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Engineering the Fitness Relationship between an ERP and the Supply Chain Process at SNCF

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ABSTRACT

Ensuring the adequacy of ERP implementations to business requirements is still an issue that needs to be addressed if we want ERPs to provide the advantages expected by organizations. One important cause of inadequacy results from the gap between the languages used by ERP implementers and the other stakeholders. Our approach to this issue is to materialize with a goal model the so-called fitness relationship between the ERP and the business processes that it supports. Based on the assumption that the Map formalism can be used to achieve this, we have developed at SNCF a method that helps eliciting ERP implementation requirements together with business adaptation requirements in an integrated way. This paper outlines this method and the issues that were met while developing and using it in an SNCF project in which PeopleSoft is being implemented to support the Supply Chain processes.

INTRODUCTION

One major issue of any Information System (IS) project relates to the need to establish the adequacy between the organization's requirements and the IS functionalities. This especially holds with Enterprise Resource Planning (ERP) Systems in which functionalities are already designed and built-in for standard business processes. Our work at SNCF (the French national railways company) consists in developing a methodology that would help demonstrate that the PeopleSoft ERP [PeopleSoft03], which is being implemented, fits to the supply chain processes that it shall support.

As often in this kind of project, the project is mostly driven by the ERP functionalities. These are defined at a low level of details, such as transactions or operations to be carried out. However, organization stakeholders at SNCF think in terms of their goals, tasks and outcomes. This results in a difficulty for organization stakeholders to adapt to the language of ERP experts and furthermore in a difficulty to foresee how the system will fit to their requirements. This mismatch exposes the project to classical and well-documented risks of failure [Standish95] [Davenport00].

Inspired by [Potts97], our approach was to materialize the *fitness relationship* between the system and the business by a model that gathers the business and the system perspectives, namely Map [Salinesi03]. The Map formalism is built on two central concepts that are natural to business experts, goals and strategies:

- We use *goals* to identify the business processes for which the system provides (at least partial) support.
- *Strategies* indicate how the business intends to achieve goals with and without the system.

Our purpose at SNCF was to establish a way of working to: (i) define and understand the fitness relationship with maps, and (ii) preserve it in the face of change. We did not intend to replace or change the modeling techniques and models already used at SNCF and by PeopleSoft teams. On the contrary, our approach was to materialize the relationship between those.

The methodological need of the project team goes however far beyond this as the interviews also showed us that methodological assistance was expected to:

i. identify the *engineering class* at hand, formalize the method ological framework that corresponds to it, and adapt it to the specificity of the project;
ii. rationalize the design decisions by systematically *exploring alternative* system strategies to the business goals at hand;
iii. provide *engineering strategies* that improve the efficiency of requirements specification documents production; and
iv. *model and guide the engineering process* so as to make it documented, repeatable and optimisable.

The next section gives a brief overview of the Map formalism. Each of section 3 subsections deals with one of the four aforementioned issues. Related works and conclusions are respectively presented in sections 4 and 5.

THE MAP REPRESENTATION SYSTEM

A *map* is a directed graph in which nodes are labeled with goals and edges labeled with strategies [Rolland00] [Rolland01]. The directed nature of the graph is a way to represent the flow of goals. Therefore, (i) an edge enters a node if the strategy that it represents can be used to achieve the corresponding goal and (ii) a node is the source of an edge if the achievement of the associated goal is a precondition. Having several edges pointing to the same node allows representing the multiple strategies available to achieve a unique goal.

A *goal* aims at some situation that an organization wants to see attained. This situation is reached through one or several business processes using one or several components of the organization's IS. For instance, the goal '*Solve the production plan*' is an essential goal of SNCF production units (the purpose is to manage the manufacturing of rails, sleepers, catenaries, etc). In PeopleSoft, this goal can be achieved using a number of transactions of the Production Planning module.

Strategies define approaches and manners to achieve goals. For example, SNCF uses three different strategies to solve the production plan: one is '*for items managed with the forecast*', the second is '*for items managed with orders*', and the third is '*based on the first two months of the planning horizon*'. On the other hand, PeopleSoft proposes fourteen other strategies to achieve this goal, e.g. '*using planning solvers*', '*using pegged chains*' or '*using frozen fence*', etc [PeopleSoft02].

As Fig.2 shows it, all these strategies target the same goal. They are indeed alternative -although not mutually exclusive- ways to achieve this goal. For example, the '*frozen fence*' strategy provided by PeopleSoft is one way to support the '*based on the first two month of planning horizon*' strategy employed at SNCF.

SNCF'S APPROACH TO ENGINEER THE FITNESS RELATIONSHIP

Rather than developing or adapting a priori a global ERP implementation methodology then evaluate it in the project, our approach is that of action research methodology [Dick02]. In this research approach, actions in the project (using the methodology) and research (understanding the issues and developing the methodology) are achieved at the same time. This is an intertwined process in which the results of action and research influence each other. As reflected in the four sub-sections below, the research activity was structured around four aspects: adapting the framework provided by the engineering class, exploring results, identifying useful techniques, and modeling the methodological process.

Methodological framework

As proposed by [Jarke93], a general framework can be defined to situate the different concepts of a method in the context of IS evolution. Besides, there are different kinds of IS evolutions, each of them can be characterized with a more specific framework [Salinesi03].

The issue in the SNCF project is typically that of '*Customization from a product family*'. As shown in Fig.1, this issue requires dealing with four kinds of models:

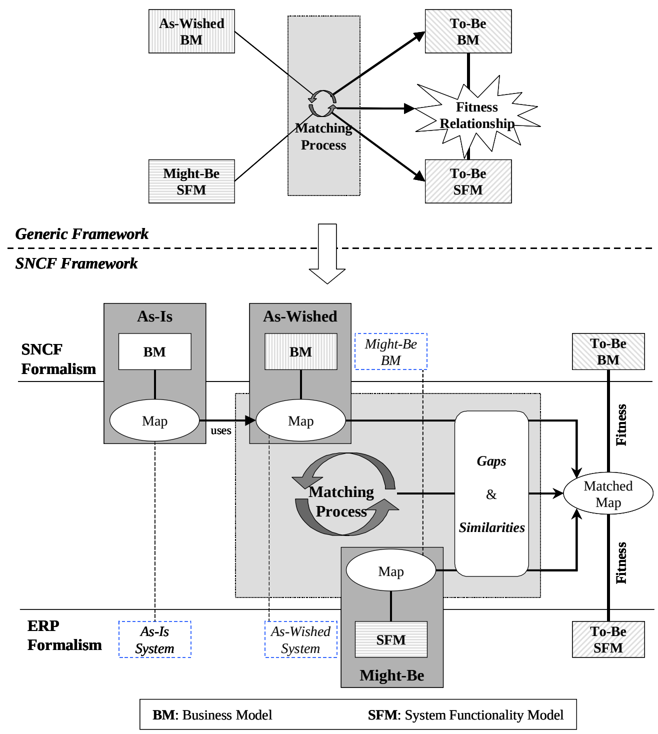
- *As-Wished Business Models (BM)* to capture the business processes that the organization requires for the future. At SNCF, these are modeled using MEGA [MEGA03].
- The *Might-Be System Functionality Models (SFM)* to represent the different functionalities provided by the ERP. For example, a Petri Net - like formalism is used at PeopleSoft [Aalst98]. The purpose of these models is to identify the functionalities and define the corresponding standard parameterization strategies that the system proposes.
- The *To-Be Business Models* to represent the business processes after the project. At SCNF, these models are specified using the same formalism as the As Wished BM. However, this is not a mandatory situation, and changes of formalisms can be required for several reasons (such as through the influence of external consultants). The contents of As-Wished and To-Be BM can also be different, e.g. when choices are made to adapt the business to the functionalities provided by the ERP.
- The *To-Be SFM* to specify the ERP after the project, i.e. after parameterization, re-development of existing functions, and development of new specific functions. The formalism used for these models can be different from the ones used for Might-Be SFM. For example, the tendency at SNCF is to use UML for specifying any new system functionality [Eriksson00].

As shown in the upper part of Fig.1, the purpose of the *Matching Process* is to establish the fitness relationship between the business and the system at the end of the project, i.e. to make sure that the future system fits to the use of the future business. On the business level, this calls for adaptation of the Business Processes; on the system functionality level, this calls for customization of the ERP and legacy system.

As illustrated above, the situation at SNCF is an even more complex one. Different formalisms are used for the four aforementioned families of models. Besides, the project managers found that the business processes are too complex to be defined at once, and therefore chose to develop them by analyzing the current situation. This choice appears through a fifth family of models, namely the *As-Is BM*, which was once again specified with another (house-made) formalism. This adaptation is shown in the bottom part of Fig.1 together with the other framework adaptations achieved for the project.

A major aspect of the project is that each kind of model is developed by a specific part of the team using specific formalisms. However, these formalisms are too different from one another to allow a systematic matching. Furthermore, all team members are not used to all formalisms; there is even sometimes reluctance to change from the formalisms usually used by some of them.

Fig.1: Methodological Framework for engineering the fitness relationship



Our proposal was to use the map formalism to represent the existing As-Is BM, As-Wished BM and Might-Be SFM in a unique way. This matched the project requirement of not influencing or intending to replace the development of existing models. Let us notice that, the other way round, the additional work that was needed to develop these maps was also useful as it allowed to synthesize the models at hand in abstract terms, check their consistency and completeness, and remove cumbersome details. Besides, a similar (if not larger) work would have been necessary if the decision had been to develop As-Is SFM, As-Wished SFM or ERP BM. Last, the matching process was facilitated as it resulted in producing specifications of *gaps* and *similarities* between specifications expressed with a unique meta-model.

Exploring alternatives

While observing the discussions made at SNCF about what the To-Be should look like with respect to the As-Wished BM and Might-Be SFM, we found that a number of approaches were taken:

- Develop a To-Be that is similar to the As-Wished BM, and differs slightly from the Might-Be SFM. This approach is taken when the decision is to make a specific customization of the ERP to fit with the particularities of the business.
- Develop a To-Be that is similar to the Might-Be SFM, but differs slightly from the As-Wished BM. This is when the best practices recommended by the ERP are adopted in place of the solution initially designed by SNCF. It is usually planned to use a standard customization in this situation.
- Develop a To-Be that is similar to Both the As-Wished BM and Might-Be SFM. This typically occurs when these are already similar, e.g. because the corresponding BPs are usual standards.
- Develop a To-Be that differs from both As-Wished BM and Might-Be SFM. This happens when forces that are external to the project recommend to adopt a solution that neither corresponds

to the one initially defined by the project, nor corresponds to the one proposed by the ERP. For example, this solution can stand in a COTS which use across the company is imposed by another project.

This experience showed us that a number of alternative To-Be solutions could always be envisaged. This calls for a systematic way to explore alternatives by identifying them and finding the best To-Be solution.

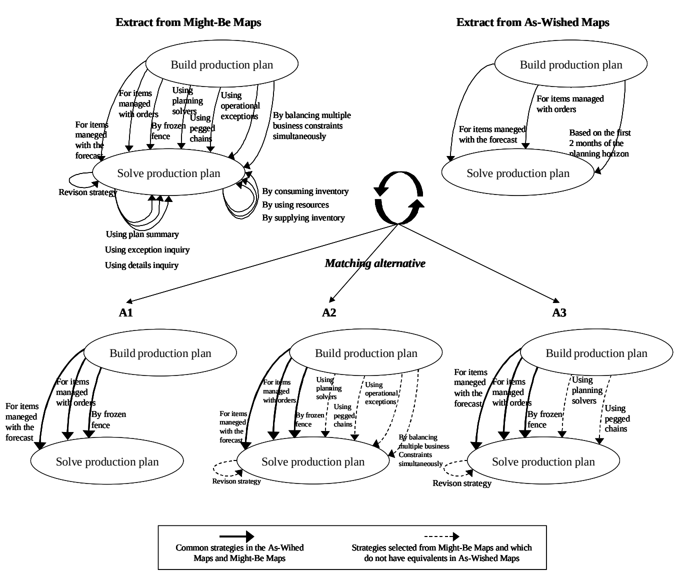
Fig.2 shows an example of situation in which alternative matching can be explored. In this situation a number of wished business strategies and system functionalities were identified to '*Solve the production plan*'. These are respectively shown by the right and left map extracts in the upper part of the figure. Matching these maps as suggested above leads to at least three possible To-Be maps as the bottom part of the figure shows it:

- Alternative A1 results from an *As-Wished driven matching*, i.e. the solution is mostly similar to the As-Wished BM. One strategy has also been renamed as suggested by the Might-Be, as the decision was to use the more general ERP approach rather than the specific way of working initially intended at SNCF.
- Alternative A2 is issued by a *Might-be driven matching*. This solution adopts all the strategies from the Might-Be SFM that can be useful to SNCF and that cover the ones existing in the As-Wished maps. This alternative is justified by the need to keep the ERP consistency.
- Alternative A3 can be surfaced by a *Two-way matching*. This alternative includes the As-Wished strategies as well as a number of Might-be strategies found useful by SNCF.

Discussions were raised to choose among the alternatives resulting from the matching process. Our observations showed us that these decisions were made using a number of criteria such as the percentage of specific development in the ERP, non-regression, cost, delay, available competencies, negotiation margins, etc. It appeared during discussions that not only these criteria do not have the same weight, but also that the importance of each criterion could change depending on the context. Techniques such as Multi Criteria Decision Aid [Roy93], or the Analytic Hierarchy Process [Saaty88] can support Payoff analysis. However, these techniques do not take into account the fact that the weight of criteria can change. More advanced techniques are thus needed.

Engineering techniques

Fig.2. Alternative fitness relationship



Our observation of the matching process showed us that looking for alternative To-Be solutions was systematically done in reference to the As-Wished BM and Might-Be SFM. Discussions with the other team members on the cognitive process of matching models showed that *gaps* and *similarities* between the As-Wished BM and Might-Be SFM were first looked for. Then a matching approach was adopted. Solutions were mentally expressed relatively to the As-Wished BM and Might-Be SFM under the form of gaps and similarities, before being materialized by the common models. Three issues were raised:

- it was found very difficult to express gaps and similarities between models expressed with different formalisms;
- it was found impossible to materialize all the alternatives gener ated by the matching process if these were not expressed in a very synthetic way;
- a systematic language was found necessary to define the gaps and similarities between the To-Be models and the As-Wished and Might-Be models.

Based on these observations, we introduced a generic typology of gaps and similarities that was adapted to the map formalism [Etien03]. This typology was used to facilitate the As-Wished vs. Might-Be comparison, and to define the To-Be in a very synthetic way. The synthetic definition of the To-Be being relative to the As-Wished and Might-Be models, it helped assessing the impact of the selected solution as well as to facilitate its specification with the commonly used models.

We believe that the gap and similarities approach is necessary to: (i) improve the efficiency of the matching process, (ii) make the systematic specification of alternative solutions scalable to the entire project, and (iii) generate more synthetic requirement documentation. This must however be evaluated in a more formal way [Etien03].

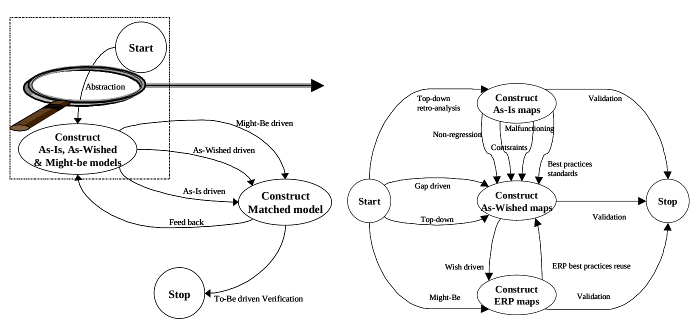
Modeling and guiding the engineering process

Methodologies such as ASAP [Khan02] or ARIS [Scheer02] are useful to guide project management. However, they provide very little insight on how to deal with the engineering issues. Like a number of authors such as [Maiden98] or [Finkelstein02], we believe that engineer-ing methodologies are still necessary to guide the ERP requirements processes. For this reason we used the methodological process model shown in Fig.3. This model was specified using the Map formalism as it allows abstracting the core goals of our method as well as the different ways of achieving these, without imposing any constraint on the project organization. This model was developed in an iterative way, and other improvements are being achieved along the project.

As the figure shows, our method has two main goals: *Construct As-Is, As-Wished and Might-Be models* and *Construct the To-Be models*. The To-Be models can be built through a matching process driven by As-Is, As-Wished or Might-Be (as suggested in section 3.2), and the As-Is, As-Wished and Might-Be models can be either abstracted into maps or improved by feedback. Each of these strategies requires adequate ways of working.

The abstraction process is detailed in the right part of Fig.3. This finer grained description shows that: (i) the construction of As-Is, As-Wished, and Might-Be maps is intertwined, (ii) each kind of map is

Fig.3. ERP requirement analysis process



constructed using specific strategies, and (iii) the production of one kind of map can inform the construction of the two other kinds of maps.

So far, these methodological process models are not further documented. However, each <intention, strategy> pair should be documented as an independent method fragment with:

(i) More precise definition of the goals. This should include information about the resulting products, project situation after it is achieved, criteria for evaluating the achievement status, quality of achievement, and added value.
(ii) A complete specification of the ways of working, including arguments for adopting one strategy rather than another one, pre-conditions, organizational constraints, schedule, resources, skills, costs, time constraints, and influence by external factors. Besides, each way of working should be described by a sequence of steps to be achieved.
(iii) Information about adaptation of the method fragment to different contexts.

No systematic evaluation of our method has been undertaken so far. However, a number of required qualities were already agreed upon with SNCF: easiness of use, fast learning, adaptability, low cost, demonstrated added value with reference to existing methods, and efficient tool support. We believe these can be systematically evaluated through a number of experiments such as interviews, observation, and empirical evaluations.

RELATED WORKS

Despite the widespread adoption of ERPs by business organizations [Joseph98], there is little academic research on ERPs from the engineering perspective [Borell00]. Discussion with team members of several other ERP projects showed us that the fitness issue is a real concern that is seldom dealt with by consultants and project leaders. Whereas it has been recognized that this is an inadequate approach, many deciders adopt ERPs because they believe they will provide them with better business processes, and facilitate their BPR projects [Robey02].

Research achieved so far on how to ensure fitness can be categorized in two main families: management and system. In the management family, research intends to define the impact of ERP installation on corporate culture [Krumbholz00], organization [Robey02], or business processes [Esteves02]. In the system family, the purpose has been to guide the identification and selection of the most appropriate ERP [Ncube00], and to elicit requirements to inform the most adequate customization of ERPs [Finkelstein02].

Our approach is in-between the two families. Its main assumption is that in an ERP project, the issue of organizational change and system engineering are fully intertwined. Therefore, the method used in ERP implementation projects should be neither driven by the business nor driven by the system functionality, but should materialize the fitness between both.

CONCLUSION

Our experience in an ERP project at SNCF confirmed to us the importance of establishing and preserving the fitness relationship between the world of business and the one of systems. Our approach to this issue was to materialize the fitness relationship with goal/strategy models called maps. So far, we have: (i) developed a specific methodological framework that sets in context the business models, system functionality models, and activities of our approach, (ii) defined the issues of matching business models and system functionality models, (iii) adopted a gap and similarity approach to systematize the specification of the result from matching activities, and (iv) established a methodological process model to document and guide our approach.

The lessons learned so far at the SNCF PeopleSoft implementation project are the following:

- The map formalism is adequate to represent the fitness relationship as well as to match BM and SFM. Maps offer a common language between business and system people that offers the advantage of being both systematic and intuitive to business people.
- The matching process between BM and SFM always generates several alternatives. A systematic payoff analysis is thus needed to decide the most adequate alternative to the situation at hand. Traditional Multi Criteria Decision Aid techniques that are based on fixed criteria weight are not sufficient and more advanced techniques are required.
- A language to express gaps and similarities is necessary for an efficient matching process, to make the approach scalable, and to generate more synthetic requirement documentation.
- The methodological process model is necessary to produce systematic, repeatable and improvable way of establishing and preserving the fitness relationship.

The next task in our research program is to further document our methodological process model outlined in this paper.

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