Analyzing the Scope of a Change in a Business Process Model

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Abstract. Organizations often change their business processes. These changes lead to adjustments in the business process support (BPS) system. The impact of a change in a business process may extend beyond the specific point that has been changed, affecting pre-conditions required for other activities, outputs to be created, or requiring new inputs. This paper introduces a concept of a scope of a change, whose identification facilitates focused efforts when adjusting the BPS system to changes in business processes.

1 Introduction

Alignment of business processes and a Business Process Support (BPS) system, once established, needs to be maintained over time, through changes the organization undergoes.

As we live in a fast changing world, an organization constantly changes its business processes. It may be a result of ongoing improvement efforts, changes in the business environment, and advances in technology. When business processes are changed, the BPS system should be adjusted accordingly.

Since changes of various magnitudes are frequent in the business world, it is important to maintain the fit between the business processes and the BPS system in an evolutionary rather than a revolutionary manner. Managing change should consider the two systems in parallel: the business system and the BPS system, where changes in one are manifested to the other and vice versa. When a business process is modified, the resulting effect may extend beyond the specific point that has been modified. Identifying the scope and magnitude of this effect is not straightforward and is of great importance when adjusting the parallel system accordingly. Misidentification of this scope may result in insufficient adjustment of the BPS system or in unnecessary redesign efforts, extending beyond the affected scope.

This paper introduces and discusses the concept of a scope of change, focusing on changes made in business processes. Identifying the scope of a specific modification in a business process sets boundaries to the adjustment efforts made in the BPS system. While software systems are usually designed to be modular so that changes can be locally administered, business processes are often not designed this way. Therefore, the non-modular nature of business processes may cause a modification made to them to be affected across different modules of the BPS system.

We shall present the basic concepts of our process modeling approach and a taxonomy of modifications that can be made to a process. Then we shall characterize the effect and scope of different types of modifications, and indicate properties that are of relevance for identifying the scope of a change.

2 The GPM Modeling Framework

As a basis for discussing the scope of a change we use the Generic Process Modeling (GPM) framework, presented and discussed in [4, 5]. GPM is a theoretical framework, based on Bunge's ontology [1] (also known as the BWW ontology). It provides a goal-driven model of a process, viewed as a sequence of unstable states, transforming by law until a stable state is reached. *State* refers to the state of a domain in which the process occurs, and is described as a vector of values assigned to state variables at a certain point in time.

A process model in GPM is a quadruple $M_P = \langle S, L, I, G \rangle$, where: S is a set of states defining the domain of the process, L is a law defined on S, I is a subset of unstable states in S: the set of possible initial states, and G is a subset of stable states in S: the goal set.

GPM addresses the initiation of a process and its goal as subsets of states, defined by conditions over criterion functions. The criterion functions determine the subset of state variables that are relevant for determining the initiation of an action and its termination, while the conditions specify the values of these state variables. Other state variables that describe the state of the domain may assume a range of values. Hence, the process may start or end in a set of states rather than a single state. Similarly, the law, that defines the possible state transitions, is specified as mappings between subsets of states, defined by conditions over criterion functions.

As an example, consider a production process. The initial set I={s| Production Order = "Released"; Materials = "Available"; Resources = "Available"}. The number of states in I is unlimited. They may differ from each other in properties such as required completion time, current machine load, etc. The production process progresses as production activities are carried out, changing the state of the domain according to the law that sets the order of state transitions. For example, {s| Production Status = "1st Operation Completed"} $\rightarrow$ {s| Production Status = "2nd Operation Completed"}. The goal of the process is G = {s| Production Status = "Completed"; Quality = "Approved"}. The states in this set may vary in properties such as production time and cost, but they all satisfy the conditions specified.

3 Process Model Modification Taxonomy

Modifications made to a process model can range from an overall redesign to local modifications. An overall redesign implies that the BPS system is to be adjusted to a new business process not supported before, while a local modification is when one point in the process is modified. In most cases the modification is limited to specific parts of the process, although not necessarily purely local.

The modification taxonomy presented in this section outlines the types of modifications that can be made to a business process on the basis of the GPM set of concepts. Other modification taxonomies have been suggested in the literature (e.g., [2, 3]), mainly in relation to workflow models. However, their aim was to facilitate workflow version management, hence, they differ from the current one. This taxonomy does not deal with an overall redesign of a process, as this kind of action may lead to a totally new process. Rather, it addresses modifications that can be made to an existing process. Some modification types are associated with global changes in the process, while others may be either of a local or a global nature.

The modification taxonomy is as follows:

- Modification in S: redefinition (enhancement / reduction) of the domain
    - Insert / delete states in the possible state space
    - Insert / delete state variables in the state definition
- Modification in L:
    - Insert / Delete a transition: a mapping from a set of states to a set of states
    - Change in a condition over a criterion function
        - Change condition value
        - Change relation (e.g. $<$, $=$)
        - For a composite condition: change in combining operator (e.g., AND)
    - Change in a criterion function
        - Change subset of state variables
        - Change the function defined on the state variables (e.g., average)
    - Insert / delete a branching point
    - Insert / delete a joining point
- Modification in I or in G:
    - Change in the criterion function
    - Change in the condition

We shall now discuss the modifications listed in the taxonomy. A modification in S usually implies a global change in the process. Enhancement of the domain either means that new possibilities for action are taken into account or that a change is made in the information, resources, or actors participating in the process. Reduction of the domain may imply that certain possibilities for action are not available or that specific parts of the domain are no longer internally controlled (e.g., in case of outsourcing). A modification in S is naturally accompanied by a modification in L.

Modifications in L may either have a local effect or a global one. An example of a modification of a local nature is a change in the condition values. It does not affect the structure of the process. Rather, the likelihood of a certain transition is changed. In terms of the BPS system, this is at most a change in a parameter value. For example, consider a batch of produced items that is approved if the defect rate is below X%. Assume the defect rate for approval is changed to Y%. The effect of this change would be in a parameter value, with no structural implications.

Inserting, deleting or replacing a transition might have an effect that extends further than the specific point of change, but not necessarily. Assume that in the production process discussed above, a new machine has been acquired, so that two consecutive production operations are now integrated and replaced by one. In terms of the process, it means deleting two transitions and inserting one instead. The effect of the change does not extend beyond this point, since the state obtained after the new transition is equivalent to the state previously obtained through two transitions. In contrast, assume that one production operation is modified to be performed by a subcontractor. This means that material has to be sent to the subcontractor, received back and checked, payment to the subcontractor needs to be made, and inventory management should consider material held by the subcontractor.

Inserting or deleting a branching point is actually a special case of inserting or deleting transitions. It may also relate to changing the nature of an existing branching point (e.g., from an OR branch to an AND branch). The effect of inserting or deleting a branching or a joining point clearly extends until the following joining point, and may extend beyond it as well. For example, inserting a quality inspection operation in the production process may lead to a rework path (branching point), which will join the original process once rework is completed and the produced items are ready for the next production operation. The effect of the change might not extend beyond this point, unless rework has further implications (e.g., certain customers would not receive reworked goods).

A modification in I clearly requires a change in L as well. It may either be local or global. When a change in I occurs, it requires checking that the newly defined triggering states are feasible in terms of relationships with other processes that exist in the organization.

A modification in G, while clearly affecting L, can be considered as creating a new process rather than modifying an existing one. Semantically, this is an important question. However, in practice the change might be minor or applicable to only a small portion of the process occurrences (e.g., exceptions), hence, it may be of less importance. In practical terms, an important implication of a change in G is that its effect might extend to other processes that use the outputs generated by the process being modified. Hence, this should be examined carefully. As an example, the production process discussed earlier might have a step, in which it is decided whether to complete the production or to leave the semi-finished products and sell them as they are. The goal of the process is then changed from the set of states where production is completed and approved to this set of states OR the set of states where semi-finished products are produced. In the latter case, if finished products are required by a customer, they will not be ready as ordered.

4 Scope of Changes

As discussed in Section 3, modifications in S, I, and G all lead to modifications in L. Hence, this section is focused on modifications in L and provides a basis for analyzing the impact of a single such modification.

The impact of a certain change may be different with respect to different subsets of state variables. Hence, impact identification must relate to a defined subset of state variables. Consider the above mentioned example of a new machine that enables replacing two production operations by one. The impact of this change (in terms of the state of the produced item) is limited and would not extend beyond the end of the specific production operation. However, with respect to a broader subset of state variables, such as production time and cost, the impact will extend and result in a different goal state in terms of these variables. For process design purposes, state variables such as time and cost are of great importance. However, for the purpose of adjusting the BPS system to the changes made in the business process, it is important to identify the impact on the process course and information flow, while reduced cost and time are not to be considered. Hence, we shall address the impact of modifications with respect to the subset of *course-defining* state variables, which are the state variables that participate in the criterion functions specified by the law. We term this impact the *scope of the change*.

Considering a local change in L in which the set of course-defining state variables is not changed, the scope of change is between the point of change and an *equivalence point*. The equivalence point is the point where the values of the course-defining state variables in the modified process are identical to values they would assume in the original process.

As an example, consider again the production process discussed earlier and assume two possible (independent) local modifications, as shown in Table 1.

Table 1: Production process example

<table>
<tr><th>Process states</th><th>Modification I</th><th colspan="2">Modification II</th></tr>
<tr><td>s_1 – before production</td><td>s_1’ – before production</td><td colspan="2">s_1’’ – before production</td></tr>
<tr><td>s_2 – after 1st production operation</td><td>s_2’ – after 1st production operation</td><td colspan="2">s_2’’ – after 1st production operation</td></tr>
<tr><td>s_3 – after 2nd production operation</td><td>s_3’ – after 2nd and 3rd production operations</td><td colspan="2">s_3’’ – after 2nd and 3rd production operations, uncertain quality</td></tr>
<tr><td>s_4 – after 3rd production operation</td><td>s_4’ – after 4th production operation</td><td colspan="2">s_4’’ – after 4th production operation, uncertain quality</td></tr>
<tr><td>s_5 – after 4th production operation</td><td rowspan="5">s_5’ – after 5th production operation, production completed</td><td rowspan="4">$s_{5.1}$’’ – after quality inspection: approved</td><td>$s_{5.2}$’’ – after quality inspection – rework needed</td></tr>
<tr><td rowspan="4">s_6 – after 5th production operation, production completed</td><td>$s_{5.3}$’’ – after rework 2nd +3rd production operations</td></tr>
<tr><td>$s_{5.4}$’’ – after rework 4th production operation</td></tr>
<tr><td>$s_{5.5}$’’ – rework approved</td></tr>
<tr><td colspan="2">s_6’’ – after 5th prod. operation, production completed</td></tr>
</table>

Considering Modification I, the new state s_3’ is identical to the original s_4 (in terms of the produced item’s status). Hence, this is the equivalence point, from which the modified process proceeds as the original one. Modification II includes a new integrated production operation, which is of an uncertain quality and requires inspection, to be performed only after the next operation. Quality inspection may lead to rework (branching). The equivalence point is at the joining point, which is when the product is approved after inspection ($s_{5.1}$'' and $s_{5.5}$'' satisfy this condition). From here on, the modified process proceeds at the same course as the original one. The scope of the change in Modification I is [s_2, s_4], while Modification II results in a scope of [s_2, s_5]. The scope of change is expressed in terms of the original process.

In cases where the modification enhances the subset of course-defining state variables, the following cases can be distinguished:

1. The new course-defining state variables are not course-defining state variables in any other process that exist in the organization (i.e., they are internal to process P). Two possibilities exist in this case: (a) The new course-defining state variables are applicable only to a part of the process. In this case an equivalence point may exist between the point of change and the goal set of the process. For example, assume that the results of the inspection in Modification II (Table 1) determine the type of the rework operation. These results are course-defining state variables for the states $s_{5.2}$'' – $s_{5.3}$'' only, and are not relevant for any other process. An equivalence point exists ($s_{5.5}$''). (b) The new course-defining state variables apply from the point of change s_i and on. Then no equivalence point exists, and the scope of change is [s_i, G].
2. The new course-defining state variables are course-defining state variables in other processes that exist in the organization (i.e., they form inputs or outputs to operations in other processes). In this case it should be examined whether the satisfaction of the conditions defined by the law in the other processes is affected by the change these state variables undergo in the modified process. The scope of change might extend beyond the specific process P. This can be illustrated by the earlier mentioned example of replacing one of the production operations by a subcontracted operation. Here some of the added course-defining state variables are course-defining in other processes as well (e.g., subcontractor payable account, inventory held by subcontractor). Hence, the scope of the change extends beyond the boundaries of the process.

5 Conclusions

Identifying the scope of a change made to a business process is crucial for adjusting the BPS system accordingly. The impact of a change may be limited to the specific point that has been changed, or may extend far beyond. When adjusting the BPS system to modifications made to business processes, a definite scope of change facilitates focused efforts and completeness of the adjustment.

The concepts presented here form a basis for a systematic identification of a scope of a change. Nevertheless, they are far from being an operational and practical procedure. The examples presented in the paper are simple and serve for illustration purposes. However, real life processes, modifications and their impact are much more complicated. Effort is still needed in order to operationalize the concepts presented in this paper and develop them into a set of tools that can be applied in practice.

References

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