Goal-based business process models: creation and evaluation

Peter Kueng
Institute of Informatics, University of Fribourg, Switzerland and
Peter Kawalek
Informatics Process Group, University of Manchester, UK

Introduction

In the business process modelling community, considerable attention has been given to the modelling of certain aspects of business processes (e.g. roles, activities, interactions) and throughout this there seems to be a general recognition that these processes serve goals. This said, amid the many debates about various modelling formalisms little attention is paid to the value of making goals explicit or to the fundamental purposeful nature of the system we are modelling. A further shortcoming of today's modelling approaches is that they do not give enough attention to the evaluation of models at the conceptual level. Instead, the evaluation task is deferred to the implementation level when the information technology (IT) systems are built. By contrast, we explore the benefits and feasibility of evaluating a process model at an early stage of its creation. The advantages we anticipate are twofold: first, errors or invalid design concepts are detected earlier with consequent savings in costs. Second, non IT-relevant aspects (e.g. the way activities are carried out by human actors) can come to light at an appropriate stage.

This paper is structured as follows. First, through analysis of literature and reference to the authors' empirical work, we look at the value of modelling goals. Second, we present in outline a design method for modelling business processes in which the concept of the goal is fundamental. This approach can be characterized as being primarily concerned with the construction of a process from its functional goals. Third, we look beyond the current scope of this method to the issue of evaluating the process designs. We explore some of the current approaches and consider whether process modelling can assist in the appraisal of the non-functional effectiveness of processes at the design stage. In conclusion, we summarize the strengths and weaknesses of the approach.

In a design project, during the modelling of business processes, the modelling team is confronted with the following question. How *good* is the design of this business process? The question invites many different responses

We would like to thank Peter Bichler, Maya Daneva, and Michael Schrefl for the often stimulating discussions. The work of Peter Kueng has been supported by the Swiss National Science Foundation.

Business Process Management Journal, Vol. 3 No. 1, 1997, pp. 17-38.

but the most obvious riposte is probably to ask: "What do you mean by good?" In other words, we accept that the business is a complex system which is made up of many people, each of whom has his/her own beliefs about how it should operate as well as their personal hopes, aspirations and motivations. That is to say, we accept that what makes a business process good is a subjective matter.

To summarize, the failure to rigorously understand and assess goals risks directionless modelling, design that is almost by definition not fit for purpose, and makes a business process assessment – at both pre- and post-implementation stages – impracticable. Therefore, part of the discipline of business process modelling must be the representation of goals; an understanding of how they shape the form of the process and their use in evaluation and assessment. The empirical evidence that we have so far (Kueng *et al.*, 1996; Warboys, 1996), supports this view that the modelling of goals is a critical step in the creation of useful process models.

The significance of models and goals

Why should we bother with business process modelling? Perhaps the answer is obvious. Managers, systems analysts and their ilk, all those who use business models of one sort or another, are concerned with managing complexity. The models that they use are explicit representations of the form that they understand the business to take. Moreover, the process of creating the model is a learning process. In their creation, knowledge is gathered, assumptions are tested and dilemmas are confronted. It being a modelling process, this knowledge is always partial but the richness of the model possessed by those who seek to manage a process is critical to their ability to do so (Beer, 1979). This point is fundamental. It leads to the hypothesis that business process modelling is a prerequisite to the design and management of what we believe to be a good business process.

Human action is primarily driven by goals (Scherer and Zölch, 1995). In other words, humans have targets, wishes, desires and purposes, and try to achieve them by doing some things and by avoiding (i.e. not doing) other things. The challenge to the modellers seems to be fourfold:

(1) they have to capture the different kind of goals from the business process participants;

(2) they have to assess the captured goals for compatibility;

(3) they have to manage inconsistencies;

(4) they have to create business processes which fulfil "all" goals.

Following Scherer and Zölch (1995), we may say we need goals because human action is driven by goals. But can we be more specific? Or to put a rather different emphasis on it: what are the difficulties and problems if we do not declare the goals in the modelling process? Several difficulties seem to arise:

- We need to be able to state what we want to achieve so that we are then able to define the necessary activities which a business process should encompass (i.e. goals are used to *structure the design*).
- A clear understanding of goals is essential in the management of selecting the best design alternative (i.e. goals are used to *evaluate the design*).
- A clear understanding of goals is essential for it to be possible to evaluate the operating quality of a business process (i.e. goals are used to *evaluate the operating process*).
- A clear expression of goals makes it easier to comprehend the organizational changes that must accompany a business process redesign. For example, it may include transformations concerning organizational power and controls, reporting relationships, management practices, incentives, job description, job changes, skill requirements and training (i.e. goals help the modeller to *better understand the broader implication* of design, beyond those of the business process itself).

Different categories of goals exist. The most obvious and commonly used differentiation is between goals that are functional and those that are non-functional. To illustrate the difference, we refer to the example of an insurance company given in Kueng *et al.* (1996). A functional goal of the company may be "to sell insurance". Two examples of non-functional goals held by particular employees may be "high autonomy" or "having an integrated job". In a business process, we may also be concerned with what may be rather more ephemeral and subjective concerns such as impressing the customer with politeness and punctuality or ensuring that all staff are motivated and happy.

To summarize: business process models are created in order to manage the complexity of the behaviour of human organizations, and human activity can be described as inherently purposeful. Winter *et al.* (1995) show how alternative conceptualizations of the purpose (functional and non-functional goal) of an organization lead to differing behavioural and IT requirements (business processes). The example they use is a prison. If it is understood to be a system of rehabilitation, then it will be required to perform processes which facilitate the educational, psychological and recreational development of the inmates (e.g. therapy programmes). If it is understood to be a system of punishment then it will be required to perform processes which facilitate the physical and mental discomfort of the inmates (e.g. chain gangs). The operational processes which result from these alternative conceptualizations are very different as they are determined by the goals which the system is intended to fulfil.

For our purposes in this paper, we seek to make clear the assumptions and conclusions (see Figure 1). They can be seen as a concentrate of the above ideas. A short discussion about a modified set of assumptions follows at the end of the paper.

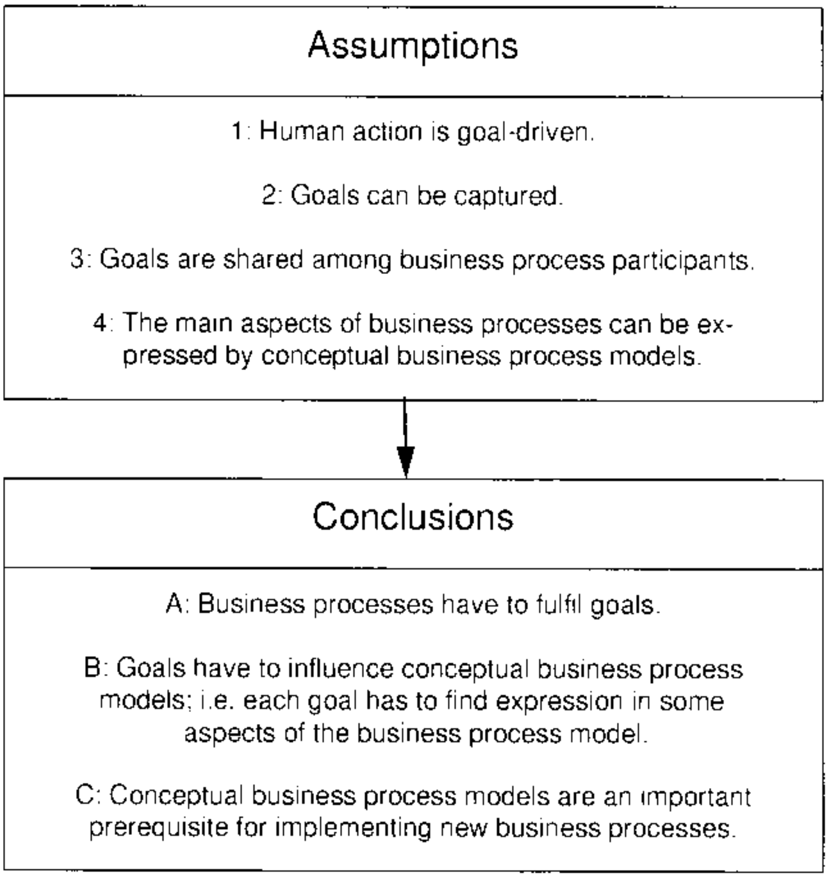

Figure 1.
Process modelling-related assumptions and the conclusions drawn

Definitions

This section seeks to develop a usable set of definitions suitable for the purposes of this paper. Recognizing that the development of methodology eventually blurs with the development and use of language, and that language evolves, we are only seeking to develop a working understanding of the problem domain. Precise and wholly sustainable definitions are beyond our immediate concerns.

Goal

According to Loucopoulos and Karakostas (1995), goals express intentions and capture the reasons of the system to be built. The creation or definition of goals initiates the questions: what are we trying to achieve? and what are we trying to avoid? The answers are goals. In our context, goals are statements which declare what has to be achieved or avoided by a business process. Goals and objectives are treated as synonyms within this paper.

Business process
According to Feiler and Humphrey (1993) and Hammer and Champy (1993) a business process can be seen as a set of partially ordered activities intended to reach a goal. From this it can be proposed that a business process consists of the following five elements:

(1) One or more customers – company-internal as well as company-external customers.
(2) An output – products and services to be delivered to customers.
(3) Activities which create value for the customer.
(4) Agents – who are assigned to roles – which carry out the activities of a business process.
(5) Information and materials required to perform activities.

Business case
From the perspective of a process participant, the core element is not the business process, it is the business case. This is the instance of a business process; e.g. "loan application No. 5971" or "insurance claim of Mr D. Thomas".

Business process model
Using the elements above, we can define a business process model as a generic description of a class of business cases. Business process models describe how business cases have to be carried out. They highlight certain aspects and omit others. A *conceptual* business process model is independent of a particular IT or organizational environment. An *executable* business process model is customized to a particular environment, it may be instantiated to carry out a specific business case (Garg and Jazayeri, 1996).

Role
Following Ellis and Wainer (1994): "A role is named a designator for an actor, or grouping of actors … A role may be associated with a group of actors rather than a single actor … An actor is a person, programme, or entity that can fulfil roles to execute, to be responsible for, or to be associated in some way with activities and procedures".

A goal-based approach to business process modelling

This section describes a way of building process models from a statement of goals. Thus, we are concerned with the structuring of a model from these goals and the transformation of goals into objects where appropriate. It is common to describe business methods as a number of discrete steps. However, intuitively it seems unlikely that requirements will be elicited in one and only one step. Given that we are dealing with problems that are complex, subjective and dynamic, it would seem to be better to take an adaptive and cyclical approach. In other words, we regard the process of creating and implementing a new business process as a cycle, in which each phase is carried out several times and the composed documents are extended in an incremental way (see Figure 2).

The presented business process modelling method seeks to define the following aspects:

- *Why* has something to be done? – define goals.
- *What* has to be done? – define activities and output.
- *When* has it to be done? – define logical dependencies between activities.
- *By whom* has it to be done? – define roles (carried out by human and machine actors) and assign them to activities.

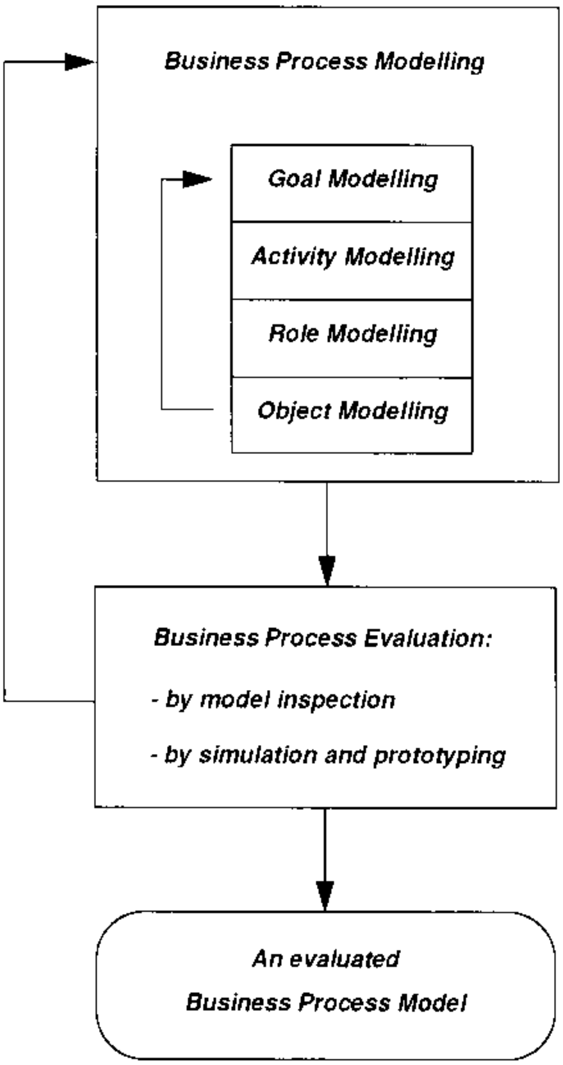

Figure 2.
The major steps in creating a business process model

Subsequently we give an overview concerning the process of business process modelling and describe shortly how business process-dependent goals can be transformed into a conceptual model. A more detailed description can be found in Kueng *et al.* (1996).

Step 1. Definition of business process-related goals, goal measurement criteria, and restrictions

In the first modelling step, goals have to be captured and represented graphically. The objective is to reduce or decompose process-related goals until they can be transformed into activities which have to be carried out within the process. It is useful to note that this method allows definition in the positive sense of "ensure that something happens" and also in the negative sense of "ensure that something does not happen". In addition to goal definition, we have to define the measurement criteria by which to assess the extent to which goals have been fulfilled. Furthermore, Step 1 includes also the definition of legal, technical, and social restrictions which have to be considered in the execution of a business case. Goals, measurement criteria and restrictions are graphically represented by a Goal/Means-Hierarchy.

Certainly, this is a simplistic view. By creating a Goal/Means-Hierarchy, a problem we will face is that goals have a different relationship to each other: some are contradictory, others are interdependent, and several are complementary. Furthermore, we have to deal with the fact that different goals get different priorities.

Step 2. Derivation and definition of business activities

As a general rule (see Hammer and Champy, 1993), business processes should only include such activities which create value for the customer. In other words, activities have to make a contribution to the functional business process goals. What does this mean more precisely? In the terms of this method the activities have to be derived from the Goal/Means-Hierarchy and each leaf from this hierarchy has to be transformed in at least one activity. If the modeller is not able to derive an activity from a certain leaf, the Goal/Means-Hierarchy has to be refined further. As we have already inferred, it is not sufficient just to derive activities from the business process goals, we have also to take into account the goal measurement criteria, and the restrictions. That is:

(1) we have to define activities which are able to measure and judge to which extent the defined goals are fulfilled; and

(2) we have to define activities which ensure that the restrictions of a business process are adhered to.

This stems from the observation that business processes subsume both value-added and non value-added activities.

After deriving the essential activities and presenting them in a Goal/Activity Model, these activities are described more precisely.This involves describing the inputs which are required for each activity to be carried out and the outputs the activity will produce. This information is presented in an Input/Output-Table. This is used to check the consistency of the Activity Model. This requires that we ask two questions:

(1) Is every input that is needed by an activity produced by another activity?

(2) Is every output, produced by a certain activity, delivered to customer or used as input by another activity?

In general, activities within a business process cannot be carried out in any arbitrary order. Using the Input/Output-Table, we deduce the logical and temporal dependencies between activities and define which activities can be carried out sequentially, alternately or concurrently. In order to show the execution order of the business process activities, we apply Petri-nets; and within this category we use condition/event nets.

Step 3. Description and assignment of roles

Activities are carried out either by human actors or by machines. In Step 3, we first define the required (human or machine) role and second we have to make effective links between activities and roles. By "effective" we mean that two objectives are fulfilled. The first is that business cases can be carried out in an efficient way; e.g. the output has to be produced with few resources. Second, the work environment and the work conditions are designed in accordance with the expectations of the people taking part; e.g. we might create "self-contained units" and "integrated jobs". Careful role assignment is needed in order to avoid overly hierarchical departmentalized structures and constrained job specifications which might have a negative impact on the motivation of the staff.

Step 4. Modelling of objects

After defining the business process-related goals, the essential activities, the input and output for each activity and assigned the activities to roles, we have to create an object-oriented model which can be seen as a prerequisite for an implementation of the IT-oriented part. In the Object Modelling phase, we have to answer the following questions:

- Which object classes should our model subsume?
- What does the life-cycle of the objects look like?
- How do these objects interact?

In order to describe these three aspects, the software engineers typically deal with three different models: Object Relationship Models, Object Behaviour Models, and Object Interaction Models (Embley *et al.*, 1992; Jacobson *et al.*, 1994). Experience we gained so far shows that the definition of a comprehensive Object Relationship Model is crucial. To facilitate the process identification and structuring of objects, we distinguish three object classes:

(1) *Business case classes*. Objects of this class describe and control the sequence of events. Their attributes describe the actual states of the

running business cases, and they define the relationships between a certain business case and the associated classes. In other words, business case classes define the main characteristics of business processes. The identification of business case classes is straightforward as each business process has one business case class. The name of this business case class would be identical to the name of the business process itself.

(2) *Input/output classes*. These classes subsume objects which will be modified during the execution of a business case. In contrast to business case classes, objects of these classes are passive, i.e. they cannot initiate an action or a communication with other objects. The names of the input/output classes come from the Input/Output Table (see Step 2).

(3) *Role classes*. Objects of these classes are human actors and machine actors. They are active (i.e. able to initiate actions) and carry out business process activities. We identify role classes through the Role Activity Model (created in Step 2). Each involved role becomes a role class.

In this section we have shown how goals can be transformed into activities, how we can assign them to roles and how the derived model can be transformed into an object-oriented model which can be used by an information system developer to create the automated part of a business process. That is, we have been concerned with functional goals and the design of a process to their service. One question that remains is does the designed system (i.e. the business process model) fulfil not only the functional but also the non-functional, business process-independent goals? To address this question we develop a framework. First, we show some business process-independent goals and present some means in order to achieve them. Second, we apply the framework to different examples of business processes.

The evaluation of a business process

In this section we move on one step. It is just one step for we attempt to exploit the window of opportunity that exists when a design has been created but not implemented. From the comments of Adomeit *et al.* (1992) in the sphere of software process modelling, we can propose that the analysis of business process models can accomplish two things. First, it can assist in the detection of errors in the business process model; i.e. the business process model does not take the form intended for it. Second, for detecting errors in the business process; i.e. the business process model reflects what it was intended to reflect but it suggests that the process of carrying out a business case is inefficient, erroneous or in some other way unsatisfactory. It follows that before transforming a conceptual business process into an executable system, we want to know as far as possible if the designed business process is a good business process (see the middle part of Figure 2). Taking a goal-oriented view, one might say, we have to assure that the designed business process fulfils the defined goals – business process-dependent goals as well as business process-independent goals.

Requirements mentioned in BPR-related literature

We can return to our original hypothetical question: how good is the design of this business process? A lot of advice is proffered in the literature. The following fragmentary list is based on a survey of a few referenced books. The suggestions have been divided (according to the modelling steps, see Figure 2) into three categories: activity modelling, role modelling and object modelling. The points have to be understood as requirements which their authors propose must be taken into account in order to design a "good" business process. They will be used later on to formulate some typical goals which will be used as simple test cases to see how effectively they can be appraised on a pre-implementation, conceptual level.

Aspects to be considered within Activity Modelling are as follows:

- In good business processes, Step X begins as soon as Step X-1 has collected enough information to get it started (Hammer and Champy, 1993).This means that during activity modelling it is useful to maximize the degree of parallel running activities.
- Checking and control activities are used only to the extent that they make economic sense (Hammer and Champy, 1993). This statement raises questions about how "economic sense" of control activities can be estimated at a pre-implementation stage.
- Performance should not be measured only at the end of a business process, because people want immediate feedback (Harrington, 1991). An important prerequisite to achieving this is that business process performance measurement points should be close to each activity.
- Checking activities (e.g. fault detection) should be near the source (Ould, 1995).
- Productivity and quality are measured (Paulk *et al.*, 1993). This statement is related to level 3 of the Capability Maturity Model for Software.

Aspects to be considered within Role Modelling are as follows:

- In good business processes "many formerly distinct jobs and tasks are integrated and compressed into one" (Hammer and Champy, 1993). Hammer and Champy (1993) mention also that it is not always possible to compress all of the process steps into one integrated job; e.g. the steps are carried out in different locations.
- Those who use the output of a business process should perform the business process (Hammer and Champy, 1993). This statement gives on the one hand information about who should be assigned to a certain activity, and on the other hand it gives a hint of by which criteria we can group activities in order to form good business processes.

- In good business processes, human actors carry out a meaningful and integrated job (Scherer and Zölch, 1995).

Aspects to be considered within Object Modelling are as follows:

- A good business process can be tailored to deliver customized outputs (Davenport, 1993). Hammer and Champy (1993) add: "Processes have multiple versions … Processes with multiple versions or paths usually begin with a 'triage' step to determine which version works best in a given situation".
- We should have few interactions between roles, because they do not add value and they introduce delays (buffers). We can reduce the number of interactions by:
  (1) adding extra decision making;
  (2) higher skill level;
  (3) restructuring the roles (Ould, 1995).
- In good business processes, human actors have possibilities for social interactions (Scherer and Zölch, 1995).
- The business process is documented and well-defined; i.e. readiness criteria (pre-conditions), inputs, standards and procedures for performing the work, verification mechanisms, outputs, and completion criteria (post-conditions) are defined (Paulk *et al.*, 1993). This statement is related to CMM, level 3.

This small literature survey suggests some characteristics of good business processes. However, they relate to implemented business processes and cannot be applied directly on a pre-implemented stage for evaluating processes at model level.

Some selected general requirements

A business process involves different people: customers, employees, owners, suppliers, competitors, and communities. All of them have different views, a different understanding of what is meant by the predicate "good", and apply different means for achieving a specific goal. Using the selected requirements outlined above as a background, here we develop a scenario of user goals. This is used later to explore the ability to evaluate process designs before they are implemented. The scenario describes two quite different views: the view of a manager and the view of a process performer. To build a better understanding of the two views, we caricature them to a certain degree: A manager (especially a process manager) has a bird's-eye view and sees an arrangement of activities which have to be undertaken by human actors and machines to achieve a required output. This manager's view is somewhat mechanistic. To achieve a goal, he or she has to arrange the resources (human, tools, customer relationships) in an optimal way. Among the goals of this manager may be: high business process autonomy, short cycle time and low cost (see Table I). On the

Goal	Means
High business process autonomy	• Avoiding cross-process exchanges of information and material
Low operational cost	• High proportion of automated activities • Few non-value-added activities
Low maintenance cost	• Business process model is transformable into an executable system • Business process consists of small but isolated modules
Short cycle-time	• Performance measurement is inside the business process and near to the performer • High proportion of automated activities • High proportion of parallel running activities • Few exchanges of information and material between human actors • Few control activities
An up-to-date business process	• Continuous checking between model and reality • Business process model is modifiable and transformable into an executable system
Consistency/integrity	• Business process model defines "exactly" what process performers have to do • Every output is needed as input and every input is delivered correctly

Table I.
Manager's view of a "good" business process

other hand, a process performer does not look at one particular business process. His viewpoint focuses on his tasks which may relate to different business processes. This means business process goals, which may be valid at the top level of a business process but are not relevant in the same way as they are for the process manager. The more immediate focus to the process performer is the degree of satisfaction of his process-internal and process-external customers. Perhaps even more important than these might be his personal satisfaction with the working conditions. These may involve an integrated job, high autonomy, or possibilities for informal communication (see Table II).

After developing this scenario about which general goals (non-functional requirements) a business process should fulfil we are going to discuss how a business process model can be evaluated concerning the aforementioned goals.

An exploration of the evaluation of selected goals

Those goals that follow are taken from Tables I and II as representing typical outcomes that may be expected of many processes. The question considered is: How can these goals be evaluated using process models?

High business process autonomy

According to Feiler and Humphrey (1993) the degree of autonomy indicates the extent to which business cases within a business process are independent of

Goal	Means
Integrated job	• Human actors carry out different activities • Activities assigned to a human actor are logically linked together • Few human actors per business case • Avoiding left-over allocation strategy
High job autonomy	• Business process is not split up in many activities • Activities are assigned to teams instead of single actors
Responsibility	• High proportion of human actors are involved in decision making • Few forwarding (i.e. escalating to senior management) activities • Few control activities
An easy job	• A business process model which defines "exactly" what humans have to do • Business process is simple and easily understandable • Human actors carry out few different activities
Possibilities for informal communication	• Different possibilities to communicate: e-mail, voice, face-to-face, etc. • Frequent information and material exchanges between human actors

Table II. Performer's view of a "good" business process

other business cases within other business processes. In software engineering terms, a software is called autonomous if their modules are loosely coupled but highly cohesive. The advantage of autonomous, loosely coupled business processes is obvious. The business process performers may act in an independent way, they may arrange their work how they want, and last but not least a breakdown of an autonomous business process has a lesser impact on other business processes than a more tightly coupled one. In order to get high autonomy, business processes should minimize activities which require cross-process communication. If we need input (data and material as well as human knowledge) from another business process, or we have to deliver output to another business process, we risk that this input/output cannot be delivered within the required time. Generally speaking, high business process autonomy may be achieved by ensuring that the resources needed for carrying out business cases are within its own control.

How can we check the degree of business process autonomy? Of course, a comprehensive check is inordinately complex as there may be many parameters. However, one of the major causes for low autonomy concerns the input which is needed by activities. As a general rule, any input which is needed for carrying out an activity within a certain business process has to be delivered or produced within the same business process. In order to check this aspect we have to find out how many activities within a certain business process need input which is produced by business process external activities. The higher this proportion, the lower the business process autonomy.

After this short theoretical background, we turn to our examples and ask: To what extent are business cases within a business process independent of other business cases within other business processes? In order to answer this question, we look at the flow of information (see Figures 3, 4 and 5), at the exchange of information between different business processes. While RADs (Role Activity Diagrams (Ould, 1995)) subsume the flow of information, Petri-net based diagrams do not show this aspect. In other words, we are not able to determine the degree of autonomy concerning Figure 5. What about Figures 3 and 4? If no interaction links are hidden (e.g. potential links to process-external activities are shown), we may say that the degree of autonomy in the business process, "composing and reviewing of a business report", is very high.

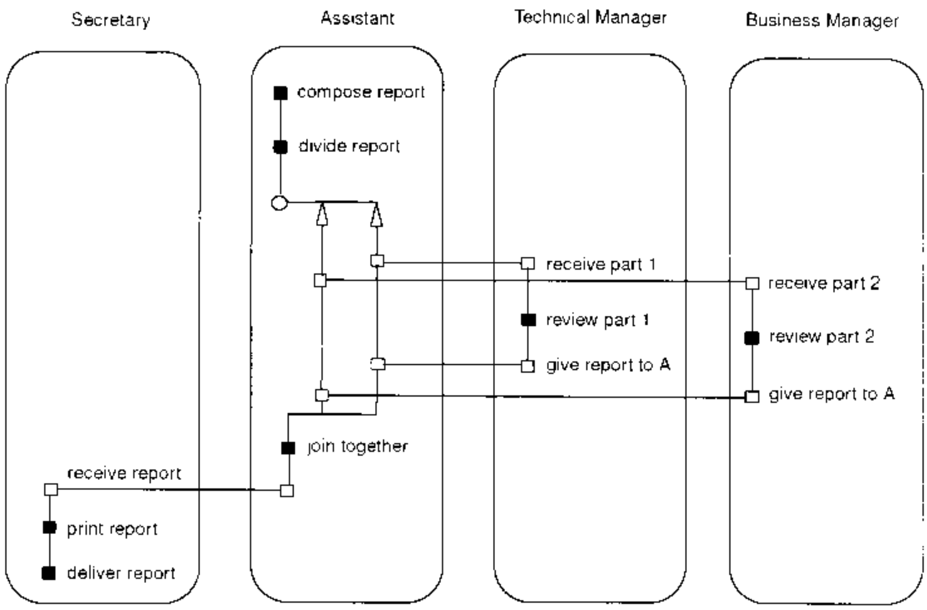

Figure 3. Business process "Composing and reviewing of a business report" as RAD: Option A

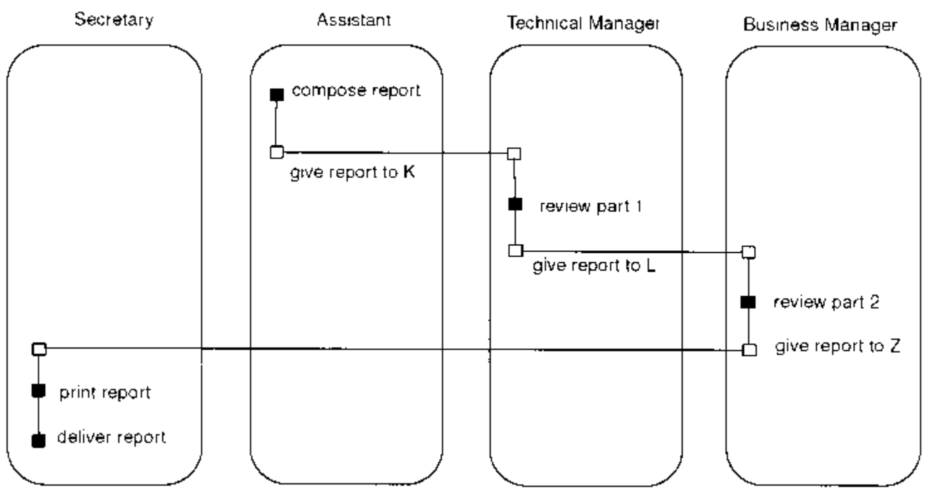

Figure 4. Business process "Composing and reviewing of a business report" as RAD: Option B

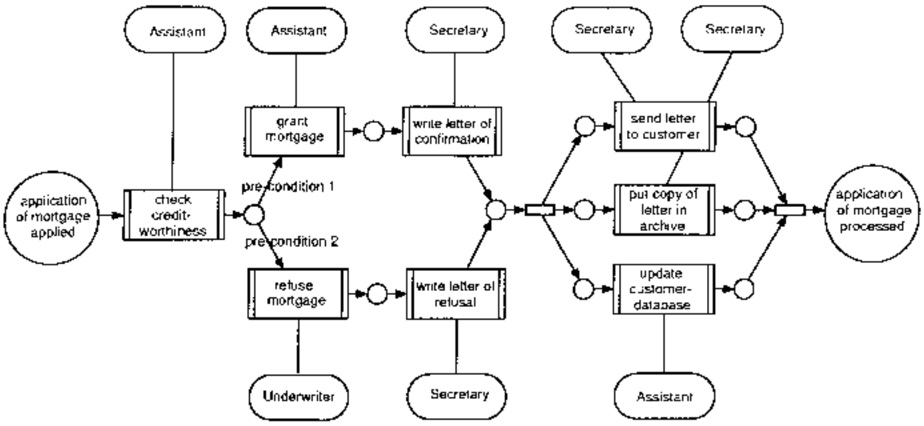

Figure 5. Business process "Manage mortgage applications" in Petri-net notation

Low operational costs

It is obvious that a business process should not have high costs associated with it, and that these costs may be implementation costs as well as operational costs. As implementation costs may not be calculated on the basis of business process models, we consider only operational cost. In order to assess a business process on conceptual level, we may be interested in the *amount* of operational costs a business process causes. But, evaluating different techniques for estimating the operational cost of a new, not-yet-implemented business process is beyond the scope of this paper. Instead, we want to address the question how we can *achieve* low operational costs. In the context of business process assessment, the main question will be: Is there a potential to reduce costs? In order to find an answer, we check the business process model concerning two aspects and ask the following questions:

(1) How big/small is the proportion of automated activities?

(2) How big/small is the proportion of non value-added activities?

These relate to the general BPR remedies of cutting that which does not add value and of automating that which is done better by machine than by a person. Certainly, there are other factors which influence the operational costs as well (e.g. staff motivation, cycle time), and these aspects are discussed later.

Are today's business process models able to provide information in order to answer these two questions? The answer seems to be that they are, at least in part. In order to answer the first question, we simply have to have an attribute for every activity which indicates whether it is carried out by a human or by a machine actor. In our small examples (Figures 3-5), every activity is assigned to human actors. Of course, this does not always happen.

Do our examples provide information about the proportion of non-value-added activities? Unfortunately not, because the showed activities have not been analysed concerning cost drivers and non-value-adding activities. In order to do that, the concepts of Process Value Analysis or Activity-Based Costing may be applied and the estimated added value for every activity has to be shown as the assigned roles are shown (Copper and Kaplan, 1991).

Short cycle time

The above-mentioned idea that gathering and presenting information about costs does not help much in assessing a business process is also true for temporal aspects. It would be possible to differentiate between a lot of different time aspects (e.g. processing time, queue time, transport time) but this kind of information is not adequate for assessing a conceptual business process model. It is much more interesting to analyse how good some mechanisms – which are able to reduce cycle time – are exploited. Subsequently, we mention some conditions/requirements which contribute to short cycle time, and we shortly discuss how well these conditions are fulfilled by some examples (see Figures 3-5). Cycle time of a business case may be short if the following requirements are fulfilled:

- Performance measurement activities are inside the business process and near to the performer. None of our examples fulfils this requirement. Either they do not encompass any performance measurement activities or they are not shown at this level of abstraction.
- The proportion of automated activities is high. From a conceptual point of view, RAD as well as Petri-nets are able to show whether an activity is carried out by a human actor or by a machine actor. But at this level of abstraction (see Figures 3-5) we do not have any information about the proportion of automated activities.
- The proportion of parallel running activities is high. Looking at Figure 3 we can see that the business process encompasses seven activities (communication-oriented activities are not included). Two of these activities are carried out concurrently. In other words, the proportion of parallel running activities amounts to 29 per cent. In Figures 4 and 5 the proportion are 0 per cent and 37 per cent, respectively.
- The proportion of control activities is low. In the examples, the level of abstraction is high and therefore we are not able to gather this information and to compare the examples under this aspect.
- There are few exchanges of information and material between human actors. Although the concept of roles has been widely accepted by the modelling community, today's business process modelling methods are not able to represent the aspect of exchanges between actors adequately. To achieve a better understanding, we look at Figure 3 and assume that: (1) four actors may be assigned to the role A, and (2) some of the four actors hold other roles as well. This leads to the following question: How many exchanges of information and material between human actors does the business process "Composing and reviewing of a business report" contain? As we can see, we are not able to answer the question, at model level, because we do not have information about the allocations

between roles and actors. Is it then possible for the modeller to get information about the degree of information exchange? Simulation could be used here to generate some hypothetical business cases, allocate the activities to roles and monitor the number of information exchanges needed.

Consistency

A real business process subsumes many rules. These are sometimes referred to as integrity rules or integrity constraints. In a business process model it may be useful to specify these integrity constraints. An example of an integrity constraint could be that "the total number of actors involved in a business case should not exceed eight persons".

Non-observance of integrity rules leads to inconsistent business processes and this may lead to the effect that "equal" business cases are carried out in a different way. In circumstances where this may be detrimental, it may be necessary that a business process model defines "exactly" what process performers have to do while carrying out a business case. To achieve this goal, the granularity of the activity model has to be low. That means, we have to break down the activities (at least such activities carried out by humans) in sub-activities until we get simple isolated tasks. How can we check if an activity is defined exactly? One probably very subjective way is to ask the potential process performer. If they say "each activity is exactly defined", we may refrain from further activity refinement. Another means which helps to ensure that the business process model is consistent is simulation – to carry out, in a dedicated environment, hypothetical business cases.

In our examples we can only check that the syntax of RAD or Petri-nets is not violated. For more comprehensive tests we also need other kinds of representation, such as Goal/Means-Hierarchy or Input/Output-Tables. In general, support and enforcement of integrity constraints is a weak point in most modelling techniques as well as in many process modelling tools and workflow-management systems.

Integrated job

In order to help create integrated jobs, four principles may be applied on a conceptual business process model:

(1) *Human actors carry out different activities*. That is, the variety of skills necessary to complete the job is large. There is a belief that the more fragmented and specialized the jobs are, the less humans are able to carry out different activities. Figures 3 and 4 show that four roles are involved in one business process. Assuming that each role is assigned to one and only one human actor – this assumption does not correspond with the definition given above – we see that role A carries out six activities (Figure 3), respectively two activities (in Figure 4). If we apply the usual role definition, we will not be able to assess in the model whether a certain human actor carries out just one or many activities.

Furthermore, by looking at Figures 3 and 4 as well as Figure 5, we do not get any information about the number of business processes in which one human actor is involved.

(2) *Activities assigned to a human actor are logically linked together*. This helps to increase the task identity, to improve the understanding of the work to be done, and that it is part of an integrated job. Do our examples fulfil this requirement? In Figure 5, we can see that the activities, carried out by an assistant, are only partly linked together: he has to carry out "check credit worthiness", "grant mortgage", and "update customer database". While the first two activities are linked together, the third one is not; he has to update the database in case of a credit confirmation as well as in case of a refusal. On the other hand (in the same example), the secretary carries out quite a few consecutive activities, except "update customer database". One possible solution might be that the activity "update customer database" is carried out by the secretary instead of the assistant. By this small modification, the job of the secretary becomes more integral while the job of the assistant will not be affected in a negative way.

(3) *Few human actors are assigned per business case*. In order to shorten cycle time we may use the principle of parallelism. Instead of activities proceeding in a sequential order they can be carried out concurrently. Unfortunately this may lead to segregated business processes and to non-integral jobs. From the process performer's perspective, it might be preferable if the proportion of parallel-running, non-automated activities is low. Is this third principle fulfilled in our examples? Even though this question is rather trivial, we cannot find the answer, because it is not known how many human actors are allocated to one certain role (e.g. in Figure 3, in business case 4711, activity "compose report" might be carried out by Mrs Glenn and activity "divide report" by Mr Mellor). Or more generally, the number of roles assigned to a business process says little about the number of persons involved in a business case.

(4) *Avoiding leftover allocation strategy*. Before activities can be allocated to roles it is necessary to decide which activities should be carried out by humans and which by machines. According to Bailey (1989), we can distinguish between five allocation strategies:

- *comparison allocation* – each activity has to be analysed and then compared with established human and machine performance criteria;
- *leftover allocation* – as many activities as possible are allocated to a machine and the activities left over are done by humans. Bailey remarks that this strategy would probably be the most popular;
- *economic strategy* – the decision, man versus machine, is based completely on financial assessment;

- *humanized task approach* – the main goal of this approach is to design meaningful human jobs/ human roles;
- *flexible allocation* – humans allocate activities in the system based on their values, needs and interests.

Due to space limitations we resist a further discussion of these allocation strategies. Nevertheless, it seems reasonable to propose that the humanized task approach and the flexible allocation would be the two most appropriate strategies. However, we cannot use the models to determine which allocation strategy has been used.

High job autonomy

To possess autonomy at work may be very important both in practical terms (being able to complete the task) and psychologically (a sense of self-worth). It is conceptually possible to grade degrees of autonomy available within different process designs. The question we want to discuss is: How can the process model be assessed with regard to the degree of autonomy afforded to the participants?

It seems reasonable that the detailed tailoring of activities is not made by the process modeller in advance but by the process performers. This tailoring may then vary from individual to individual and from business case to business case. In this way flexibility is gained. The degree of autonomy may also be influenced by the role assignment. In short, in order to increase the autonomy, *activities should be assigned to teams instead of single actors*. These teams may then work in a relatively autonomous way and may decide *ad hoc* which activities they want to carry out individually or as a group. Note here that Davenport (1993) warns that team structures do not always have a wholly positive impact: “Particularly when teams are cross-functional, members may lack a shared culture, leading to conflict and misunderstanding … Therefore, careful attention must be paid to cultural compatibility issues in selection of team members”.

From a business process modelling point of view, we may raise the question: Is it possible to estimate the degree of autonomy by looking at a conceptual business process model? In our examples we can see that the number of activities is rather low. Therefore, this suggests that the first requirement is fulfilled. In contrast, the second requirement (activities should be assigned to teams instead of single actors) would hardly match. Just looking at the roles’ label (e.g. assistant, secretary), does not help us to decide whether to allocate activities to a single person or a group.

To summarize, business process models provide little help if one wants to check the consistency of a business process or the degree of job integration. In particular, the role concept hides relevant information on actor level. In contrast, business process models are able to provide strong information if one wants to evaluate process autonomy, job autonomy and operational costs. Further research has to show which contribution other approaches (e.g. business process simulation) may offer in order to get an integral evaluation of not-yet-implemented business processes.

Antithesis

This investigation leads to the formulation of three antitheses and a short discussion of their effects.

Goals cannot be captured

As mentioned above, a business process has to fulfil different goals. Some might be easily elicited in stakeholder interviews but there are others which are much harder to elicitate. Some of these might be so fundamental that the stakeholders omit to mention them – until the business process or the IT system fails to deliver them (Macaulay, 1996). Other goals may not be so obvious and may require more sophisticated techniques, such as observing the behaviour of individuals or groups at work to support the process of goal elicitation.

Goals are not shared among business process participants

The process of creating a business process model is a political process. It includes conflicts, not only at the goal-modelling phase, but also at the activity and the role-modelling phase. It follows that a requirements engineer should have "negotiation skills to support consensus building" (Macaulay, 1996). In order to facilitate the negotiation process, we should first try to elicit a non-conflictual super-goal. Second, we could label the conflicting sub-goals with priorities. Furthermore, it is helpful to define thresholds which say to which extent the sub-goals must be fulfilled. Another partial approach to deal with this problem might be that not just one, but several different solutions are provided. This would mean that different process participants work in a different way, and, generally, the more autonomous the business processes and the higher the job autonomy, the less virulent the problem of non-shared goals becomes.

Conceptual business process models are not able to express the main aspects

It is intrinsic to business process models that they highlight certain aspects of the real world and omit others. Whether or not they highlight the most important aspects needs ongoing empirical investigation. Rather than strive for a "perfect" modelling approach, it might be best to tactically adopt different approaches in the creation, evaluation and modification of a model.

Summary and future work

This paper gave an overview of an approach to modelling and evaluating business processes at a conceptual level. It has been shown which steps are needed to create an object-oriented business process model, and how business process models can be evaluated against non-functional goals. Overall, we get some kind of guarantee that business process models are useful. They not only facilitate the communication between team members, but can also be seen as an essential prerequisite for information system developers. Nevertheless, although models are useful, it is of course accepted that an evaluation of a business process carried out using a model will only ever be partial.

What are the strengths of the presented approach?:

- The method helps to ensure that the model is consistent; i.e. it helps to make sure that every functional goal is transformed into at least one activity, that activities which measure the degree of goal fulfilment exist, and that every needed input is produced or delivered by another activity.
- Today's modelling approaches do not give enough attention to the utility of evaluation at the conceptual level. Instead, IT systems are built and the evaluation task is carried out primarily at the implementation stage. This paper considered the utility and difficulty of evaluating a business process model at an early stage.

Where are the limits of the approach?

- Evaluation is carried out by model inspection. This can give only a partial impression of the quality of a business process. A more extensive assessment requires other means such as simulation and organizational prototyping.
- In order to evaluate business process models, non-functional goals have to be elicited and presented in an adequate way. The process of their evaluation would be enhanced by the use of a semi-formal language.

It has been seen that business processes can be evaluated before they are operational – but only partly. In order to develop this and to test various aspects of a new business process (e.g. the fit between IT and work organization), we may develop organizational prototypes. Such prototypes can be seen as small-scale, quasi-operational versions of a business process which allow the simulation of different and realistic business cases. The goal of such prototypes is gradually to shape the organizational environment or, alternatively, to revise the IT (Davenport, 1993). Although the idea of organizational prototypes is several years old, few empirical reports exist. In future work we will create an organizational prototype for validating a new business process. This will be carried out in co-operation with a Swiss pharmaceutical firm.

In conclusion, reference is made to Trisoglio (1995), an advocate of non-linear approaches:

> The complex world has two sides, unpredictability and creativity, both of which have implications for management. Unpredictability cannot be avoided, but must be coped with. This means moving away from decision-making systems that are based on prediction, optimization and control, and towards approaches of resilience, flexibility, evolutionary and learning.

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