and Owner, consisting of tasks 1109 (Prepare Bridging Documents) and 1110 (Approve Design Intent).

DB procurement involves bidding based on facility requirements rather than on finished prescriptive design documents. Therefore the owner must be able to express building needs earlier and more precisely than with traditional delivery methods, where exact needs may only become apparent during the process of design development. With DB, changes in requirement after issuing the Request For Proposal will frustrate offerers and, especially after contract award, it will result in additional expenses through contractual stipulations and Change Orders. The Owner's information package generally contains performance-oriented specifications for elements such as the facility program, delivery dates, site (parking, zoning), architecture (aesthetics, spaces, circulation, adjacencies, etc), maintenance, security, user comfort, structural, HVAC (heating, air-conditioning and ventilation), and MEP (mechanical, electrical and plumbing) systems.

A relevant body of research to mention in this context is the field of Performance-Based Building (PBB), which aims to replace prescriptive requirements, regulations and contract provisions with performance-based equivalents. Local prescriptive contracts, codes and standards in current AEC practice are considered to obstruct international trade, quality vs. cost optimization in building construction, and the introduction of innovative building products and construction methods. In describing the targets rather than the solutions, PBB is bringing user needs to the center stage of the design and construction process. Endeavors in implementing the approach are undertaken by many countries and international organizations like ISO (International Standardization

Organization), ASTM (American Society of Testing and Materials), RILEM (Materials Research), WFTAO (World Federation of Technical Assessment Organizations) and CIB (International Council for Research and Innovation in Building and Construction). The CIB Working Commission of the Performance Concept in Building has taken a leading role worldwide in coordinating the development of the performance concept since its inception in the 60's. The benefits of adopting and using a performance-based approach are widely recognized, yet there is some confusion on its actual meaning and consequences. Some mistake the performance concept simply for an approach to strive for quality without a systematic method of analysis and verification. Instead, PBB is strictly based on performance indicators and their objective evaluation methods. Goals, interests and needs of building stakeholders (consumers, building professionals or the community at large) are translated into functional and performance requirements, and then assessed with appropriate analysis techniques – like testing, calculation or a combination of both (Foliente 1998). It needs to be stated that prescribing (e.g. by lack of an objective testing method) is another option to guarantee compliance. A prescriptive approach is complementary, but subordinate to the performance approach (Gross 1996). Nevertheless, a unified framework and vocabulary is still needed for exactly describing building performance standards. A wide range of functional requirements with appropriate indicators and required values must be established, for building aspects like energy, ventilation, thermal comfort, lighting, egress, acoustics, esthetics, life-cycle analysis, etc. Most research efforts only address a single aspect or subsystem (e.g. Chen *et al.* 1996; Mahdavi 1996; Karni 1996; Kalay 1996). In a concrete attempt to solve the issue, Vanier *et al.* (1996) propose a comprehensive structure based on product modeling

for systematically describing user requirements. Unfortunately their work also focuses on just one initial subsystem (the building envelope) and their methodology leaves many fundamental questions unanswered, for example the remaining lack of libraries and hierarchies of user needs, functional requirements and matching building elements.

Compared to other industries, the construction industry has a relatively low customer orientation (supply driven) and a low level of industrialization / technological innovation. Customers often receive limited fitness for use and value for money. The industry is fragmented, often with separate responsibilities for design and construction, and with a primary focus on low initial cost instead of low user costs over time (e.g. for maintenance, operation, demolition). Contractors have few options and incentives for optimization of the delivered end product, and the building process suffers from poor communication and information transfer, while being regulated by constraining prescriptive instead of stimulating performance based codes. A shift to PBB can change and improve these shortcomings by encouraging the development and use of both innovative products (new, improved or altered), as well as manufacturing and production processes that are better, more efficient or less expensive. It enables international trade (exchange of products), and can thus drive down prices due to increased competition among suppliers. Furthermore, a common 'taxonomy' to express added value will reduce miscommunication and foster stronger customer awareness. Design and construction output would better meet customer demands, with an extended focus on the entire life-cycle of the building, replacement of phase-bound and work-type oriented tasks, and the potential of resource savings and less construction waste.

Since many Owners do not consider building or facility management (FM) as their core business, they need third-party assistance to survey and catalog the space requirements of their organization to a qualitative level commensurate with the planned DB project delivery method. Specialized criteria consultants bring experience and expertise to the table in assessing organizational needs for certain types of facilities. Activity 1108 is closely related to 1107; a structured dialogue can support interactions between the two.

1109 Prepare Bridging Documents (Schematic Design) [By: Consultant]

After specification of facility wishes and requirements is complete, the workflow engine will activate activity 1109 for the “owner’s architect”, if the Owner decided in activity 1106 to apply bridging. Usually bridging documents are roughly equivalent to design development documents, but too much detail or emphasis on exact utilization will negate some of the advantages of DB i.e. the ability for the Design-Builder to use its internal creativity and expertise to optimize the offered design solution. Moreover it will force competition based mostly on price instead of on value. Critics have therefore called bridging “bidding with incomplete documents”. If bridging is applied, the bridging documents are in general specifically omitted from the DB contract, as will be shown in Section 7.2.6, to prevent ambiguities over design responsibilities and further reinforce the single point of responsibility of the DB-er.

Activity 1109 and 1110 take place in close collaboration between Owner and Consultant in much the same fashion as an Owner would employ an architectural firm during the early stages of design in traditional procurement. However in this case, having the schematic design made only serves to communicate an idea or design intent to DB-ers who will later provide the real design. Operational variations of DB may vary anywhere between:

- Direct DB (full project definition under DB-er's control)
- Design criteria DB (detailed Owner requirements)
- Preliminary design DB (program plus some prescriptive design in the RFP)
- Bridging (prescriptive design and specifications)

Within the selected operational DB variation, there are various options for procuring AEC services. Before opening communication with offerers, Owners must realize that DB-ers will want to know in what capacity they will be operating and what competition they would have to expect. With the various available options different levels of subjective, qualitative and quantitative factors play a role.

Procurement possibilities might be for example:

- Sole source; when long-term working relationships and trust already exist between an Owner and a service provider, for example from earlier projects
- Quality-Based Selection (QBS); based on submitted qualifications in regards to past performance, technical competence, capacity to accomplish the work and geographic location
- Price and technical score evaluation; selection through a formal review process with a predefined rating system, for example an “adjusted low-bid” where a formula is provided to make proposals comparable by incorporating both cost and provided value (a score on features)
- Negotiated Greatest Value; where bilateral discussions with offerers iterate towards an optimized design solution and proposal
- Low cost bidding; this option can be quite similar to traditional bidding, while diverting from DB principles. An alternative might be for example to work with a “fixed budget / best technical response” selection.

Another important choice at this point is whether to promise offerers to either make a unilateral choice, or to allow negotiations. Negotiations and discussions may take time, may sometimes be legally forbidden (for example on public projects), but also provide an opportunity to further explore user needs and revise offers before contract award. If negotiations are allowed and desirable, the Owner must make clear at what point he wants to receive so-called Best-And-Final-Offer (BAFO).

The major decisions for this activity are for the Owner to select the type of standard contract to apply, and the methods and levels of compensation to offer to proposers. It is customary to reimburse offerers for the effort of making a proposal and for possible preceding qualification interviews, but not for submitting qualifications. The available standard contracts, usual payment methods, and determining aspects are elaborated in Chapter 9, where task 1112 and 1135 will be taken as example cases for the possible implementation of a detailed structured dialogue. If the Owner decided in activity 1111 to use sole source procurement, the next activity will be to issue the Request For Proposal (RFP) to the selected DB-er (activity 1134).

With the decisions taken and information items generated thus far, the Owner should be ready to invite AEC firms to apply for being included in the later Request For Proposal. This call-and-response mechanism is intended to solicit an initial interest in collaborating from both supply and demand side (respectively DB-er and Owner). The Owner must convince proposers through its RFQ that he has the authority and available funding, with a realistic budget and contingencies, to actually carry out the project. The RFQ must describe the intended project and the requirements on offerers, such as the scope of work needed from them to submit a proposal. Because of the time involved it is appropriate to inform potential offerers of any requirements on possible mandatory attendance at

Owner's briefings. A critical ingredient for the DB-er to participate, compose its team and present itself, is to know to what extent the eventual award is made based on costs versus on value. The method of cost determination must therefore be communicated in the RFQ, together with a fixed or variable price, and with a policy on alternates (unrequested major design alternatives allowed or not). In order to ensure a fair process to all participants, restrictions on contact and communication must be clearly stated. To keep all participants on an equal footing, answers to individual questions must be provided in public (with anonymous asker) to all involved parties. Furthermore the RFQ must outline practical issues like the notification procedure, whether interviews are part of the selection process, how to submit qualification packages, the required number of copies, etc. RFQs are usually circulated through publications of trade organizations or via other channels for announcing project leads. If the project is large, or the timeframe for selection short, a notice of intent to request DB qualifications may be issued early.

1123 Set up Legal Entity

[By: Design-Builder]

The following structural variations for Design-Builders are possible:

- Joint-venture
- Constructor-led Design-Builder
- Designer-led Design-Builder (A/E Prime)
- Integrated firm
- Developer-led Design-Builder

The applied structural variation basically reflects the combinatorial groupings of the lower three swimlanes in the DB process model. The legal entity can be set up permanently to work a market segment for a specified period of time, or in response to a particular RFQ or RFP, to acquire the appropriate skills and licensing within one company to be able to participate in a certain district. Some Owners may favor joint-venture or integrated firm arrangements in order to avoid having to go through one of the disciplines to have issues addressed (true single-point responsibility). Public owners however may not be allowed to show bias or favoritism for one type or the other because of the risk of violating anti-competition statutes. The constructor-led DB entity is the most prevalent variation.

1124 Select Architect of Record / General Contractor [By: Design-Builder]

In traditionally procured construction projects, contractor selection usually takes place through bidding instead of qualitative selection. Selecting an architect though is a more common phenomenon for which one could imagine devising a separate guided sub-process. At first choosing architectural services may seem a rather unintelligible selection process based on a wide range of often-subjective criteria, and largely based on firms' reputation -- unlike for example price-based bidding. Nevertheless, when undertaking a building project selecting an architect is an important decision process that adheres to certain rules and regulations.

In principle, three basic methods of selection are available to a client or Design-Builder seeking an architect (RAIC 2003):

1. "Direct selection" is most often used by an individual undertaking a relatively small project, but also by a Design-Builder who may have previous experience with a certain A/E firm. In this case the client or DB-er selects an architect on the basis of reputation, personal acquaintance or recommendation.
2. "Architectural design competitions" are sometimes used as a means of selecting an architect and a design for both public and private projects. They are occasionally conducted to generate prototypical ideas. In order to attract enough qualified contestants, and because this method involves considerable effort from the participants, compensating them is deemed appropriate.
3. "Quality Based Selection" (QBS) is a common method of selecting an architect, particularly by committees representing institutions, corporations or public agencies. In essence, one architect is compared with others and the client makes a selection based upon his or her judgment of which firm is most qualified for the successful execution of the project. Most people advise to compare three to five qualified firms – enough to see the range of possibilities, but not so many that an already tough decision will be further complicated.

In the case of architect selection by a DB entity the latter two methods might not be an option because of time constraints (the tight schedule of the DB competition itself) and the discouragement of a double selection (first by the DB-er, then by the Owner).

Typical contracts for this type of arrangement are provided for example by the AIA contract B901 “Standard Form of Agreements Between Design/Builder and Architect” or the DBIA’s contract #540 “Standard Form of Agreement Between Design-Builder and Designer”. If it does not pertain a longer-term alliance, but rather a project-based collaboration, this activity 1125 serves not only for negotiating an internal contract within the DB entity, but also for the Architect to get acquainted with the project requirements, and make a judgement on whether participating would be possible and sensible – time, resource, and business wise.

Similar to activity 1125, typical contracts for this type of arrangement are provided for example by the AIA contract A491 “Standard Form of Agreements Between Design/Builder and Contractor” or the DBIA’s contracts #550 “Standard Form of Agreement Between Design-Builder and General Contractor - Cost Plus Fee with an Option for a Guaranteed Maximum Price” and #555 “Standard Form of Agreement Between Design-Builder and General Contractor - Lump Sum”. Here also, the activity serves to introduce the project specifics to the general contractor, in order for him to make a judgement about the desirability of participating. If the DB entity is contractor-led, the two swimlanes in the process modeler for the DB-er and the contractor would effectively merge, and a separate contract would not be necessary.

A surety bond is a credit transaction between the principal – a party providing AEC services – and the surety as a guarantee towards a third party – the obligee. The surety lends its financial backing to a project to assure to the obligee (Owner) that the obligations of the principal (DB-er) will be met. Compared to designer-led DB-ers, constructor-led DB entities often have a relatively strong financial position with considerable assets and (cost and schedule) management capabilities to be bonded for larger sums.

Typical bond products are:

- Performance bonds – to guarantee to the obligee (Owner) that the contractor will perform its contractual obligations after contract award
- Payment bonds – to guarantee to the obligee (Owner) that the contractor will fulfill its payment obligations towards subcontractors and suppliers
- Bid bonds– to guarantee to the obligee (Owner) that the Design-Builder qualifies to submit a proposal in response to an RFP and will follow through if the proposal were to be accepted.

Some common types of insurances are:

- Errors & Omissions (E&O) insurance – against professional liabilities arising from negligence such as faulty work, pollution, incomplete drawings

- Commercial General Liability (CGL) insurance – against claims by third parties for bodily injury or property damage
- Builder’s risk insurance – to protect the insured’s property interests in the work during construction

Some risks are inherent to the development of construction projects (labor strikes, weather, unforeseen site conditions) and are therefore considered business risks to be managed by assigning them to one of the contract parties. Other risks are routinely transferred to insurance carriers or bonding companies. Many of the existing risk-covering products however are not tailored to the unconventional situation of integrated design and construction, therefore leaving gaps in coverage and significant exclusions. Intelligent decision support tools and up-to-date knowledge bases, with access to knowledgeable insurance and surety brokers, can provide valuable services to clients in this still evolving field of risk allocation for Design-Build project delivery.

1128 Submit Qualifications

[By: Design-Builder]

Interested offerers should submit their qualifications in accordance with the issued RFQ from activity 1113. The Design-Builder must basically demonstrate its ability, available resources, experience and enthusiasm to generate a competitive proposal, and to carry it out till completion. The DB-er must prove for example that it employs registered and licensed professionals in each discipline within the jurisdiction of the project, and may want to provide short resumes for key personnel it intends to employ on the project.

Pre-submittal conferences can be held to clarify ambiguities or unanswered questions from interested offerers face-to-face. Strict rules must be adhered to in distributing any additional information beyond the initial call or detailed requirements as they emerge to all relevant parties, in order not to develop an unintended bias towards one of the DB-ers. For that purpose a special online newsgroup may be designated where Q&A results will be posted, accessible to all offerers.

Important aspects for this activity are whether interviews are conducted as part of the qualification process, and/or whether initial concept generation is part of it. On the one hand interviews or so-called Interview-with-Concepts may be time-consuming, but on the other hand they can save the Owner effort in the long run; they may be useful not only to give the Owner an idea of a team's solution direction and creative potential, but also to demonstrate the collegiality and team dynamics within a DB entity. Typical areas of inquiry for the jury during interviews are the methods used to design the building within budget, techniques to resolve possible conflicts within the DB team, the format for team management and leadership, and their quality control philosophy. Interviews-with-Concepts can alleviate some of the concerns that may exist for a lack of direct contact between designers and Owner representatives (since the designers in DB project delivery are subcontracted by the DB-er instead of employed by and accountable to the Owner).

Typical prequalification selection criteria for a Design-Builder are:

- Financial and bonding capacity
- Building type experience
- Record of design and technical excellence
- Staff experience / Design-Build experience
- Organization management plan for the DB entity
- Quality Assurance (QA)
- Record of on-time and on-budget performance

It is customary to announce pre-qualified Design-Build consortia and their constituent firms to each other. The competitive range is best kept between three to five firms, depending among others on the complexity of the project. Too large a pool of finalists will not only require more funds from the owner but it will also discourage offerers to participate with full consideration because of their decreasing chance of contract award. Technically each additional DB-er would require an extra three replicated swimlanes in the process modeler (one for the DB entity, its contractor and its A/E), but for the sake of simplicity (explaining the working) the displayed situation applies to sole-source procurement (one DB-er only) – notwithstanding the prequalification steps that would only be applicable in the case of multiple competitive proposers. A generic username and login can be associated with each swimlane (e.g. “Contractor2”) and later assigned to an actual selected firm or individual(s) once a name is available.

Since even submitting qualifications may involve considerable effort from offerers, it can be appropriate to debrief unsuccessful submitters. This will not only help DB-ers to learn for future projects, but it will also help avoid procedural protests (e.g. in the case of public projects). Furthermore it enables the unsuccessful submitters to release reserved resources for other purposes. In debriefing firms, care should be taken not to reveal proprietary information of any of the parties (including the qualified consortia).

The Request For Proposal is obviously a pivotal set of documents that is essential to the entire DB process. In summary, the RFP package serves as an advertisement to attract quality Design-Builders to the construction project. The RFP typically contains sections on the required goods and services (a technical description) including the desired quality and complexity, project characteristics such as the location and available time for completion, the legal framework that will govern the collaboration, and the basis for ultimate evaluation with weighted selection criteria. The latter will convey to offerers what emphasis the Owner is placing on the various aspects of the building, and it will send a message of openness, cooperation and fair selection. Much can be said on the various components that make up the RFP, so an in-depth analysis of the deliverables (WRD) would be a valuable resource for project participants to help streamline the DB process during execution. The project budget for example will indicate to the DB-ers the

relative value of design and construction services to the overall budget that includes the costs of land, legal fees, furnishings and equipment, insurances, contingencies, move-in costs, initial operating costs, etc. It portrays the image of a reliable Owner that is fiscally realistic and whose project is reasonably secure to warrant the DB-er's effort of participating, without later contingencies being taken out from the basic design and construction budget, thus reducing the DB-er's flexibility to deliver quality beyond a code-minimum facility. If low first cost is the overriding factor in comparing offers, the call for proposals could be characterized as an Invitation For Bid rather than an RFP, in which case some of the advantages of DB project delivery may be compromised (e.g. tapping into the design skills of proposers).

1135 Accept Proposal Contract (Part 1)

[By: Design-Builder]

Standard DB contracts such as the AIA's A191 "Standard Form of Agreements Between Owner and Design/Builder" often consist of two parts; one for the proposal stage and one for the detailed design and construction phase. Usually Owner and Design-Builders should try to reach substantial agreement on the Part 2 contract even before embarking on the phase of proposal generation (Part 1), in order to avoid later difficulties in negotiation. The Part 2 agreement kicks in when the construction is commissioned to the winning offerer. The Owner signs multiple Part 1 agreements, one with each of the prequalified Design-Builders. Chapter 9 deals with activities 1112 and 1135 in more detail in the context of extended structured dialogues.

1136 Hold Pre-proposal Conference / Q&A Sessions [By: Owner]

Similar to activity 1129 for prequalification, meetings can be held before having the offerers submit their proposals. During these pre-proposal conferences the DB-ers can bring up questions that came up during their design process or that were not addressed in the RFP specifically. Videotaping Q&A sessions is recommended and making the outcomes available to all parties required.

1137 Generate Preliminary Design [By: Architect]

During activities 1137 and 1138 the actual proposal is generated; a design is conceived that fulfils the Owner's requirements, detailed till a level where it may serve as a clear indication of the proposed facility, to which a price can be attached, and which can serve as a contractual basis if it were to be selected for construction.

1138 Revise Design [By: Contractor]

Activities 1137 and 1138 form a closely intertwined loop and together they establish a major advantage of DB over other delivery methods; construction knowledge is directly infused into the design process early on, not as an "afterthought" to fit a more or less finished design into a budget, or a construction into a design. The close integration of design and construction knowledge is intended to foster innovation and more affordable alternatives for unnecessarily expensive design solutions.

Submitting a proposal may involve in-person presentations to the jury by the finalists, in which case ahead of time the presentation order and venue should be established, and rules on the duration, what media are allowed (slides, animations, interactive models) and who can be present during the presentations (jury, public, press, no competitors, etc). Presentations will allow the DB-ers to explain the rationale behind their designs, as submitted by narratives and graphical materials in response to the RFP. A specific presentation format can be mandatory, for example if proposals are to be put on public display or presented to a large jury, or if physical models of the various designs must fit in a common model by the Owner of the surrounding site. Models, color and material samples can be required, although the Owner should realize that models can be costly and time-consuming, especially for RFPs on a tight schedule.

As domain expert (in the field of AEC and DB in particular) the Consultant must check if the proposals conform to the requested format. If unintentional discrepancies exist, the Consultant must require adherence to the RFP or else disqualify the proposal. If significant and intentional breaches of the RFP procedures occur, the Consultant must investigate the irregularities and take or recommend corrective actions, including disqualification if warranted.

Evaluation starts upon receipt of the responses to the RFP, and consists of scoring and ranking proposers against the stated requirements, based (only) on the published weighted criteria. Following the competitive evaluation of proposals, the Owner can award the contract or proceed to negotiations first, if allowed according to the earlier set groundrules of the competition. Offerers in the competitive range may be asked to submit a so-called Best-And-Final-Offer (BAFO) before final selection takes place. The requests for BAFO have a common cut-off date.

Alternates are solutions outside the scope and requirements (e.g. over-budget) that might be interesting to the Owner nonetheless. Care should be taken in taking along alternates in the evaluation as it places proposals on an unequal footing and may confuse evaluation. Alternatively, the Owner may provide a prioritized list of desired but not required features in the RFP which proposers may then elect to include if their proposal base price allows for such extras.

Typical proposal selection criteria are (subjective or objective):

- Architectural image and character
- Functional efficiency and flexibility
- For engineering projects: technical innovation and environmental acceptability

- Quality of materials and systems
- Quantity of usable area
- Access
- Safety and security
- Energy conservation
- Operation and maintenance costs
- Cost versus value comparison
- Completion schedule

Usually some pre-established fashion of numerical scoring is applied on the various subtopics. Notification of the jury's recommendations and the Owner's action upon it must be prompt, and in writing to all invitees simultaneously. A best offeror is selected under the condition that negotiation of a final contract will take place within a reasonable time period.

1143 Debrief Unsuccessful Offerers

[By: Owner]

Similar to activity 1133, fairness dictates that the Owner gives unsuccessful proposers an opportunity to learn why their proposal did not make it to be the final selection. This debriefing is not just meant to be beneficial to the proposers (to learn from shortcomings and to release reserved resources); it is also in the best interest of the Owner, as it may prevent litigation and protests, and preserve the reputation of the Owner for later capital projects, thus ensuring quality RFP responses in the future.

After selection of a proposer, the Owner may need to revise its documents to reflect the outcome of the discussions during negotiation. A record of negotiations can be necessary as audit trail in case of a protest or investigation in public RFPs. Whereas the (Part 1) contract with the other offerers is terminated, negotiation on the finalization of the Part 2 agreement is opened with the winning DB-er.

The AIA recognized the necessity of improved collaborative contract editing, and contract-party-specific change tracking in particular, by releasing new and entirely redesigned software for editing AIA contract documents in October 2003. The computer program, based on the widely accepted Microsoft Word platform, is available with a yearly license to generate a set number of contracts, and offers features for creating, editing, collaborating on, storing and retrieving contract data, and for printing a final document, like:

- Dialog boxes guiding users through a series of questions, with answers automatically being filled into the blanks in the document and stored for future use.
- MS Word editing functionality like change tracking and prominent "draft" watermarks.
- Customized templates, to call up project data and automatically incorporate it into new documents.

- A variance check can be conducted that compares the draft of a document against standard AIA language to note any differences.
- A variance-checked version can be created in PDF format, locked to prevent further editing.
- A "clean copy" final document can be produced, without strike-throughs or underlines, noting all the additions and deletions with a small marker in the margin and details of the changes in an "Additions and Deletions" report at the end of the document.

The contract editor can be used for any of the earlier described standard AIA contracts that may be used in activities 1125, 1126, 1134, 1135, 1144 and 1145.

1145 *Sign Construction Contract (Part 2)* [By: Design-Builder]

Upon final acceptance and signing of the contract by the selected DB-er, the phases of detailing out design documents and actual construction can commence. Separate processes could be devised for those phases, although they are outside the scope of this chapter. The Part 2 agreement usually arranges construction related issues such as the Owner's on-site representation, how to handle changes in the work after contract award (Change Orders), dispute resolution (mediation and arbitration), and protection of persons and property during construction.

7.2.5 Workflow Relevant Data

Whereas the previous section provided a short general description for each of the activities of the introduced Design-Build process model from Table 7.1, this section will list the deliverables (WRD) that need to be produced along the way. As explained in Section 6.5.1, WRD have a crucial function since they are used to pass on values of parameters between activities and processes within a package. This way the submittal of an output deliverable for one task can become the input for the next. WRD may also serve to steer the process itself, for example when a Boolean value is used to switch between two mutually exclusive downstream branches of a workflow.

A literature review on Design-Build activities reveals a range of needed inputs for each activity of Table 7.1. By starting at the end of the process and tracing back where the inputs for the activities were generated as outputs of upstream activities, a catalog of deliverables can be composed, see Table 7.2.

Unless otherwise noted in Table 7.2, the default data type is a string (text field or text area) that may contain hyperlinks also (e.g. text starting with “http://”). This means that a submitted data item can be a simple text string, but it may also contain URL-s referring to various online resources, such as a blog, portal, wiki, or a specific uploaded document on an ftp-site or in the Content Manager of the project -specific (e-HUBs) Website. (Wiki is a type of software that allows visitors to edit web pages). Access rights to online resources can be set according to the project’s needs and the features of used external

applications. By allowing links to online resources, the process model can accommodate scale differences and varying levels of detail; for example a complex office building may require far more extensive documentation than a single-family residence for the same DB activity.

Every activity starts with a system-generated data item called “General activity instructions”, which is a URL to a dedicated task-specific Website. Such a Website serves as a task manual and an evolving knowledge repository to aid the task performer in completing his/her activity, among others with descriptions of each WRD deliverable and why and where it is used or was generated downstream and/or upstream. The various activity and WRD descriptions in Section 7.2.4 and 7.2.5 can be considered brief summaries of each of those dedicated Websites, whose functionality will be elaborated in Section 7.3.1. Since each of these URL-type WRD are exclusive to one activity and one activity only, they are excluded from Table 7.2.

The URL-data type is different from the string type as mentioned earlier, since the URL-type is set during design-time of the workflow by the human process modeler, whereas the value of the text field is set run-time by the process participants. During the execution of the workflow, URL-type WRD appear as pre-defined clickable links, whereas string-type WRD appear as text fields (text boxes).

One column in Table 7.2 (marked with “#”) indicates whether the WRD item would have to be replicated for each additional DB entity (in case of multiple DB-er swimlanes).

Table 7.2: Multi-Activity Workflow Relevant Data for DB Project Delivery

WRD	#	Type	WRD-ID
Letter of award		Text	LettOfAward
Construction contract documents (Part 2)		Text	Part2contract
Part 2 signing instructions from Owner		Text	Part2ownInstr
Contract part 2 negotiation		URL	Part2negotiation
Construction contract signed by DB-er		Boolean	Part2signed
Identification of Owner		Text	OwnerID
DB-er honoraria and compensation methods		Text	DBhonoraria
Detailed program of facility requirements		Text	FacRequiremnts
Performance indicators and specifications		Text	PerfIndicators
Estimated budget & contingencies / cost categories		Text	BudgetCat
Ownership (financing, site acquisition, feasibility)		Text	Ownership
Selected Design-Builder		Text	SelectedDBer
Competition schedule		Text	CompSchedule
Consultant evaluation		Text	ConsEvaluation
Communication, selection & notification procedure		Text	CommProcedure
List of all invited offerers		Text	InvitedOfferers
Shortlist of offerers in competitive range		Text	ShortlistOfferers
Selection rationale / basis of award		Text	BasisOfAward
Jury composition		Text	JuryComposition
Weighted proposal selection criteria		Text	SelectionCriteria

Continued on next page...

Table 7.2 (Continued)

WRD	#	Type	WRD-ID
Proposal documents	x	Text	PropDocs
RFP inquiry response addenda		Text	QandAaddenda
DB-er qualification, licensing & certification docs	x	Text	DBerLicensing
Best-And-Final-Offer allowed		Boolean	BAFOallowed
Request for BAFO	x	Text	BAFOrequest
Clarifications / revisions / additions / negotiation	x	URL	ClarifyNegotiate
Award on unilateral basis (no negotiations)		Boolean	NoNegotiations
Presentation details & requirements		Text	PresentationReq
Identification of building occupants / users		Text	BldgUserID
DB Procurement Methodology		Text	DBprocureMeth
Policy on alternates		Text	AlternatePolicy
Move-in logistics, operation & maintenance		Text	FMresponsibility
Sole Source Design-Build Procurement		Boolean	SoleSource
Proposals ready for final selection		Boolean	PropsReady
Instructions to offerers / RFP requirements		Text	RFPrequiremnts
Supplements to proposal form (owner information)		Text	OwnerInfo
Governmental approvals (environmental, zoning)		Text	GovApprovals
Bridging Documents (schematic design)		Text	BridgingDocs
Proposal valid and complete	x	Boolean	PropOK
Consultant honoraria and compensation methods		Text	ConsHonoraria

Continued on next page...

Table 7.2 (Continued)

WRD	#	Type	WRD-ID
Grounds for disqualification		Text	Disqualify
Operating / maintenance budget & energy efficiency		Text	FMbudget
Responsibility for obtaining permits		Text	PermitResp
DB-er internal design critique iterations	x	URL	DBdsgnCrit
Proposal ready for submittal according to DB-er	x	Boolean	PropOK_DB
Proposal ready according to Architect	x	Boolean	PropOK_AE
Proposal ready according to Contractor	x	Boolean	PropOK_GC
Identification of Consultants		Text	ConsultantID
Project description, location (if any) and scope		Text	ProjDescription
Building type and size		Text	BldgTypeSize
Consultant oversight of DB work		Boolean	ConsDBcontrol
Pre-proposal conferences details		Text	PrepropConf
Proof of Owner's funds		Text	OwnerFunds
Part 1 signing instructions from Owner		Text	Part1ownInstr
Part 1 agreement	x	Text	Part1contract
Contract part 1 negotiation (if sole source)		URL	Part1negotiation
Number of finalists		Text	FinalistsQnt
Unqualified / rejected offerers		Text	RejOfferers
Bonds / proof of DB-er's credit / insurances	x	Text	DBbondsInsur
Qualifications submittal requirements		Text	QualSubmReq

Continued on next page...

Table 7.2 (Continued)

WRD	#	Type	WRD-ID
Weighted prequalification selection criteria		Text	PrequalCriteria
Identification of Design-Builder	x	Text	DBerID
Architect-of-Record	x	Text	ArchOfRecID
Eligibility / minimum requirements of DB-teams		Text	EligibilityReq
Details qualification interviews (if any / incl. concept)	x	Text	QualInterviews
Details pre-submittal conferences / Q&A sessions		Text	PresubmConf
Designer license within Design-Builder	x	Boolean	AElicenseOK
Contractor license within Design-Builder	x	Boolean	GClicenseOK
DB internal contract negotiations	x	URL	DBinternalNeg
Architect-DB-er contract	x	Text	DBerAEcontr
Contractor-DB-er contract	x	Text	DBerGCcontr
Structural variation DB (legal) entity	x	Text	DBstructVar
Bridging		Boolean	Bridging
Permanent / project DB entity existing	x	Boolean	DBexisting
Schematic Design Approved		Boolean	BridgDocsOK
Fast-tracked project components (packages)		Text	FastTrckPckgs
Facility requirements complete for RFQ/RFP		Boolean	FacReqCompl
Fast-tracking		Boolean	FastTracking
Consultant requirements engineering assistance		Boolean	ReqEngHelp
Private / Public sector project		Text	PrivatePublic

7.2.6 Matrix of Workflow Relevant Data per Activity

As indicated, the WRD output of one activity can be the input of the next, thereby connecting activities in a logical web of interdependencies. The WRD thus form an underlying invisible but crucial data layer beneath the process diagrams shown in Figure 7.3 to 7.5. Effectively WRD constitute a second type of task dependencies beyond the earlier displayed temporal connections between activities. These dependencies can be visualized by reverse engineering the data needs of the DB activities from Table 7.1; by starting at the end of the process and tracing back where the inputs for the activities were generated as outputs of upstream activities, a pattern of repetitively used WRD starts to emerge. These data dependencies can be expressed as illustrated in Table 7.3 by placing the activities from Table 7.1 on the y-axis, and the catalog of WRD from Table 7.2 on the x-axis of a matrix, and then marking in each matrix field which deliverable is used or produced by which activity and how.

Whereas Table 7.3 merely shows the pattern of WRD use, Table 7.4 provides the same repeated data but in a more legible format, zoomed in across several pages.

The following symbols are used in Tables 7.3 and 7.4, denoting:

W	Writable; WRD item needs to be filled in or can be edited
R	Read-only; WRD item can be viewed but not edited
S	System-generated WRD; design-time or deduced from user database
T	Transition-channeling WRD; used to direct workflow

Table 7.3: Matrix of Workflow Relevant Data per Activity

[illegible]

Table 7.4: Detailed Data Access Rights by Activity and WRD

ID	ACTIVITY	PHASE	TYPE	MULTIPLE	WRD	Letter of award	Construction contract documents (Part 2)	Part 2 signing instructions from Owner	Contract part 2 negotiation	Construction contract signed by DB-er	Identification of Owner	DB-er honoraria and compensation methods	Detailed program of facility requirements	Performance indicators and specifications	Estimated budget & contingencies / cost categories	Ownership (financing, site acquisition, feasibility)	Selected Design-Builder	Competition schedule	Consultant evaluation	Communication, selection & notification procedure	List of all invited offerers
1102	Hire Consulting Architect / Criteria Consultant	A	Owner								W		W		W	W					
1103	Advise Owner	A	Consultant								R	W	W	W	R	R		W		W	W
1104	Determine Ownership Situation	B	Owner								W		W		W	W					
1105	Apply Fast-tracking?	B	Owner												W						
1106	Apply Bridging?	B	Owner																		
1107	Specify Performance Requirements	C	Owner										W	W	W			W			
1108	Gather Facility Requirements	C	Consultant										W	W	R			W			
1109	Prepare Bridging Documents (Schematic Design)	D	Consultant										W	W	R	R					
1110	Approve Design Intent	D	Owner										W	W	W	R					
1111	Select DB Procurement Methodology	B	Owner								R										
1112	Select DB Contract Format	B	Owner			W					R							W			
1113	Issue Request For Qualifications	E	Owner			R					R	W			W	R		W		W	
1123	Set up Legal Entity	A	Design-Builder									R			R	R		R		R	
1124	Select Architect of Record / General Contractor	A	Design-Builder									R			R	R		R		R	
1125	Sign DB-Architect Contract	A	Architect									R			R	R		R		R	
1126	Sign DB-Contractor Contract	A	Contractor									R			R	R		R		R	
1127	Secure Bonds and Insurances	E	Design-Builder									R			R						
1128	Submit Qualifications	E	Design-Builder												R						
1129	Hold Pre-submittal Conference	E	Owner												R			R		R	
1130	Screen Qualified Firms	E	Owner													R					
1132	Evaluate Qualifications	E	Owner													R				R	W
1133	Debrief Unsuccessful Submitters	E	Owner																	R	R
1134	Issue Request For Proposal or Invitation For Bid	F	Owner			W					R	W	W	W	W	W		W		R	R
1135	Accept Proposal Contract (Part 1)	F	Design-Builder			R					R	R	R	R	R	R		R			R
1136	Hold Pre-proposal Conference / Q&A Sessions	F	Owner								R		R	R	R	R		R		R	R
1137	Generate Preliminary Design	F	Architect								R	R	R	R	R	R		R			
1138	Revise Design	F	Contractor								R	R	R	R	R	R		R			
1139	Submit / Present Proposal	F	Design-Builder									R	R	R	R	R		R		R	
1140	Check Proposal	G	Consultant			W	W	W	S				R	R	R	R		R	W	R	R
1141	Evaluate Proposals	G	Owner										R	R	R	R		R	R	R	R
1142	Select Proposal	G	Owner										R	R	R	R	W	R	R	R	R
1143	Debrief Unsuccessful Offerers	G	Owner									R	R	R	R		R		R	R	R
1144	Revise Documents / Prepare Contract	H	Owner			W	W	W	S	R	R	W	W	W	W	W	R	R	R		
1145	Sign Construction Contract (Part 2)	H	Design-Builder			R	W	R	S	W	R	R	R	R	R	R					

Table 7.4 (Continued)

[illegible]

Table 7.4 (Continued)

ID	ACTIVITY	PHASE	TYPE	Multiple WRD	Boolean	Boolean	Text	Text	Text	Text	Boolean	Text	Text	Text	Text	URL	Boolean	Boolean	Boolean	Text
					Sole Source Design-Build Procurement	Proposals ready for final selection	Instructions to offerers / RFP requirements	Supplements to proposal form (owner information)	Governmental approvals (environmental, zoning)	Bridging Documents (schematic design)	Proposal valid and complete	Consultant honoraria and compensation methods	Grounds for disqualification	Operating / maintenance budget & energy efficiency	Responsibility for obtaining permits	DB-er internal design critique iterations	Proposal ready for submittal according to DB-er	Proposal ready according to Architect	Proposal ready according to Contractor	Identification of Consultants
1102	Hire Consulting Architect / Criteria Consultant	A	Owner					W			W		W	W						W
1103	Advise Owner	A	Consultant		W		W	W			R	W	R	W						R
1104	Determine Ownership Situation	B	Owner					W	W		R		R	W						
1105	Apply Fast-tracking?	B	Owner				W													
1106	Apply Bridging?	B	Owner				W	W		W										W
1107	Specify Performance Requirements	C	Owner					W	W				W	W						W
1108	Gather Facility Requirements	C	Consultant					W	W		R		W	W						R
1109	Prepare Bridging Documents (Schematic Design)	D	Consultant					W	W		R		R	R						R
1110	Approve Design Intent	D	Owner						R		R		W	R						W
1111	Select DB Procurement Methodology	B	Owner		W			R	R											
1112	Select DB Contract Format	B	Owner		R			R	R											
1113	Issue Request For Qualifications	E	Owner						R				W	W						
1123	Set up Legal Entity	A	Design-Builder						R				R	R						
1124	Select Architect of Record / General Contractor	A	Design-Builder						R				R	R						R
1125	Sign DB-Architect Contract	A	Architect						R				R	R						R
1126	Sign DB-Contractor Contract	A	Contractor						R				R	R						R
1127	Secure Bonds and Insurances	E	Design-Builder																	
1128	Submit Qualifications	E	Design-Builder																	
1129	Hold Pre-submittal Conference	E	Owner										R							R
1130	Screen Qualified Firms	E	Owner										R	R						
1132	Evaluate Qualifications	E	Owner										R	R						
1133	Debrief Unsuccessful Submitters	E	Owner										R							
1134	Issue Request For Proposal or Invitation For Bid	F	Owner				W	W		R			W	W	W					
1135	Accept Proposal Contract (Part 1)	F	Design-Builder				R	R	W				R	R	R					
1136	Hold Pre-proposal Conference / Q&A Sessions	F	Owner				R	R		R			R	R	R					
1137	Generate Preliminary Design	F	Architect				R	R	W	R			R	R	R	S	R	W	R	
1138	Revise Design	F	Contractor				R	R	W	R			R	R	R	S	R	R	W	
1139	Submit / Present Proposal	F	Design-Builder				R	R	W	R			R	R	R	S	W	R	R	R
1140	Check Proposal	G	Consultant				R	R	R	R	W	R	R	R	R					
1141	Evaluate Proposals	G	Owner		T	W	R	R	R	R										
1142	Select Proposal	G	Owner																	
1143	Debrief Unsuccessful Offerers	G	Owner																	
1144	Revise Documents / Prepare Contract	H	Owner																	
1145	Sign Construction Contract (Part 2)	H	Design-Builder																	

Table 7.4 (Continued)

[illegible]

Table 7.4 (Continued)

ID	ACTIVITY	PHASE	TYPE	MULTIPLE WRD	Text	Text	Boolean	Boolean	URL	Text	Text	Text	Boolean	Boolean	Boolean	Text	Boolean	Boolean	Boolean	Text
					Details qualification interviews (if any / incl. concept)	Details pre-submittal conferences / Q&A sessions	Designer license within Design-Builder	Contractor license within Design-Builder	DB internal contract negotiations	Architect-DB-er contract	Contractor-DB-er contract	Structural variation DB (legal) entity	Bridging	Permanent / project DB entity existing	Schematic Design Approved	Fast-tracked project components (packages)	Facility requirements complete for RFQ/RFP	Fast-tracking	Consultant requirements engineering assistance	Private / Public sector project
1102	Hire Consulting Architect / Criteria Consultant	A	Owner																W	W
1103	Advise Owner	A	Consultant	W	W															R
1104	Determine Ownership Situation	B	Owner																T	W
1105	Apply Fast-tracking?	B	Owner													W		W	T	
1106	Apply Bridging?	B	Owner										W			R		R	T	
1107	Specify Performance Requirements	C	Owner									T				W	W	R		
1108	Gather Facility Requirements	C	Consultant													W	R	R		
1109	Prepare Bridging Documents (Schematic Design)	D	Consultant													W				
1110	Approve Design Intent	D	Owner												W					
1111	Select DB Procurement Methodology	B	Owner										R		T					
1112	Select DB Contract Format	B	Owner										R							
1113	Issue Request For Qualifications	E	Owner	W	W								R							
1123	Set up Legal Entity	A	Design-Builder	R	R			S	W	W	W	W	R	W						
1124	Select Architect of Record / General Contractor	A	Design-Builder	R	R	R	R	S	W	W	W	W	R	T						
1125	Sign DB-Architect Contract	A	Architect	R	R	W	R	S	W	R	W	R								
1126	Sign DB-Contractor Contract	A	Contractor	R	R	W	S	R	W	W	W	R								
1127	Secure Bonds and Insurances	E	Design-Builder			R	R													
1128	Submit Qualifications	E	Design-Builder	R	R	R	R													
1129	Hold Pre-submittal Conference	E	Owner	R	R															
1130	Screen Qualified Firms	E	Owner	R																
1132	Evaluate Qualifications	E	Owner																	
1133	Debrief Unsuccessful Submitters	E	Owner																	
1134	Issue Request For Proposal or Invitation For Bid	F	Owner																	
1135	Accept Proposal Contract (Part 1)	F	Design-Builder																	
1136	Hold Pre-proposal Conference / Q&A Sessions	F	Owner																	
1137	Generate Preliminary Design	F	Architect																	
1138	Revise Design	F	Contractor																	
1139	Submit / Present Proposal	F	Design-Builder																	
1140	Check Proposal	G	Consultant																	
1141	Evaluate Proposals	G	Owner																	
1142	Select Proposal	G	Owner																	
1143	Debrief Unsuccessful Offerers	G	Owner																	
1144	Revise Documents / Prepare Contract	H	Owner																	
1145	Sign Construction Contract (Part 2)	H	Design-Builder																	

Since the e-HUBs platform provides only limited functionality for users to have threaded discussions, activities can get links to specialized external communication tools (indicated by the “S” in Table 7.4) when a process model is customized to a particular project at the time of project initiation. Such external applications could be a project team’s preferred blogging site (online threaded discussion), a project wiki (jointly editable Website), Skype links (launching Internet telephony), or a project-specific discussion forum. Dedicated communication tools such as blogs may be preferable over the simple passing of WRD text messages between process activities if many iterations can be expected and a clear message log is needed.

At the same time, humans may be using other means of communication in parallel to or as a substitute for assigned interaction channels, such as the phone, fax, e-mails, or face-to-face meetings. The system not only acknowledges, but assumes such flexibility in communication preferences. Any mode of interacting is allowed as long as decisions and deliverables are recorded in the customized data templates (representing the WRD of Table 7.3) that are presented to the project participants during process execution.

Examples of close interaction loops in the DB process are (see Figure 7.6) the facility requirements specification and production of bridging documents (between Owner and Consultant), the contract negotiation within the DB entity (between Design-Builder, Contractor, and Architect-of-Record), the proposal generation (between Contractor and Architect-of-Record), the requests for clarification / negotiation of DB proposals, and the Part 1 / Part 2 contract negotiations (between Design-Builder, Consultant and Owner).

- a: Facility requirements specification
- b: Production of bridging documents
- c: Contract negotiation within the DB entity
- d: Part 1 Contract Negotiations
- e: Proposal generation
- f: Requests for Clarification / Negotiation of Proposals
- g: Part 2 Contract Negotiation

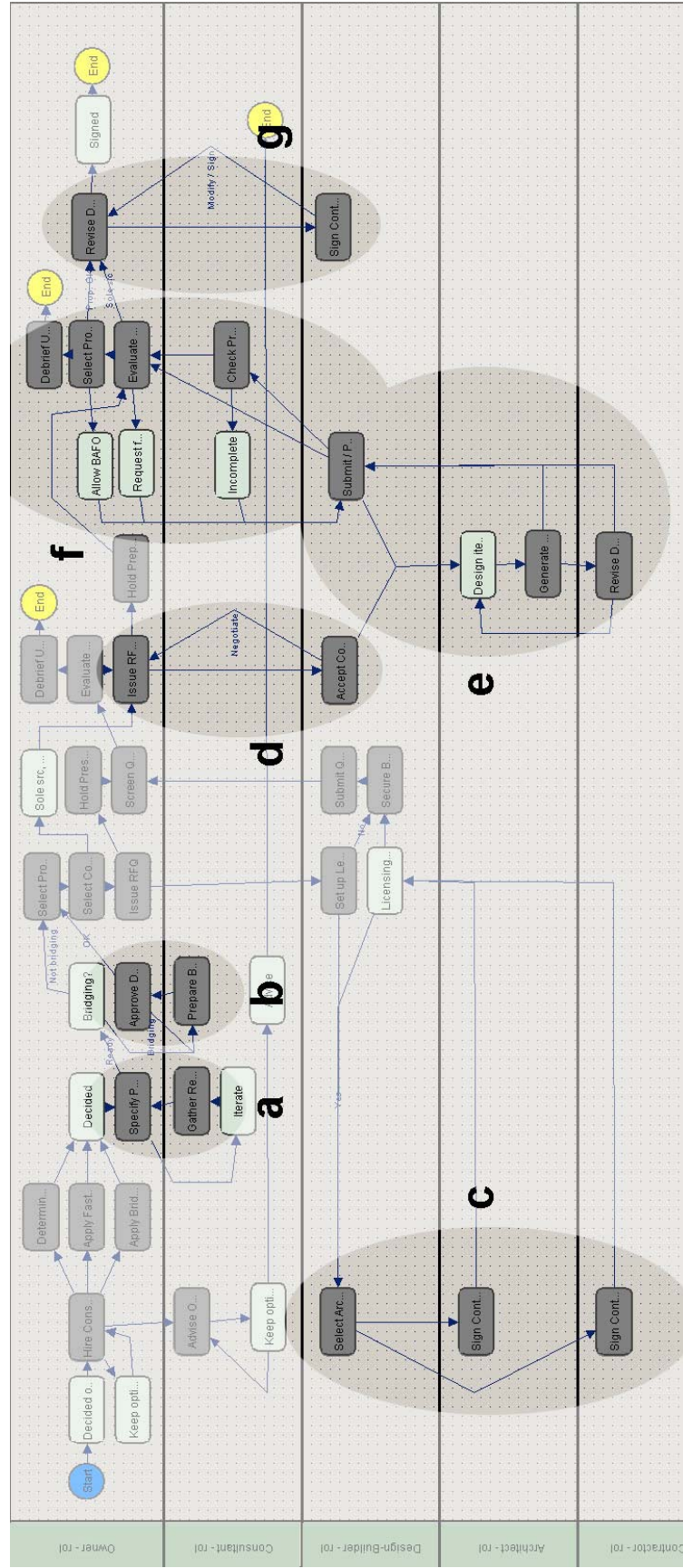


Figure 7.6: Instances of Close Interaction Loops

7.3 Process Implementation

The process from Section 7.2 with its activities and WRD could be instantiated for a specific case, i.e. for a construction project called “Atlanta High Museum of Art”. At the request of the building’s Owner, Donald Trump, the e-HUBs industry coordinator for the “Architecture” domain would create a project space with generic usernames and logins for the involved project participant roles, e.g. “Contractor1”, “Architect2”, etc. The Owner, a Consultant or the industry coordinator can then use the process modeler to tailor the Design-Build XPDL process to the situation (assign actual persons to roles, adapt required WRDs, activities, transitions, resources, etc). While logged in, a registered project participant can upload the customized XPDL file in the project planning module of the project space (see Figure 7.7), available for launching by any of the project participants. Once uploaded, multiple parameterized process instances could be created, although in this case it is likely that only one process instance would be used. Upon launching a process instance (by clicking the “Play-button”), the workflow engine dispatches the first activity to the appropriate role / participant(s). In this case the first activity is the Owner’s activity 1102 “Hire Consulting Architect / Criteria Consultant”. Donald Trump will find this activity listed in his “project dashboard”, and when he accesses the task (by clicking on it), he will be presented with a task-specific pop-up data template that contains form fields (read or write) as specified in Table 7.3. The read-only fields contain relevant resources for the successful completion of the activity, whereas the write-enabled fields require submittal or adaptation of data for downstream activities.

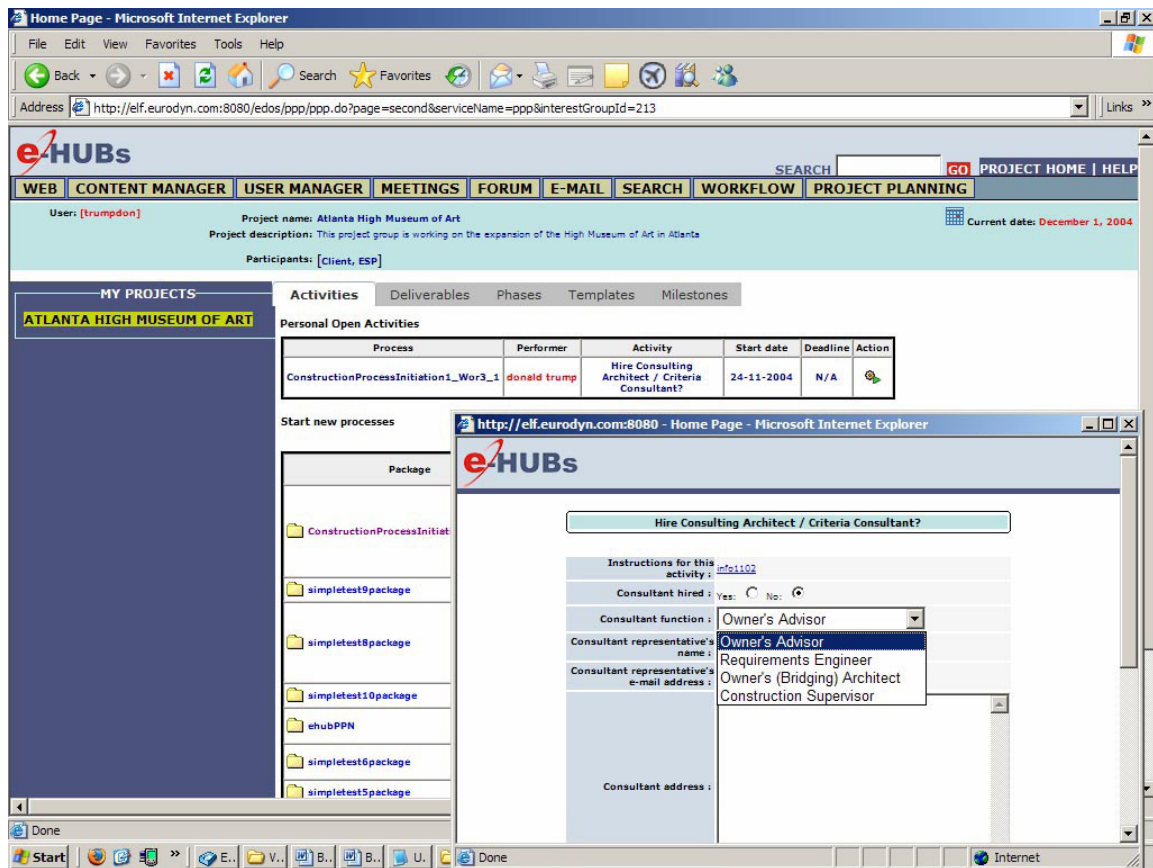


Figure 7.7: Task-specific Data Template during Enactment

Although the purpose of guided project planning is to avoid information overload at all stages of the process, generating the required data items for one activity can amount to a significant effort, for example when “generating an architectural design”. Completing an activity may therefore require the revisiting of one particular pop-up data template multiple times before final submission. By eventually submitting all the necessary WRD items, which can each be mandatory or discretionary, the next activities will be launched in a similar fashion according to the defined process logic.

7.3.1 Task-specific Knowledge Bases

As indicated before, each activity contains a link to a task-specific Website that is intended to serve as a continuously evolving and self-learning knowledge repository describing the intricacies of the particular activity (see Figure 7.8).

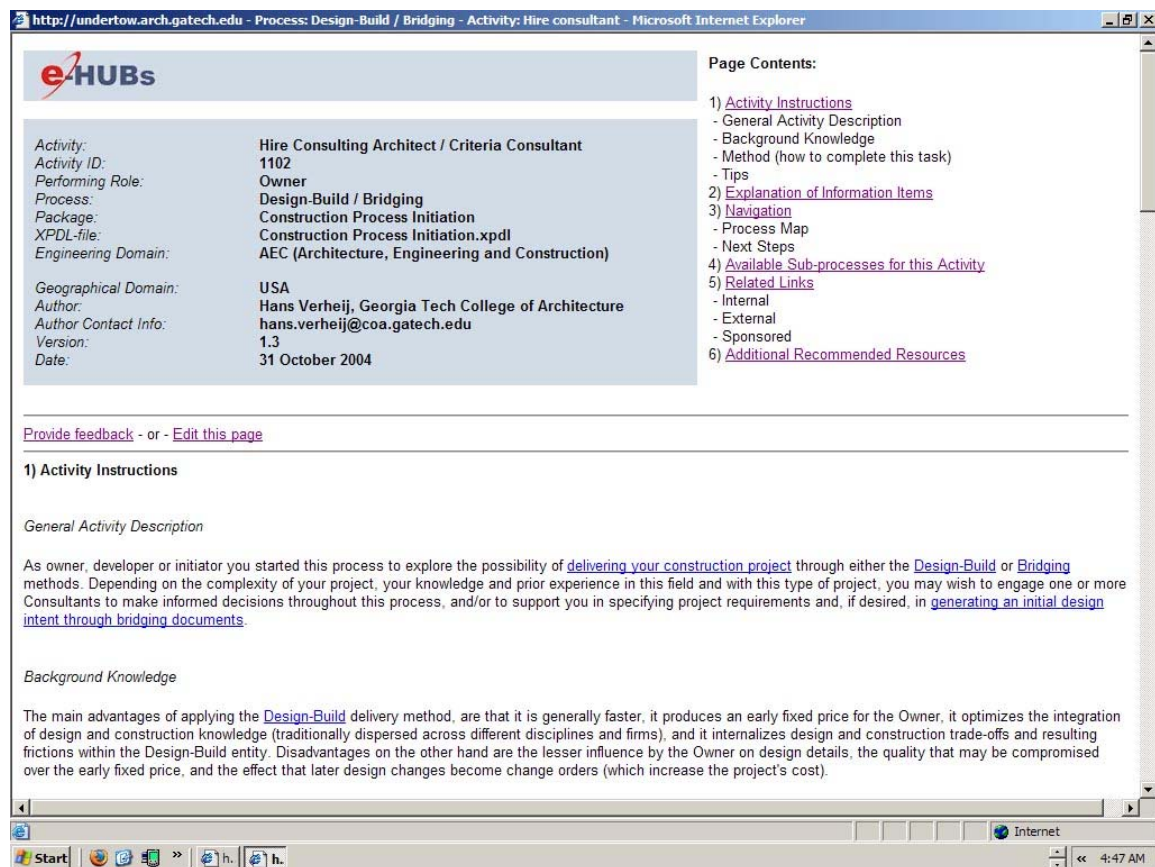


Figure 7.8: Online Activity Knowledge Base

Each task-specific Webpage contains (Figure 7.8):

1) *Activity Instructions:*

- | | |
|------------------------------------|--|
| - A general activity description | A brief summary of the work to be done |
| - Background Knowledge | An extended version of the task descriptions and domain knowledge as provided in Section 7.2.4 |
| - Method | How to physically complete the task, steps to take, available tools, techniques, resources |
| - Tips, tricks, warnings, pitfalls | Tapping into the experience and know-how of colleagues on other / similar projects |

2) *Explanation of Information Items:* Where each WRD was generated upstream and/or will be used downstream, basically a task-specific extract of Table 7.3 (type, ID, description, purpose)

3) *Navigation:*

- | | |
|---------------|---|
| - Process Map | Providing orientation to individual users |
| - Next Steps | Which tasks will follow for who upon completion |

4) *Available Sub-processes:* A library of processes (nestable XPDL files) that may be useful to support parts of the current activity

5) *Related Links:*

- | | |
|-------------|---|
| | Weblinks and contact information; |
| - Internal | URLs to similar sites of other related activities |
| - External | URLs to information from trade organizations etc. |
| - Sponsored | Domain experts, professionals, local specialists |

6) *Additional Resources:*

Books, articles, research projects, publications

Wiki technology can be used to make online information editable by all professionals involved in the process, potentially with access rights set up by the industry coordinator. The gradual adding and finetuning of task relevant information would make the knowledge base richer and increase its practical value over time, with tips, tricks, case studies and warnings for common pitfalls in each of the AEC activities. Since documents can be attached to wikis, relevant files such as XPDL processes or contract templates (clauses) could be shared as open-source repositories. Although the seemingly uncontrolled accumulation of bits and pieces in open-source development efforts may raise concern for continuity and coherence, there is ample evidence of success by emerging technologies such as the Apache server, the Linux operating system, and the JaWE process modeler applied in this research project. An example of a successful jointly edited knowledge base is the online encyclopedia wikipedia.com. Other examples of free wikis are riters.com, wikicities.com, and seedwiki.com. Wiki content is version controlled, so that earlier (e.g. correct) versions of pages can always be retrieved in case of incorrect edits. Peer-control also ensures the quality of collected information, so that content can be maintained with a minimum of administrative oversight and operational cost. A supervising role could be played by the e-HUBs industry coordinator or by trade organizations, whose purpose is after all to support professionals and cultivate domain knowledge. The AEC industry could thus develop a library of standardized procedures in order to increase its repeatability and efficiency, and to prevent an ad-hoc approach to project management. A better knowledge management would also reduce the dependency on seasoned professionals, improve knowledge transfer, and cultivate the collective know-how and experience in an otherwise fragmented industry.

7.4 Quick Survey of Process Applicability

In order to test the implicit hypothesis of this work that project planning could benefit from process guidance, two initial steps were taken to attempt to either prove or disprove the assumption. First, the research effort was introduced to a domain expert for evaluation – to determine whether the DB process correctly reflects actual practices, whether it is complete enough within its domain to be useful, and whether it needs further calibrating or fine-tuning. Secondly, the work was presented to practitioners – to survey the applicability, usefulness, and value of the system in general.

A summary of the approach with the DB process model was demonstrated to Jeff Beard, past President of the Design-Build Institute of America. His assessment confirmed the shown process as appropriately representing existing Design-Build practices, and having potential value for actual process support or for educational application (teaching the working of DB to students in role plays). According to his encouraging findings, the workflow provided a unique and comprehensive process model for the domain of Design-Build project delivery.

A short version of the demo was then presented to a group of medium to high-level experienced project planners in a 40 minute presentation at a joint conference of the Building Futures Council (BFC) and Associated General Contractors of America (AGC) in Las Vegas on May 17, 2005. After a Q&A session, a quick survey was distributed

among the attendants (see Appendix A), with the explicit verbal and written assurance that for research purposes an honest evaluation would be more valuable than an evasive polite response. The questionnaire was designed following the Survey Design Guidelines prepared by the Institutional Research for Service Excellence Project (available from <http://www.mdc.edu/hr/ServiceExcellence/SurveyDesignGuidelines.pdf>).

Results of the survey are displayed in Appendix B. Although the number of respondents present does not make the outcome of the survey statistically relevant, the quality of represented expertise and the provided feedback make the result a promising indication that seems to corroborate the earlier hypothesis.

The presented research was awarded one of three \$1000 “Awards for Outstanding Doctoral Research Paper & Presentation”, out of 55 papers, submitted world-wide and double blind reviewed by academia and industry professionals. Selection was made explicitly based on foundation rigor, originality, vision and the potential to have an impact on the future of the industry.

The format and duration of the above two demos did not allow an in-depth analysis and extensive use of the system and its functionality by the respondents, and they can therefore not be considered a fully irrefutable scientific proof of concept. A third validation method is envisioned to be the enactment of an actual, or at least revisited, planning process – to measure usability issues and system limitations of the implemented prototype as further evidence of the hypothesis. A possible approach to measuring system usefulness is described in Chapter 10 (Hypothesis Testing).

However, the prototype-like environment (with bugs and unreliable components and such) may actually distract users from the concept of guided project planning as such, and its potential value for the AEC industry. As indicated earlier, the need to have a fully working and interoperable collaborative system for demonstration and measurements purposes (using existing components and services) conflicts with the need to expand the theoretical framework (collaborative taxonomy) which would be needed to support structured dialogues on an extended level, as will be explained in the next chapter.

CHAPTER 8

STRUCTURED DIALOGUES

One of society's grand challenges is to increase mankind's collective problem-solving capabilities, or "collective IQ", to assess and solve its complex and ill-structured problems. Such problems can only be addressed through dialogue and collaboration between people. This chapter sets out to analyze dialogues and how they may be better structured and supported, by first reflecting on the limitations of the collaborative system described in Chapter 7. Based on that investigation (8.1), it proceeds to compare existing workflow technologies to structured dialogues (8.2), and the metaphors that apply to each of them. The remainder of the chapter will focus on the most relevant literature on dialogue taxonomies that may serve to arrive at the envisioned systematic dialogue support (8.3). The described methodologies pertain respectively the ActionWorkflow paradigm, speech act theories, the Milan Conversation Model, group interaction management, computer-mediated Collaborative Decision Making, and graphical conversation mapping. The chapter will conclude by summarizing the gained knowledge, and comparing the characteristics of the various methodologies (8.4), as an informal requirements analysis for the prototype application that will be illustrated in the next chapter.

8.1 Workflow Management System Limitations

The system architecture of the applied DB process in Chapter 7 fulfills the requirements on a process-controlled PP prototype outlined in Section 6.4 – regarding interoperability, Web-based ubiquity and practical aspects such as reliability and implementation costs. By using existing components numerous man-years of development effort are saved that would otherwise be needed to build up a home-grown combination of a process modeler, enactment engine, online knowledge repository and multi-user collaboration platform. As such the selected architecture circumvents a steep curve of getting up to par with the level of technology provided by existing Collaborative Virtual Environments, limited as even they may still be in their functionality and usability – evidenced by slow user adoption of many applications and services.

The accompanying downside of using existing components is the automatic transfer of some inherent component shortcomings into the overall system. Some apparent but, as explained, almost inevitable drawbacks have been elaborated earlier, such as the e-HUBs questionable operational speed and longer-term system maintenance. Another expressed shortcoming is the lack of dedicated instrumental support for truly collaborative and continuous (run-time) workflow modeling versus single-point (at most consecutive) and pre-concluded process definition. Though workflows support group work, they hardly provide support for group meetings and dialogue. Furthermore, the current set-up hardly allows the layout of the data templates to be customized to the task and user during

process execution. A series of other concerns are addressed in Chapter 12 as possible directions for future research and system fine-tuning.

In summary, on the one hand the selected set of tools does enable a live demonstration of an applied type of structured dialogue to actual users, but on the other hand it carries disadvantages that may paradoxically prohibit a genuine, fair and thorough evaluation based on the full potential value of the concept. The realization of imperfections in the demonstrated set-up therefore also prompts for a theoretical exploration of the ontology of structured dialogues, as a means to expose a fundamental basis on which to possibly advance the concept for the future.

An ontology can be defined as an explicit formal specification of how to represent the objects, ideas and other entities that are assumed to exist in some area of interest, and the relationships that hold among them. When the knowledge about a domain is represented in a declarative language by a set of defined representational terms, the set of objects that can be represented is called the universe of discourse. Definitions associate the names of entities in the universe of discourse (e.g. classes, relations, functions or other objects) with human-readable text describing what the names mean, and formal axioms that constrain the interpretation and well-formed use of these terms. Formally, an ontology is the statement of a logical theory.

In the next sections, the underlying theoretical concepts of structured dialogues are explored based on a comparison of “traditional” progressive workflows with advanced structured dialogues, and a literature review on existing academic dialogue taxonomies.

8.2 Workflow versus Structured Dialogue

A workflow is defined as the automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules (WfMC, 1999a). A loose distinction is sometimes drawn between production workflows, in which most of the procedural rules are defined in advance, and ad-hoc workflows, in which the procedural rules may be modified or created during the operation of the process. In the context of this chapter, it is more important to distinguish the concept of a structured dialogue, such as a guided product development process, from a “traditional” progressive workflow – as in the opening definition – that would be applied to for example insurance claims processing.

A structured dialogue can be thought of as an advanced type of (sub)workflow, which is:

- *Topic based (instead of data-oriented)*

Enforces the timely discussion of relevant topics rather than focusing on specific data input that is required. When task deliverables cannot exactly be predetermined in terms of scope or specific data fields, a structured dialogue raises the aspects that need to be considered. For example, while the number, content and format of design deliverables for a building may be hard to predefine, the dialogue can ensure that sustainability, constructability and usability are

adequately addressed (leaving the detailed submittals open to the intelligence of the dialogue participants).

- *Scalable (internally)*

Because of its focus on topics rather than specific data, a structured dialogue is meant to easily adapt itself to the simplicity or complexity of the project at hand.

- *Adaptable*

Unlike for example the handling of insurance claims, participants in a structured dialogue have the ability themselves to change a process before starting or continuing it, if needed. The dialogue structure can be adapted without intervention from the system administrators.

- *Expandable (assembly)*

Since users have direct access to the dialogue modeler themselves, a library of available (sub)dialogue templates can be developed and combined on an as-needed basis – wherever firms, individuals or project teams conclude that a structured (self)dialogue can help them to achieve higher quality or efficiency.

- *Self-learning*

The above characteristics make (“dynamic”) structured dialogues better suited than (“static”) workflows to improve over time, by increased usefulness and incrementally added knowledge.

- *Optional*

Participants in a structured dialogue have the ability to bypass the system if they feel confident or experienced enough to handle certain issues without system guidance. Decisions and deliverables will still be captured for later use.

- *Communication medium neutral*

Rather than prescribing the use of phone, fax, websites, instant-messaging or face-to-face meetings, conducting a structured dialogue allows participants flexibility in the use of communication tools, as long as 1) necessary discussion topics are addressed according to a predefined logic, and 2) the necessary decisions and deliverables are captured.

- *Synchronous*

Whereas a workflow usually tends to ship documents between successive actors, a structured dialogue is in principle intended to be more of a synchronous collaboration.

- *Empowering versus Automation*

Whereas a workflow tries to automate processes and reduce human error and inefficiency, a guided dialogue attempts to avoid information overload and empower its participants with timely and regulated knowledge.

8.2.2 Metaphors

The metaphor of a traditional progressive workflow would be a “Task Manager” that handles the timely and accurate delivering and shipping around of forms, parcels and documents between worker’s offices (Figure 8.1). In contrast, the metaphor for a structured dialogue would still include the clerk’s job of delivering mail, but also cover the extended responsibilities of the office “Team Organizer” who is ushering the appropriate project participants into meeting rooms whenever necessary. In the seminar rooms whiteboards on the wall are ready with predefined lists of relevant discussion topics for the efficient generation of needed data items. Colored pens or a microphone could be handed to meeting participants or passed around in a planned order for marking up the whiteboard or making comments during the gathering in an organized fashion.

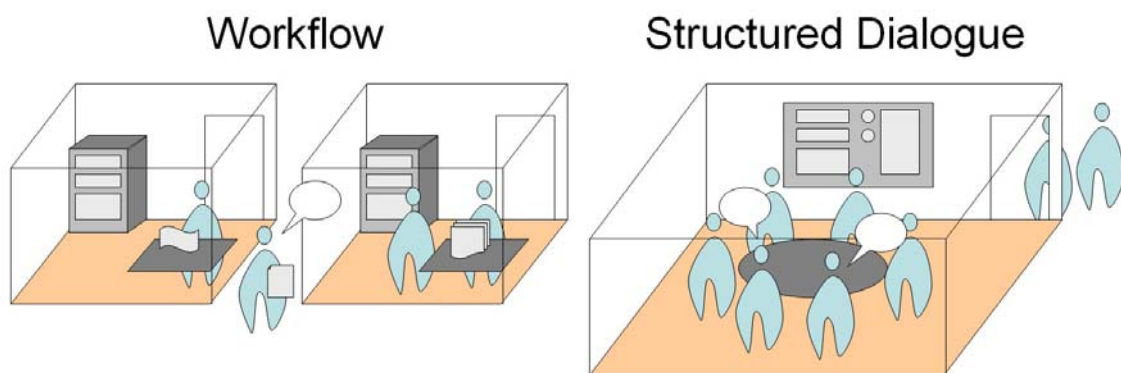


Figure 8.1: Metaphors of Workflows versus Structured Dialogues

8.3 Literature on Dialogue Taxonomies

In order to arrive at an extended dialogue model as sketched in the previous sections, a literature review was undertaken with the aim to identify possible existing dialogue taxonomies, and to reflect upon and enhance the understanding of the domain language and terminology in general.

8.3.1 ActionWorkflow

Harris *et al.* (1997) state that emphasizing customer focus, increasing worker participation, and using workflow models have been instrumental in supporting formal, rationalized processes, but that many organizations are experiencing difficulties in applying those approaches to informal, ill-structured processes such as research, development, design, engineering and planning (called *innovative* processes as opposed to *operational* or real-time “*moment-of-truth*” processes - such as customer support hot-line responding). A novel process model, based on the ActionWorkflow paradigm of Winograd *et al.* (1986), is proposed, which treats organizational processes as networks of conversations among people who are coordinating their actions to satisfy their customers. The coordination model is meant to support participatory process design (like described in Section 6.2.2) as interactions between skilled, experienced, creative individuals rather than as a static series of tasks connected by inputs / outputs and information flowing through mechanical procedures. By actively involving the process participants in the

design and management of a work process, a respect for their experience and opinion is conveyed through which a sense of shared ownership and responsibility can emerge, in a social interaction that involves creativity, negotiation, experimentation and collaboration. Most systematic attempts to extract tacit knowledge from individuals or “communities-of-practice” have had limited success, since informal storytelling (dialogue) is often the predominant source of learning. The coordination model stresses that words are not only descriptive, language can be a form of action; people engage in conversation to interact.

Conversations generally serve to:

- Develop and maintain relationships
- Build shared context
- Explore possibilities, and/or
- Coordinate action

The argument is made that important conversations should be deliberately planned to achieve their intended purpose. The coordination model identifies people’s commitments and explicitly defines the chain of customer-performer relationships that are claimed to exist in every conversation. Each conversation for action is depicted as a loop representing four phases (see Figure 8.2):

1. Preparation and the making of a request or offer
2. Negotiation and agreement (or failing to reach an agreement)
3. Performance and a report that the work is complete
4. Assessment of the work and a declaration of (dis)satisfaction



Figure 8.2: Core Element of the ActionWorkflow Coordination Paradigm

The interdependencies among conversations are represented by links drawn between the conversation loops. The model thus provides a view of a work process as a dynamic structure of social relations that manages commitments, and is established and maintained through language: a network of conversations for action. Although the method seems to be applied mostly for reflective organizational analysis rather than for actually structuring dialogues, it provides a valuable contribution in that it makes explicit the states of agreement and resolution in interactions.

8.3.2 Speech Act Theories

Speech act theory forms no unified single theory, but actually houses several variants for dealing with semantics, pragmatics, and social context of communications (Auramäki *et al.* 1996). Their common feature is the assumption that language is not merely a means of describing but also a means for doing things, like in the ActionWorkflow paradigm. People perform something by saying. Several different speech act theories have been recognized in Information Systems research.

The original speech act theory was put forward by Austin, who examined the performative uses of language. According to his theory, appropriateness of utterances in the context plays an important role, rather than just the truth value of propositions. Austin also classified speech acts, into five categories: verdictives, exercitives, commissives, behavitives and expositives. However, his taxonomy was criticized for overlapping categories, too much heterogeneity of categories, ambiguous class definitions, and misfit between the classification of verbs and the definition of categories.

Searle and Vanderveken have extended Austin's work. Their focus is on the speaker, and the concept of commitment to what is being said. According to them the success of a speech act depends on the speaker's ability to perform a speech act that is understandable and valid in the context; the speaker should be sincere, have authority, and the proposition should be possible. A speech act (illocutionary act) is the minimum meaningful unit of language, which consists of three elements: context (speaker, hearer,

time, place, possible world), propositional content, and illocutionary force. The latter in turn consists of:

- Illocutionary point (purpose: e.g. to direct or to assert)
- The mode of achievement of the illocutionary point (e.g. a humble way to ask)
- The strength of the illocutionary point (e.g. to ask instead of to demand)
- Preparatory conditions (e.g. the speaker commanding has authority to command)
- Propositional content conditions (e.g. one cannot ask to draw a triangular ellipse)
- Sincerity conditions (e.g. the speaker promising intends to keep the promise)
- Sincerity conditions strength (e.g. the extent to which one believes what one says)

Searle also classified illocutionary acts in five categories:

1. Assertives (the speaker commits to something being the case)
2. Directives (the speaker attempts to get the hearer to do something)
3. Commissives (the speaker commits himself to a future course of action)
4. Expressives (the speaker expresses a psychological state; feelings and attitudes)
5. Declaratives (to bring some new state into the world)

Habermas criticizes Searle's speech act theory for the inappropriateness of the taxonomy, for the failure to distinguish between strategic and communicative action (use of power versus claims to validity such as truth, justice and sincerity), and for an incomplete notion of success of speech acts by ignoring their orientation. Hearers need to be motivated to accept a speech act offer, they need to be convinced of the reasons for carrying out the

requested actions. Whereas Searle's theory recognizes only speaker's intention and commitment, Habermas claims a successful speech act is based on mutual agreement and negotiation of validity claims between speaker and hearer, and he therefore presents an alternative speech act taxonomy, called Theory of Communicative Action, consisting of:

- Imperativa (based on claims to power)
- Constativa (based on claims to truth)
- Regulativa (based on claims to justice)
- Expressiva (based on claims to sincerity)

Nevertheless, this theory is also being criticized for being inappropriate in its classifications and too narrow in dealing with larger communication contexts.

Ballmer and Brennenstuhl joined the critics of Searles' work; they doubt the overall clarity of the taxonomy, the definition of declaratives as a speech act type, the principles used in classifying, and the vagueness of the line between illocutionary force and propositional content. They argue that there is no strict demarcation line between understanding and (re)acting. Based on the criticism they propose a classification which contains both simple linguistic functions such as expression and appeal, and more complex functions such as interaction and discourse. The focus is on larger units of communication, where speech acts are analyzed in relation to the conversation where they occur.

Steuten and Van Reijswoud propose a combined approach for the interpretation of business conversations (Steuten *et al.* 1996). Their speech act model is based on Functional Grammar and the Transaction Process Model. The former is devised to provide a complete account of the linguistic structure of an utterance, where the speech act is the highest unit of analysis. The latter considers the structure of conversations as inter-related communication acts, where the speech act is the smallest unit of analysis as the initiating or reactive moves in a conversation between speaker and addressee, aimed at modeling the mutual agreement dimension of a business communication process. Though the authors claim their approach provides a richer understanding than the previously mentioned approaches, the model is only applied to relatively standard, structured and simple conversations like hotel reservations over the phone. In practice, random conversations can have many levels of nuances, non-apparent meanings and ambiguous interpretations. Moreover, the method works as a post-conversation analysis tool rather than as a means to structure a dialogue preemptively or to systematically retrieve process content (like WRD parameters).

Cleal *et al.* (2004) implemented and analyzed a prototype system based on speech act theory. The ‘Collate’ system was intended to support distributed asynchronous collaboration between archivists of three movie institutes for accessing, indexing and annotating documents related to film censorship. The core of the system was a threaded discussion application with predefined classifications to mark commenting statements as being of a certain type (e.g. expectations, commitments, retractions, corrections, clarifications, counter arguments, corroborations, etc.), categorized based on their

communicative purpose and role assignment. However, evaluation of the system revealed that the model did not seem to encompass the social richness of the everyday activities performed. Users indicated their comments often were ascribable to a mixture of categories (e.g. partially agree and disagree), and that the tool was actually impacting their discussions in a negative way, forcing them to think in a fixed, restraining set of discourse elements. The discourse model only seemed to capture surface phenomena of actual conversations, and the rich tacit knowledge and social interactions embedded in them. The applied speech act model basically failed to support the way the users worked.

Evidence for the effectiveness of predefined conversation models is ambiguous (Auramäki *et al.* 1996). De Moor (2000) states that a major criticism of the application of speech act theory in systems development is that it is not able to represent what people really do, as it is said to provide models that are too rigid and simplistic to capture the complexities of actual work practices. Also, the use of individual speech acts is insufficient to coordinate meaningful work-related communication. To do so, larger units of communicative interaction – conversations – are needed. He sets forth that what is needed is a natural language-like discussion facility based on a formal communicative action-grounded discourse coordination mechanism. Virtual professional communities require a legitimate user-driven specification approach of their network information systems (De Moor 2002). *User-driven*, because users have the tacit knowledge (e.g. of work breakdowns) that is often unavailable to external analysts and system designers. The specification changes produced should be *legitimate* in the sense that they are not only meaningful but also acceptable to all members of the community. His approach, the

RENISYS (REsearch Network Information SYstem Specification) method, is grounded in the Language/Action perspective by facilitating conversations for specification. Conversations are seen as a series of interrelated communicative acts aimed at defining and reaching a goal. They are formalized as little as possible, in order to provide flexibility and not to cognitively overburden users. The importance of the context of conversations is acknowledged, yet the idea of context in speech act theory is still only vaguely defined and it is not very clear how it is to be used in system development.

In summary, the crucial differentiating points between the aforementioned speech act taxonomies are the classification principles, categorizations, the proposed units of communication, the influence of context, the concept of commitment, and the success of speech acts. With all theories it has been proven very difficult to define the success of speech acts. The relationship between speaking and acting is not straightforward; e.g. things can be done without words, responses to speech acts are given without words, knowledge is embedded in actions, commitments can be interpreted ambiguously and not lead to a proper action, deadlines are not kept, people make mistakes, the full context of a conversation is impossible to know and model, and so on. Also, the level of words and sentences seems too detailed to provide support in structuring dialogues in advance. Because of these issues, modeling of information systems cannot be solely based on speech acts, commitments and conversations. But although agreement cannot be coerced by computer support, computers can give opportunity for representation where people can compare their views and negotiate, help them to recall commitments and contracts, track states of commitments, and also remind people of their roles in routine workflows.

8.3.3 The Milan Conversation Model

The Milano system is an interdisciplinary client-server prototype CSCW application based on the Language/Action perspective described earlier, rooted both in computer and human sciences. Agostini *et al.* (1997) list five design requirements for systems that aim to support work practices and cooperation in organizations, and Milano in particular:

1. Openness – In order not to constrain its usefulness, the system boundaries should be flexible in allowing various degrees of community membership, by enabling the support of interaction between those having it and those not having it
2. Multi-media continuity – Communities performing a cooperative process can be distributed in space and time, and use varying media. At any time users should be able to use the most suitable communication medium.
3. Contextualization – Actors of a cooperative process are immersed in its history and need to be able to refer to a representation of it in order to act effectively. Any communication / action event may logically follow or trigger others.
4. Integration between Communication Flow and Action Flow – the system should provide its users support for both conversations and workflows, and to their integration, as they form the basic units of cooperative work
5. A personalized and selective workspace – the system should at any moment bring forth to its users all and only the objects needed at that particular moment, with a sometimes visible, sometimes transparent context, providing order and control.

Figure 8.3 illustrates the system architecture of Milano. Its main modules are an object repository (MOR), a workflow management system (MWMS), and a multi-media conversation handler (MCH), which will be explained hereafter. In line with the openness requirement, the Milano system supports, with different levels of service, cooperation between three types of actors: those having the Milano system, those having the so-called Safe-Tcl interpreter with their e-mail program (e.g. enabling visualization of the activity context or the state of the running cooperative process), and those using e-mail only.

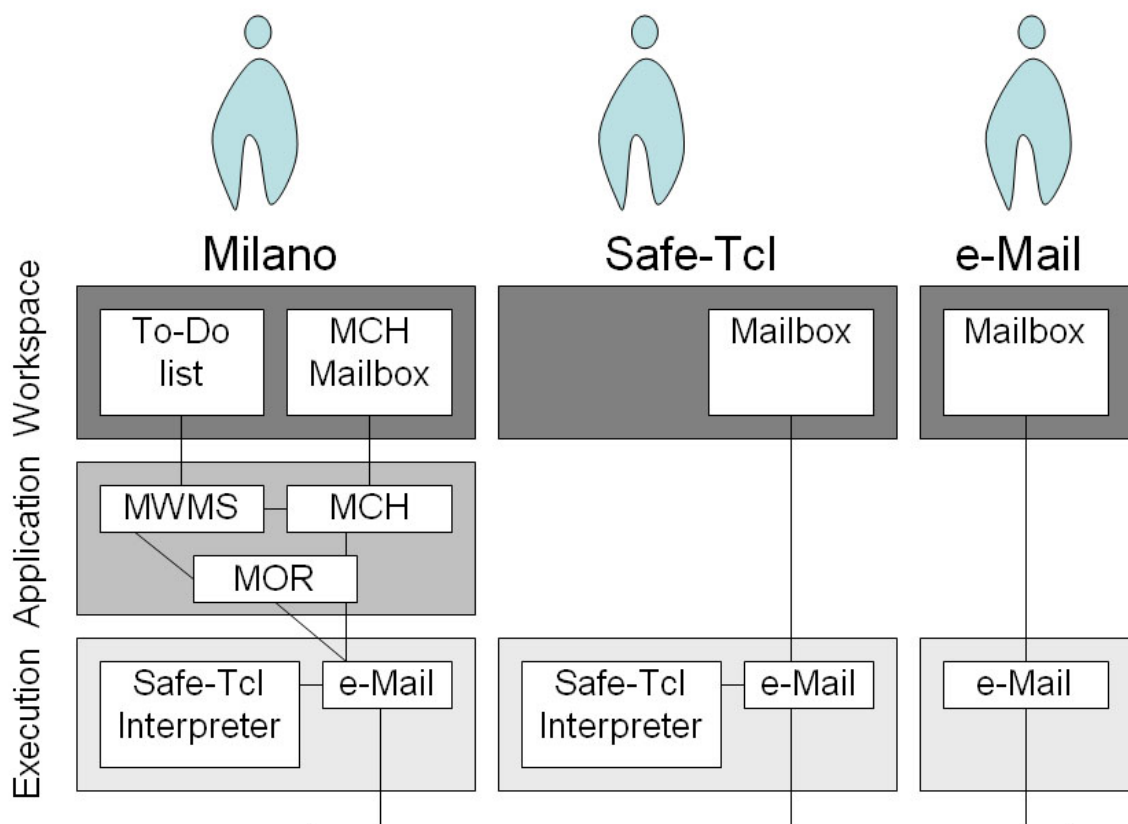


Figure 8.3: The Milano Multi-level System Architecture

The Milano object repository (MOR) handles both the personal archives of each member on their workstations and a common archive of the whole community on a Web server. Milano also contains a component devoted to representing the context of the organization, thus duplicating some of the classification work of the Workflow Management Coalition (described in Section 6.2).

An interesting feature of the workflow management module (MWMS) is that it makes an attempt at providing a routine for change and exception handling to enable both static and dynamic changes. It is intended to support evolutionary workflow definition, in already ongoing process instances, by using safe and unsafe states instead of just checking deadlock- freeness like most workflow modeling applications (Agostini *et al.* 1998).

The most relevant module in the context of this chapter is the conversation handler (MCH), which is claimed to be devoted to supporting both informal and *structured* types of communication among the users, providing a special kind of enclosure that formalizes the definition of activities to be performed. A conversation in Milano is a sequence of communicative events (e.g. e-mails), and it is the basic unit of communication; any communication event (message, meeting session, phone call, etc) is always considered part of a conversation, within which it gets its sense. The so-called Milan Conversation Model (MCM) serves as a theoretical framework for understanding communication within work processes and as a system to support it, based on the Language / Action perspective (De Michelis *et al.* 1994). In line with speech act theory, Workprocesses are regarded not just as input-output transformations, but as communicative relations

between those who request a service and those who perform it – which *may* have input-output transformations embedded. However, De Michelis and Grasso (1994) consider it wrong to assume a one-to-one mapping between utterances and illocutionary acts, or between conversations and commitments, which, they point out, is not recognizable in real-life dialogues. On the one hand communicative behavior of participants should not be constrained by normative conceptions of tools that defy the complexity of human communication. On the other hand a community of practice uses artifacts of various types among which are often relevant procedures, like commitment negotiations within work processes. Making a commitment explicit is often very useful, particularly when one must ensure that it will be completed satisfactorily. Commitment negotiations, including procedures and communicative events, are by their nature special procedures embedded in conversations. They can be supported by a system that makes accessible the records of their negotiation steps, together with their annexes and the conversations of which they are part.

A conversation in the Milan Conversation Model must be:

- Usable in any type of communication event irrespective of the particular tool used (multi-media, phone, e-mail, etc)
- Able to generate a record of any communication event, and link it to records of previous events within a conversation
- Available in different locations (since people move during their work time), thus offering broad access to communication media.

Despite the first listed condition, the described implementation of the MCM by De Michelis and Grasso (1994) concentrates on an application for electronic mail, and unfortunately leaves the usefulness of the principle in other media types vague and unresolved.

Nevertheless e-mail is often credited to be one of the most successful groupware applications together with fax and telephone. At a functional level, it matches the way people work in that it is asynchronous, easy to learn, and simple to be electronically stored. At a technical level, it runs on heterogeneous environments, and can be used across many different software programs. E-mail is therefore declared to be a natural candidate to serve as middleware (enabling technology) for groupware like Milano.

An MCM conversation is univocally identified by title and (dynamically changing) actors involved, and can contain multiple attached documents, and any number of commitment negotiations. During a negotiation, a commitment can be in any of the following states:

- Offer
- Request
- Agreement
- Delivery
- Acceptance
- Refusal
- Cancellation

8.3.3.1 Criticism on the Milano Conversation Handler

According to the developers the objective of Milano conversation support is not in the first place to reduce complexity of the work process and its communications, but to support users in coping with that complexity, with minimal effort and an awareness of relevant context. In all however, that claim remains largely unsubstantiated and the innovation proposed by Milano is mainly architectural. The treated prototype is basically a specialized tool for threaded discussions which allows the attachment of commitment messages in one of a fixed set of states, to be advanced by participants as the conversation progresses. No clarity is provided on the potential need to set user privileges and restrictions in regard to promoting negotiations to a next state. The manual labeling of the state of commitment messages is likely to suffer from the same perceived unpractical rigidity as the work reported on the Collate system in Cleal *et al.* (2004), described in Section 8.3.2, where users were found to mostly use the “unspecified” label to tag their messages, for lack of exact appropriateness of other provided categories (e.g. what if a message expresses agreement, contains an offer, and transmits a request simultaneously?). Moreover, despite the self-expressed requirement of media-continuity, only a subset of communication possibilities is implemented (synchronous, asynchronous, dispersed, collocated), whereas the implementation – and integration – of other (multi-)media types than electronic mail raises many questions in regard to the proposed tagging, storing, linking, accessibility, and so forth. There seems to be little evidence that conversations through synchronous media (e.g. face-to-face meetings, video conferencing, talks, phone calls) would benefit from the proposed system.

8.3.4 Workflows augmented with Group Interaction Techniques

As outlined earlier the main focus of workflow systems has been the automation of formal procedures in the workplace. On the other hand, Communication and Group Support systems have addressed informal aspects of organizational interactions like support for ad-hoc conversations through Voice over IP. However, real work in real organizations is a mixture of both formal and informal processes. Hence the separation is to some extent artificial, and a potential cause of ineffectiveness of systems.

Antunes *et al.* (1995) therefore propose an approach to increase mutual awareness when integrating support for workflow systems and group interaction techniques, while preserving a degree of independence between them. In their solution, part of the larger Orchestra research project, the workflow system must be able to identify situations where formalized solutions do not exist. Once identified, and categorized as a problem to be solved through an informal interaction, several group interaction techniques are available to support the interaction. Once the system finds a match between problem characteristics and available tools for group communication, an informal process is activated through the launch of the computer-based tool that supports the selected technique. The outcome of the informal process is fed back into the workflow system that is then able to progress with the execution of the triggering formal flow. The main component of the system therefore is the so-called Matcher, which identifies the problem and chooses the most appropriate agents and techniques based on a set of decision criteria. Problems are categorized in a 3-dimensional matrix which automatically identifies the type of problem

(well or ill-defined), solution (well or ill-defined), and process (judgment, bargaining, inspiration, or reasoning). Available tools that support cooperative techniques for informal group communication, negotiation and decision making – like brainstorming, voting, surveying or deal-making – are assigned to one or more of the matrix fields.

The following classes of problems are identified that may lead to flow interrupts:

- Insufficient data
- Inadequate knowledge of executor
- Unavailable resources for task execution
- Time expired
- Deficient autonomy

The system developers do not provide a decisive answer regarding the completeness of the above problem classification, as well as that of the dimensionality of the tool categorization matrix (the number, type and clarity of parameters used for matching). Also, the method for selection by the system of qualified actors for an informal interaction seems rather rudimentary. In general, the proposed attempt to expand workflows into “softer” areas leaves system users with a rather mechanistic instrument for initiating informal interactions, like conversations. Workflow actors will certainly want to be in control of the timing and choice of launching interaction techniques, if at all, rather than ceding such authority to an automated agent. More, they will likely be well capable without system support of identifying moments where informal interactions are needed, and what tools might be appropriate for a particular problem resolution

(brainstorming, voting, etc). In fact, the very reason for involving humans in a further automated workflow in the first place, is their ability and intelligence to perform activities and solve issues better than computers. Automatic selection of group interaction techniques might be a solution in search of a problem, trying to replace instead of support human judgment. Apart from potentially enabling conversation, a tool for dialogue support should thus suggest rather than impose tools and resources (discussion topics, background knowledge, conversation partners, etc).

Simone and Schmidt (1998) identify further requirements that a computational coordination mechanism should meet, for example if it is to support workflows extended with structured dialogues. Firstly and indispensably, coordination mechanisms must be malleable; actors should be able to (re)define the protocol of a new computational coordination mechanism by making lasting modifications to it, so as to be able to meet changing organizational requirements. Furthermore, actors must be able to control the execution of the protocol and make local and temporary modifications to its behavior to cope with unforeseen contingencies or to circumvent inefficient protocols. In order for actors to be able to define, specify, and control the execution of the mechanism, the protocol must be visible to actors at the semantic level of work articulation, i.e. it must be accessible as well as expressed in terms that are meaningful to competent members of the collaboration. To allow for evolution of the protocol through continual adaptation, it should be possible to specify the behavior of the coordination mechanism incrementally, while it is being executed. Finally, it should be constructed in such a way that it can be linked to other coordination mechanisms in the wider setting.

8.3.5 Computer-mediated Collaborative Decision Making

Collaborative Decision Making (CDM) Systems can be defined as interactive computer-based systems which facilitate the solution of ill-structured problems by a set of decision makers, working together as a team. The category of “wicked” problems, for which each attempt to create a solution changes the understanding of the problem (Conklin 2005), can only be resolved through discussion and collaboration among the actors involved. This in turn can be achieved by removing communication impediments, and by providing techniques for structuring the decision analysis and for systematically directing the pattern, timing, or content of the discussion. Sometimes relevant information for decision making is missing, sometimes the time needed for retrieval and comprehension of the existing volume of information is prohibitive.

Two main approaches to decision making exist; with the first one, the task is to select one of a set of alternatives that is determined a-priori. With the second one, the task is to find a real case that best approximates an ideal case which has been decided upon first. In both approaches there are a number of common elements:

- An overall task goal is specified;
- A set of alternatives is selected (this set may not be exhaustive);
- A collection of choice criteria must be determined by the participants;
- A decision function must be composed which combines criteria to decide between alternatives.

Multi-agent decision making is viewed as a collaborative process, where agents have to follow a series of communicative actions in order to establish a common belief on the dimensions of the problem. These dimensions may for instance pertain choice criteria, alternatives, or the decision objective. Since conflicts of interest between actors are inevitable, support for achieving consensus and compromise may be useful.

Karacapidilis *et al.* (1999) claim that although some CDM approaches provide a cognitive argumentation environment and methods to structure related discussions, they lack consensus seeking and decision making capabilities. In addition, the majority of them is not based on a well-defined set of users' communicative actions. Most systems merely provide threaded discussion forums, where messages are linked "passively", which arguably leads to unsorted collections of vaguely associated comments. Work in Artificial Intelligence (AI) on dialogue and discourse is considered not sufficient for modeling dialogues in the context of collaboration and negotiation.

A discourse system is proposed which provides a mechanism for automating processes such as discussion structure, consistency checking and reasoning for decision making. The focus is on distributed, asynchronous collaboration (online threaded discussions), where the system is intended to act as an assistant and advisor, by facilitating communication and recommending solutions, but leaving the final enforcement of decisions and actions to the agents. The structured protocol of conversations may be administered by a discussion moderator who can intervene when needed. Argumentation in the proposed framework is performed through a set of discourse acts, especially

defined for the CDM context following an artificial intelligence perspective. A prerequisite for computer-mediated CDM tools is the ability for the computer to understand (at least partially) the dialogue in a decision-related argument between people, and the discourse structure used in presenting supportive material in a document. For that to be the case, statements in a conversation must be tagged according to a predefined set of discourse act categories, similar to the work reported in Cleal *et al.* (2004).

The presented model consists of the following discourse acts:

- Consider
- Inform
- Request information
- Request an opinion
- Request an act
- Compare two beliefs
- Compare criteria and values
- Propose
- Agree
- Acknowledge
- Disagree
- Corroborate
- Challenge
- Discard
- Clarify
- Counter-offer

It should be made clear that this is not considered a complete model of human discourse, but an interesting subset which allows an analysis of the collaborative decision making process.

In fact, the number of applied categories in the prototype application is further reduced to simplify the user's burden of statement categorization, while still maintaining enough logic to enable computerized reasoning support. Applied argumentation elements are:

- Issues
- Alternatives
- Positions (pros or cons)
- Constraints (representing preference relations between the previous classes)

A constraint is a tuple of the form [position, preference relation, position], where the preference relation can be "more (or less) important than", or "of equal importance to". Constraints may give various levels of importance to alternatives. Alternatives, positions and constraints also have an activation label indicating their current status; they can be active or inactive depending on stated constraints and on whether a related statement was made last (recent supporting or counter arguments). Active positions are thus considered "accepted" due to the discussion underneath (e.g. strong supporting arguments, no counter-arguments), while inactive positions are (at least temporarily) "rejected". Similarly, active alternatives correspond to "recommended" choices, i.e. choices that are the strongest among the alternatives in their issue. The specified model of discourse acts is proposed as a way to cross the divide between on the one hand simple systems for remote CDM that just provide a communication channel and archiving facility between participants (e.g. newsgroups and web forums), and on the other hand full-blown reasoning systems that attempt to automatically solve decision making problems.

Although the proposed system provides an interesting and conceptually relevant example for structured dialogue support, many serious and critical side notes can be placed. First of all, it is not realistic to assume that a position statement always refers to a single other position or alternative, hence categorizing remarks will not be obvious, if objectively possible at all. Implicit goals, office politics, a-priori positions, and biases of participants will affect the intended impartial way in which alternatives are presented and judged. Also, constraints (comparative statements relating other remarks, e.g. position A is more important than position B) would still have to be manually interpreted by a conversation moderator, thereby foregoing the envisioned automatic decision making support. Moreover, the method of decision selecting (recommending) through automatic active and inactive states remains rather dubious, as there is no convincing proof that a certain position should be preferred simply because no actor bothered to oppose the last given statement – in other words, dragging on a debate would result in determining its outcome. Along similar lines, the selection mechanism does not take into account any contextual aspects such as the potential hierarchical relations between participants, which would have a profound impact on the perceived weight of particular statements and on the liberty of actors to articulate themselves freely. For situations where participants are of unequal stature (like when a mixture of middle and upper management is involved) the current system would generate illogical, senseless or contradictory recommendations. Despite the ambitious claims, the system developers acknowledge that unrestricted natural language understanding by computers is a long way from being solved. The current system is still more focused on capturing than on predetermining a conversation. A structured dialogue would rather require preemptive argument building.

8.3.6 Graphical Conversation Capturing

Since people working in groups engage in discussion and argumentation, it makes sense to incorporate discussion and argumentation in CSCW research on human-computer interaction and groupware. Identifying and understanding real world problems, as well as agreeing on what might be solutions to them, requires extensive discussion. One approach to better understanding dialogue is to graphically capture and index conversations. The CSCW field of Computer-Supported Argument Visualization (CSAV) is focusing on graphical conversation capturing, as an aspect of information visualization. It seeks to explore argument visualization as a tool to understand positions on issues, surface assumptions and criteria, and collectively construct consensus on whatever grounds can be found. CSAV tools are designed to assist in collating, and then making sense of information and possible narratives that weave threads of coherence by enhancing deliberation and fostering collective intelligence. This section will describe the related (consecutively developed) IBIS grammar, the QuestMap tool, the Compendium methodology, and finally the Reason!Able software.

The Issue-Based Information System (IBIS) is a modeling structure for rational dialogue among a set of diverse stakeholders, developed by Horst Rittel, an urban planner and designer who found traditional planning methods in the 70s inadequate for the ill-structured problems he encountered in city planning (Conklin 2005).

The QuestMap application of the CogNexus Institute (<http://cognexus.org>) adopted gIBIS – the graphical version of IBIS – as a basis for its Dialog Mapping technique, a tool for supporting group problem-solving and decision-making by facilitating the formal visualization of its discourse. A group of people working on a project or a problem in a typical meeting room (Figure 8.4) would be joined by a facilitator, or "technographer", who sits at the computer and records the conversation by paraphrasing statements and issues in a hypertext diagram (see Figure 8.5), which is projected on screen and stored for later retrieval. The displayed icons represent the basic elements of the (IBIS) Dialogue Mapping grammar: Questions, Ideas, Pros and Cons, and hyperlinked resources.

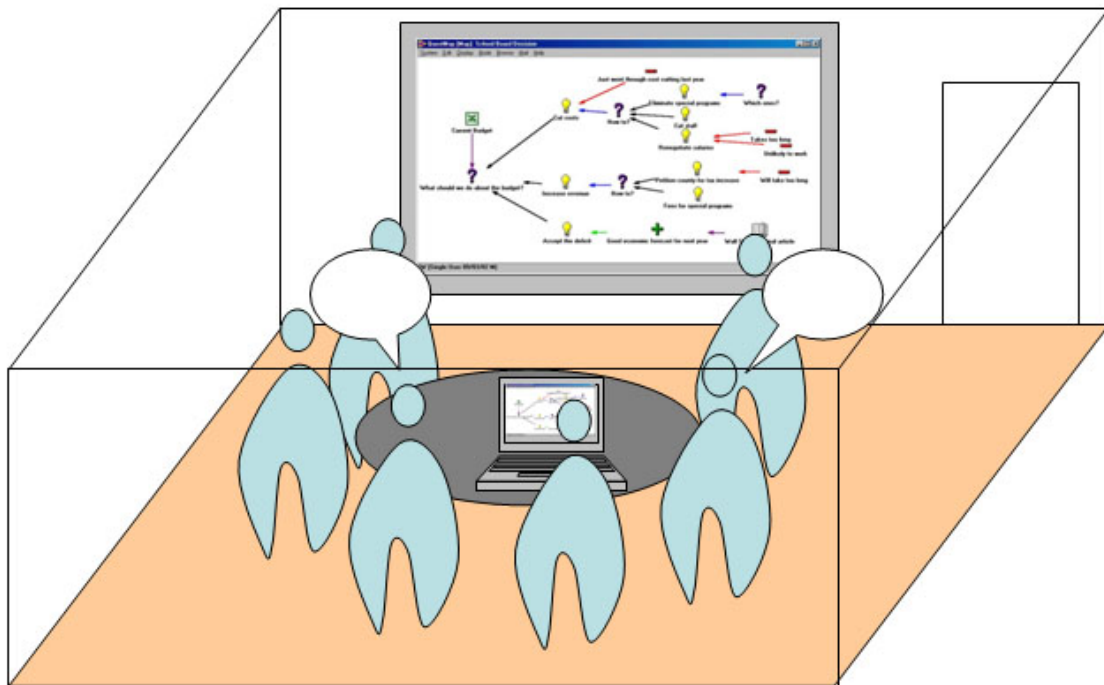


Figure 8.4: Symbolic Set-up for the Dialogue Mapping Technique

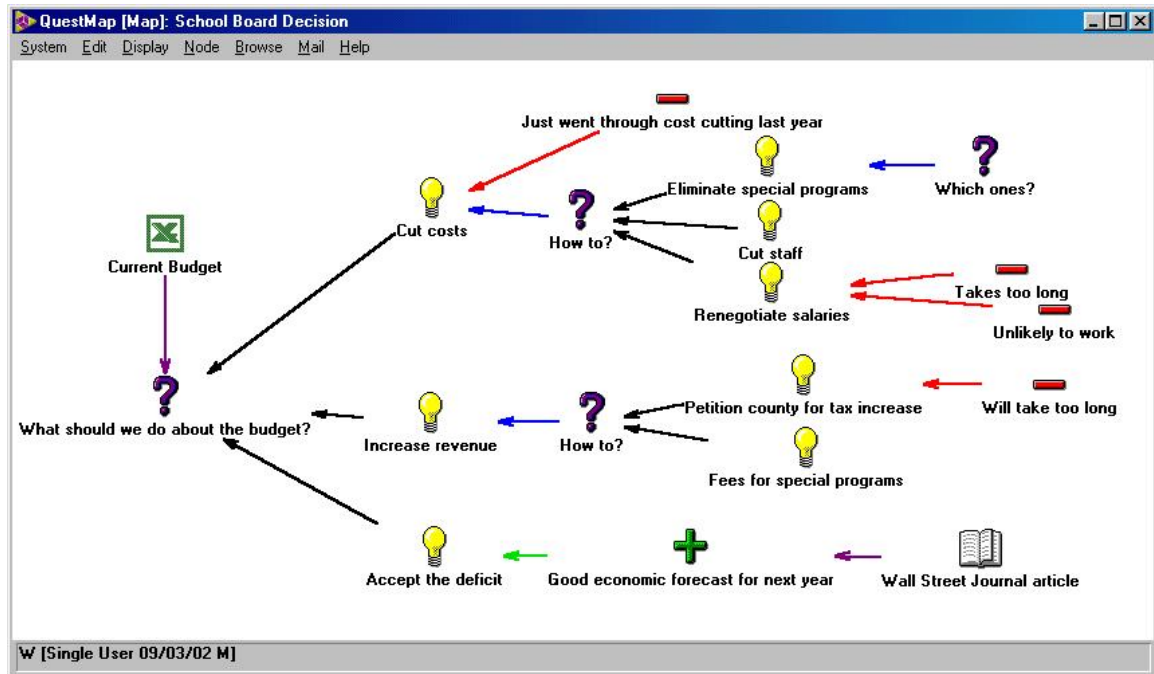


Figure 8.5: Conceptual Elements of Graphical Conversation Capturing

Meanwhile the so-called Compendium software (<http://www.compendiuminstitute.org>), although formally unsupported, has replaced QuestMap as its next generation version (QuestMap files can still be imported into Compendium). It is arguably the most advanced IBIS mapping tool available, with a number of graphical user interface (GUI) enhancements, and support for web publishing, hyperlinks to other documents and resources, integration with other software, and export to common applications like Word processors. For the latter, a hierarchical concept map in Compendium would be transformed into an indented textual outline for further manipulation.

Compendium acknowledges that not every comment in real-life conversations can simply be categorized as a supporting or opposing statement to a discussed *Idea*, hence the element library that contained only *Pros* and *Cons* has been expanded to include more neutral *Remarks* or *Arguments* (see Figure 8.6). Also, the Questmap syntax provided a rather open-ended representation of the dialogue, hence the introduction of the concept of *Decisions* to indicate convergence on certain *Ideas*.

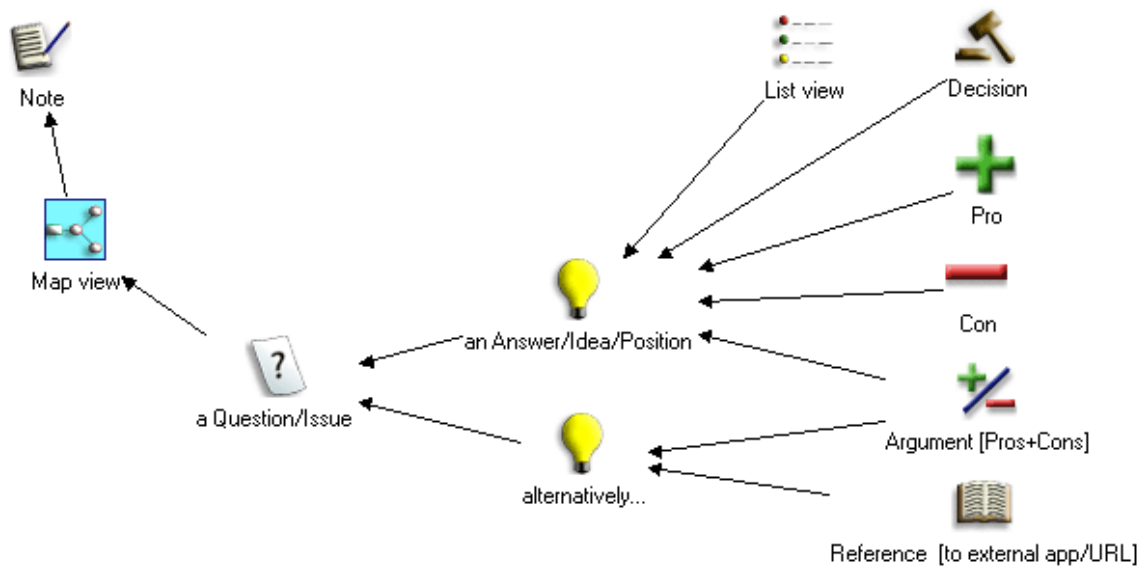


Figure 8.6: Expanded Library of Compendium Dialogue Capturing Elements

Compendium centers on face-to-face meetings, potentially the most pervasive knowledge-based activity in working life, but also one of the hardest to do well. Meetings are knowledge-intensive events that are often unfocused, inefficient and undocumented, but they can be improved with facilitating tools that help participants express and visualize their views in a shared, common display. Moreover, meetings could be more tightly woven into the overall fabric of work; they are preceded and followed by much other communication and the generation of associated artifacts. The Compendium developers therefore express the importance of weaving the process and products of meetings into this broader web of activity (workflows). Although the method was initially devised for capturing collocated synchronous collaborations, it could in principle also be applied to other types of space-time configurations.

Compendium thus provides a methodological framework for the rapid construction and manipulation of semantic knowledge elements in a visual hypertext environment that may serve as an organizational memory. It enables groups to collectively elicit and organize domain-independent information from group meetings and offers a strategy for tackling some key challenges in managing knowledge by:

- Improving communication between dissimilar communities addressing ill-structured problems
- Real-time capture and integration of hybrid material (both predictable/ formal, and unexpected/informal) into a reusable group memory
- Transforming the resulting resource into various representational formats for different stakeholders

The Reason!Able software provides a similar environment for enhancing deliberation through Computer-Supported Argument Visualization. Like the Compendium method, it also supports rapid and easy construction, modification and evaluation of argument visualizations in group meetings, thus helping to translate abstract logical complexity into simple colorful diagrams. Reason!Able contains as only modeling elements reasons (green) and objections (red), organized in a hierarchical tree structure of statements. A cluster of argumentation bears upon a single primary reason believed to be the main conclusion (see the example in Figure 8.7, where "Villawood" refers to a factory name).

The described set of CSAV tools each requires a (skilled) moderator, which may inhibit the application for very technical or sensitive meetings, where the recorded choice of words or technical terms requires a precise expression. Also, a moderator introduces a degree of subjectivity in interpretations (although reduced by the presence and possible immediate feedback of the discussion participants). All treated dialogue mapping tools are focusing on visualizing argumentation while assuming a rather open-ended dialogue with a possible endless diverging of arguments; a structured dialogue on the other hand is intended more to enforce decisions and compliance, or at least to aid in detecting open, non-resolved dialogue issues. Whereas the dialogue mapping techniques are applied *post-conversation*, structured dialogues should also provide guidance *pre-conversation*. It may be argued that the more the argument space is fixed, constrained and/or structured, the likelier it will be that a productive system will result from it. For one, embedding a dialogue in the larger context of a workflow – that ushers actors inside and out, puts forward dialogue topics, detects (non)resolution – may provide such an environment.

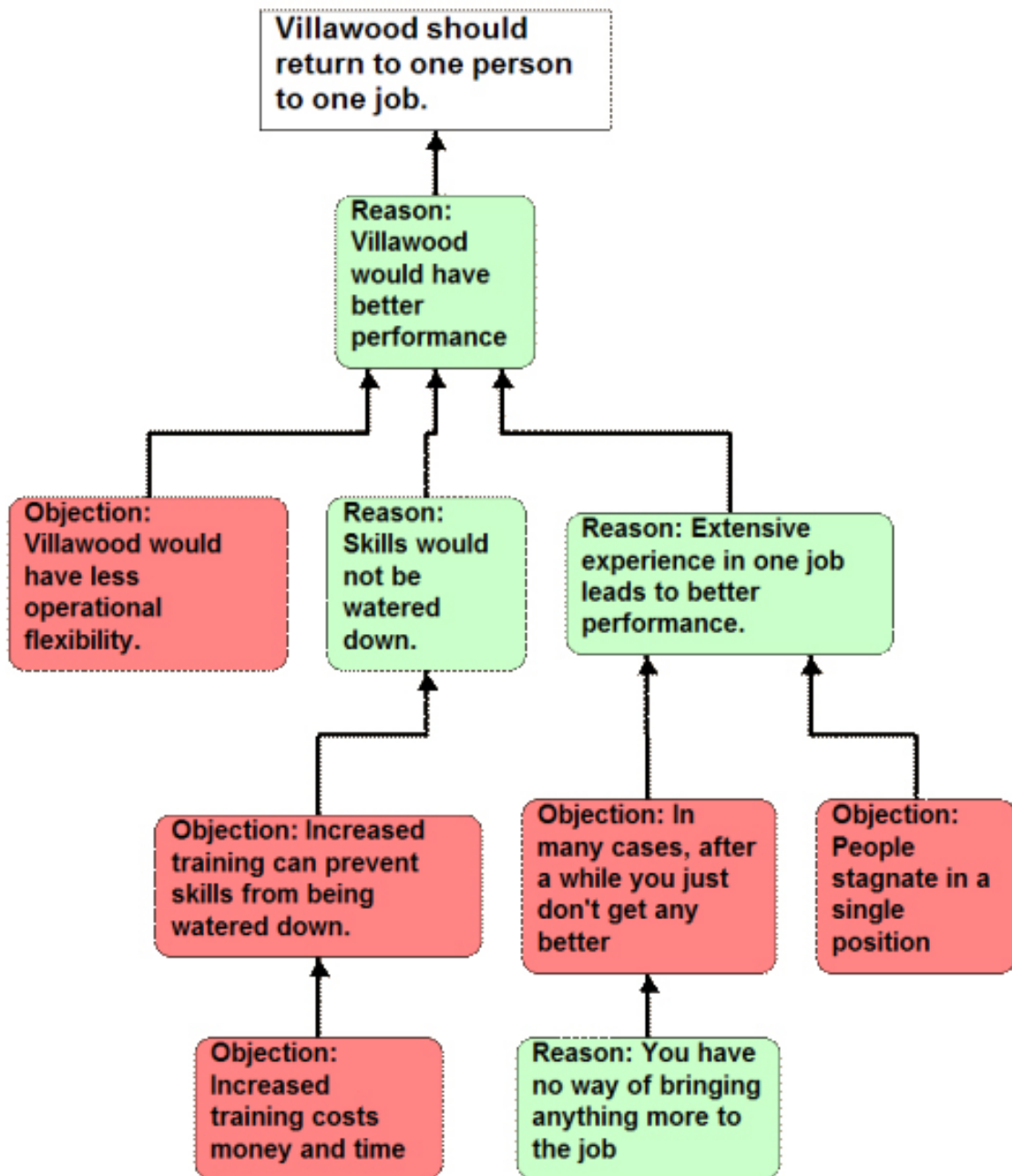


Figure 8.7: Computer-Supported Argument Visualization with Reason!Able

8.4 Summary

This chapter started to explain (in Section 8.1) that traditional workflows as described in the previous chapter (7) fall short in their support for structured dialogues, both in their presentation layout of workflow relevant data and in their limited support for group meetings and dialogue. Section 8.2 proceeded to lay out the conceptual difference between workflows and structured dialogues, among others by comparing their metaphors. These metaphors portray structured dialogues as extended types of (sub)workflows that not only support the shipping around of documents between knowledge workers (as a “Task Manager”), but also convene efficient gatherings when needed (as a “Team Organizer”). The support for group interaction and discussion in such meetings is studied in various fields of research that are explored in Section 8.3 in order to arrive at an extended dialogue model.

The ActionWorkflow paradigm (8.3.1) treats organizational processes as networks of conversations for action (loops) among people who are coordinating their actions to satisfy their customers. Although the method seems to be applied mostly for reflective organizational analysis rather than for actually structuring dialogues, it provides a valuable contribution in that it makes explicit the states of agreement and resolution in interactions between people.

The various speech act theories in the next section (8.3.2), representing a large body of research, showed that the analysis of conversations at the level of words or individual statements is too detailed to provide meaningful support at the level of structuring entire dialogues. For that, analysis of discussion topics and their possible states (accepted, unresolved, etc) seemed more appropriate.

The Milan Conversation Model (8.3.3) provided an integrated workflow environment, but despite claims otherwise, its conversation handler focused mainly on electronic messaging rather than including the full spectrum of possible media types in work-related conversations, such as face-to-face meetings and phone calls. Moreover, the manual tagging of individual commenting statements as being of a certain predefined classification type has been proven to be too rigid, unpractical and restrictive for dialogue participants.

The Orchestra system (8.3.4) also centered around a workflow engine, in this case aimed at automatic selection of informal group interaction techniques when a breakdown of the formal flow occurred. It provided a rather mechanistic instrument for initiating informal interactions, like conversations, and seemed to try to replace instead of support human judgment.

The computer-mediated Collaborative Decision Making application introduced in the next section (8.3.5) attempted to take dialogue support beyond simple communication channels and archiving facilities by supporting automated reasoning and decision

making. However, the system also relied heavily on statement classification (prone to ambiguity, subjectivity, etc) and thus still required manual interpretation, thereby foregoing the envisioned automatic decision making support. Furthermore the method of decision selection remained largely unresolved.

The chapter concluded by presenting some graphical conversation capturing techniques (8.3.6). Although these domain-independent tools require a moderator, and are focusing on the visual mapping of dialogues *after* the conversation takes place rather than also guiding the discussion *beforehand*, they provide useful taxonomies for structuring a dialogue, simple enough not to constrain the human interaction, yet powerful enough to serve as an accessible and meaningful organizational memory. Hyperlinks from dialogue maps to other resources provide further integration with the larger work process of the organization.

By analyzing the characteristics of relevant dialogue taxonomies and methodologies this chapter indirectly serves as a requirements analysis for the implementation of the prototype application for structured dialogues illustrated in the next chapter (Section 9.1).

The various supporting methodologies described so far can be ordered along a spectrum of dialogue phases (Figure 8.8). The first logic-driven phase, aimed at avoiding information overload, lets a dialogue modeler predefine the discussion during *design-time* by having the system (workflow) usher actors into an interaction on certain topics (e.g. a meeting or threaded discussion). The second phase, during *run-time* (execution), lets the

actors themselves adapt the system-suggested dialogue agenda if needed before entering the “productive” third stage of the discussion, the actual interaction. After capturing the debate, the last stage aims at propagating results and feeding back deliverables into the overall process (larger workflow). An appropriate mechanism should be devised to let users influence the first phase in a manner to render the system evolutionary and self-learning, thus acknowledging their expertise and benefiting from previous dialogues (run-time enhancement of the design-time dialogue model). Actively involving the process participants in the design and management of a structured dialogue not only taps into their collective knowledge, but also conveys a respect for their experience and opinion through which a sense of shared ownership and responsibility can emerge.

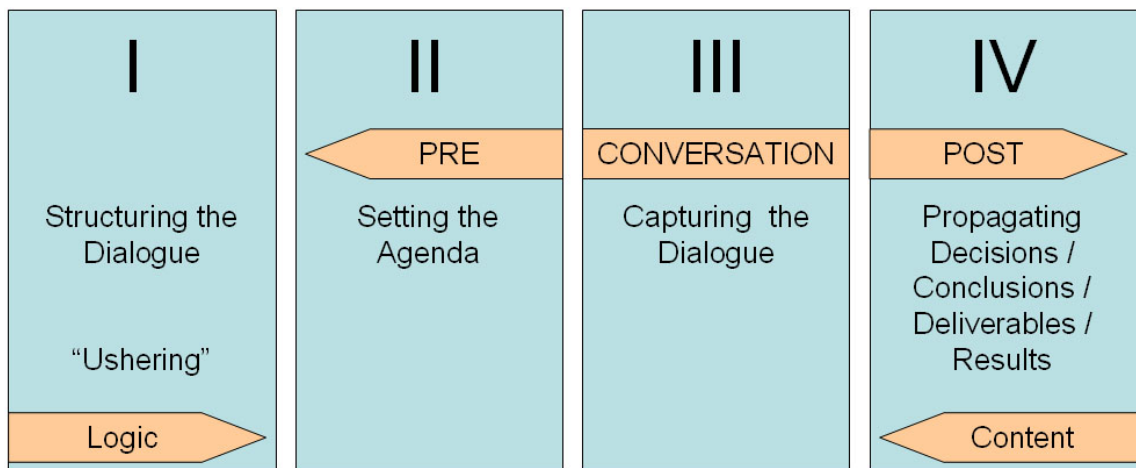


Figure 8.8: Dialogue Phases

CHAPTER 9

PROTOTYPE DIALOGUE SUPPORT MODULE

This chapter describes an implementation of how existing workflow technology could be advanced by including support for structured dialogues. The first half of the chapter establishes an expanded taxonomy of relevant discourse entities, based on the findings of the previous chapter on underlying and related dialogue theories. The second half of the chapter describes an early mock-up prototype built on the proposed fundamentals.

Section 9.4 provides a conceptual diagram of the integrated overall system architecture. The demonstrated dialogue structuring is applied to the selection of the contract format, an activity in the earlier introduced Design-Build process model. In a walk-through of the system's possible use, Section 9.5 contains screenshots of the Graphical User Interface for the selected scenario. The next section starts with listing design principles for the new system, driven by the hypothesis that adding structured dialogue facilitation to a workflow-managed Collaborative Virtual Environment provides an improvement in functionality to project planning support. At the end of the chapter, the prototype will be compared against the listed design guidelines. This leads up to a further evaluation in the next chapter on hypothesis testing.

9.1 Design Principles of a Structured Dialogue Support System

From the literature analysis in the previous chapter design guidelines (labeled G1 till G16) can be deduced for a system that intends to support structured dialogues:

- G1: The system should not only focus on capturing conversations (8.3.6), but also on guiding the interaction beforehand, and on making its decisions explicit afterwards (8.3.1), thus stimulating convergence instead of open-ended debate; it should be covering all instead of some of the 4 dialogue phases in Figure 8.2. The system can preemptively order the discourse by setting the typical agenda items for a certain activity-related dialogue, while having users adapt the topics as needed to the particulars of the project at hand – in advance or during the actual engagement. The workflow-prompted dialogue initiators should take a first cut at adapting the agenda before inviting other participants to (attend and) do the same.
- G2: In pre-structuring and analyzing a dialogue, the system should focus on topics (to be) discussed and arguments made rather than on the level of granularity of words or sentences (8.3.2). Attempting to label all individual statements would suffer from the lack of sufficiently rich classification mechanisms, since it is almost impossible to reflect the richness and nuances in real human conversations (8.3.3, 8.3.5). Therefore full dialogue content categorization should best be avoided. In

this study the structuring of dialogue content is kept as straightforward and “minimalistic” as possible (like in the Compendium tool, 8.3.6).

- G3: While making dialogue decisions explicit, at the same time it should be noted that the most crucial decisions are usually backed anyway with written agreements, such as contract documents, official certificates or signed letters. The intended system will likely be more useful when its main aim is to guide a focused dialogue and clear up participants’ stands on certain issues, rather than serving as a contractually binding (“trapping”) repository to store conversational “evidence”. In order not to reduce the system to a constraining verbal contract manager, decision making should be handled rather loosely and to some extent informally. The system development should certainly not be directed towards automate decision making (8.3.5).
- G4: In general, the system should aim to support, not replace human judgment and intelligence in solving issues collaboratively and selecting appropriate means for it (8.3.4, 8.3.5). For example, scheduling a synchronous dialogue (e.g. a meeting) may involve political and tactical sensitivities over the agenda, tone, attendees, roles, powers, time, timing, place, etc, requiring the social intelligence, politeness and diplomacy that only humans can provide.
- G5: Since participants of a real dialogue are free to bring up any issue within the social context and implicit rules of behavior, the system should allow its users

open access to the topics (to be) discussed. Notwithstanding, a moderator may be appointed to manage the pattern and timing of speech interactions (“manage the microphone”). An exception to the open access to the agenda may apply to a category of “audience”-users (comparable for example to the visiting audience in a parliamentary debate or public hearing).

- G6: Similarly, participants in a dialogue may bring along other invitees if they feel and are allowed and able to do so, maybe within certain limits (e.g. numbers). Participants may also send a representative with a certain mandate. Therefore access (logins etc) to the dialogue must be possible for such actors.
- G7: The system should make clear to its users who is to be, is or was involved in the dialogue, and how.
- G8: Like in the Milano system (8.3.3), various levels of support should be provided in order to enable interaction with users on or outside the system boundaries, i.e. dialogue should still be possible with someone who is not using the tool and/or not part of the workflow model. This means that it would not be realistic to assume that all participants of a dialogue are maintaining their personal calendars within the system to enable “easy” scheduling of a synchronous (part of the) dialogue.

- G9: Similarly, dialogue must not break down if (some of the) process participants prefer to engage in a dialogue without using the system (like in the Collate system, 8.3.2) or if they simply resist the potential change it may incur in their working habits. Users may also find themselves engaging in dialogue *without* system support unintentionally or unexpectedly, e.g. when bumping into a colleague “at the water cooler”. The system should not crumble in the face of only partial use.
- G10: The system should not impose a single fixed communication channel for dialogue (8.3.3, 8.3.4) as this may inhibit free interaction and cause resistance by restricting rather than empowering users, e.g. when demanding users to refrain from phone conversations. The tool should rather suggest communication channels based on the available media of the involved dialogue participants, the type of dialogue (synchronous, dispersed, etc), and the topics to be addressed – leaving the final choice up to the dialogue participants.
- G11: Dialogues may not only be synchronous or asynchronous, dispersed or collocated, include data, voice and/or video (Nickerson 1997), but they may also be partially collocated (e.g. a full meeting room with some remote partners) or partially synchronous (e.g. a face-to-face meeting whose agenda was negotiated in advance over e-mail). The dialogue must be supported along all those possible combinations of dimensions, independent of a particular medium (8.3.3).

- G12: Other practical issues must be considered; such as a dialogue participant missing part of a conversation in a multi-person meeting, e.g. because of an interrupting private phone call or other previous / concurrent obligations. A dialogue supporting system should allow a participant's temporary absence and pick up after it (enabling) rather than grinding to a halt.
- G13: Participants involved in one task-related dialogue may continue their conversation or temporarily divert to issues related to another activity ("By the way, now that we're talking on the deadline of project A, how are we doing on the schedule of project B?"). Since side-tracking happens in real dialogue, its consequences should be addressed by the system.
- G14: The dialogue should be enriched by enabling hyperlinks to topic-relevant resources, which can also provide tighter integration with the larger work process of the project organization (8.3.6). In many cases dialogue will not directly produce deliverables for the larger process, but rather lead up to the generation of those deliverables (Workflow Relevant Data).
- G15: At the same time, information overload of system users must be avoided at all times, as this is one of the principle motivations to structure the dialogue in the first place.

G16: Run-time enhancement of the design-time dialogue model (8.4): users must be able to influence the first (pre-structuring) phase of a dialogue (Figure 8.8) in a manner to make the system evolutionary and self-learning, thus acknowledging existing human expertise. The mechanism should enable propagation of a proposed dialogue design change with varying scope (e.g. to a recurring dialogue one may want to link a one-time project-specific topic, a permanent personal reminder, a company-wide guideline, or a pitfall warning to the entire industry).

9.2 Conceptual Structure of Dialogue Database Back-end Implementation

In order to incorporate the notion of structured dialogues into processes (extending the metaphor of the “Task Manager” to include “Team Organizer” functionality), the workflow model entities from Figure 6.2 (page 89) must be expanded with representations of dialogue elements. These building blocks for modeling discourse interactions are derived from the design guidelines outlined in Section 9.1 and they will serve as containers to hold dialogue information in the back-end database of a rapid-prototype application for structured dialogue support.

9.2.1 Concept in Express-G

Figure 9.1 provides a conceptual overview of the proposed dialogue modeling elements represented in Graphical Express. Express-G is a modeling language originating from the US Air Force and further developed in the ISO-STEP community, aimed at representing product models in an application independent manner, and at defining how instances of data objects will be organized for use. For a more detailed overview of the constructs in Graphical Express see Schenk (1994).

In Figure 9.1 the entities that are already present in the current WfMC model are gray-colored, to indicate where the proposed extension would connect to the existing data structure of the workflow model from Figure 6.2 (page 89) – which also contains activities, roles, people and organizations. Boxes with a double line to the right symbolize primitives such as a number, real, integer, string, or Boolean. Dotted boxes denote an enumerated / select type, while dotted connecting lines indicate optional elements. Texts near connections verbally describe the relation, and sometimes they also denote the so-called arity between the joined entities, with a lower and upper bound indicating the possible values (e.g. one-to-many). Gray connecting lines in this scheme stand for entities belonging to a relation (to another connecting line) rather than to its connected entities, which will eventually be mapped to column headers in so-called joint tables of many-to-many relations in a relational database implementation.

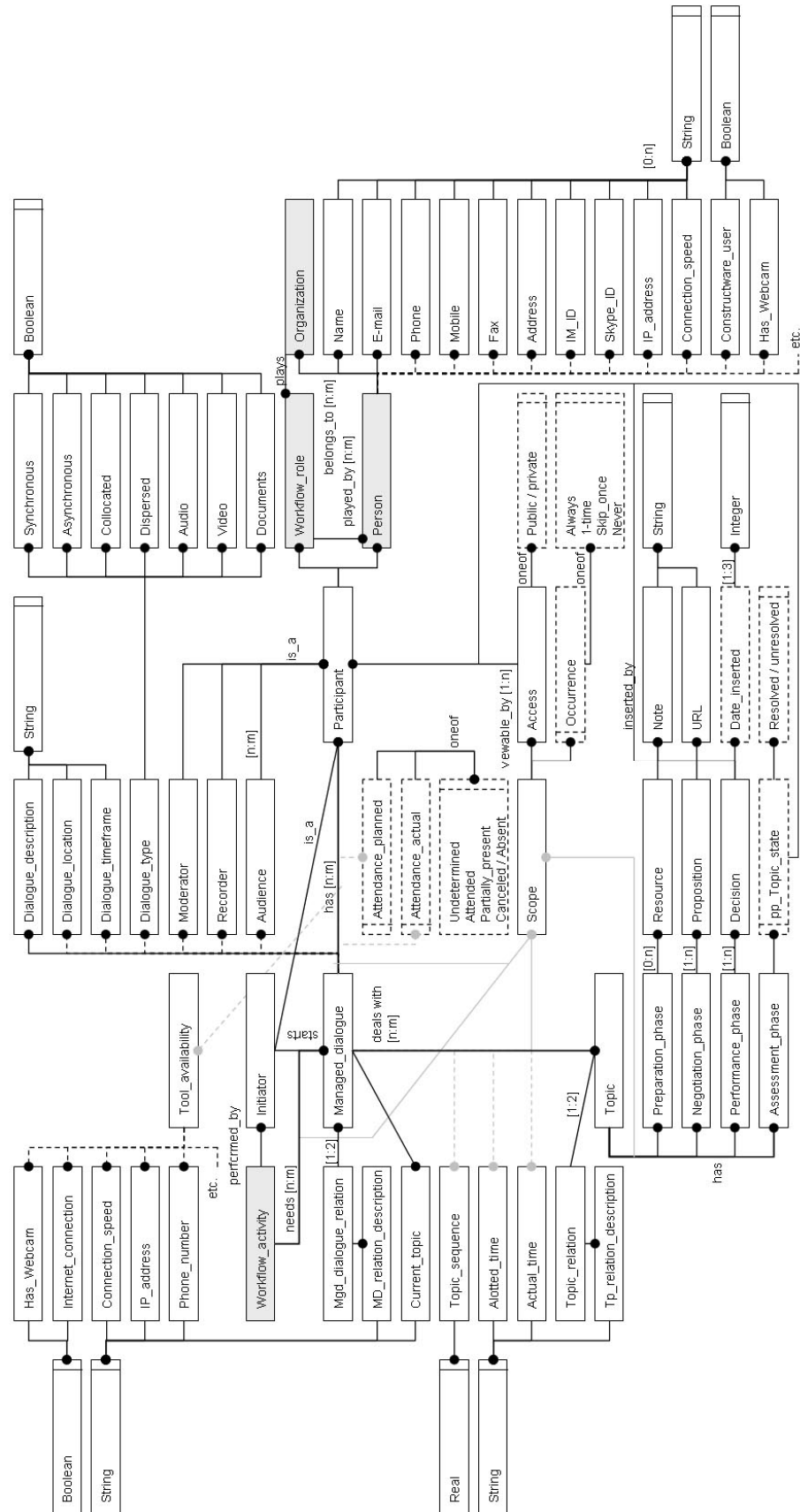


Figure 9.1: Dialogue Modeling Entities represented in Graphical Express

A *Workflow_activity* can invoke multiple *Managed_dialogues*. Although reversely a *Managed_dialogue* may also be linked to multiple *Workflow_activities* – for example because several *Initiators* are assigned the task to initiate the same discussion – a particular *Managed_dialogue* only occurs (“happens”) once. Its attributes may be recurrent though, through the *Scope* entity, as will be explained in Section 9.2.1.2.

A *Managed_dialogue* may be a communication event of any type according to the classification of Nickerson (1997), i.e. synchronous / asynchronous, collocated / dispersed, and pertaining audio / video and/or documents – or a combination of all those. A *Managed_dialogue* can have multiple *Initiators*, who are notified by the workflow engine of an impending (suggested) dialogue. An *Initiator* is not necessarily a person who starts the actual discourse, but rather the one taking the initiative to execute a structured dialogue by inviting other participants to a particular communication event (cyber meeting, conference call, threaded discussion, e-mail correspondence, etc).

A *Managed_dialogue* can have multiple *Participants*, who may be represented by abstract *Workflow_roles* or concrete *Persons*, and who may be predefined design-time by the dialogue modeler or selected run-time by one of the dialogue *Initiators* or invitees. Likewise, a *Participant* can participate in multiple *Managed_dialogues*, hence the many-to-many relationship between them. In case of a synchronous event the unique relation between a *Managed_dialogue* and a *Participant* also accommodates the option to register a person’s planned and/or actual attendance, i.e. one of *Undetermined*, *Attended*, *Partially_present*, *Canceled* or *Absent*.

Likewise the $n:m$ relationship between *Participants* and *Managed_dialogues* can hold data regarding the temporary contact information of meeting attendees, which may vary from their default contact information, for example when someone is traveling yet still available via a temporary phone or Internet connection somewhere. The model provides an extended set of personal contact information for *Persons*, thus aiding the *Initiators* in proposing and selecting possible communication media and dialogue types. Yet, the actual selection and possible negotiation of the most appropriate means and attributes of *Managed_dialogues* (such as its location, time, tools, etc), and the invitation of dialogue *Participants*, is left to the judgment and diplomacy of the *Initiators*, since it is unlikely an automated system would outperform human intelligence in this often delicate task. Nonetheless, the system may assist *Initiators* by providing tips and guidelines on how to go about setting up a dialogue successfully and efficiently (similar to the task-specific online knowledge bases described in Section 7.3.1). An *Initiator* may not even necessarily participate in the dialogue.

The workflow logic (through an enacting system) thus manages which registered CVE users are assigned to initiate the dialogue, and it can suggest other dialogue *Participants* to them (*Workflow_roles* or *Persons*). The contact information attributes of *Persons* are derived from the database of CVE users, provided by users during their initial registration. A *Managed_dialogue*, like a real dialogue, can also have *Participants* who merely form an *Audience*, that can listen in, view or revisit the *Topics* and associated data but not engage in the interaction, add or edit any records (no write access). An example of such an audience could be attendees in a public hearing on a building permit, who may

not necessarily play any “active” role in the larger project planning workflow, yet whose presence may still be valuable to keep a record of. Contact information is stored both through *String* values (for street, ZIP code, various types of Instant Messaging IDs, Internet connection speed, etc) and through *Boolean* values. The latter can register whether or not the participant has the disposal of certain hardware and/or memberships of online services, such as respectively a speaker phone, a Webcamera, audio equipment (speakers, a microphone), but also membership of Application Service Providers such as AEC-specific eBuilder, Constructware, or general purpose tools like LiveMeeting or Documentum/eRoom. A matrix with dialogue *Participants* on one axis, and means of interacting on the other not only aids in quickly identifying possible communication channels, but it can also highlight available options that were unknown to a user before (e.g. relatively new tools such as Skype for VOIP).

A *Managed_dialogue* can deal with multiple *Topics*, and reciprocally, *Topics* may recur in multiple *Managed_dialogues* (for example, when a meeting runs over time, and some agenda items are postponed to a next meeting). *Topics* may have been proposed:

- By the system (the dialogue modeler) during design-time,
- By *Initiators* before inviting dialogue *Participants* to a *Managed_dialogue*,
- By *Participants* after invitation in the run up to the dialogue,
- By *Participants* during the dialogue (“ad-hoc”), or
- During previous *Managed_dialogues* when *Topics* were deemed important recurrent issues across projects.

During the enactment of a *Managed_dialogue* the *Current_topic* value indicates to all *Participants* where the focus is of the interaction in progress, even as they may scroll through the agenda of past or upcoming *Topics*.

Participants, for example an *Initiator* or *Moderator*, of a dialogue can assign a *Topic_sequence* and an *Allotted_time* beforehand, and an *Actual_time* afterwards, to the relation of a *Topic* and a *Managed_dialogue*. By linking them to the relation, the *Topic_sequence*, *Allotted_time* and *Actual_time* spent on a *Topic* may be different in the context of different *Managed_dialogues*. Indicating an *Allotted_time* per *Topic* will aid *Participants* in planning the estimated duration of a *Managed_dialogue*, in staying on schedule, and in aiming for convergence rather than open-ended debate. The *Actual_time* serves to register the real duration as part of the conversation capturing, and as a potential aid in planning similar future dialogues if serious discrepancies existed between planned and used time frames. The *Topic_sequence* is expressed by a real (10, 20, 30), based on which records will be listed in ascending order. A *Participant* can insert a *Topic* anywhere into a *Managed_dialogue* by assigning an intermediate number to it (e.g. 25.3).

Apart from the *Topic_sequence*, *Topics* may also have other logical relations between them that may be of interest to the dialogue *Participants*, for example sub-topics or groupings of related *Topics*. In order to keep versatility in such *Topic_relations* they can be defined broadly in a *Topic_relation_description* between two *Topics*. Similarly, *Managed_dialogues* can also have logical relations, expressed in a description of *Managed_dialogue_relations* between two of them – as will be shown in Section 9.3.

In line with the ActionWorkflow coordination theory (Section 8.3.1), the *Topics* of a “conversation for action” consist of the four phases preparation, negotiation, performance and assessment. For the *Preparation_phase* of a *Topic*, the dialogue modeler or *Participants* of an upcoming or ongoing *Managed_dialogue* may link relevant *Resources* to the *Topic* in order to aid the discussion and decision making process in consecutive stages (the *Preparation_phase* corresponds to dialogue phases I and II in Figure 8.8). A *Resource* may be a simple remark, or a link to an online source such as a portal, a project-specific Web site, a blog, a wiki, a podcast, or a relevant document on an external ftp-site or in the Content Manager of the e-HUBs platform itself. An example of a valid *Resource* would be a link to a standard contract in a *Managed_dialogue* for “contract format selection” on the *Topic* “contract options” (see Section 9.5).

9.2.1.1 Topic Attributes

The *Negotiation_phase* covers the actual discourse (phase III in Figure 8.8), where *Participants* engage in debate by making consecutive statements or, generalized, *Propositions* (although in a strict sense of course not every utterance or posting in this phase would literally be a direct proposition). A *Proposition* may again be a simple textual statement in the dialogue database, typed by a *Participant* personally or written down by a dialogue *Recorder* (similar to Compendium’s concept in Section 8.3.6), it may be a summary log of a phone conversation, or it may be a reference to an e-mail, only a link to a dedicated external blog (specialized in supporting threaded discussions), or even a URL to a literal recorded audio or video fragment (e.g. a podcast) of an entire actual

synchronous conversation (thus containing multiple *Propositions*). A *Proposition* could even be created that links to a dialogue map created with Compendium. By posting a less neutral *Resource* in the *Preparation_phase* before or during the discourse, a *Participant* may convey a certain bias or subjective position on a *Topic* in anticipation of the *Negotiation_phase*, hence the boundary between these phases is not always clear-cut. Yet this categorization has no other implication other than to order the dialogue – as opposed to statement categorization to attempt enabling automated decision making or selection of group interaction techniques (illustrated in Sections 8.3.4 and 8.3.5).

The *Performance_phase* is intended for the *Participants* to make explicit the negotiated outcomes and *Decisions* taken during the discussion of a *Topic* (much like for example the final black-on-white treaty declarations at the end of an international summit). All dialogue *Participants* have access to the *Decision* database records, and can thus modify the statements until overall agreement is reached (over the content, wording, etc) – or not.

The final *Assessment_phase* of a topic serves to provide an immediate overview at the *Managed_dialogue* level of consensus (or lack thereof) on the various dialogue *Topics*. Representation-wise it varies slightly from the three previous phases. It provides each *Participant* the chance to express per *Topic* whether resolution has been achieved, or whether it remains an unresolved open issue according to personal views – despite any (maybe partial or only secondary) *Decisions* reached on the particular *Topic*. An agreed upon *Decision* may for example also be to cut off negotiations, thus still resulting in an *Unresolved* topic-state. For each dialogue *Participant*, no matter how insignificant, the

individual topic-state (*Resolved* or *Unresolved*) is presented, since in real situations *Participants* in multi-person dialogues will quickly recognize or learn from each other who has the meaningful authority, mandate, seniority, experience, or hierarchical position to matter in the dialogue's decision making – or in stalling it. Since the application is not intended to be a legally binding verbal contract vault, the possible dialogue *Moderator* and/or *Recorder* can mark the personal topic-status for other individuals based on their expressed views during the discourse, in case a dialogue *Participant* forgot to mark any opinions, or is simply a slow-adopter of the technology.

By placing a discussed *Topic* on the agenda of another *Managed_dialogue* also (linking it to the other dialogue as well), the *Topic*'s previous *Resources*, *Propositions*, and *Decisions* (not states – as these apply per dialogue and participant) become available to the other dialogue instance, ordered by date so that earlier entries are listed first. Carrying over dialogue resources and results stimulates the transfer of knowledge between activities and helps avoid redundancy and duplication of efforts.

Although *Managed_dialogues* can be predefined, they can also be created on the fly as a communication event occurs spontaneously in the context of a *Workflow_activity*, for example when the performer of a task decides to make a related phone call worth keeping a log or recording of. In this case, run-time dialogue creation would entail inserting a *Managed_dialogue* record with two involved *Participants* and associated *Topic* entries with a desired level of detail (from a simple log that the call took place, to a detailed account of exact remarks).

9.2.1.2 The Scope of Structured Dialogue Entities

When creating instances of *Managed_dialogues* with *Participants*, *Topics* and their attributes, the *Scope* attribute of their relations serves to determine whether they should be recurrent or not, and who should be able to view their records. The *Scope* consists of the entity's *Occurrence* and *Access* rights. The *Occurrence* defines how broad the object should be propagated across multiple projects by letting repeated process instances inherit it (becoming part of the larger workflow model). The *Occurrence* can be one of:

- *Always* (every time the structured dialogue is reused in a new instance)
- *1-time* (default value – just for the current dialogue instance)
- *Skip_once* (to keep the recurrence, but exclude the current dialogue instance)
- *Never* (only used to delete a previously inserted recurring object)

The *Scope* is set by assigning frequency values to its *Occurrence* for tuples according to Table 9.1 (next page), so that for example a *Topic* may be *Always* recurring in repeated *Managed_dialogue* A, whereas it only appears *1-time* in repeated *Managed_dialogue* B (for the particular instance of B only). The *Scope* is thus an attribute in joint tables between entities, as will be demonstrated in Section 9.2.2.

Table 9.1: Scope of Managed Dialogue Entities

The <i>Scope</i> for Entity...	...is set in the relationship between:
<i>Managed_dialogue</i>	<i>Workflow_activity</i> and <i>Managed_dialogue</i>
<i>Participant</i>	<i>Managed_dialogue</i> and <i>Participant</i>
<i>Topic</i>	<i>Managed_dialogue</i> and <i>Topic</i>
<i>Resource</i>	<i>Topic</i> and <i>Resource</i>
<i>Proposition</i>	<i>Topic</i> and <i>Proposition</i>
<i>Decision</i>	<i>Topic</i> and <i>Decision</i>

The *Access* rights define which *Participants* (concrete *Persons* or abstract *Workflow_roles*) will be able to view the object when they are accessing their structured dialogue user interface, as presented in Section 9.5. (These viewing rights for records within the dialogue interface are supplemental to any existing access privileges set up for external resources, such as access rights to referenced documents on a secure ftp-site). For example, a *Participant* may want to attach a virtual sticky note to a particular *Managed_dialogue* log as a private reminder of an unspoken “perishable” thought (*Occurrence: 1-time, Access: personal*). Alternatively, the *Participant* may want to distribute a valuable piece of information to colleagues within the organization possibly performing the same *Workflow_activity* on a future project, engaging in the same *Managed_dialogue* (*Occurrence: Always, Access: own Workflow_role*), thus making the

resource a permanent part of the workflow model (the dialogue-extended XPDL file). Recurrence can only transpire in as far as connecting elements up the entity tree are also recurrent, for example a *Topic* can only be carried over to other process instances if its *Managed_dialogue* is also repeated, maintaining the logical connection to its instigating *Workflow_activity*.

A dialogue-extended XPDL file could be reused by either modifying its workflow in a process modeler (“JaWE+”), or by launching additional instances of the uploaded XPDL file in the execution environment (“e-HUBs platform+”). In both cases a parser could strip from the XPDL code all object instances of *Managed_dialogues*, *Topics*, *Resources*, etc. whose *Scope* was labeled with an *Occurrence* of *1-time* or *Never*, upon opening the XPDL file for modification or (re)use.

However, even with an *Occurrence* of *Always* and unrestricted *Access* rights, a recurrent object would still only be available to those with access to the originating XPDL file. In order to enable a broader diffusion of knowledge across projects and companies to benefit the industry at large, the *Access* attribute of an object’s *Scope* has a *Private* label which can be set to *Public* to make the XPDL string describing the object available to the larger professional community if desired. The XPDL parser (workflow engine or process modeler) could for example notify process instance users and creators of available additional process / dialogue “resources”. It could also send the public data to a shared online library of open-source process models, or to a trade organization which is maintaining and optimizing standardized workflow models for a certain domain.

The possibility to elevate objects to be recurrent across projects would also require the ability from the process modeling software (“JaWE+”) to merge modified versions of a similar standardized process to include all desired extensions of parties who have not collaborated before. This situation could occur for example when an Owner and a Design-Builder on separate earlier projects have both used and customized the proposed DB process model of Chapter 7, and now want to integrate their process-embedded knowledge on a joint new project.

9.2.2 Application in MS Access

The abstract Express-G schema of structured dialogue modeling elements from Figure 9.1 translates into the applied MS Access database schema of Figure 9.2. Tables are represented as boxes containing data field names (column headers). Each table can hold many records with values for the shown column headers. Lines between tables denote how the tables are connected by corresponding keys (unique record identifiers).

The main tables are called Activity, Dialogue, Participant, Topic and Phase. The other tables mainly serve to establish extended relations between these main tables, for example to indicate a particular *Participant*’s attendance in a particular *Dialogue* (stored in the “DialogueParticipant” table). Such many-to-many relationships between objects are implemented through so-called joint tables.

The tentative graphical user interface to this data structure is illustrated in Section 9.5.

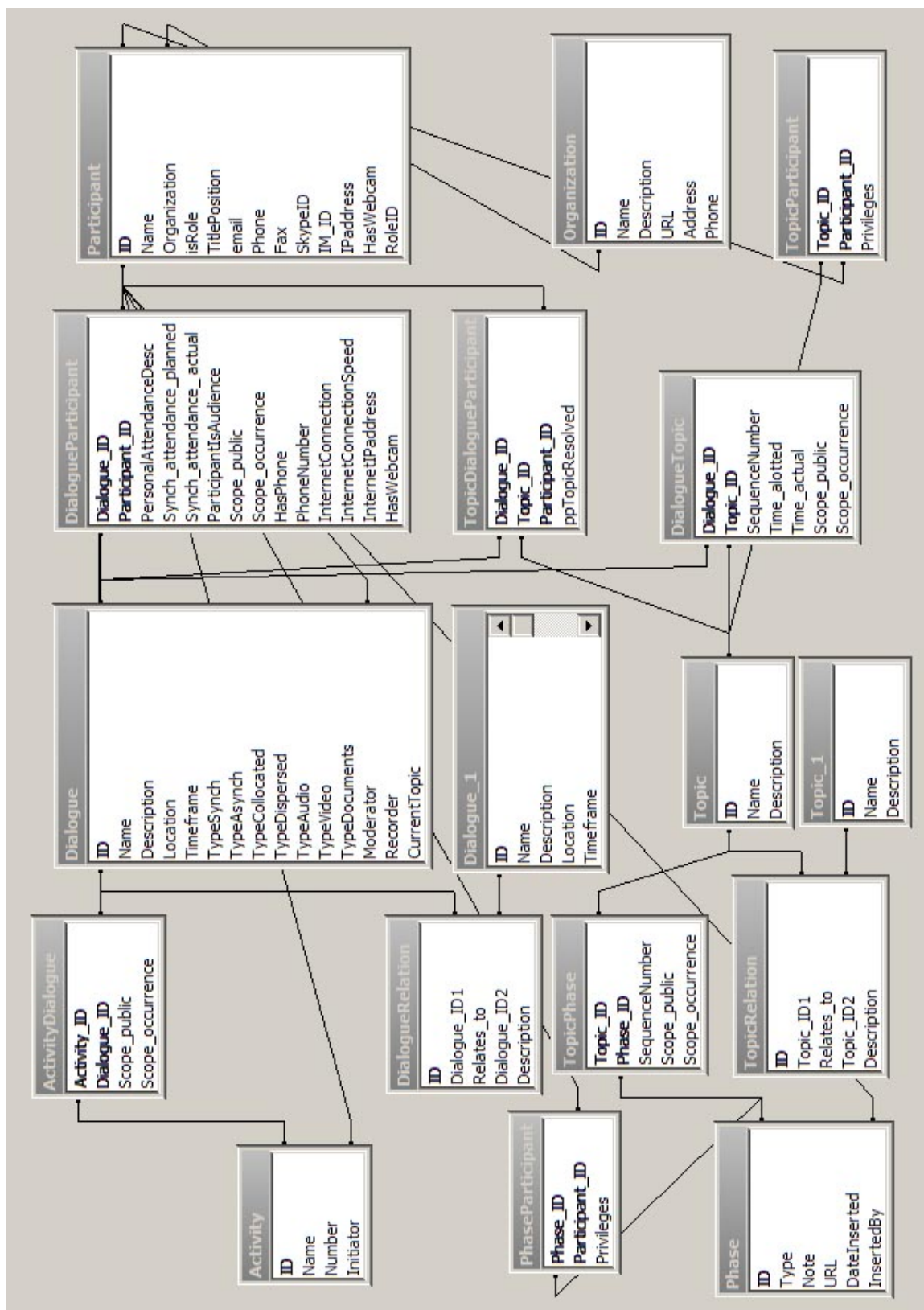


Figure 9.2: Applied Dialogue Modeling Objects and Attributes in MS Access

9.3 Example Case: Selection of Contract Format

For concept testing and evaluation the proposed dialogue framework from Section 9.2 is applied to one of the Design-Build activities from Chapter 7. The selection of the contract format for example (*Workflow_activity* 1112 in Figure 7.5a) involves some typical recurring interactions on *Topics* that are similar across contract negotiations of every Design-Build project. These interactions may therefore well be supported by *Managed_dialogues*.

The Owner can impose a given contract on the DB offerers as part of the Request For Proposal, or he may want to specifically negotiate provisions with them, especially in the case of sole-source procurement (only one offerer). In either case, the Owner will first want to engage in a self-dialogue (within the Owner organization internally) and/or in a dialogue with his Consultant to decide on the positions, terms and conditions with which to approach the DB proposers. The dialogues between Owner and Consultant, and then between Owner and Design-Builders are thus related – i.e. consecutive and with respect to content – *Managed_dialogues*, both belonging to *Workflow_activity* 1112 (Select DB Contract Format). These dialogues can be initiated by multiple *Participants* within the Owner role. The results of these two *Managed_dialogues* will later be important for additional *Managed_dialogues* belonging to *Activities* 1135 (Accept Proposal Contract Part 1), 1144 (Revise Documents / Prepare Contract), and 1145 (Sign Construction Contract Part 2).

From Table 7.3, that shows the relation between Activities and Workflow Relevant Data, it can be concluded that the only significant deliverable of *Workflow_activity* 1112 are the Part 1 and Part 2 contract documents, prepared for later signing by the pre-qualified Design-Builder(s) – see the excerpt in Table 9.2. (The Competition Schedule only has write-access to enable possible minor modifications to an earlier submitted deliverable). Despite the fact that there is only one single real deliverable of *Workflow_activity* 1112 – the DB contract – there are several recurring decisions to be made (*Topics* to discuss) when drawing it up.

Table 9.2: Excerpt from the Activity-WRD Matrix for Contract Format Selection

Workflow Relevant Data (Activity 1112 – by: Owner)	Read / Write	Type
Construction Contract Documents (Part 2)	W	Text
Identification of Owner	R	Text
Competition Schedule	W	Text
DB Procurement Methodology	R	Text
Sole Source Design-Build Procurement	R	Boolean
Supplements to Proposal Form (Owner Information)	R	Text
Bridging Documents (Schematic Design)	R	Text
Part 1 Agreement	W	Text
Number of Finalists	R	Text
Bridging	R	Boolean

Typical recurring issues when drawing up the contract are:

- The type of standard contract to apply
- Ownership of created design documents
- Level, categories and methods of compensation
- The competition schedule (deadlines etc)
- Procedures to follow
- Identification of AE services (who are the designers on the DB team)
- Design requirements (performance specs and/or bridging documents)
- Construction phase issues (Part 2 agreement), such as
 - Identification of the Owner's legal representative (for approving change orders etc)
 - Identification of the Owner's on-site representative
 - Insurances
 - Proof of funds
- Other specific clauses and provisions of interest

Some of these issues will have been addressed in the DB process model during earlier activities, such as the competition schedule or design requirements, that are available as read-only Workflow Relevant Data (see Table 7.3, page 170). The main issues at stake in the context of this dialogue are thus the type of standard contract to be used, the level and type of compensation to be offered, and to a lesser extent the legal ownership of any produced design documents – as will be explained in the next pages.

The most obvious available types of standard agreements in the US are contract documents of the following trade organizations:

- AGC: 400, 410, 415 (between Owner and DB-er)
 420 (between DB-er and Architect)
 450, 499 (between DB-er and Contractor; teaming)
- AIA: A191 (between Owner and DB-er)
 B901 (between DB-er and Architect)
 A491 (between DB-er and Contractor)
- DBIA: 520, 525, 530, 535 (between Owner and DB-er)
 540 (between DB-er and Designer)
 550, 555 (between DB-er and General Contractor)
- NSPE *: 510, 520, 525, 700 (between Owner and DB-er)
 505 (between DB-er and Designer)
 521, 526, 750 (between DB-er and General Contractor)
 500 (between Owner and Consultant)
- (Company-specific contracts – not recommended for most DB projects)

*) The National Society of Professional Engineers (www.nspe.org), among which the AGC, aims to develop and update through its Engineers Joint Contract Documents Committee (EJCDC) fair and objective standard documents for contractual relations between all parties involved in engineering design and construction projects.

These standard agreement options, and potentially the contract documents themselves, can be provided in the *Managed_dialogue* as *Resources* of the Contract Selection *Topic*. The various contracts differ in their length and emphasis on certain aspects. Hence an independent comparison of the choices, or a link to a selection wizard, would be a valuable additional *Resource* for the dialogue *Participants* in the *Preparation_phase*.

A major difference between contract types is for example the issue of the ownership of generated design documents; whereas the AGC contract transfers the rights on a design from the Design-Builder to the Owner once payment has taken place, the AIA contract keeps the ownership with the Architect of the DB-er (see the contract excerpt in Appendix C). The latter means that the Owner is not entitled to build a designed project with a different contractor after terminating the Part 1 agreement. This restriction may on the one hand make the Owner favor an AGC contract, but on the other hand not using AIA documents may deter quality architectural firms from lending themselves to engage in a participating Design-Build entity – especially since many architectural firms are still unfamiliar with and hesitant about Design-Build project delivery anyway. The acceptable contract terms therefore may also depend on the current local economic situation and the eagerness of companies to take on design and construction projects there and then. The Topic of design ownership therefore needs to be discussed each time when selecting the contract format for a DB project.

Likewise, the level and methods of compensation to Design-Builders are influenced by market conditions (supply and demand) and must obviously be addressed in the context

of any contract definition. In general, the basis of compensation can be a stipulated sum, percentage fee or cost of the work, potentially with a maximum to cap Owner expenses, unit prices, cash allowances or contingencies, if any, or a combination of various methods. The basis of compensation applies to, and may vary for, categories of services that should be described in the contract, such as basic and additional services (in the A191 contract of the AIA). Reimbursable expenses may be specified, with a multiplier for profit and overhead. These are expenditures made by the DB-er or its subcontractors in the interest of the project, such as the fees to request a building permit on behalf of the Owner, or travel expenses by the Architect for the direct benefit of the project. Furthermore, an initial payment (varying in type, amount or timing from subsequent payments) may be specified to jumpstart the project. For each category of compensation the pay dates or schedule (milestones, frequency), the used currency, and the manner it will be credited need to be identified in the contract. Also the rate of interest for past due payments must be agreed to, defaulting to the prevailing rate if not specified, and potential penalties or additional compensation if through no fault of the DB-er services have not been completed before a certain date. Acceptable forms of compensation will also depend on the amount of financial risk involved in the construction project. For example in commissioning a highly complex nuclear facility, integrated design and construction would be appropriate, yet the DB-er is unlikely to want to assume all responsibility for budget and time overruns.

The next sections will illustrate how the implemented rapid prototype incorporates the issues just described in a structured dialogue on contract format selection (Activity 1112).

9.4 System Use Scenario

For reasons described earlier in Section 5.2 (keeping this research effort feasible), the components for process driven project planning (described in Chapter 6) and for enhanced dialogue support (proposed in this chapter) are not actually integrated in the overall system architecture of the implemented prototype configuration. The Design-Build process guidance described in Chapter 7 thus did not include the detailed dialogue support features outlined in this chapter (the “Task Manager” versus the included “Team Organizer” paradigms). However, it is not hard to envision the possible seamless connections between these components, since the structure of the dialogue syntax extension proposed in Section 9.2 builds directly on the existing fundamentals of the standard workflow taxonomy that enabled process enactment earlier (Section 6.2).

Describing a use scenario for the proposed dialogue support system is therefore partly based on the assumption that “Task Manager” and “Team Organizer” are actually integrated components. This assumption means that the process modeler used earlier (JaWE) would be able to also model dialogues and append them to activities (“JaWE+”), and that the Web-based workflow engine (the e-HUBs platform) would be able to parse such dialogue extensions when enacting a process. Whereas the current dialogue support prototype is a separate client-server application, it would ideally be a fully integrated part of the configuration as illustrated in Figure 9.3 (compared to the actual system architecture as depicted in Figure 6.1 on page 85).

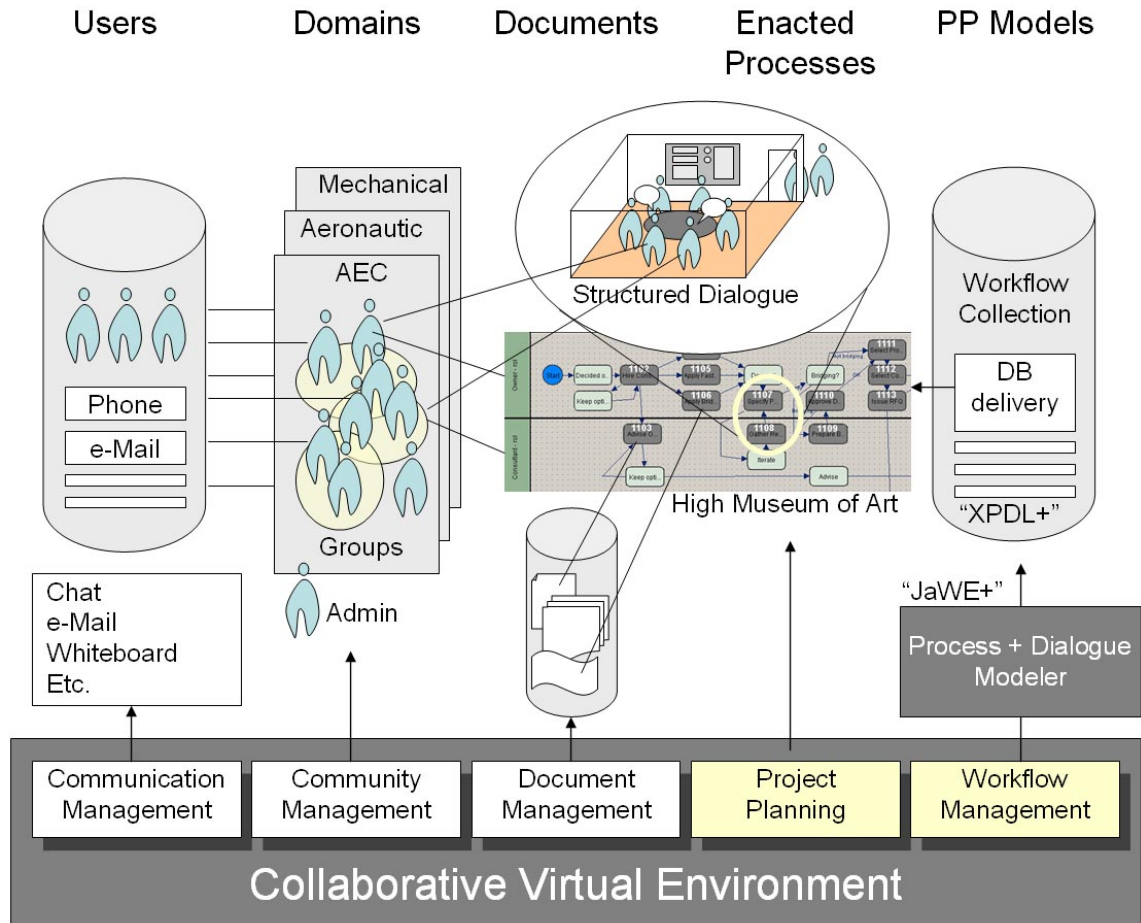


Figure 9.3: Idealized integrated overall System Architecture

With this system architecture, registered CVE users can model new or adapt existing processes, including structured dialogues – and then upload these dialogue-enhanced workflows into the project planning module of the platform for execution. Upon the launching of a process instance by a user, the embedded workflow engine starts dispatching tasks according to the logic defined in the uploaded process model. Users will find consecutive tasks on their to-do list, which they can access by clicking on them.

By clicking on a received task, a pop-up window still appears with a data template that contains links (e.g. to a task-specific Web site) and data fields, with previous submittals or needed deliverables (activity inputs and outputs; Workflow Relevant Data). However, when an activity includes a predefined dialogue (of which the user is an *Initiator*), an extra link could appear which launches the (then Web-based) dialogue support application, illustrated with a walk-through in the next section of this chapter.

This dialogue support window lists fellow dialogue *Initiators* with contact information, it suggests other dialogue participants to invite, proposes topics to address, and provides an environment to structure the interaction before, during and after the discussion – through respectively useful resources, space for propositions, and explicitly recorded decisions. This environment is intended to limit the dialogue’s expansive solution space while focusing the participants on an efficient handling of their agenda.

With the dialogue window open, the Initiator can use his own judgment to decide what type of dialogue he will propose, depending on the needed exchange of ideas, the size of the group, topics at hand, the setting, people’s location, work culture, time pressure, etc. For example, he may decide to set up a formal synchronous meeting, by inviting participants to a future gathering. But he may equally well launch a conference call right away to get a simple dialogue out of the way immediately. The dialogue *Initiators* may opt to send the invitees a secure link to the online dialogue support window ahead of time, so that they too can prepare themselves in advance (view the agenda, access resources, suggest discussion topics, etc). Extended contact info can be solicited through a standard Web form by the dialogue *Initiators* upon electronic invitation to participate.

The next section provides snapshots from a potential dialogue to select the Design-Build contract format, as introduced in Section 9.3, through screenshots of the implemented MS Access dialogue support application.

These snapshots are derived from a fictitious more detailed process planning scenario, which contains a chronological storyboard with actual communication. This narrative of a structured dialogue should be seen against the backdrop of its “conventional” counterpart, which consists of a typical dialogue from a “day-out-of-the-life of a project planner” as it would occur now in a non-structured situation. The comparison is meant to make the argument, and provide anecdotal proof, that dialogue structuring supports and makes a contribution to actual project planning activities. Better organizing discussions can improve knowledge proliferation, decrease dependency on few experienced people, and prevent or at least reduce typical interaction problems, such as misunderstandings, inefficiencies, delays, errors, forgotten issues, rework and process breakdowns.

A detailed inspection of occurrences in the worked out scenarios can reveal how the proposed prototype would distinguish itself from an open-ended, unconstrained group communication medium.

9.5 Prototype Mock-up Graphical User Interface

This section gives an impression of the potential user interface for a dialogue support application, by providing screenshots of a mock-up prototype (implemented in MS Access) for parts of a possible dialogue for selecting the Design-Build contract format, as introduced in Section 9.3.

Figure 9.4 depicts the main dialogue window with a series of tabs across the top. The two tabs to the left are intended to reflect the online workflow environment that triggered the dialogue, with the process details in which the dialogue is embedded. The six tabs – Workflows, Activities, Dialogues, Participants, Agenda and Topic Details – are zooming in to more detail from left to right. For example, with a dialogue selected, one can then see its agenda by clicking on the corresponding tab. The navigation buttons at the bottom scroll through all the available dialogues for the activity that launched the dialogues. This bar also provides a button (all the way to the right) to create a new dialogue record on the fly, for example as an unexpected phone conversation occurs that is worth documenting in the context of the activity. A dialogue can be promoted to recur every time its activity occurs, by setting the scope accordingly. By even making the dialogue “public”, its attributes would become available to the industry at large for potential reuse. The dialogue window shows dialogue attributes in the middle section, and dialogue relations in the lower part. The latter are intended to allow users to further embed the dialogue in its larger context.

Dialogue

Workflows

Activities

Dialogues

Participants

Agenda

Topic Details

Activity

ID

T112-1

Select Contract Format

Owner Consultant

Initiators

Owner Consultant

Dialogue

Name

Contract Definition

Description

This dialogue between Owner and its potential Consultant is intended to support the selection and definition of the contract (AIA, AGC, DBIA, EJCDC, etc), and the type of compensation (lump sum, cost plus, GMP, etc) to be offered in the DB Request For Proposal.

ID

1

Location (if any)

Renaissance Hotel Downtown, conference room 2.23 - N. Ave, Atlanta GA 30332
Jack will be in New York on the speaker phone

Timeframe

Friday September 30, 2005 - from 4:6 PM EST

Scope

Always

Public

Access rights...

Type

Synchronous

Collocated

Asynchronous

Dispersed

Involves Audio

Involves Video

Doc exchange

Dialogue Relations

Edit

Dialogue ID1	Dialogue A	Relates to	Dialogue B	Dialogue ID2
1	Contract Definition	precedes	Contract Acceptance	2

Interactions regarding contract provisions made before distribution of the Request For Proposal will be relevant again at the time of contract award / acceptance by the Design-Builder.

Record:

1

of 2

Figure 9.4: Graphical User Interface of an Activity's Dialogues

With a dialogue selected on the previous tab, the next tab (Figure 9.5) lists the dialogue ‘s participants. Participant listings may have been entered by the system (the workflow logic), such as dialogue Initiators and suggested participants (abstract roles and concrete persons), or they may be added by the dialogue participants themselves, in case they want to bring along someone or send a representative to a dialogue. Inviting participants, even system-suggested ones, is initially left to the concerted social intelligence of the *Initiators*, since it is unlikely that a support system would outperform humans in this area. Nevertheless, by listing means of contact for participants, the system may help the *Initiators* to invite people and to set up a technically possible dialogue (synchronous / asynchronous, partially collocated, using certain media, etc). Users can look up who is, was or will be participating in a dialogue by accessing its information via the task environment of their Collaborative Virtual Environment or via a direct link to the dialogue window provided by the *Initiators*. Without advance notification of an impending dialogue there will of course likely be less use of the pre-structuring for the other party.

With a participant selected on the left, the middle and right section of the tab will show the participant’s details. Whereas the middle section shows a person’s “static” information (not changing per dialogue), the section to the right contains dialogue-specific information (tied to the specific relation of the particular dialogue and the particular participant). An example of the latter is a person’s temporary contact information that overrules any regular contact information, and only applies to the date and time of the dialogue instance.

Dialogue

Workflows

Activities

Dialogues

Participants

Agenda

Topic Details

Dialogue

ID

1

Moderator

Activity

1112-1

Recorder

Susan Keaton

Involved Participants

Name	Organization	Role
Consultant	KPMG	Consultant
▶ Jack Smith		
Owner		
Peter Walton	DHI Realty Developers	Owner
Susan Keaton	DHI Realty Developers	Owner

Record:

1

2

3

4

5

of 5

Create Participants

Link Participants to this Dialogue

Participation Scope

Recurrence

1-time

Public

Participant Details

ID

3

Name

Jack Smith

Title / Position

Senior VP

Organization

KPMG

Participant is a role (abstract)

...or plays role

Consultant

Contact info:

email

consultant@selectarchib

Phone

212-335 6278

Fax

212-335 6279

SkypeID

genius

IM_ID

-

IPaddress

124.98.12.102

Has a Webcam

☒

Edit Participant Information

Dialogue-specific

Is audience only for this dialogue

☐

Attendance:

Planned

W'll attend

Actual

Attended

Description

W'll be in NY on the phone

Temporary contact info:

Has a Phone Connection

☒

Phone #

212-672 9821

Has Internet Connection

☒

Speed

ADSL

IP address

28.38.86.136

Has a Webcam

☐

Edit Scope / Dialogue-specific info

Record:

1

2

3

4

5

of 2

Figure 9.5: Graphical User Interface of a Dialogue's Participants

The Agenda tab (Figure 9.6) lists topics that need to be discussed in the dialogue (selected in the Dialogue tab). The lower section displays potential relations between topics, whereas the section to the right provides a per-participant quick overview of the status for the selected topic to the left (either resolved or unresolved). Dialogue participants can add or edit topics to the upcoming or ongoing dialogue (if they were not categorized as “audience” by the *Initiators*). This allows for flexibility in the agenda to accommodate variance in individual projects. The provided dialogue support is independent of the used communication media and type of dialogue to be held (e.g. an online threaded discussion, a face-to-face meeting, a phone call, etc). Users can keep the dialogue window open before, during or after the actual interaction, regardless of the actual communication media used. For example, they may want to keep the agenda in front of them while having a phone conversation or while attending a face-to-face meeting. They can scroll through the previous, ongoing or upcoming topics while engaging in the dialogue. The Current Topic field can keep dialogue participants on the same page and show to all how far the discussion has progressed. This field may be updated live by the dialogue’s moderator or chair, or by the participants themselves.

Each topic can be linked to multiple dialogues (e.g. when it was not resolved in a previous meeting), so information like the allotted and actual time per topic are stored in the relation between a specific topic and a specific dialogue.

With a topic selected to the left, the next tab provides detailed topic information for the participants to use, such as resources, comments and decisions made.

Dialogue

Workflows

Activities

Dialogues

Participants

Agenda

Topic Details

Activity

1112-1

Dialogue ID

1

Current Topic

Topics

Create Topic

Edit Topic Description

Edit other Topic info

1.1

Design ownership

It is important to decide whether the Design-Builder's design documents should become the Owner's property after payment, so that the Owner may still switch to another contractor or not. The standard AIA contract keeps ownership with the Design-Builder, the AGC contract transfers ownership. However, the AGC contract may therefore negatively impact designers' willingness to

Time:

Alotted

4.15 - 4.30 PM

Actual

10 min.

Scope

1-time

Public

1.2

Choice of standard contract

Several standard contracts for Design-Build project delivery are available from various trade organizations; AIA, AGC, DBIA, EJCDC. Consider their differences, and select and/or edit accordingly.

Time:

Alotted

4.30 - 5.15 PM

Actual

50 min.

Scope

Always

Public

2.1

Type of compensation

Available payment options: lump-sum, cost-plus-fee (potentially with Guaranteed Maximum Price), unit-price, or a combination of these.

Time:

Alotted

5.15 - 6.00 PM

Actual

Scope

Always

Public

Record:

1

of 3

Topic Resolution Overview

Name

OK

Peter Walton

Jack Smith

Owner

Consultant

Susan Keaton

Topic Relations

Edit

Topic A

Relates to

Topic B

ID 2

1

Design ownership

depends on

Choice of standard contract

2

The choice of standard contract determines design ownership, if the original provisions are left unedited

1

Design ownership

influences

Type of compensation

3

Higher compensation might be necessary to attract enough qualified Design-Build offerers willing to give up design ownership

Record:

1

of 2

Figure 9.6: Graphical User Interface of a Dialogue's Agenda

Figure 9.7 shows the last and most zoomed-in tab, where topics are handled in detail. The tab is vertically divided in four main sections (according to the four phases of the ActionWorkflow paradigm): resources, propositions, decisions and a topic status for the logged-in participant. (The latter is the resolved/unresolved status per participant compiled in the previous tab).

In the top section users (or the system) can list relevant resources for the topic at hand, ahead of time or during the interaction, to make the debate more knowledge-driven and better informed, for example through a certain guiding document or an online information source.

In the Propositions section the actual dialogue takes place. The level of detail for recording the dialogue is left to the judgment of the participants. Each entered “proposition”-record may be an entry of an asynchronous threaded discussion, or it may for example be a summary statement submitted by the dialogue recorder on behalf of a participant. A proposition could also be a simple log that a dialogue took place, or a way to distribute the minutes of a meeting. However, it may also contain a link to an external blog or to a full voice or video recording of a discussion, such as a phone call, podcast, or video-mail.

The Decisions section is meant to distill results from the dialogue and make its conclusions explicit. Finally, the topic status provides an overall summary for participants to get a quick indication of the resolution achieved (or lack thereof).

Dialogue

Workflows

Activities

Dialogues

Participants

Agenda

Topic Details

Resources

Note

Design Build Institute of America
This site provides relevant statistics regarding the chances of Owners not wanting to proceed with a selected Design-Builder

URL

<http://dbia.org/>

Note

An interesting publication of the Building Futures Council that describes among others ownership aspects in Design-Build projects in section 4

URL

www.thebfc.org/whitepaper0304.pdf

Add

Edit

Propositions

Note

I suggest we stick with the standard AIA 191 contract

URL

Note

OK, but why don't we change article 3.2 as follows:
3.2
If the Part 2 Agreement is not executed, the Owner shall not use the drawings, specifications, and other

URL

Add

Edit

Decisions

Note

We'll use AIA contract 191 for our RFP, but with a slight adaptation in article 3.2, see contract on our ftp site

URL

<ftp://highmuseumexpansion.com>

Note

Albert will compose the contract document

URL

Add

Edit

Topic Status

☒ Resolved

according to Participant

3

Edit Status

Activity

1112-1

Dialogue ID

1

Topic ID

1

Record:

1

of 2

Figure 9.7: Graphical User Interface of a Dialogue's Topic Details

265

The shown dialogue example – contract format selection – may look somewhat obvious, thus not adding much value for domain professionals, but of course the dialogue structuring could go into the level of granularity of detailed provisions where existing individual expertise may not be sufficient. It should also be noted that the practical value of the structured dialogue is intended to increase over time as it is being used by industry practitioners who would benefit from each other's knowledge by sharing it (recurring topics, resources, decisions, and such).

One could wonder if detailed dialogue structuring would not require too much overhead from a project organization. However, it could be argued that, with or without dialogue support, the planning effort will be (re)done anyway for each project (defining activities, setting up meeting agenda's, finding resources, etc), so preserving planning data for reuse might not require much additional effort, while it could well prevent redundancy and save planning effort across projects.

Although the user interface may be rather preliminary and rudimentary compared for example to some more seasoned blogging applications, the added value lies in the embedding of the dialogue in the larger process, and the cultivation of knowledge that could otherwise easily get lost in the daily operations of getting a project done.

9.6 System Comparison against Design Guidelines

When compared to the design guidelines put forward in the beginning of this chapter, the proposed dialogue support system has the following characteristics:

- G1: The system supports dialogues in all phases: before, during and after the interaction.
- G2: The focus is on topics and statements rather than on individual sentences or words.
- G3: Access to records in the database is left largely open by default, in order not to restrain users unnecessarily.
- G4: The application leaves human intelligence in the center of its use, there is no automated decision making.
- G5: Any participant can add topics to the agenda of a dialogue, before or during the discussion. A moderator can be assigned to manage the dialogue's efficiency.
- G6: Participants can invite others to join the dialogue, or they can appoint a representative to stand in for them.
- G7: The system makes clear to its users who is to be, is or was involved in the dialogue, and how – to a desired level of detail.
- G8: Dialogue is possible with someone outside the system boundaries (not part of the workflow model).

- G9: Others (e.g. the official dialogue Recorder) can insert statements on behalf of a participant who is unable or unwilling to use the system.
- G10: The system is media-independent in that does not impose or restrict possible means of communication to its users.
- G11: Various types of dialogue can be supported (synchronous, asynchronous, collocated, dispersed, etc).
- G12: The negative effect of a participant's temporary absence from a dialogue is lessened by the recorded interaction trail.
- G13: Side-tracking (temporary diversion to another dialogue's topics) is possible, since one can easily switch to the records of another dialogue temporarily.
- G14: Hyperlinks are possible to resources such as documents or Websites that are relevant to the dialogue.
- G15: Information overload is combatted by organizing the available information in tabs that gradually reveal more detail on demand only.
- G16: A mechanism is envisioned to enable the dialogue to enrich over time as it is being used by industry practioners.

When compared to random existing applications for threaded discussions (e.g. blogs), the proposed system provides the power to embed dialogues tightly in the larger process. A process that “ushers” participants into efficient meetings, where decisions are made explicit and where topics and their resources are carried over from dialogue to dialogue and from project to project.

The next chapter (10) will review methods of verifying the hypothesis that the proposed process driven project planning through structured dialogues would benefit the efficiency of the AEC industry.

Chapter 11 and 12 will respectively summarize conclusions and indicate possible directions for future research.

CHAPTER 10

HYPOTHESIS TESTING

The aim of this dissertation was to provide an initial proof of concept for each of three premises (i, ii and iii) that constitute the main hypothesis – that project planning in the AEC industry would benefit from process mediation, and from structured dialogues in particular. Previous chapters have demonstrated i) that a planning process can be modeled with workflow technology (Chapter 7), and ii) how more collaborative activities of the planning process, like the building requirements gathering between the Owner and the Owner's Architect, can be supported by structuring dialogues between process participants (Chapter 9). The modeling of an example workflow showed that such a planning process in AEC can be predictable and constant enough to warrant a more ordered approach, with a systematic generation of planning deliverables over time, with a well-organized decision trail for later reference, and hence with a more explicit knowledge retention across projects. The latter part of the hypothesis – iii) that execution of dialogue-enabled workflows would indeed add value to existing planning practices – is thus far made plausible by surveys among experienced project planners and by a concept validation by experts in academia.

Evaluation of the devised process model by domain experts and industry practitioners (Section 7.4 and Appendices A and B) proved that it correctly reflects actual work practices, that it is comprehensive, and that it could be useful in practice and/or education. Moreover, the approach was considered to be original, visionary and unique, certainly for the domain of Design-Build project delivery, while even having the potential to have an impact on the future of the industry.

The qualitative evidence for the validity of the third premise iii) could not be quantified yet, since the implemented system is just a prototype configuration in the early stages of development, with some intrinsic robustness and usability issues. To provide a definite confirmation of the validity – beyond just a proof of concept – the process-guided planning would have to be compared against existing methods in terms of potential efficiency gains (e.g. increase of accuracy, and reduction in time, errors, forgotten issues, re-iterations, less reliant on few experienced people, etc). A useful environment for initially measuring possible performance improvements might be an educational setting, where for example students in Construction Management could simulate Design-Build delivery on a class room project in which students play the roles of the project planners. Groups of students with more or less equal competence and experience, but some with and others without system support, could be compared to measure the needed time and resulting quality of generated project planning deliverables. The system's exposure to prolonged use would steadily populate it with valuable data to serve as an initial knowledge base; a richer repository of recurrent topics, deliverables, resources, etc. Hence this approach would provide a chance to gradually optimize the system's user

interface, embedded data and data structure before submitting it to any tests in practice. Direct field-tests may not yield meaningful test results, since users are likely to judge a system's usefulness largely on its lack of initial user-friendliness rather than on its potential value in the long run.

The method of system comparison against perceived relevant design guidelines, as applied in Chapter 9, was inspired by the Cognitive Dimensions approach (Green and M. Petre 1996). This qualitative evaluation approach in the field of Human Computer Interaction (HCI) was devised to evaluate mappings between data structures, independent of actual implementations, along criteria such as consistency and error proneness. This method helps to provide a proof of concept without having to do user trials on a prototype system which is still in its early stages of development.

Before extensive quantitative testing, even in an educational setting, additional research and development should be considered, as described in Chapter 12 (Future Research). For example, the dialogue support module should be fully integrated with a dialogue-enabled process modeler, and execution environment, to be able to benefit from the full power of the multi-layered support.

Overall, findings from the three-tier hypothesis testing thus far seem to provide sufficient proof of concept to warrant further research in the direction of process mediated project planning.

CHAPTER 11

CONCLUSIONS

This dissertation aims to make project planning in the Architecture, Engineering and Construction (AEC) industry less dependent on individual skills, experience and improvisation by introducing a meta-process model that captures the logic of project planning in a given domain and from the perspective of a particular client organization. The meta-process model consists of a set of workflows that are linked to project information templates. Enacting this model enforces a more systematic approach to the planning of actual projects. The meta-process drives the interactive planning activities across organizations. As a demo, the approach was applied to the domain of Design-Build project delivery, for which a detailed workflow model was developed. This process model is a domain-specific, collaborative and detailed subset of the larger Project Management Body Of Knowledge, an abstract project management framework put forward by the US Project Management Institute.

Project planning is a dynamic, inter-organizational and collaborative process which does not lend itself to the notion of a purely mechanistic task execution. In this dissertation a hybrid approach is developed which mixes high-level task logic and information templates with the execution of structured dialogues between planners. Whereas a

conventional workflow can be viewed as a “Task Manager”, a structured dialogue can be regarded to include a “Team Organizer”. For that to be possible, a dialogue taxonomy extension to existing workflow modeling technology is proposed based on a literature review and analysis of dialogue theories.

The main contributions of this dissertation are a new approach to computer-mediated process-driven project planning, a detailed workflow model of Design-Build project delivery, and a WF modeling extension to support the capture and management of structured dialogues.

To demonstrate the application of the proposed concepts, a prototype system is presented which builds on an existing collaborative virtual environment developed in the European e-HUBs research project. This experimental, but full-featured Web-based platform supports the enactment of workflows that are generated with an integrated custom process modeler built on JaWE. Its workflows are expressed in the syntax of the neutral process definition language XPDL, a standard set by the Workflow Management Coalition. The structured dialogue extension was demonstrated through a separate dialogue management prototype developed as a MS Access database module. The applied system configuration, though operational and useful for demonstration purposes, is still a prototype in its early stages of development, thus inhibiting extensive field testing yet. However, initial evaluations of the system’s overall idea by industry practitioners and domain experts have provided a preliminary proof of concept in support of the hypothesis that project planning will benefit from process mediated structured dialogues.

CHAPTER 12

FUTURE RESEARCH

The preliminary results of this dissertation justify further research and development of process driven project planning with support for structured dialogues. In order to further the idea, several avenues of inquiry and fine-tuning come to mind.

Dialogue Integration

For simple lack of time and resources on an individual Ph.D. dissertation like this, the implemented prototype system had to be built on a platform that does not fully support the proposed innovative syntax extensions for structured dialogues. An integrated environment is necessary with both a process modeler and an associated enactment environment able to handle structured dialogues attached to workflow activities. With enough future standardization, one could imagine that a dialogue-enabled process could eventually even be run between several different user-preferred platforms.

Knowledge Retention

The mechanism to make processes and dialogues evolve and enrich “themselves” over time, beyond project and company borders, requires implementation of data exchange between individual project participants and the professional community at large (e.g. best

practices, resources, etc). Although the proposed dialogue taxonomy accommodates such prospective interactions, the same must be true for the existing workflow part of the syntax, to which the dialogues are linked. Moreover, the process modeler and/or CVE would have to be capable of sending back and forth modeling objects that are labeled as “public” resources. Furthermore, the resulting dynamic library of process embedded data must be managed somehow, either through an active user community (self regulation) or through a responsible central stake-holding entity with some authority, such as a trade organization in the AEC industry, an academic institution, the government, or a commercial organization. As a comparison, “open source” communities in the software industry have proven track records in joint development efforts through free exchange of knowledge to the benefit of all.

Enhanced Workflow Modeling Capabilities

Currently available workflow modeling standards only provide a rudimentary set of basic interoperable modeling entities, for example the so-called “Minimum Meta Model” of the Workflow Modeling Coalition described in Section 6.2. Not only would this model need to be expanded along the lines described in the above two paragraphs, but several additional enhancements would be desirable. Important features that could be supported are for example the collaborative definition of processes (described in Section 6.2.2), and run-time process adaptation i.e. exception handling and/or permanent process design changes. For example, a running process may require the dynamic addition of an additional “swimlane” (actor) at some point. The workflow technology must allow such flexibility, without any running process instances collapsing.

Concept Scalability

Ideally, practitioners would gradually compose a library of processes or detailed sub-processes within larger more general processes. Each of these potentially overlapping workflows will require its participants to submit deliverables (Workflow Relevant Data). For a smooth integration of parallel running processes, deliverables may need to be classified, in case several processes are working on the same data simultaneously. An agreed naming convention or indexing system for project deliverables may be necessary to be able to coordinate and identify who is doing what within a project, and to prevent duplication of efforts. This classification of deliverables could cover typical industrial concepts like Change Orders, Requests For Information, and punchlists. The taxonomy of dialogue entities (topics, resources, etc.) and Workflow Relevant Data (deliverables) would thus have to be mapped on industrial concepts so as to categorize them adequately. That way, a project partner could for example easily look up all Change Orders on the project irrespective of the processes in which they were generated and whether he was involved in those processes or not. Also, project partners would be made aware if several simultaneous processes would be working to generate or edit e.g. a specific contract.

Process Model Merging

In addition to the scalability issue, companies who have not collaborated before, but who each have customized versions of the same standard workflow may want to integrate their built-up resources by merging their process models. An enhanced process modeler should provide an easy procedure for such an operation, and for copying relevant data from one process model to the other.

Usability

The implemented system architecture consists of a series of combined prototypes (the process modeler, the enactment platform, the dialogue module, etc) with many practical shortcomings such as the slow and unreliable operation of the experimental e-HUBs enactment platform. Another important drawback of this platform, is its lack of transparency of the overall process, so that actors hardly have an idea of how their activities fit within the larger workflow (downstream or upstream). Also, the system does not provide a process trail, with no access to a history of completed tasks or earlier decisions, etc. For any system to be embraced by a broader user base beyond early adopters, thorough usability improvements over time must be executed, for example on the user interface and system performance, to convince initial skeptics.

Systematic Process Generation

Many system users may not be accustomed to modeling processes by nature, habit and education, since their core expertise will likely be a construction related trade. To benefit from the proposed process mediation, a systematic approach to defining workflows may have to be provided, such as one along the steps suggested in the PMBOK.

Quantitative Testing

While it seems reasonable thus far to assume that benefits may be expected from the proposed system approach in this dissertation, eventually user tests, end-user observations, case studies and surveys on further developed system versions will have to verify whether efficiency gains and improved knowledge management indeed occur,

even though such improvements may be difficult to quantify in hard metrics of time, cost, and quality indicators. Chapter 10 (Hypothesis Testing) outlined some possible avenues for additional comparative studies through experiments in an educational setting.

In General

This chapter identified some open questions and remaining issues regarding the further implementation of a dialogue-enhanced project planning environment. While the list of potential improvements for an “ideal” system may seem discouraging, none of the described shortcomings seem too complex to resolve.

Hans 2005

APPENDIX A

QUICK SURVEY OF PROCESS AND CONCEPT APPLICABILITY

BFC / AGC Conference, Las Vegas, NV, 17 March 2005

SURVEY

With presentation: “Collaborative Planning of AEC Projects and Partnerships”

Please be candid – since truthful answers are more helpful

Fully agree
Agree
Maybe
Disagree
Totally disagree

Your Background:

- | | | | | | | |
|---|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1 | I have a lot of experience with project planning | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 | I have a lot of experience with Design-Build project delivery | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 | I understood this presentation | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 | My job description & type of company: | | | | | |

Concept:

- | | | | | | | |
|---|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 5 | A “structured dialogue” can support project planning | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 | It is hardly possible to structure the planning of our projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 | I wish I had something of a “process map” to guide my projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8 | What’s new here? I’ve seen stuff like this before | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9 | Experience of our experts make guided project planning unnecessary | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Chosen Example: Design-Build

- | | | | | | | |
|----|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 10 | The Design-Build process as presented reflects how we work | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11 | The process is so obvious that following it does not really add value | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12 | I can imagine the proposed approach being used on actual projects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13 | The system can be useful for education (learning Design-Build) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Implementation:

- | | | | | | | |
|----|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 14 | The shown implementation through e-HUBs seems practical | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15 | I fear this system integrates poorly with our existing tools | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

General Comments / Questions / Suggestions: *(use back if necessary)*

May I send you an optional Internet survey over e-mail? (Please...) If so, your e-mail:

.....

Thank you for your feedback!

Hans

E-mail: hans.verheij@arch.gatech.edu / Ph: 404-918-6314



This survey will be picked up from your table by me around noon

APPENDIX B

QUICK SURVEY RESULTS

BFC / AGC Conference, Las Vegas, NV, 17 March 2005

5 = Fully Agree, 4 = Agree, 3 = Maybe, 2 = Disagree, 1 = Fully Disagree

5 = Fully Agree, 4 = Agree, 3 = Maybe, 2 = Disagree, 1 = Fully Disagree

- 1 I have a lot of experience with project planning
- 2 I have a lot of experience with Design-Build project delivery
- 3 I understood this presentation
- 4 My job description & type of company: (See below)

5 A "structured dialogue" can support project planning
6 It is hardly possible to structure the planning of our projects
7 I wish I had something of a "process map" to guide my projects
8 What's new here? I've seen stuff like this before
9 Experience of our experts make guided project planning unnecessary

Chosen Example: Design-Build

10 The Design-Build process as presented reflects how we work

11 The process is so obvious that following it does not really add value

12 I can imagine the proposed approach being used on actual projects

13 The system can be useful for education (learning Design-Build)

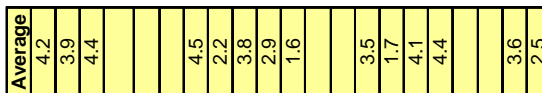
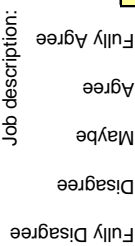
Implementation:

14 The shown implementation through e-HUBs seems practical

15 I fear this system integrates poorly with our existing tools

General Comments / Questions / Suggestions: (See elsewhere)

Y
Y
N
N
Y
Y
Y
Y
Y
Y
Y
N
Y
Y



Survey:

Partner Construction law firm
Construction Delivery
President General Contractor
Business / Envir Engr Constr Company
Ph.D. Stanford Univ, experienced project planner
President Broker / Consultant, heavy construction
Vice Chairman, Contractor
Former Project Maanager US Airforce, Ph.D.
President / CEO Electrical Contractor
Senior Vice President, CM / Contractor / Builder
Academic, Construction Management
Chairman Arch / Eng firm
President small general contractor
Dir. of Strategic Biz Planning, mgt consulting firm
Retired Construction / Engr Consultant

5	4	5	5	4	3	5	5	5	5	5	3	4	4	5	1
4	3	3	3	4	3	5	4	5	5	4	3	3	5	4	4
5	5	4	5	5	3	4	5	5	5	4	4	4	4	5	3
5	5	3	4	4	4	5	5	5	5	3	5	3	5	5	4
1	4	2	2	2	4	2	1	2	2	2	2	2	4	4	
4	4	2	3	4	4	4	4	4	5	4	4	4	3	4	
3	2	4	4	3	3	2	1	3	3	3	2	2	4	3	
1	2	2	1	1	3	2	1	2	1	1	2	2			
4	3	2	3	4		4	4	3	5	3	4	3	4		
1	2	3	1	1	2	2	1	2	2	2	1	2	2	2	
4	4	3	4	5	3	4	5	4	5	4	4	4	4	4	
5	4	3	5	4	4	5	5	4	5	5	4	5	4	4	
4	4	2	4	4	3	4	5	3	4	3	4	3	4	3	
1	3	4	1	3	3	2	2	3	3	2	2	3	4	3	

APPENDIX C

AIA A191 CONTRACT EXCERPT ON DESIGN OWNERSHIP

A191: Standard Form of Agreement between Owner and Design/Builder

Part 1 Agreement, Article 3: Ownership and Use of Documents and Electronic Data

3.1

Drawings, specifications, and other documents and electronic data furnished by the Design/Builder are instruments of service. The Design/Builder's Architect and other providers of professional services shall retain all common law, statutory and other reserved rights, including copyright in those instruments of service furnished by them.

Drawings, specifications and other documents and electronic data are furnished for use solely with respect to this Part 1 Agreement. The Owner shall be permitted to retain copies, including reproducible copies, of the drawings, specifications, and other documents and electronic data furnished by the Design/Builder for information and reference in connection with the Project except as provided in Paragraphs 3.2 and 3.3.

3.2

If the Part 2 Agreement is not executed, the Owner shall not use the drawings, specifications, and other documents and electronic data furnished by the Design/Builder without the written permission of the Design/Builder. Drawings, specifications, and other documents and electronic data shall not be used by the Owner or others on other projects, for additions to this Project or for completion of this Project by others, except by agreement in writing and with appropriate compensation to the Design/Builder, unless the Design/Builder is adjudged to be in default under this Part 1 Agreement or under any other subsequently executed agreement, or by agreement in writing.

3.3

If the Design/Builder defaults in the Design/Builder's obligations to the Owner, the Architect shall grant a license to the Owner to use the drawings, specifications, and other documents and electronic data furnished by the Architect to the Design/Builder for the completion of the Project, conditioned upon the Owner's execution of an agreement to cure the Design/Builder's default in payment to the Architect for services previously performed and to indemnify the Architect with regard to claims arising from such reuse without the Architect's professional involvement.

3.4

Submission or distribution of the Design/Builder's documents to meet official regulatory requirements or for similar purposes in connection with the Project is not to be construed as publication in derogation of the rights reserved in Paragraph 3.1.

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Hans Verheij was born in the Netherlands in November 1972. He received his Masters in Architecture Cum Laude from Eindhoven University of Technology, specializing in computer visualizations through 3D building models, animations, virtual reality, etc. Funded by a Fulbright scholarship and a grant from the Dutch Talent Program, he started his doctorate in the Building Technology track in the College of Architecture at Georgia Tech. His research focuses on Internet collaboration in general, and in particular a) the application of networked game engines and b) process support by structured dialogues in online environments. As a Graduate Student Assistant he developed among others a document management system and an interactive online campus map for the Capital Planning and Space Management Department of Georgia Tech.