

# APPLYING BUSINESS PROCESS MODELING TO ORGANIZATIONAL CHANGE

**Ricardo Mendes, João Mateus, Eduardo Silva, José Tribolet**

Centro de Engenharia Organizacional, INESC Inovação.

{ricardo.mendes}@ceo.inesc.pt

{jgm ,ejms}@mega.ist.utl.pt

{jose.tribolet}@ceo.inesc.pt

## Abstract

*Organizational change can be regarded as a process that changes the state of the organization. This simple yet powerful idea is the ground basis for the work being presented in this paper.*

*This original work brings a new dimension to business modeling: time. Looking at the organization as a dynamic entity that changes through time, allows us to reason over the processes that make the organization evolve, in a formal and objective way. The purpose of this research is to develop tools that help managers to drive business more effectively through time, by keeping in perspective all the issues regarding change in the organization. The first step towards this goal is to create an adequate modeling environment that can be used to represent (1) the organization (at different time frames) and (2) the change processes (that make the organization evolve between time frames). The modeling framework being developed uses UML and, more specifically, the CEO Framework, a business process oriented UML modeling framework.*

*This research is based on a vast theoretical study of process modeling techniques and application domains, as well as on hands-on industry experience in several change processes in real-life companies. The paper presents a formal definition of all the concepts involved in this research, the first version of the UML Profile for Business Change Modeling that is under development and the preliminary results of the application of this research in the Portuguese Army.*

**Keywords:** Business Process Modeling, Organizational Change, UML, Process Re-engineering, Process Improvement, Business Strategy.

## Introduction and Motivation

The work here presented is being developed in the Center for Organizational Engineering (CEO). The CEO was created in 1999 to research the organizational aspects of information systems. The current researchers working at the CEO are Computer and Software Engineers connected to the Computer and Software Engineering Department at the Instituto Superior Técnico (IST) of Lisbon, Portugal.

Since its creation, the CEO as been developing a business process oriented modeling framework based on UML, which has grounded the development of several software tools. The CEO Framework focuses primarily on capturing the operational reality of the organization by using four major concepts and their relations: processes, resources, goals and systems. This

framework has been applied as a tool for supporting the analysis of complex organizational problems in several organizations, which has allowed the CEO to validate through practice all the concepts involved (Caetano 2000)(Vasconcelos 2001). The CEO Framework has been subject of study of four MSc Thesis and several undergraduate studies, and is currently under development with several PhD, MSc and undergraduate studies.

One of the major shortcomings in most business modeling frameworks is the lack of support for a fundamental issue in organizations: change. This occurs because they are primarily designed to support the modeling of operational aspects in the organization and lack the capability for supporting reasoning over Organizational Change, *i.e.*, the way operations change through time. The research presented in this paper focuses on creating a ground for reasoning over Organizational Change, using the CEO Framework as a basis for modeling the organization, but introducing a fundamental aspect of change: time.

Coping with the organizational change is, as an example, one of the major issues regarding the implementation of an information system in an organization, since it usually has great impact on the way work is done. However well built the system is, if the organization doesn't adapt well to its usage, it won't work. Hence the relevance of studying Organizational Change from the standpoint of Business Modeling and of Computer and Software Engineering (Laudon 1996).

Organizations change through time (Mintzberg 1996). Many disciplines try to cope with change from several different perspectives. Strategic Planning (Mintzberg 1998)(Wheelen 2001), Process Reengineering (Hammer 1993) and Process Innovation (Davenport 1993) are some of the management disciplines that have targeted the issue of organizational change. These disciplines have presented methodologies and models that support the analysis of issues related to organizational change and, although they have different perspectives, there is always one common issue: however change is being analyzed, the notion of time sequence is of the utmost importance. The research being presented doesn't aim at producing yet another methodology for evolving the organization or creating a strategy that guides that evolution, it focuses solely at creating a sound basis for reasoning over Organizational Change over a defined time-scale.

The next section presents a very brief overview of some of the research being done in this area and of the CEO Framework. Section 3 presents a definition of the fundamental concepts this research. Section 4 presents the form by which these concepts are introduced in the CEO Framework and in the UML language. Section 5 presents a simple example of the application of these concepts to a real organization, by showing some preliminary results of an ongoing applied research work. Section 6 draws the final conclusions in terms of the contributions this research brings and the next steps that are going to be taken.

## Background and Related Work

Creating a model of a dynamic and highly non-deterministic entity like an organization is a difficult task. Nevertheless, the creation of this abstraction of real world is of fundamental importance to allow managers to abstract from irrelevant details and focus on the important problems (Eriksson 2000) (Marshall 2000). This is one of the most common ground basis for Business Modeling, and is also the fundamental motivation behind the investigation held at the CEO.

### *The CEO Framework*

The CEO Framework (**Error! Reference source not found.**) aims at providing a formal way of describing business goals, processes, resources and information systems and the dependencies between them. It is composed of three separate levels, each of which provides adequate forms of representing the notions about the layer being described (Vasconcelos 2001). In the first level, the aim is at describing the current set of goals that drive business. These goals must be achieved through one or more business process. The business processes are described at the second level and must exist in order to satisfy one or more goals. Besides serving goals, business processes interact with resources in order to do work and may be supported by information systems. The information systems layer aims at modeling the components of the system that support business. Although the framework presents a clear separation of concerns (business and system), the dependencies and relationships between the different layers are easily recognized (Caetano 2000) (Vasconcelos 2001).

The modeling language used to implement the CEO Framework was UML. As UML was initially designed to describe aspects of a software system, it had to be extended to more clearly identify and visualize the important concepts of business, namely by use of stereotypes. A stereotype is an extension of the vocabulary of the UML, which allows you to create new building blocks specific to your problem from existing ones. Stereotypes may have their own icons (OMG 1999). Due to size restrictions, there will not be a full presentation of the CEO Framework (for further reading, refer to (Vasconcelos 2001)).

The present investigation uses the CEO Framework as a basis for creating Business Change Modeling Extensions to UML.

## Organizational Change

Organizational Change has been a subject of study from many research fields, especially in the management area. Although this investigation is inserted in an Engineering environment, it was fundamental to deeply study the major research lines targeting Organizational Change from the Social Studies perspective. Regarding this perspective, the most important basis for this research were three interconnected, yet different perspectives over Organizational Change: Strategic Planning, Process Reengineering and Process Innovation.

There is a common basis for several Strategic Planning frameworks and methodologies with regard to Organizational Change. The purpose of Strategic Planning is to create a plan that will drive the organization to success in a dynamic and evolving environment. Whatever definition is chosen for *plan*, it denotes two things: action and time. A plan usually organizes action over time and, when applied to a business environment, it implies stating the course of action throughout a defined time period. This notion is at the heart of the presented research (Mintzberg 1998) (Wheelen 2001).

Process Reengineering and Process Improvement are two different approaches towards how to do business better. While Process Reengineering defends that only re-drawing business processes from scratch can bring significant added value to the original process, Process Improvement defends the opposite thought: you cannot ignore the current processes, you have to make small, sequential improvements in order to optimize your processes (Hammer 1993) (Davenport 1993). Although these disciplines take opposite positions towards how to change business processes, they both begin with a clear picture of how things are currently done and aim at achieving one or more states where things are done in a better way. As with Strategic Planning this notion involves the occurrence of change in business processes over a determined timeline.

As will be explained in the following sections, the undergoing research doesn't aim at implementing either one of these methods. It aims at creating a modeling basis that could easily accommodate each one of these techniques when analyzing change in the organization.

## Domain Definition

In order to address the issue of Organizational Change in a modeling environment, it is necessary to introduce a new dimension: time. To accomplish it, this research introduces two new concepts: *Scenarios* and *Change Processes*. *Scenarios* capture the state of the organization at a specified time frame. *Change Processes* connect scenarios that occur at different time frames and represent the changes that occur between those scenarios. These concepts are explored in depth in the following sections.

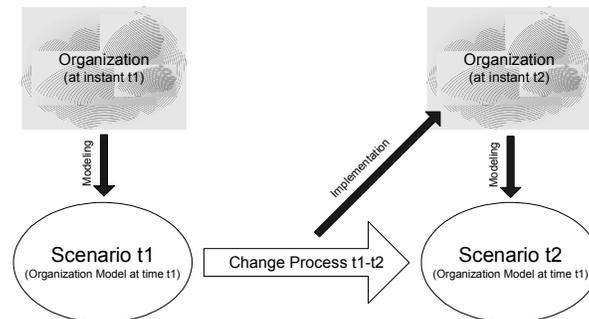


Figure 1 - A conceptual view over *scenarios* and *change processes*

## Scenarios

A *Scenario* is a partial view of the organization in a specific time period. It is fundamental to introduce scenarios because they allow the modeler to specify *time* and *scope*. Modeling change in the organization is a complex task because it implies the simultaneous consideration of the organization at different time periods. However, and since business modeling frameworks typically only target the modeling of the organization at a specified instant in time, there are no mechanisms that allow the modeler to cope with this problem. The introduction of Scenarios sets the basis for such a mechanism, by creating a way of specifying the time period to which a model refers. This capability introduces an enormous flexibility in models, since it allows the simultaneous consideration of models regarding different time periods.

Although different methodologies imply a different way of determining organizational change, the need to focus on specific parts of the organization is common. Scenarios help the modeler to cope with this need by introducing a way of organizing the specificity of the analysis scope. A scenario thus introduces the notion of scope in the models.

A Scenario can contain processes, resources, goals and systems, as well as their relations. A Scenario can be specialized into more specific scenarios that contain subsets of its elements. The specialization of scenarios is thus the basis for controlling the modeling scope. If two scenarios are connected by a specialization relation, than they must relate to the same time period. Scenarios that relate to different time periods can only be related by change processes that occur between those periods.

### **Change Processes**

A *Change Process* is a special kind of business process that produces structural change in the organization. A Change Process is *applied* to the organization at a defined scenario, and *produces* a different scenario. A Change Process is *owned* by the Change Owner. The owner isn't necessarily the executioner of the Change Process. In order to produce change, the Change Process *uses* resources (that are or not owned by the company). Special kinds of resources used to execute the Change Processes are the human resources that execute the change. Change Processes exist for a given *reason*. This reason can either be expressed in natural language, or by connection to other Change Processes.

Change processes relate to other domain entities and can relate to each other in different ways. Change processes relate to scenarios by either being applied to them or producing them. Change processes induce an order between scenarios, as they transform each scenario into a different scenario, occurring at a more advanced period in time. Producing change in an organization can imply changing different kinds of entities, such as processes, resources, systems or goals. Change processes can thus affect each considered entity in an organization, by either being applied to a scenario that contains that entity (producing change based on it) or by producing a scenario that contains it.

### **Effect-Specialization of Change Processes**

Change Processes can be specialized in terms of the effect they produce in the organization. Regarding this aspect, we can arrange the hierarchy of change processes in two major types: *high-level* and *low-level change processes*.

*Low-level* change processes can be directly applied to the organization without further decomposition and they do not demand the creation of intermediate scenarios. There are two kinds of low-level change processes:

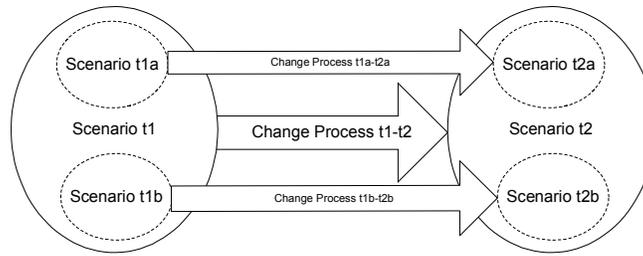
- *Terminate: Termination Change Processes* terminate one entity in the organization
- *Create: Creation Change Processes* create one entity in the organization.

*Low-level change processes* can be further specialized in accordance to the kind of entities they aim to change: processes, resources, goals or systems. We can thus further specialize change processes into: *Terminate Process*, *Terminate Resource*, *Terminate System*, *Terminate Goal*, *Create Process*, *Create Resource*, *Create System*, *Create Goal*.

*High-level change processes* allow the organization of all the changes in the organization in wider steps that must be decomposed into more specific change processes and induce the creation of intermediate scenarios. Although *high-level* change processes can be further defined, the only kind considered at this point will *Modification* Change Processes (*Modify*). Modification Change Processes modify one or more entities in the organization. This kind of change processes induce the need for further decomposition into more specialized change processes and the creation of intermediate scenarios.

### **Scope-Specialization of Change Processes**

Change Processes can represent change in different parts of the organization, and thus induce a scope-specialization hierarchy. Change Process A is more scope-specific than Change Process B if the scenarios A connects are more specific than the scenarios B connects (recall that scenario A is more specific than scenario B if A contains a subset of the elements in B). The following figure represents a change process t1-t2 that can be decomposed into two more scope-specific change processes: t1a-t2a and t1b-t2b.



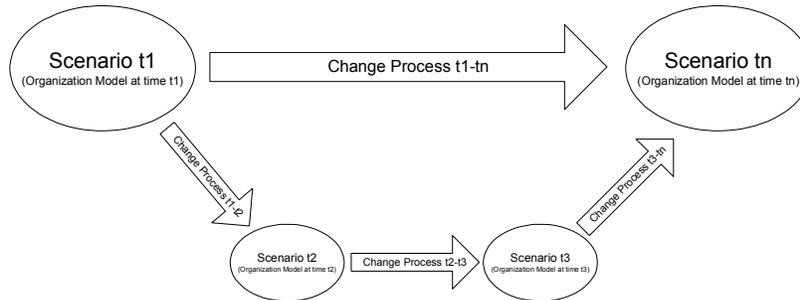
**Figure 2 - Conceptual view of Change Process scope-specialization**

It is to notice that Change Processes can only connect scenarios that have the same scope (that refer to the same part of the organization). Although this restriction imposes some limitations in this framework, it creates a simpler way of handling change.

**Time-Specialization of Change Processes**

Change processes can be decomposed into more time-specific change processes. A change process is more time-specific than other if it relates two closer scenarios (in terms of the time-distance between scenarios).

The time-specialization relation can only be applied to Change Processes that have the same scope. This induces a restriction in the modeling methodology, since it demands that scope-specialization is done previously to time-specialization.



**Figure 3 - Conceptual view of Change Process time-specialization**

The above presented figure represents a change process t1-tn that can be decomposed into three more time-specific change processes: t1-t2, t2-t3 and t3-tn.

**Other Relations between Change Processes**

Some Change Processes can require the existence of other change processes that are not hierarchically related to them. This characteristic induces the creation of a special kind of relation between change processes: *activation*. This activation relation can thus justify the need for the existence of a change processes. This feature has been incorporated in this framework in order to allow the representation of trigger change process. As an example, the activation of a Terminate Resource Change Process might trigger the activation of a Modify Change Process upon a scenario that contains a process that uses the resource being terminated.

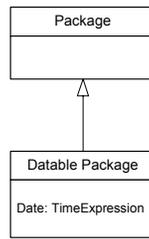
**A Notation for Modeling Change**

In order to introduce Scenarios and Change Processes in the CEO Framework, two new specific model elements were created. With this extension, the CEO Framework constitutes a first draft proposal for an UML Profile for Business Change Modeling. The following sections present the modeling elements as well as the relations between them.

**Scenarios**

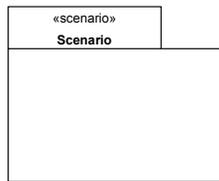
The natural representation for Scenarios in UML is by use of Packages, since they both intend to group a set of model elements that are somehow interrelated. However, Packages don't have attributes and therefore don't allow the specification

of the time period to each the scenario relates. In order to create such an attribute, a new meta-class *Datable Package* as to be created at the meta-model level.



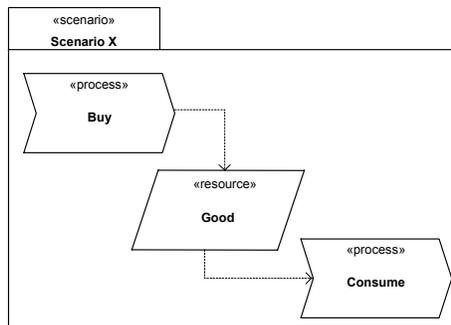
**Figure 4 - Creation of Meta-class Datable Package**

After creating the Datable Package Meta-class, it can be stereotyped to Scenario at the model level.



**Figure 5 - Scenario Stereotype**

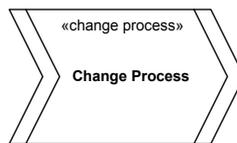
The specialization of scenarios can thus be accomplished by use of standard UML specialization (since Packages are Generalizable Elements). As Packages, Scenarios connect to the Model Elements they contain (in this specific case, Processes, Resources, Goals, Systems and the relations between them), and the contents of a Scenario can be shown within the largest rectangle of the Scenario symbol.



**Figure 6 - Example of a Scenario**

### Change Processes

Change Processes can be represented formally introduced in UML by creating a stereotyped activity (an action state), that imposes the necessary semantic restrictions. They apply the following semantic restriction: “*Change Processes are potentially complex activities that induce structural change in the organization*”.

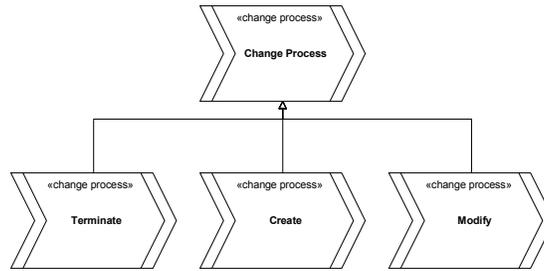


**Figure 7 - Change Process Stereotype**

Three different specialization forms of change processes were defined (effect, scope and time). In order to cope with this need, two association stereotypes were created. This will be presented in the following sections.

**Effect-Specialization**

To represent effect-specialization, UML Class inheritance was used. A change process can thus be specialized in a Terminate, a Create or a Modify type process.



**Figure 8 - Effect-Specialization of Change Processes (using UML Class inheritance)**

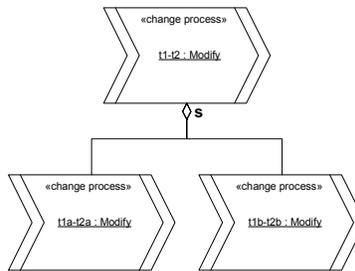
**Scope-Specialization**

Scope specialization is accomplished by using a special kind of association: *scope-specific*. The *scope-specific* association is represented as a stereotype of class association and is used to connect two Change Processes that relate to the same time period, but have different, hierarchically-related scopes (this notion was presented in section 4).



**Figure 9 – Scope-specific Association**

Figure 10 presents an example of the usage of scope-specificity between Change Processes. Notice that this example relates to the case presented in Figure 2.



**Figure 10 - An example of a scope-specific hierarchy of Change Processes**

**Time-Specialization**

Time specialization is accomplished by using a special kind of association: *time-specific*. The *time-specific* association is represented as a stereotype of class association and is used to connect two Change Processes that have the same scope but that relate to different time periods (where one of the time periods contains the other).



**Figure 11 – Time-specific Association**

Figure 12 presents an example of the usage of time-specificity between Change Processes. Notice that this example relates to the case presented in Figure 3.

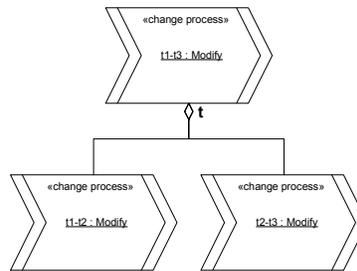


Figure 12 - An example of a time-specific hierarchy of Change Processes

**Relations between entities**

Change Processes either are applied or produce Scenarios. These two relations can be expressed as two stereotyped associations: *apply* and *produce*.



Figure 13 - The *apply* and *produce* stereotypes

Figure 14 presents an example of the relation between two Scenarios and one Change Process. In this example, Change Process *t1-t2* (which is a *Modify* Change Process) is applied to Scenario *t1* in order to produce Scenario *t2*.

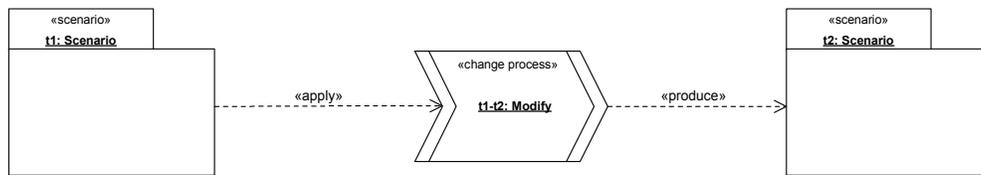


Figure 14 - An example of the relation between Scenarios and Change Processes

It is fundamental to acknowledge that Change Processes do not relate directly to specific entities (like processes, resources, systems and goals), they relate through scenarios (remember that a scenario can include as little as one entity!).

**Benefits of the Proposed Notation**

The approach and the notation proposed in this paper represent an dimensional increase in the flexibility of a traditional business modeling framework. The ability to explicitly represent time and models that represent the reality at different time periods creates a basis for solving several different problems.

In order to analyze business models that occur at different periods, the user of a modeling tool usually has to explore one model and then open and explore another one (if, of course, the used tool incorporates validation schemes for coherence between model elements). By implementing this notation, a business modeling tool can resolve all coherence issues and additionally allow the creation of model elements that connect both models (as presented before, we can use change processes to accomplish this).

This possibility can be extremely useful in several conditions. When analyzing past changes in an organization, the analyst may need to keep references between two or more model elements occurring at different time periods (e.g. the reason for the occurred change; or the gain from a newly introduced process). By using this notation, this possibility comes naturally and is embedded into both models (by association of Change Processes and Scenarios). When specifying proposed changes in an organization (at some business or technological level) there is usually a lack of representational power in traditional business modeling tools and often there is a need for recurring to other presentation strategies. By using this notation, the specification of the evolution of a certain group of model elements (e.g. the processes related to a certain resource) can be correctly and unambiguously presented to an heterogeneous audience.

## Experience from the Portuguese Army

The presented research is being completely supported by practical work in real-life Portuguese organizations, in both the private and the public sector. One of the organizations with which the CEO is interacting is the Portuguese Army. In September 2002, two undergraduate Software and Computer Engineering students, who are simultaneously Captains in the Portuguese Army began a project in the Portuguese Army, under the coordination of the CEO. This project aimed primarily at analyzing the Personnel Management Department and its underlying processes, in order to (1) identify processes that must be subject to change due to the implementation of a new ERP (that is due to start by the end of the year and is expected to have great impact on the organization) and (2) identify processes that can be easily optimized and propose and justify changes to those processes.

### *Modeling the Organization*

In order to achieve the proposed goals, a complete model of the Personnel Management Department was created, by recurring to the CEO Framework. This model includes:

- A detailed goal model of what the department is aimed to achieve
- The information systems architecture relative to the Personnel Management Department
- A complete business process model, including all the business processes, the manipulated resources (created and used by the business processes), the goals each process is currently aiming to achieve, and the information systems that are currently used by each process

Due to the limited space available, the examples will focus only on the change modeling aspects and therefore no diagrams of the main *as is* model will be presented.

### *Modeling Change in the Organization*

Although this work is currently under development (it is planned to end by July 2003), the preliminary results indicated that there was an imperative need for mechanisms that would allow the representation of change in the organization, namely for analysis, communication and discussion effects, but also to allow the organization of the models that were being created and that had different scopes and targeted different time-frames.

In this section, a very simple example of the models that could be created by use of the above presented extensions will be presented. All change models are being developed and validated in straight relation with some of the key persons on the Personnel Management Department. By this time, it is evident that this communication is being widely benefited by the use the created Business Change Extensions, since they allow modelers to communicate with both business and technical specialists. Due to the lack of space and to the inadequacy of the means of communication, only some of the simpler and smaller examples will be presented, namely regarding Course Information Distribution.

Currently, the course information distribution process follows the workflow presented in Figure 15.

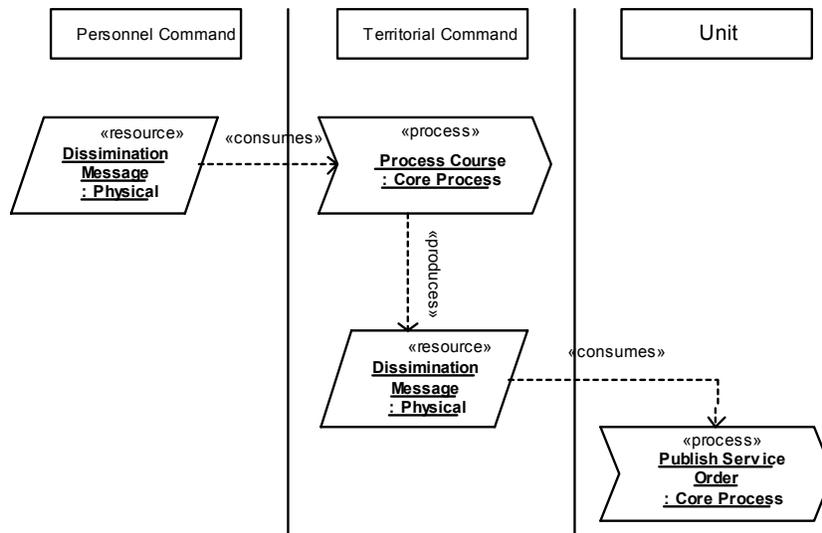


Figure 15 - Current Course Information Distribution Process

It was observed that this process, although being very simple, originated many delays. After analyzing the situation, the researchers found that the “Process Course” process, executed by Territorial Commands, was causing the delay (because of the heavy workload), which is a normal situation in public organizations. However, the researchers also found out that the dissemination message created by that process had always to be the same as the original dissemination message (the state of the resource was completely unchanged), since the Territorial Command doesn’t have the power to change resources that come from the Personnel Command. This state of affairs was due to legacy, in conditions that no longer occurred. The researchers then proposed a very simple, yet effective change in the process.

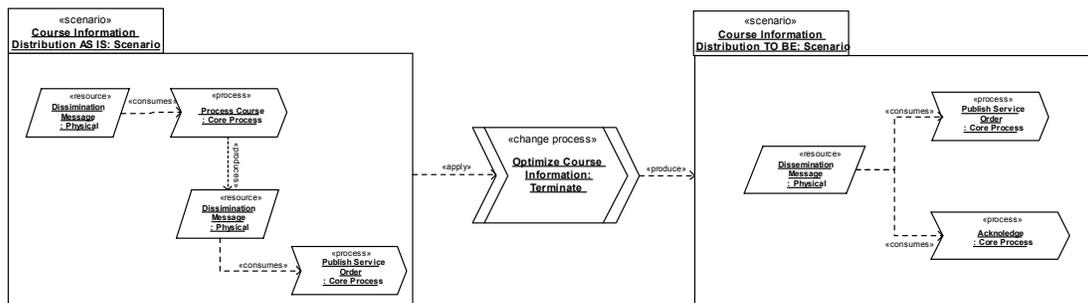


Figure 16 - Current vs. Future Situation

Figure 16 presents the current and future (proposed) scenarios, regarding the Course Information Dissemination Process, as well as the Change Process that will take the organization from one state to the other. Notice that both scenarios must have the same scope.

In order to specialize Change Process “Optimize Course Information”, it is necessary to specialize the scenarios presented into more specific scenarios. This is presented in Figure 17.

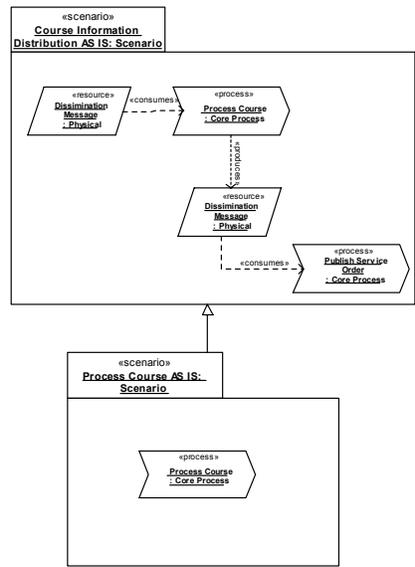


Figure 17 - Specialization of the AS IS Scenario

More detailed Change Processes can than be created so that it is possible to represent, in an organized form, the necessary steps to implement change (Figure 18).

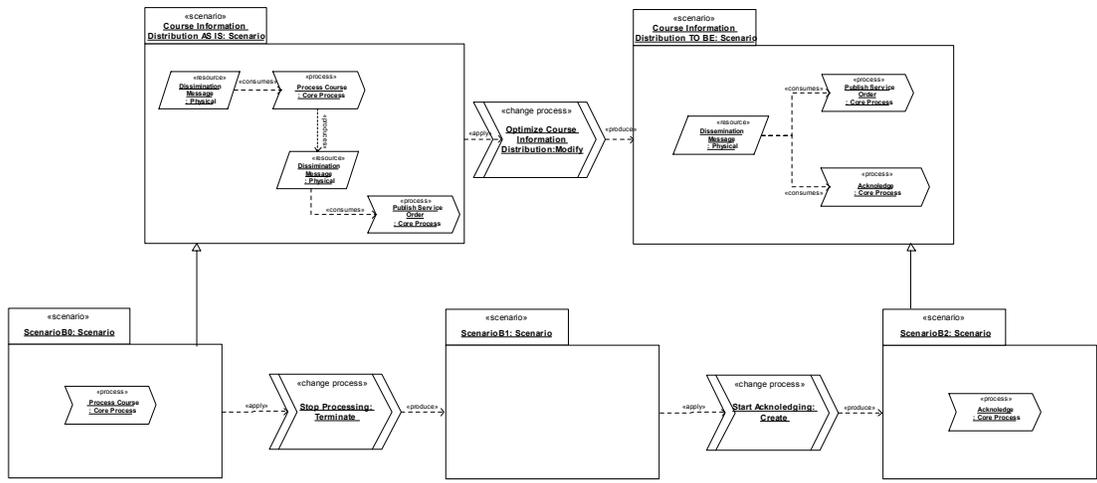
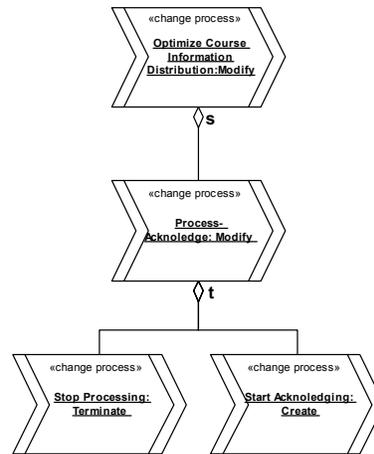


Figure 18 - Planning the Change

The Change Processes presented in Figure 18 are related by scope and time-specialization relations, as can be observed in Figure 19.



**Figure 19 - Relations between Change Processes**

Although very simple, this example enabled the demonstration of the use of the above presented extensions. When applied at a wider extent, these extensions are extremely useful in facilitating the communication between all the participants, as well as on documenting the whole change planning process. Although there is still no practical evidence, the usage of these models upon the execution of the change processes might be of great assistance for managing the whole change process, since they clearly state the scope and timing for all the change processes.

## Contributions and Future Work

The original research presented in this paper is based on a very simple, but strong and useful concept: time. For the first time, this concept is included in a business modeling framework to cope with the complexity of Modeling Business Change.

Although the results presented are still based on unfinished work in a real organization, preliminary data indicates that the business change modeling extensions presented in this paper are fundamental for dealing with reengineering, strategic planning, improvement, or other techniques that involve change in a business modeling environment.

The presented extensions, although being of great use, are still the basis for a wider view that intends to use the presented time-analysis mechanisms to create a set of tools for supporting:

- Business Strategy Specification, Implementation and Control: Business Strategy is based upon the conception of change (in the internal and external environments). A tool is being created that will support the specification of business strategy in terms of change processes and scenarios, and that will support the implementation and execution control of the defined strategy;
- Project Evaluation: Based on this research, the CEO is currently undergoing an industry-project that aims at creating an evaluation mechanism for Information Systems Projects, with relation to a previously defined Information Systems Strategy. In this project, researchers from the CEO are using Change Processes and Scenarios to represent IS Projects.
- Change Patterns Analysis: This research will be applied to the analysis and representation of change patterns in organizations. This will be accomplished by modeling past changes as Change Processes that evolved the organization through different scenarios, and analyzing those processes chains.

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