The OfficeObjects® WorkFlow Business Process Lifecycle

Anna Staniszczak, Witold Staniszkis

Rodan Development

1 Introduction

From the application point of view one of the crucial issues of every software technology and tools is to support them with an appropriate methodology. Our methodology stems from extensive experience in the BPM software tool development, resulting in design and implementation of the OfficeObjects® platform [OfficeObjects..], as well as from implementation of large scale BPM solutions in the public administration.

Methodology presented in this chapter has matured over several years of intensive use and refinement. The ensuing discussion covers the entire business process life-cycle form the initial conception of a BPM application solution thru to the continuous business process improvement.

2 The BPM approach

Information technology has been one of the principal enablers of the fast growing BPM field. Yet the process orientation has its roots in the management science field although business process re-engineering is the principal driver of the organizational change in a modern enterprise. Consequences of a BPM project are reaching far beyond the responsibility of an IT department and often they affect directly the mission and the strategy of an enterprise by providing support for the underlying critical success factors (CSF) . Hence, a new multi-disciplinary approach to a BPM project methodology is an indispensable ingredient of any successful project. The situation is best illustrated by a new buzzword "invasive IT" highlighting the role of the process-oriented information systems in creating lean and agile enterprises capable to withstand the global competition.

The multi-disciplinary agile BPM project teams with role involvement varying over time are the pre-requisite of any successful BPM project. The strategic project phases, dealing with identification and framing the key business processes of an organization, require knowledge and experience far beyond typical capacities of an IT consultant. Yet, on the other hand, the methodological knowledge, the technological erudition, and proficiency with the software tools supporting the design process are the principal enablers of a successful BPM project. We are invariably in the situation where all project team members must deal with new issues, often remote from their professional experience, in the course of the project. Therefore, all techniques that may steepen the learning curves of the project team members are beneficial to the quality of the project results.

Due to the technological focus of this chapter, we rather identify issues then provide hard and fast rules, in particular with respect to the early BPM project phases, pointing to references that constitute

Chapter 3 in BI Application Tools in Knowledge Management and Strategy Development: Methodological aspects and case studies, LAP LAMBERT Academic Publishing, Germany, 2016.

sound and proven methodology information sources. On the other hand we strive to provide sufficient information to allow a BPM project team to fare safely through the project life-cycle roadmap.

Worthy of our process orientation, we look at the BPM project life-cycle from the design process perspective highlighting the project team member roles, the project activities and their relationships (i.e. the project graph), and the project deliverables. Consistently with the classical business process re-engineering loop., we view any BPM project as a continuous loop initiated by the "big bang" radical change of inventing the "new" brave reality enabled by the "to be" business processes, and then steadily going through the continuous step-wise process improvement cycle resulting in less radical, yet steady, business process refinement. Although our methodology provides guidelines for a BPM project supported by any standard BPM software tools, we tend, in particular while discussing project deliverables, to concentrate on those issues that can satisfactorily be dealt with in the OfficeObjects® environment. There exist a host of good books, one may say classics, that provide important information sources discussing many of the issues raised here in much greater detail. We recommend [Davenport1993, Jacobson1995, Koulopoulos1995, Muehlen2004, and Sharp2000] for the early BPM project phases and [Aalst2002] for the execution level design of workflow processes.

3 The BPM project team roles

The multi-disciplinary project team dealing with such critical issues as business processes must comprise actors competent to resolve all design problems throughout the entire BPM project life-cycle. The focus of BPM projects is on enabling an initial radical change of such critical areas of an enterprise as its core business processes, often cutting deep into the organisational tissue. Existing business processes may be abandoned, followed by drastic modification of the organisational structure, and new ones are created to provide support for a more effective and efficient organisation. Instituting such changed requires sufficient power in an organisation to at least cover the functional areas undergoing the radical change. In the case of the BPM projects, it may often be the entire enterprise functional structure. To design business processes cutting across the "functional silos" one requires to assemble knowledge corresponding to all functional areas involved. This requires fostering collaboration of a largely diversified group of "domain experts" including those representing the notoriously hermetic IT field, typically using different and sometimes ambiguous "domain ontologies". Yet the task at hand calls for good communication among the BPM project team members to exploit synergies to be derived from the wealth of tacit knowledge to be potentially shared by all participants of the project team.

The broad division of expertise usually required in BPM projects is the non -IT/IT line categorising the team members into the application domain vs. the technological categories. Although the enabling role of IT is beyond question, the primary role in business process design, step-wise refinement, and change management is played by the application domain experts.. The specific role of the BPM Project Sponsor falls on the lap of the executive management and the respective manager power must correspond to the scope of business processes within the terms of reference established for the project. We consider the project sponsor role to be external to the BPM project, in fact she acts as the principal client of the project, although the support and motivation stemming from sufficiently powerful position is one of the critical success factors.

Importance of the domain knowledge, both specific for a given organisation, and general pertaining to the domain "best practices", is the mantra of BPM projects. The application domain participants of a BPM project comprise the following distinct roles:

- The Domain Expert role
- The Management Consultant role
- The Process Owner role
- The Process Participant role

The **Domain Expert** role, encompassing representative knowledge from all functional areas affected by the business process, is usually played by employees from the corresponding parts of the organisation carefully selected on the basis of their professional position and peer esteem. The latter is indispensable for gaining user acceptance (sell in) during the enactment phases of the BPM project. Often happens that the best candidates for the role are usually the most busy ones, therefore, it is critically important to explicitly define and assign sufficient resources, in terms of time and number, to cover this role. Domain experts provide insight into the existing situation and they are in the position to best explain the reason for change and the intricacies of the existing "As-Is" business processes. They are also in the best position to generate and validate ideas leading to the new "To-Be" business process in the context of their respective functional areas.

The **Management Consultant** role should be filled in by individuals expert in the BPM field, the application domain experience is not indispensable, whose principal contribution to the project is the BPM methodology knowledge and the team building and mentoring skills. Experience in BPM projects should provide knowledge of the best practices pertaining to the application domain. Note that the emerging BPM field, exploiting the notorious lessons learned during the BPR (business process re-engineering) era, reconciles, often contrasted by management scientists, approaches of the radical change (BPR) versus the continuous process improvement (TQM). The past experience shows, that the management consultants should have sufficient technological knowledge to foster good communication among the non-IT and the IT categories of a BPM project team members.

The **Process Owner** is an individual responsible for the business process enactment, supervision, and maintenance. Usually such an individual is a middle level manager of an enterprise using the business process responsible for meeting the business metrics and constraints established for the process, as well as providing the first level support and supervision to the process participants acting within the predefined roles. Continuous monitoring of the business process enables the process owner to evaluate improvement claims proposed by the work participants as well as the process clients (external or internal). Apart from the usual coordination responsibilities a process owner acts as a coach stimulating the desirable behaviour of all process participants. Although a typical process owner is the representative of the application domain community, rather than of the IT background, she should be sufficiently trained to change the business process behaviour by modifying such process parameters as the routing predicates, the work participant assignment predicates, as well as other business rules declaratively specified in the process definition.

The **Process Participant** is an actor of business process instances allocated to selected process activities via the role model specification mechanism. In fact, coordination of work participants is the primary rationale for the BPM technology. The participant behaviour within a business process is largely determined by the business process specification, and sometimes by the prior behaviour of a process instance. Although, the process participant focus is on performing business tasks established for the process activities, she may be an important originator of the process improvement claims. Typically, in a business process structured enterprise, a process participant may act within many different roles defined for a number of usually related business processes.

Other business process stakeholders, such as the customers receiving services implemented by the business process, or enterprise management monitoring the business-oriented key performance indicators (KPI's), are not directly involved in the mechanics of the respective business processes. Although, they may voice important opinions and claim process improvements, we do not consider their roles to be directly involved in a business process life-cycle.

The BPM field would not grow to its current importance and dimension if not for the information system technologies jointly providing the enabling BPM platform. Hence, the IT expert roles are indispensable in the BPM multi-disciplinary project team. Some of the roles are specific to the workflow management technology, some other are always required regardless of the information system architecture. Naturally, we concentrate on the former ones, due to their impact on the business process life-cycle. The IT roles directly relevant to the BPM projects are:

- The Information System Architect role
- The Information System Implementer role
- The Quality Assurance Auditor role
- The Information System Administrator role

The **Information System Architect** is responsible for the conceptual design of the entire IT infrastructure supporting the business process. The information system architect is the principal intermediary between the IT experts responsible for design and implementation of information systems underlying the business process, thus her participation in the early phases of the business process life-cycle is mandatory. In fact, the information system architect is involved, in varying capacity, in all phases of the BPM project life- cycle. The conceptual design of the information system infrastructure includes definition of the conceptual data model and the workflow process data container, as well as mapping of the business process graph specification onto the specific (i.e. OfficeObjects® WorkFlow) workflow management system representation. Typically, business processes are supported by data and user-visible functions of the pre-existing information systems. Hence, the enterprise application integration (EAI) techniques are an important ingredient of the required information system architect's skills.

The **Information System Implementer** takes over the business process conceptual design to perform all technical design and implementation steps including the final refinement of the workflow process implementation model as well as design and implementation of the underlying information system functionality. In fact, the information system implementer's duties, apart from the workflow process implementation, are not different from similar roles specified in all generally accepted information system development methodologies (e.g. the RUP methodology).

The **Quality Assurance Auditor** surveys all steps of the IT-oriented phases of the BPM life-cycle to ensure compliance with the implementation standards adopted within the IT department. The QA auditor's responsibilities cover design and development of acceptance and regression test scenarios, as well as execution of the QA trials to certify the workflow process and the underlying information system functionality. The QA auditor's competencies are determined by most leading information system development methodologies.

The **Information System Administrator** performs standard system administrator's duties ranging from new information system deployment thru to system monitoring and back-up. There are no system administration requirements specific for the workflow management technology, so the standard system administration job description adopted by the respective IT department may be used to administer the workflow process operation.

4 The BPM project phases

A BPM project may evolve following a standard spiral information system development model. However, especially in the early project phases, the business process focus calls for strong integration of management and IT-related skills. The BPM project development team requires varying multi-disciplinary skills throughout the project life-cycle. A cross reference of project participant roles and project design teams corresponding to the BPM project phases is shown in Table 1.

Table 1. The BPM project team/ participant role cross-reference.

The BPM project design team	The BPM project participant roles							
	DE	MC	PO	PP	ISA	ISI	QAA	SA
Strategy Design Team	X	X			X			
Conceptual Design	X	X	X		X			
Implementation Team					X	X	X	
BP Deployment Team	X		X	X		X	X	X
BP Operations Team	X	X	X	X	X	X		X

DE - the Domain Expert role

MC - the Management Consultant role

PO - the Process Owner role

PP - the Process Participant role

ISA - the Information System Architect role

ISI - the Information System Implementer role

QAA - the Quality Assurance Auditor role

SA - the Information System Administrator role

Although, the early phases of a BPM project may be governed by methodologies supporting the BPM conceptual design tools, we present the complete life-cycle, in order to highlight the minimal design modelling requirements underlying the interaction of distinct BPM project development teams. An important aspect of our approach is the consistent use of modelling techniques and formalisms during all project phases supporting the stepwise refinement of design deliverables to achieve the detail level required by the respective phases. An overview of the BPM project life-cycle is shown in Figure 1.

Introduction of the **BP Operations Team** comprising almost all roles defined for the BPM project life-cycle is to provide a representation of the continuous business process improvement initiatives inherent in the business process operations phase. Note, that the domain expert and process participant roles are not necessarily disjoint, in fact, in most practical situations domain experts (i.e. opinion leaders), instrumental in the project sell-in in the target organisation, are also the process participants.

Consistently with the “continuous business process improvement” paradigm, we believe that the BPM project life- cycle spans the entire period of the business process operations. Hence, the project life-cycle is a closed loop very similar to the information system maintenance activities. An important difference is, that, due to the declarative nature of the business process specification, an important part of the process improvement decisions may be independently implemented by the non-IT staff (i.e. by the process owner). We shall discuss the issue of the continuous process improvement in more detail in Section 4.5.2

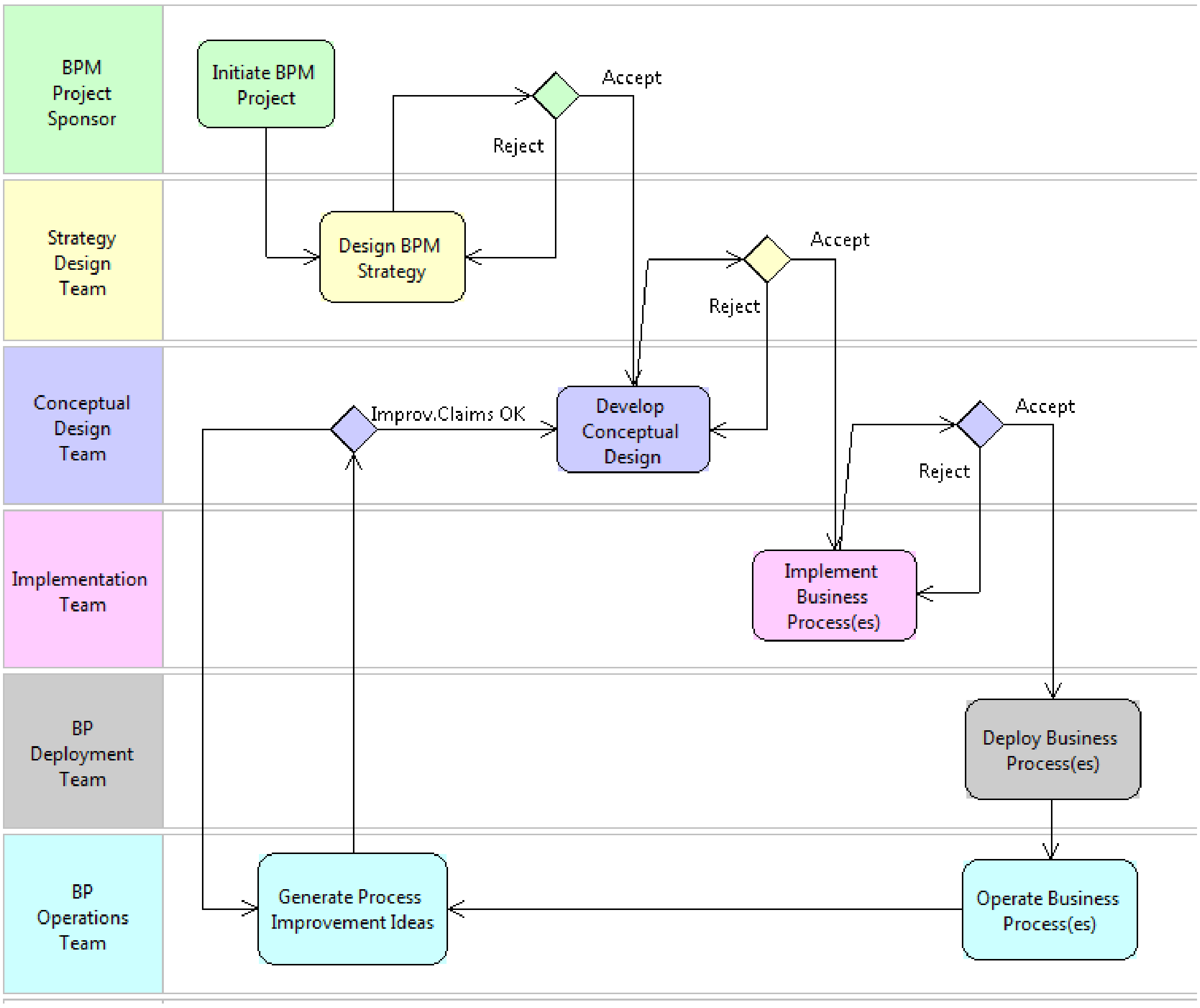

Figure 1. The BPM project life-cycle

4.1 The BPM Strategy Design Phase

A fundamental concern of introducing the BPM approach into an organisation is abandoning the traditional functional view of the universe of discourse, usually exemplified by a hierarchical view of the organisational chart, in favour of a process-oriented view. Processes, if identified properly, always span organisation chart boundaries serving external or internal customers and involving different members of the organisation. One commonly considers the business processes serving external customers as the core business processes serving the mission and implementing the strategy of an organisation.

The **process identification** is what causes most problems in the initial phase of the BPM project and a common mistake is to refer to a work activity underlying a process rather than to its result and the triggering event. The "Event-tasks- result" framework is fundamental for the process identification and it is duly reflected in our business process definition. The work tasks inter-related within a process by causal relationships are commonly executed within different parts of the organisation by process participants, who are required to have appropriate skills and decision prerogatives. A well-defined business process is always enacted in response to an event and it produces a measurable and countable result for the process customer. Other stakeholders who may take interest in the process are its participants, organisation management, and actors external to the organisation participating in the process.

Business process names may make a crucial difference in business process identification. It is recommended that the *Verb-Noun* format, that clearly identifies the intended process result, is used for the process name.. Usually noun should refer to an important business artefact, such as an Invoice (Pay-Invoice), or a Shipment (Receive Shipment). Other vital steps of the process identification are definition of an event triggering the business process instance, specification of the process stakeholders and the expected results, as well as identification of the major steps required to achieve the desired result. Brainstorming sessions involving multi-disciplinary teams are commonly used at the initial phase of business process identification.

The BPM strategy should answer other vital questions, other than the process identification, such as *Why* we should occupy ourselves with this particular business process, and *What* we want to achieve by introducing its new, re-engineered version. The strategic assessment of business processes produces a set of candidates for a BPM project qualified with their relative priorities reflecting the cause for action with respect to a particular process. The process-oriented perspectives adopted by the strategy design team are the process stakeholders, the BPM enablers, and the business process metrics.

The BPM enablers collectively determining the behaviour of a business process, introduced and discussed in [Sharp2000] include the following areas:

- Process workflow design
- Application of information technology
- Motivation and measurement
- Human resources
- Policies and rules
- Facilities design

The **process workflow design** focus allows for concentration on the potential for process improvement in terms of removing existing bottlenecks, losses and inefficiencies. This perspective is further refined and expended during the subsequent steps of the BPM project.

The **information technology** is commonly viewed as the pre-dominant factor in business process re-engineering, yet, due to costs and delay involved, it is often hampering introduction of the required change. Substantial investment in hardware, software and application solutions, petrifying the “As-Is” business processes without causing the desired radical change in their actual performance, brings reluctance to endure further substantial IT investment that may be required by the new “To-Be” processes.

The **motivation and measurement** schemes determine behaviours of process participants and stakeholders, that may, and often are, be counter-productive with respect to the desired results. The reward and punishment schemes associated with the business process metrics should promote achievement of organisation’s efficiency and effectiveness at levels that match those of the competition or indeed constitute the “competitive advantage”.

The **human resources** involved in a business process determine achievement of the projected metrics and they may adversely affect achieving of the BPM projects results. Matching work participant qualifications with requirements of business process work tasks, determined by the work participant role model, is fundamental for smooth process execution in a business environment.

The **policies and rules**, often viewed by BPM teams as project invariants, may block many potential ways of radical improvement of organisation's business processes. Often a productive review of policies and rules, some of which may have been introduced years before, may bring about radical improvement in use of scarce process resources and remove critical bottlenecks.

The workplace design and physical infrastructure, collectively dealt with under the heading **facilities design**, often determine the quality of work of the knowledge workers in modern organisations. Improvement of the work place sometimes brings about results that might not have been achieved otherwise.

We shall return to the above business process enablers, at varying levels of detail, while discussing the subsequent BPM project phases. Initially the BPM enablers collectively determine the strategy of a BPM project. The business process metrics may initially provide insight into the relative business process weight, i.e. importance, in an organisation. Occurrence frequencies, execution times, and cost of a business process, collectively referred to as key performance indicators (KPIs) determine the relative priorities of BPM projects.

The case for action and the business process vision are usually qualitative statements that attempt to provide answers as to "Why" one should deal with the particular process, and to "What" such project is to achieve. However, the qualitative analysis should be supported by the relevant KPIs pertaining to the competitive situation of an organisation, or formulating the desired outcomes of the BPM project.

Results of the BPM strategy phase should be summarised in a collection of BPM posters, usually pertaining to the application domain within the terms of reference of the project. The project posters, such as the form presented in Table 2, should be widely disseminated among the process customers and stakeholders to foster discussion and involvement. The "To-Be" process "sell in" goal may be achieved much easier, if a wide audience of individuals to be involved in the actual business process execution influences the early stages of its design.

The graphic modelling notation recommended for the strategy design phase is the Use Case Diagram to be developed for the application domain. At this design level, the use cases correspond to business process classes and actors usually represent process customers. Note, that, following Jacobson's recommendation [Jacobson1995] we are overloading the Use Case Diagram semantics with respect to their general use in software engineering. Even though, it is our experience, that the graphical representation of the application domain enhances communication among the business process stakeholders.

Table 2. The business process poster.

Process name					
Event	Tasks				Result
Cause for action			Vision		
Actors		IT application functions		Metrics	

4.2 The Business Process Conceptual Design Phase

The business process conceptual design phase is performed for an application domain comprising a collection of related business processes or for an individual business process. The principal objectives of the conceptual design phase are to communicate the "change" resulting from the modified or new business processes to the organisation management responsible for the BPM strategy, as shown in Figure 1, and to provide sufficient design information to enable the ensuing business process implementation phase. The conceptual design life-cycle is shown in Figure 2.

All conceptual design steps are performed collectively by the conceptual design team members co-ordinated within individual design steps by a team member providing the respective leading expertise. The conceptual design team member roles and the co-ordination responsibilities are shown in the swim-lane diagram presented in Figure 2.

Some roles may involve the same individuals wearing different role "hats" at distinct times of the design life-cycle. A typical situation would be to have an individual of the Process Owner role play the Domain Expert role, or vice versa, and the Information Systems Architect role participant perform as the Management Consultant. Depending on the conceptual design area several individuals performing respective roles may participate in the design team.

Usually an individual designated to play the Process Owner role would be responsible for presenting the conceptual design to the BPM strategy team and to the potential business process participant community. Gaining acceptance of the latter category is an important part of the business process "sell in" activities indispensable for success of the process deployment phase. Empowerment of the Process Owner role to represent the conceptual design team requires building up sufficient conceptual design expertise, in particular with respect to the business process graph specification. Such expertise proves beneficial during the business process operations phase enabling the Process Owner to manage process maintenance and change control duties.

The BP conceptual design phase entails use of the formal modelling notations at the matching abstraction level to be further refined during the ensuing phases of the design life-cycle. The modelling techniques and their use in the conceptual design phase are summarised in Table 3.

Table 3. Modelling techniques used in the conceptual design phase.

Modelling Technique	**Use**
BPMN Process Model	The business process model is to be specified on several abstraction levels following the step-wise refinement character of the "As-Is" process assessment and of the "To-Be" process design phases.
BPMN Handoff Diagram	The handoff diagram presents involvement of each participant role in a process. All process participant roles must be specified at this level.
BPMN Milestone Diagram	The milestone diagram is to present the key steps that determine flow or impact overall performance. It refines the handoff diagram with steps illustrating achievement of milestones, decisions affecting flow in a significant way, handoff tasks introducing delay or expense, significant iterations.

BPMN Logical Diagram	This diagram level refines the “what happens” information of the preceding modelling levels with information “how” the process is to be implemented. Abstract process graph nodes are expanded with detailed task and decision nodes presenting the complete process flow.
Use Case Diagram	Use cases are shown to illustrate the information system functionalities supporting execution of a business process activity. It is a good practice to present a related collection of application functions, usually implemented by a distinct module of the underlying software architecture, as a single use case. Collectively the use cases pertaining to a specific process task represent its dialog model.
Sequence Diagram	Sequence diagrams may be optionally used to graphically illustrate the dialog model scenarios (see Table 5). Time dependencies modelled by the sequence diagram are to be refined in the subsequent development phase to implement required controls constraining the use of application functions within the dialog models.
Class Diagram	Specification of the conceptual data model representing the business process view of its own and the pre-existing data resources. All persistent object classes required by the process should be specified. In the case of an application domain comprising many processes, the partial conceptual data models defined for individual processes should subsequently be integrated.
Object Diagram	The Object Diagram notation should also be used to model the business process Data Container structure.

The conceptual design modelling techniques should be used to develop a complete design specification regardless of the conceptual tool environment selected for the task. The “To-Be” process information provided by the conceptual design phase deliverables should be sufficient to perform the implementation phase without recourse to additional information. Mappings from conceptual design notations of most popular conceptual design environments and the OfficeObjects® WorkFlow execution level process specification are presented in [OfficeObjects® WorkFlow…]..

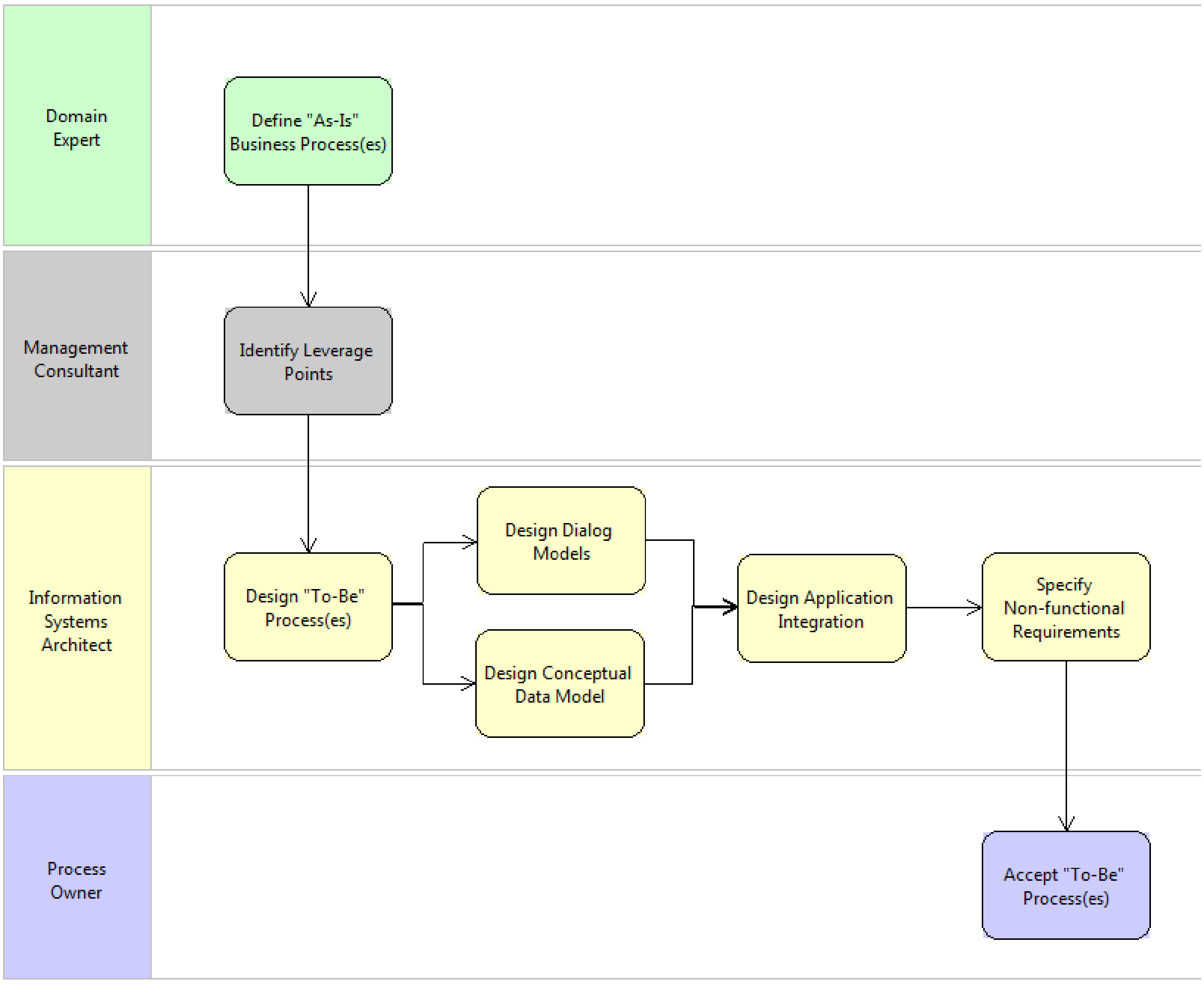

Figure 2. The business process conceptual design life-cycle

4.2.1 Define the "As-Is" Process

Understanding the application domain, although critical for a successful conceptual design, must not blur the focus of the design team to create a radically improved reality by introducing new or re-engineered business processes. A formal specification of the "As-Is" business process is an indispensable ingredient of the learning curve, in particular for the IT-oriented role participants, yet the BPMN process graph abstraction level must be kept under tight control. Usually, the process modelling level refinement terminates when sufficient knowledge regarding process behaviour has been gained and communicated to all design team members enabling them to discuss and indicate the business process leverage points. The usual control question "Is further refinement of the model enhancing my insight into the "As-Is" process mechanics?" is a good thumb rule to control the level of detail. Note, that this approach my result in a mixed conceptual process model specification in terms of the BPMN diagrams. Some parts of a business process diagram may remain at the handoff level, while other may have to be expended down to the logical level.

The "As-Is" business process knowledge must also comprise information regarding the process participants (actors) and their respective roles, the process data requirements and the existing information system functional support, as well as the key performance indicators (KPIs). It may happen, in particular in the case of an application domain comprising several related business processes, that the "new" design will propose abandoning the "As-Is" business process altogether or postulate its re-engineering beyond recognition. However, the process knowledge gained at this level is indispensable for the ensuing conceptual design steps. In particular, the business process metrics expressed as the process KPIs provide an important performance baseline to measure the improvement gained by the "To-Be" process design.

A thorough understanding of the process may unveil such "As-Is" process constraints as interfaces and commitments to other business processes. This provides critical design information, not only with respect to other related processes within the application domain, but often to processes and/or systems that may be outside the terms of reference of the BPM project. Other constraints, such as for example legal regulation or immutable business rules (design invariants) must be identified and documented for the process.

The "As-Is" business process definition step should be performed in a series of brainstorming sessions moderated by the "Domain Expert" with the methodological assistance of the "Management Consultant" and the "Information Systems Architect". Usually, the formal modelling tasks will be the information systems architect's responsibility, yet it is required for the other participants to fully understand the modelling semantics. The recommended composition of the design team performing this step has been presented in Table 1, although decisions regarding the team participants should match the task at hand and the actual situation within the organisation.

4.2.2 Identify Leverage Points

A complete "As-Is" process definition should have provided sufficient information to assesses the process in the context of six business process enablers characterized during the preceding design phase. Information collected while framing the business process during the strategic design phase should be refined in this step and assessed according to the following design perspectives:

- Process workflow design
- Application of information technology
- Motivation and measurement
- Human resources
- Policies and rules
- Facilities design

The above categories provide guidelines for potential business process improvements to be proposed for the corresponding "To-Be" process. Such leverage points, if properly identified and characterized, provide a sound base for the critical appraisal of the "To-Be" business process design.

Note, that many leverage points may lay outside the traditional IT focus usually adopted during the conceptual design phase of an information system. This is the principal difference between the BPM project and the "traditional" information system design. The holistic approach of BPM methodologies is the essence of the "invasive IT" paradigm based on tight coupling of the management science and the IT focus, resulting in an integrated design of radically improved business processes supported by properly calibrated information technology. The traditional approach tends to focus of user requirements engineering and, as a consequence of the typical IT-orientation of the design team, it may petrify the existing business processes not necessarily achieving results that match the "best practices" of the application domain. Such approach, although often resulting in business process improvement due to the information technology support, usually does not create the "radical change" solution that allows an organisation or business to gain and maintain the competitive advantage.

Since identification of process leverage points requires management, rather than IT skills, the design step is usually co-ordinated by the "Management Consultant" strongly supported by the "Information Systems Architect" providing the technological flair. It is important to characterise the leverage points, whenever possible, with measurable attributes, in order to provide a baseline for assessment of the required measurable characteristics of the new business process. The management skills required at this point are primarily pertaining to "best practices" of the corresponding application domain as well as to the sound knowledge of business rules and legal constraints governing the target business process.

The leverage points should refer to process metrics identified during the process framing step (see Table 2) and further refined during the "As-Is" process definition. Typical process improvement potential may be expressed in such metrics as process cycle time, process cost, percentage of process faults (e.g. missed deadlines) etc.

4.2.3 Design the "To-Be" Process

The "To-Be" business process design step represents the "creative" part of the conceptual design phase resulting in a new or largely re-engineered business process. Due to the strong IT bias of this design step it should be co-ordinated by the "Information Systems Architect" role. The primary goals for the conceptual "To-Be" process design step are:

- Specification of the BPMN model of the business process in sufficient detail to facilitate subsequent mapping onto the detailed OfficeObjects® WorkFlow process specification.
- Business process environment definition in terms of the process enablers to communicate the conceptual design information to management and possibly to key process participants.

The hierarchical approach to process graph modelling with the stepwise refinement loop is the most practical procedure to develop the BPMN process specification. The stepwise refinement iterations will normally comprise other design steps, such as dialog model design, conceptual data modelling, and application integration design. The resulting process graph should represent the complete business process topology including all process task, routing, and event activities. The following characteristics of the BPMN process model must be specified at the conceptual design level:

- Business process routing conditions specified for each routing activity.
- Business process work participant assignment specified for each activity.
- Business process activity pre- and post-conditions specified for each activity.
- Business process event triggers specified for each event activity.
- Process constraints (participant, application functions, temporal).
- Process alerts and notification rules.

The above workflow assertions are usually specified as disciplined natural language statements making reference to process and/or application states represented by the data container and/or persistent object class attribute values and method results. All concepts and terms used in the assertions should have been defined in the business process or the application domain ontology

The workflow assertion specification should be sufficiently precise to allow unambiguous mapping onto the OfficeObjects® WorkFlow BPQL predicates [OfficeObjects® WorkFlow].

The business process environment definition is organized along the following key business process enablers:

- Motivation and measurement
- Human resources
- Policies and rules
- Facilities design

Note, that the workflow design is sufficiently characterised by the BPMN process model, and the application of information technology is exhaustively dealt with in the subsequent design steps.

The motivation and measurement principles are one of the most important business process characteristics determining behaviour of process participants and management. The "what you measure matters" principle [Skinner1986] determines the mindset of process participants and management determining their work behaviour. Alignment with business process objectives and metrics must be achieved to create harmonious work environment supported by workflow management and application functionality. The key issue is to focus on process metrics that encourage the desired behaviour and to identify measures that may be counterproductive (e.g. low cost vs. quality).

One of the key results of a BPM project should be the new "reality" potentially introducing radical change in the job structure and employee empowerment. New sets of responsibilities and competences may have to be defined and the matching training schemes must enable the required transformation of the business process work environment. The "user system" perspective defined at this stage will govern the business process deployment phase of a BPM project.

Process policies and rules may substantially inhibit innovation inherent in the successful business process design and/or re-engineering. Some are legal constraints beyond the influence of the target organization and as such must be considered project invariants and appropriately accommodated in the process design. Others, and there usually are surprisingly many, derive from the traditional management mindset and the natural human resistance to change. Such factors should be identified, properly described and eliminated by the new business process design. This may require considerable executive power within the organization and it usually falls into the lap of the BPM project sponsor.

New workflow and application system support may require considerable restructuring of work environment including the workplace equipment (terminal devices, network access, etc.) and the office facilities (e.g. virtual desks). Such requirements must be properly specified to enable a smooth process deployment procedure.

4.2.4 Design Dialog Models

The work participant performing a workflow process activity is supported by any number of information system functions required to perform the task at hand. Each workflow process activity must provide such support usually implemented as new application features or as interfaces to the pre-existing applications. In the latter case, either application architecture allows for direct invocation of the required user-visible functions, or additional application integration functionality must be developed. Depending on the specific activity states, the work participant may use the available application functions differently, hence we propose a "dialog" metaphor to represent the information system user interface supporting each workflow process activity.

Dialog Models are designed for each process activity as Use Case diagrams, where a use case represents a logically related group of application functions, or an interface to a specific pre-existing application. In the case of automatic workflow participants developed as the software agents, the application functions must be available as appropriate application program interfaces (API's). The use case actors specified in a dialog model correspond to the work participant role defined for the associated workflow activity. Each use case specified within a dialog model must be refined with the use of the Use Case Description (USD) form presented in Table 4.

Although most of the USD form fields are self-explanatory, some require methodological guidelines. All assertions, analogically to the BPMN model assertions, should be specified as disciplined natural language statements making reference to process and/or application states represented by the data container and/or persistent object class attribute values and method results.

The sequence of application functions to be performed for the use case should represent prevalent flow expected for this application. Application function descriptions pertaining to pre-existing information systems invoked in the use case should provide reference to the corresponding system documentation. Exception conditions are to be specified separately.

Object classes specified in the data requirements field of the UCD form must refer to the conceptual data model defined for the business process or for the corresponding application domain. Actions on objects, defined in terms of the CRUD usage rules, are mandatory for all specified object classes.

The dialog model orchestration, defined in terms of a normal sequence of steps (use cases) and as any required number of alternate sequences of steps, is to be specified in the Dialog Model Description form shown in Table 5. Business rules governing execution of each use case should be specified as the disciplined natural language assertions.

Table 4. The Use Case Description (UCD) form.

Use Case Name	
Description	
Actors	
Pre-conditions	
Sequence of application functions (AF)	
AF	**Application function description**
Data requirements	
Action */	**Object Class**
Post-conditions	
Exception conditions	

Design notes

C – Create object
R – Retrieve object
U – Update object
D – Delete object

Table 5. The Dialog Model Description (DMD) form.

Activity Dialog Model Name		
Activity Dialog Model description		
Normal sequence of steps		
#	**Use Case(s)**	**Business Rules**
Alternate sequence of steps		
#	**Use Case(s)**	**Business Rules**
Design notes		

Note, that the business rules must directly pertain to the corresponding use cases and they should be encapsulated within the dialog model. This means that they should not refer to the assertions of the BPMN process model.

4.2.5 Design Conceptual Data Model

The conceptual data model of a business process is to be defined as the UML Class Diagram (CD) comprising all persistent object classes utilised by the process control functions or by applications invoked in the process dialog models. The data model must include both the new application object classes and the object model representations of the pre-existing information systems. The latter requirement may entail the need to reverse engineer the logical data models of legacy information systems in order to represent the conceptual level data semantics.

Although the CD conceptual data model is to be further refined during the subsequent business process implementation phase, the minimal specification requirements of an object class comprise object identifiers, all object attributes and methods referred to in assertions of the BPMN process model and of the corresponding dialog models.

The business process data container must also be specified within the conceptual data model to represent the process control function view of its attributes and methods as well as of those defined for all related object classes. The data container provides the principal data access mechanism to objects included in the workflow process data model for the OfficeObjects® WorkFlow process control functions. The data container structure specification modelled with the use of the Class Diagram notation is to be refined during the subsequent design phase.

In the case of an application domain conceptual design, conceptual data models developed for each related business process must be integrated to represent a unique CD model. Top down or bottom up conceptual data model integration strategies may be adopted.

4.2.6 Design Application Integration

Enterprise application integration (EAI) has become an important technology in itself due to large investment in legacy information systems and the growing new application development backlog. It is also a crucial IT enabler for the BPM technology, since most of workflow processes access pre-existing application functions or data bases. Solution complexity required within BPM projects may further be aggravated by the common need to inter-relate formatted and non-formatted data within repository supporting date requirements of workflow processes. We discuss most common aspects of application integration of BPM architectures, namely the functional application integration, the data integration, and the content repository based solutions.

The **functional integration** of pre-existing information systems provides access to application functions, both in terms of the user visible functions and of the appropriate API functions, required within dialog models and/or by the data container methods. The functional integration techniques vary from “green screen” connectors, emulating terminal users performing the required functions, to direct reference to legacy application components. The latter approach, although most appropriate, is not very common due to implementation limitations resulting from the coarse granularity of legacy information system architectures. The most common solutions are based on development of the object-oriented components called “wrappers” providing interface to the required application functions of pre-existing information systems.

The wrapper architecture should be based on the Web Services (WS) standard [Newcomer2002] providing a uniform interface to pre-existing application functions. Web Services provide a new layer of abstraction above existing software systems, capable of bridging any operating system, hardware platform or programming language. Supporting the program-to-program communication Web Services are basically adapters between distributed applications, which allow to map messages into a canonical format and to send them over the HTTP-based networks.

XML has been accepted as the general portable data exchange format, which is flexible enough to accommodate any data type and structure. Development of Web Services requires use of the following XML-based technologies:

- WSDL (Web Service Description Language) is defining such WS characteristics as data and message types, interaction patterns, operations to be performed on data and protocol mappings.

- SOAP (Simple Object Access Protocol) is a lightweight protocol for exchanging structured and typed information between peers in a decentralised, distributed environment. SOAP messages may be exchanged using a variety of underlying protocols including HTTP.
- UDDI (Universal Description, Discovery, and Integration) specifies a standard for registration and discovery of Web Services. UDDI repositories may be created for application domains to support identification of available WS-compliant pre-existing application functions.

The **data integration** functionality supports operations on pre-existing, heterogeneous data sets and databases providing access to all information resources required within a business process activity. The recommended approach is to define the entity-type Java Beans providing an abstraction layer for the underlying data structures. The corresponding object classes should be integrated into the business process conceptual schema CD. All required operations on data, regardless of the underlying data management technologies, should be implemented within methods of the corresponding object class specification. Obviously the data manipulation authorisations should match the data access rights granted to the work participant role specified for a given business process activity.

The **repository-based integration** of approach leads to development of a multi-paradigm information platform featuring an information object repository similar to the OfficeObjects® Repository integration architecture presented in [OfficeObjects® Document Manager]. Any content management system supporting similar data integration features may be used to create such an integration repository.

The OfficeObjects® repository [OfficeObjects® Document Manager] entails providing support for organization of information artefacts within a formal, yet user-friendly, semantic data model based on a common ontology facilitating storage and manipulation of knowledge objects typically comprising information gleaned from pre-existing heterogeneous information sources. Information may be inserted into the OfficeObjects® Repository information objects by an explicit user action performed on the information object representation rendered in the graphic user interface, or implicitly by the appropriate object class method specified either as an application method or inherited from a system information object class. Access to the repository is supported by powerful graphic interface features such as knowledge maps, intentional and extensional data model graphic navigation interface, and content object graphic presentation features based on electronic forms.

The information objects stored in the OfficeObjects® Repository may include actual data providing information snapshots pertaining to a particular time frame (a time interval, an instance), or references to external information sources, thus representing virtual data to be materialised and presented to users at content object access time. Materialization of structured and semi-structured data is controlled by the data wrapper generation rules. Information integration may also be supported by third party data extraction and report generation tools. Such information stored in the repository may be accessible via the standard OfficeObjects® Repository information object categorization, selection and browsing features.

4.2.7 Specify Non-functional Requirements

The non-functional requirements pertain to the entire IT system architecture, including both the systems software and application software, as well the underlying computer system hardware and network configurations. The systems software typically comprises software products such as OfficeObjects® WorkFlow, the Application Server, the Database Management Systems, and the

Operating System, whereas the application software comprises components implementing the required functionality and the business process workflow specification.

The non-functional requirements describe the tolerances, boundaries and standards that must be adhered to by the system in delivering the functionality to its users [Dyson2004]. Typically non-functional requirements may reflect the workload to be handled by the system under the performance constraints, or system availability expressed in terms of the acceptable failure rate and maximum downtime duration. Design patterns dealing with the corresponding design decisions entail specification of the underlying hardware architecture and the system software deployment scheme.

The objective of the non-functional requirements design step is to select the possible system architecture to balance the often divergent IT system operational characteristics. The design decision space within the business process conceptual design will usually be defined by such non-functional requirements of as:

- Availability
- Performance
- Scalability
- Security

Availability characteristics are typically expressed in terms of the meantime between failures (MTBF) and the meantime to repair (MTTR). Such reliability parameters are often specified for all computer system hardware components. On the other hand, they are notoriously hard to assess with respect to the software components of the system architecture.

Performance is measured in terms of the system throughput, usually expressed as the number of transactions per second (TPS) or the system response time. The second value may not be meaningful sometimes, since determining response time elements may lie beyond system design influence in the case of Internet based information systems. Achieving consistently acceptable performance, expressed in terms of the proportion of users experiencing interactions within the set performance constraints, is one of the baseline non-functional requirements. Methods to monitor and model system performance parameters are discussed in [Lazowska1984].

Scalability requirements are usually well defined for the process-oriented IT system architecture, since the workflow participant community is well-defined and predictable. Even though one may know the target number of users of a particular system, access patterns and frequencies may vary considerably due to the changing business process environment characteristics. Also growing the system implementation to effectively involve the target participant community may be a lengthy process. Thus maintaining the required system performance in view of the growing workload to be accommodated by the expansion of the underlying computer system hardware configuration, may be an important constraint for the implementation phase.

Security entails access control and system integrity features commonly specified for all IT system architectures. In fact, workflow management enhances security by introducing the process participant role model and the push paradigm of the user/system interaction. Yet, the prevailing Internet-based architecture, possibly involving several legacy applications and data bases to be integrated with the use of the newly developed process control and application capabilities, opens many loopholes to be exploited by system intruders. Although achieving 100% security may sometimes be cost prohibitive, the required level of trust must be defined and substantiated to justify additional development and possibly software licence costs.

The system architecture specified at this stage constitutes guidelines and constraints for the ensuing business process implementation phase. Appropriate system acceptance test procedures should be devised to effectively check the required non-functional characteristics of the system.

4.3 The Business Process Implementation Phase

The business process implementation activities entail all technical aspects required for development of an executable workflow process. The technical design modelling decisions are constrained by the business process models developed during the preceding conceptual design phase, in the sense that they should refine the conceptual model with information resulting from technical design decisions rather than providing additional conceptual information. Additional models, using specific modelling techniques (see Table 6), may be developed to reflect the corresponding design decisions and to establish sufficient information for the application software implementation. The following development activities are performed during the process implementation phase:

- Business process workflow implementation
- Business process user interface design
- Application software development
- Data storage implementation
- Unit and integration testing
- Business process documentation

The **business process workflow implementation** involves complete specification of the process workflow as well as design and development of the process data container. Development of an executable workflow process in the OfficeObjects® WorkFlow environment is supported by the workflow specification tools. The data container may be an arbitrary object comprising persistent data modelling of the workflow process execution context. The entity Java Bean class is the preferable data container implementation due to its universal capabilities involving modelling of the workflow process variables and application functions. The data container provides all arguments to be specified within the BPQL predicates represented by the respective object attributes and method-returned values.

The **business process user interface design** requires design decisions pertaining to visualisation of the dialog model facilities to be available to the workflow activity participant, as well as specification of the dialog model usage patterns determining orchestration of the user – dialog model interactions. Web browsers hosting the dialog model user interfaces developed in the OfficeObjects® WorkFlow environment determine the capabilities of the graphic user interface design. The information architecture design principles [Kahn2001] are recommended as the graphic user interface guidelines.

The **application software development** entails development of software components supporting the activity dialog application functions, both the user-visible and the API functions, as required by the specific dialog model, the software agents participating in workflow process activities, as well as the wrappers providing the required function and data integration capabilities. Although and arbitrary application software development methodology may be used in the OfficeObjects® WorkFlow, we recommend the Rational Unified Process (RUP) [RUP1998, RUP2002] as the underlying development approach.

The **data storage implementation** involves logical and physical design and specification of the underlying database and/or content repository within the scope of the business process data model. The logical database design entails refinement of the conceptual Class Diagram and specifications of the mappings to the relational or object-oriented database schema. The physical design depends on the capabilities and the data model of the underlying database management platform. The corresponding design decisions usually pertain to relational table index selection and specification, and device and media allocation strategy decisions determining the use of main memory and data storage device resources.

Table 6. Modelling techniques used in the process implementation phase.

Modelling Technique	Use
Workflow Process Modelling notations	
BPMN Process Model	The business process model is to be specified on several abstraction levels following the stepwise refinement mode of the "As-Is" process assessment and of the "To-Be" process design.
BPMN Logical Diagram	This diagram level refines the "what happens" information of the preceding modelling levels with information "how" the process is to be implemented. Abstract process graph nodes are expanded with detailed task and decision nodes presenting the complete process flow.
UML Structural Diagrams	
Class Diagram	Specification of the conceptual data model representing the business process view of its own and the pre-existing data resources. All persistent object classes required by the process should be specified. In the case of an application domain comprising many processes, the partial conceptual data models defined for individual processes should subsequently be integrated.
Object Diagram	The CD notation may be used to model the business process Data Container representing the well-defined object structure.
Component Diagram	Clusters of strongly interacting classes can be represented as software components constituting the principal building blocks of the application software architecture. Software components developed for dialog models are the basis for application software re-usability within an application domain.
UML Behaviour Diagrams	
Use Case Diagram	The Use Case diagram should be used for two purposes, namely for further refinements, is necessary, of the dialog models specified in the conceptual design phase, and for specification of the dialog model test cases.
Sequence Diagram	Dialog model scenarios developed during the conceptual design phase should be modelled as with the use of sequence diagrams. If sequence diagrams have been specified during the conceptual design phase, then they should be refined at this stage. Time dependencies modelled by the sequence diagram should be established to implement required controls constraining the use of application functions within the dialog models.
Collaboration Diagram	Collaboration diagrams should be used to model the interaction between software objects. Messages passed among objects and their intent are of central interest and the chronological order is represented by numbers preceding each message.

State Diagram	State diagrams are used to illustrate the possible states of an object and the causes and effects of those state changes within the object. They should be used, whenever justified, to illustrate complex behaviour of software agents acting as the automatic workflow process participants.

The **unit and integration testing** scenarios supporting testing activities involve design and development of test cases and the business process workflow and the associated dialog models. Test cases are to be developed on the basis of the dialog model use cases with the use of the organisation specific test tools and methodologies. Workflow process simulation scenarios need to be set up to analyse and test process behaviour pertaining to all feasible flows traversing the process graph.

The **business process documentation** to be developed as the result of the implementation phase includes business process technical manuals, comprising information pertaining to all technical aspects of the business process, as well as the business process stakeholder manual, usually to be available in the electronic form, providing information required for business process operation and maintenance.

The RUP notation is based on the UML (Unified Modelling Language) notation. This is the modelling language for specifying, visualizing, constructing, and documenting the artefacts of software systems, as well as for business modelling and other non-software systems. The UML represents a collection of best engineering practices that have proven successful in the modelling of large and complex systems. The architecture of the UML is based on a four-layer meta-model structure, which consists of the following layers: user objects, model, meta-model, and meta-meta-model. This architecture is a proven infrastructure for defining the precise semantics required by complex models. UML meta-model is described in a combination of graphic notation, natural language and formal language (meta-model is, in effect, a class diagram and a set of semantic and syntactic rules that defines the core elements and relationships used in UML). The advantage of logical meta-model is that it emphasizes declarative semantics, and suppresses implementation details. UML uses Object Constraint Language (OCL) to specify the semantics. The UML diagrams [UML2003] and the workflow process notations to be used for modelling in the process implementation phase are summarized in Table 6.

4.3.1 Business Process Workflow Implementation

The business process workflow implementation entails specification of the complete workflow process graph as well as implementation of the required process activity operational behaviours. The implementation platform may be the OfficeObjects® WorkFlow Business Process Query Language (BPQL) specified in [OfficeObjects®] The following activity operational behaviours depending on the activity type may be implemented with the use of BPQL rules:

- Workflow process
- Process temporal constraints
- Process alerts and notification rules.
- Work activity
- Business process work participant assignment.
- Business process activity pre- and post-conditions.
- Process constraints (participant, application functions, temporal).
- Routing activity

- Business process routing conditions specified for each routing activity.
- Event activity
- Business process event triggers specified for each event activity.

The application function to be invoked by an activity instance usually refers to an application software component orchestrating the corresponding dialog model. Notwithstanding the recommended application architecture, any required application system may be specified for an activity to be subsequently invoked the workflow process activity instance. Such design decisions are to be determined by the application software architecture established for the process.

The workflow process data container is to be implemented according to the underlying application development platform. The standard data container implementation is an entity Java Bean providing BPQL argument values as well as the process contextual information to be referenced by the dialog model application software. The BPQL reference to the process data container attribute and method values are thoroughly discussed in [OfficeObjects®]. The data container methods provide the workflow process global application logic to be used according to the specific process implementation requirements.

Other data container types, such as repository information objects or an application supported data structure, may be used provided that the corresponding application software reference is specified in the workflow process definition. The application system supporting the process data container is also responsible for rendering the container object representations in the graphic user interface. If the OfficeObjects® Repository platform is used, then the process data container is accessible to the authorised workflow participants as an electronic form providing access to the container data and application functions.

4.3.2 The Business Process User Interface Design

The business process user interface design deals mainly with two principal areas, namely the information system ergonomics and the user graphic interface “look & feel”. Both design areas pertain to the general information system design knowledge and there are few specific design guidelines relevant to the workflow process technical design.

Categorisation of the process-oriented information system users into work participant roles and their work orchestration within specific business process instances offers new potential for enhanced information system ergonomics enabled by the system personalisation features exploiting the business process contextual information as well as the history of the particular participant activities related to the business process or the application domain.

The graphic interface “look & feel” design is usually constrained by the existing technology standards enforced by an organisation or by application frameworks used for the application software development. Application of sound information architecture design principles discussed in [Kahn2001] leads to good graphic interface design.

4.3.3 Application Software Development

The spiral life-cycle of the application software development step of the BPM project implementation phase is largely determined by the process-orientation of the application software architecture naturally leading to an incremental software development process. The application software components are partitioned among dialog models of a workflow process, and among processes of an application domain, with globally invoked components clearly indicated. The application software development entails design and specification of the following application software models:

- The object-oriented application software model specified by the detailed Class Diagram.
- The application software component architecture (modules, packages, sub-systems) specified by the Component Diagram model. The component architecture represents the implementation model of the application software providing also reference to external component libraries, middleware components, and software development tools.
- The architecture component interactions specified by the Collaboration Diagram or Sequence Diagram models.
- The detailed dialog model user interface orchestration specified by the Sequence Diagram model.
- The complex component behaviours specified by the State Diagram models.

It is recommended to clearly indicate the technological functions of the application software components, namely the dialog model use case and application function components, the wrapper components and, whenever applicable, the content repository information objects. In the case of the OfficeObjects® Repository a large part of the application logic will usually be implemented by the information object methods.

The application software partial-generation and implementation is dependent on the software development environment adopted as a technological standard for the BPM project. The OfficeObjects® WorkFlow platform does not determine the programming language and the multi-tier architecture requirements for the application software.

4.3.4 Data Storage Implementation

The data storage considerations are orthogonal to the mainstream design decisions of the BPM project implementation phase. However, for completeness sake, we outline the data storage design and implementation process complementing the application software design and implementation. The following development steps would typically pertain to data storage implementation:

- The detailed specification of the persistent object classes and their relationships modelled by the Class Diagram.
- Definition of mappings onto the relational database schema or an object-oriented database schema.
- Design and specification of the physical database model.
- Allocation of the computer configuration resources (device/media allocation) to database areas (volumes).

The standard database design principles will guide the data storage implementation. In the case of a content repository providing storage services to the business process, e.g. in the case of a document management workflow process, the content management system design guidelines, such as those specified for the OfficeObjects® [Staniszkis2015], should be used to guide the design process.

4.3.5 Unit and Integration Testing

The standard unit and integration test activities, covering respectively application software components and dialog models, as well as the entire workflow process should be performed during the process implementation phase. Test cases, based on the use cases specified for the dialog models and the entire process, or application domain, covering the process topology and business rules, the application software logic, as well as the scalability and stress requirements, should be designed and developed.

The business process test suites, appropriately documented and stored in the test case library, provide an important re-usability feature enabling a smooth business process change control life-cycle supported by a reliable regression test platform.

4.4 The Business Process Deployment Phase

The business process deployment phase is performed according to two principal orientation planes, namely the technological orientation and the business process stakeholder orientation. The technological issues mainly pertain to the system distribution design goal of achieving optimal allocation of the computer system configuration resources to the system software components. The distribution optimisation should consider both, the application software layer as well as the middleware and operating software layer. The stakeholder orientation deals mainly with the absorption of the new software technology into the user environment and with the change management. The change management activities are mainly driven by the postulated significant modifications and enhancements of the process participant working behaviours. The design notations used in the business process deployment phase are summarised in Table 7.

Table 7. Modelling notation used in the business process deployment phase.

Modelling Technique	Use
Deployment Diagram	The Deployment Diagram model associates the principal software system components with the processing and storage devices of the underlying computer system configuration.

4.4.1 The Device/Media Allocation Design

A typical application software distributed component architecture, developed in the OfficeObjects® WorkFlow environment, requires a J2EE compliant Application Server environment for deployment and operation. The target Application Server (AS) environments include commercial environments, such as WebSphere (IBM), WebLogic (BEA), and Oracle Application Server (Oracle), as well as open source AS environments such as Tomcat and JBoss. A detailed specification and references pertaining to the J2EE standards and the Application Server architecture are presented in [J2EE1999].

The purpose of the J2EE-compliant distribution design is to exploit the scalability potential of the replicated distribution of the information system software components over an arbitrary number of servers. The distribution design optimisation should meet the design constraints and guidelines established to the business process application software distributed architecture.

We define the software system scalability as the ability to support varying workloads independently of the number of active users with the same principal performance measures, such as the response time and throughput, by merely providing the required processing power (CPU, I/O, data transmission). This implies that scalability should be attained without substantial modification of the system software algorithms and architecture.

The JEE Application Server distribution features provide a powerful platform for development and deployment of scalable distributed component software architectures. There are few limits in growing the hardware server and network configurations and scalability may be attained by appropriate mapping of information system software architecture modules to the JEE compliant Java components. Careful design is required to avoid software bottlenecks, such as for example software locks contention or excessive system resource consumption. Our approach is to exploit the distribution and fail-over potential inherent in the JEE compliant Application Server environments in the application software component distribution architecture and to propose systematic design criteria based on workload pattern evaluation to support design decisions during the deployment and tuning phases.

The distribution design, including both software component distribution and data distribution focuses depending on the system development stage on the following distinct design issues:

- Selection of the optimal hardware/software configuration and the optimal software component distribution configuration to meet the required performance goal for a given system workload.
- Reconfiguring the software component distribution to match the change of the system workload to reach the new optimal configuration.
- Selection of the hardware/software configuration enhancement matching the increased system workload sufficient to suport the required performance goal.

The application performance constraints may be expressed in terms of the system response time or the system throughput. The first is defined as the elapsed time between a request reaching the border hardware configuration element (e.g. the HTTP Server) and the reply to that request leaving the border hardware element. Throughput is defined as the number of completed interactions within a time unit (e.g. transactions a second). Note, that we are ignoring the network lag resulting from factors external to the application software distribution design decisions such as the network load, line/modem throughputs, the number of hops in a transmission, and similar general network characteristics. A thorough discussion of performance measures and the computer system performance modelling may be found in [Lazowska1984].

Our task is to optimally distribute the application software configuration components within a distributed hardware configuration connected by a high speed LAN while maintaining the performance constraints characterising the business process performance requirements. The response time constraint is usually applied to user interactions with the system, whereas the asynchronously executed system components (e.g. full text indexing) are better characterised by the throughput measure.

4.4.2 Transformation of the Business Process Working Environment

Transformation of the business process working environment requires consideration of the stakeholder-oriented business process enablers to create sufficient conditions for a smooth introduction of the radical change into the organisation. The following enablers are considered to be the critical success factors for the business process deployment phase:

- Motivation and measurement
- Human resources
- Policies and rules
- Facilities design

The **motivation and measurement** factors should be brought in-line with the similar drivers of the new or radically changed business process introduced into the organisation. Conflicts of the principal work evaluation criteria, such as for example motivating and measuring line management to attain the highest possible human resource utilisation levels, rather than meeting the business process cycle time constraints, may result in a business process schizophrenia hampering the process deployment activity. Although such and similar conflicts should have been resolved during the strategy, or at the latest during the conceptual, design phase, it is the realities of the new business process stimulated behaviours that unearth these problems.

The **human resources** need to acquire new or enhanced knowledge and skills to meet the new tasks and responsibilities stemming from introduction of redesigned, and usually empowered, roles defined for the new business process. Although enhanced staff competencies usually pertain to the business duties to be performed within the new process, such trivial problems as the lack of sufficient training in the use of the new information system functionalities may seriously impair the business process deployment activities. In most cases of the workflow processes deployment efforts the human actors determine meeting the business process objectives and constraints.

The **policies and rules** have already been addressed at the earlier BPM project milestones, yet the enactment of a business process usually triggers, and possibly enables, the change of the old operating modes and procedures. Appropriate communication of change from the matching organisation levels, supported by sufficient explanation of reasons and potential benefits of the radical change introduced by the new business process, may do wonders to alleviate the instinctive aversion to change that exists in most business process stakeholder communities.

The **facilities design,** including possibly investment in the new equipment, needs to match the design specification in a timely manner not to disturb the business process deployment procedure. Possibly equipment related training and help desk services should be set up additionally to those resulting from the new application functionality provided to the process stakeholders. Office facilities, or the lack thereof, meeting the new process requirements significantly influence the transition effort.

4.5 The Business Process Operations Phase

The business process operations phase should normally be treated as the BPM project continuation phase, not only due to the normal application software and process modification maintenance requirements, but also due to the need to react to significant variations of the process workloads and the resulting requirements to re-assign process resources. For example, significant changes of the business process routing probabilities, due to the significant variation of the business process environment, e.g. a sudden surge of customers to obtain mortgage of a certain level due to new tax regulations, may severely congest the otherwise well balanced business process. Simple role re-assignments of human resources to handle increased workload at some process nodes (activities) may alleviate such problems. On the other hand, increased business process participant knowledge and motivation, possibly coupled with favourable changes of policies and regulations, seemingly external to the process, may offer potential for the process improvement. Such continuous process improvement life-cycle, often stimulated by the TQM management style, may over time lead to the significant business process modification and enhancement. Hence, there are two important management activities pertaining to the process operations phase, namely the process monitoring and the workload balancing activities, supplementing the continuous business process improvement.

4.5.1 Monitoring and Workload Balancing

Business processes are characterised by performance parameter values, called process metrics, depending on the business process perspective adopted for process evaluation. Business level metrics, usually established as the business process objectives during the strategy and conceptual design phases, may pertain to such characteristics as the process cycle time, the average process execution costs and resource utilisation, and the average fault rate (e.g. violation of time constraints). On the other hand, the process operational characteristics such as the new process request arrival rate, the relative frequencies of activity executions, or the average wait time in an activity queue, provide information pertaining to the process workload characteristics as well as to the process resource utilisation levels. We call the first group of metrics the process effectiveness measures, and the latter group the process efficiency measures. The through discussion of the business process performance characteristics and models is presented in [Staniszkis2007, Staniszkis2016]

The process monitoring activity falls into the management tasks of the process owner, whose job is to react to possible business process constraint violations and to undertake a corrective and/or emergency action, as well as to track the abnormal process performance behaviour and to eliminate the process bottlenecks. While failure to meet the stated process objectives may have its roots in the business specific process KPI's, usually specified in the risk management section of the conceptual design report, the business process efficiency measures are usually affected by the change in workload characteristics. Such changes are usually out of control of the process owner and they may be accommodated by appropriate re-design and modification of the business process specification. The most likely candidates are the WPA and the routing predicates, either leading to expansion of the process resources (e.g. the number of participants in a specific role), or to reduction of load on a particular process activity, hence reduction of the workload volume imposed on a particular role.

Business process monitoring is a continuous activity instrumented by the OfficeObjects® WorkFlow performance reporting and analysis features. Additionally, the critical process effectiveness measures may be monitored with the use of the automatic process alerts and the related notification features.

4.5.2 Continuous Business Process Improvement

We have already pointed out that synchronisation of the "motivation and measurement" enabler adopted for the application domain and the business process effectiveness measures is a critical success factor of a BPM project. Business process management technologies inherently foster enhanced team collaboration, with the associated team building effect, and the objective evaluation of the team performance. Both factors are determining the pro-TQM behaviours by improving the information flow and by empowerment of an individual process participant stemming from the properly designed role competencies. The sense of accomplishment stemming from good job performance, and the resulting feeling of job security and assertiveness, foster creative and pro-active behaviours among the business process stakeholders.

The roots of process improvement claims may stem from the less than optimal initial "To-Be" business process design, or they may result from favourable changes in the business process environment. The business process environment change usually pertains to the new "policies and regulations" enabler, as well as to improvement opportunities created by introduction of the new technologies. Awareness to such favourable situations on the part of the business process stakeholders coupled with creativity and assertiveness to propose the process improvement claims is the source of organisation's competitive advantage.

The continuous process improvement activities should be managed according to clearly stated management rules in order to maintain staff motivation and confidence. A business process continuous improvement loop, similar to the knowledge management life-cycle is discussed in [Firestone2001]. New information and the business process effectiveness data stimulate process participants to formulate new BPM strategies resulting in improvement claims.

It is important to introduce the rigorous and well understood improvement claim validation process commencing with the peer review through to application of formal evaluation criteria based on the business process effectiveness measures. Accepted improvement claims result in the business process restructuring project, usually spanning all BPM project life-cycle phases, terminated by deployment of the new business process version.

References

Aalst2002	Van der Aalst, W., Van Hee, K., "Workflow Management, Models, Methods, and Systems.", The MIT Press, 2002.
BPMI2004	Object Management Group, Business Process Modeling Notation (BPMN), version 1.0, February 2006.
Corporate Modeler	Corporate Modeler User©s Guide, 2003.
Davenport1993	Davenport, T.H., Process Innovation, Harvard Administrative School Press, 1993
Drucker1999	Drucker P., F., Management Challenges for the 21st Century, Elsevier Ltd., United Kingdom, 1999..
Dundis2003	Dundis S., Benson S., Making Virtual Work Teams Successful:Measuring the'Interactive Demand ' of Tasks and Fitting it to the Demands of Technology,People,and Structure, Proceedings of the The 3rd IEEE International Conference on Advanced Learning Technologies (ICALT '03).
Dyson2004	Dyson, P., Longshaw, A., Architecting Enterprise Solutions – Patterns for High- Capability Internet-Based Systems, Wiley Series in Software Design Patterns, John Wiley & Sons, United Kingdom, 2004.
Firestone2001	Firestone, J., M., Knowledge Management Process Methodology: An Overview, Knowledge and Innovation: Journal of the KMCI, vol. 1, no. 2, 2001
Goldratt1997	M. E. Goldratt, "Critical Chain", North River Press Publishing Corporation, ISBN 0884271536, April, 1997:
IDS Scheer 2003	IDS Scheer, Aris Method, November 2003.
iGrafx2000	iGrafx, iGrafx Process 2000 User's Guide, 2000.
iGrafx2000a	iGrafx, iGrafx Professional User's Guide, 2000.
ISO1999	ISO/IEC 13250, Topic Maps, Information Technology Document Description and Processing Languages, December 1999.
Jacobson1995	Jacobson, I., Ericsson, M., Jacobson, A., The Object Advantage – Business Process Reengineering with Object Technology, ACM Press Books, 1995.
J2EE1999	Simplified Guide to the Java™ 2 Platform, Enterprise Edition, Sun Microsystems, Inc., 1999.
Kahn2001	Kahn, P., Lenk, K., Mapping Web Sites, Rotovision SA, Swizerland, 2001.

Koulopoulos1995	Koulopoulos, T.M., The Workflow Imperative, Van Nostrand Reinhold, 1995.
Lazowska1984	Lazowska E.D., Zahorian, J., Graham, G.S., Sevcik, K.C., Quantitative System, Performance, Computer System Analysis Using Queuing Network Models, Prentice- Hall Inc., USA, 1984
Muehlen2004	M. zur Muehlen, Organizational Management in Workflow Applications – Issues and Perspectives, in Information Technology and Management, Kluver Academic Publishers, The Netherlands, 2004.
OfficeObjects®	OfficeObjects® Software Product, Rodan Systems S.A., Warsaw, Poland, 2010
OfficeObjects® WorkFlow	OfficeObjects® WorkFlow BPM Handbook, Rodan Systems S.A., Warsaw, 2005
RUP2002	Rational Unified Process v.2002, IBM, 2010.
Sharp2000	Sharp, A., McDermott, P., Workflow Modeling, Artach Mouse, 2000
Skinner1986	Skinner, W., The Productivity Paradox, Harvard Business Review, July – August, 1986.
Staniszkis2007	Staniszkis W., Modelling Business Process Performance, in Proc. of the Int. Conference on Business Process and Services Computing BPSC '07, Leipzig, Germany, September 2007.
Staniszkis2015	Staniszkis W.,, Empowering the Knowledge Worker – End-User Software Engineering in Knowledge Management, Proc. of the 17th International Conference on Enterprise Information Systems, Barcelona, Spain, May, 2015.
Staniszkis2016	Staniszkis, W., Staniszczak, A., Multidimensional analysis and prediction of the OfficeObjects® WorkFlow Process Performance, Proc. of the 18th International Conference on Enterprise Information Systems, Rome, Italy, May, 2016.
UML2003	Object Management Group, OMG Unified Modeling Language Specification, March, 2003, Version 1.5.