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Modeling the Relationship between Business Models and System Functionality with Maps

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ABSTRACT

The bi-directional dependence between organisations and IT leads to better understand the necessary alignment between business models (BM) and associated system functionality models (SFM). The baseline of this paper is that there is a "conceptual mismatch" between languages expressing BM and SFM that should be minimised. For this purpose, we propose to raise the level of SFM from a functional description to a goal-oriented one. We use the SAP-Material Management example to illustrate this. We propose to represent goals together with the strategies to achieve them in a directed graph called map. The paper presents the concept of a map and illustrates it with the SAP- MM map. The BM/SFM relationship is then discussed and the alignment problem is highlighted in the case of an ERP system installation.

INTRODUCTION

It is widely recognised and acknowledged that as organisations become more and more dependent on Information System (IS), they must strive to achieve a closer relationship between the system functionality and the business model. Further investigations have shown that IS not only supports *business model (BM)* but that these two issues are linked [Gibson98]. On the one hand, it is naturally expected that the choice of a particular way of conducting business in an organisation will influence the design and the structure of the system to support this process. On the other hand, advances in information technology can generate completely new opportunities for organisations and hence influence the design of specific business models [Eatock00].

However, although the benefits of aligning *Business Model* and *System Functionality Model (SFM)* is apparent in theory, companies report low success rates in attaining it in practice [Eatock00], [Reich96]. Indeed, business analysts and IS professionals have traditionally had distinct roles within organisations, each equipped with their own tools, techniques, skills and even terminology [Gliaglis01].

The conclusions we draw from the participation of our group in projects dealing with business change management [Nurcan03], installation of ERP systems [BenAchour00], and integration due to company merge/take-over [Rolland03] share the same view.

Our reflection from these multiple projects is that there is one recurrent problem which is the one of *conceptual mismatch* between the *SFM* and the *BM* levels. *BMs* and *SFMs* are typically expressed in different languages. Business models use concepts such as goal, process, actor and role whereas system functionality models deal with objects, operations, events and the like. The distance between these two sets of concepts is referred by [Arsajani01] as the "*conceptual mismatch*" between the business model and software model. We experienced this issue in ERP installation projects, where we found that ERP experts and organisational stakeholders had difficulty to match each other requirements. Indeed, the customising process typically focuses on the ERP functionality and on its customisation. The functionality is expressed in low level details such as data to be maintained and operations to be carried out whereas organisations think in terms of their goals and objectives. This results in a language mismatch between ERP experts and organisation stakeholders which exposes the ERP system installation to the danger of failing to meet the requirements of organisations.

We consider necessary to *minimise this mismatch*. One way to achieve this goal is to express both, *BM* and *SFM* with the *same language*. This shall allow to express the alignment relationship in a more straightforward manner. Such a language should provide two faces: one for understanding the *system viewpoint* and the other for the *business viewpoint*. Thus, the resulting model should suitably integrate these two viewpoints. Goal centred languages seem to be the most adequate to this purpose as they explicitly capture the *why* (the business objectives) and the *how* (the system functionality implied by the business objective).

In this paper we present the *Map* representation system for a *uniform representation of business goals* and *system functionalities* and we illustrate its use in the case of the SAP Material Management (MM) module.

The *Map* is a goal-driven representation system based on *intentions* and *strategies*. It allows to abstract from the detail of business processes in order to highlight organisational goals and their achievement through strategies. Intentions may also be interpreted as abstractions of system functionalities and strategies represent the different ways in which they are performed. Thus, a uniform business and system view is obtained.

The purpose of this paper is to show how the *Map* representation system can be used in a case of ERP installation as a means to unify the business view of organisations to manage stocks of materials and the ERP system functionalities to support this business. We will also sketch how this representation helps the customising process.

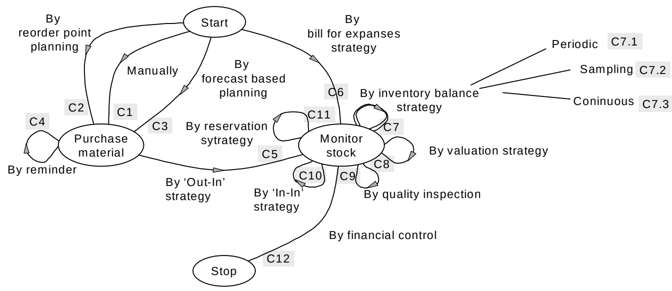
The remainder of this paper is organised as follows. In section 2, the map representation concept is introduced and illustrated with the SAP MM map. We discuss in section 3, how the map provides both a business view and a system view that help to understand the alignment. Map refinement is introduced and illustrated in section 4 as a means to handle the alignment at different levels of detail. In section 5, the ERP customising process with maps is introduced. Finally, in section 6 we draw some conclusions.

INTRODUCING THE CONCEPT OF A MAP WITH SAP-MM

In this section we introduce the concept of a map and illustrate it with the *Material Management map (MM map)* drawn from the information provided in [ASAP99] regarding the SAP R/3 Materials Management module.

The *Map* representation system allows to represent a process model expressed in intentional terms. It provides a representation mechanism based on a non-deterministic ordering of *intentions* and *strategies*. We will use it as a means for representing SAP MM goals/

Fig. 1: The Material Management Map



strategies and as a basis for aligning SAP functions to organisational requirements.

A *map* is a labelled directed graph (Fig. 1) with *intentions* as nodes and *strategies* as edges. An edge enters a node if its strategy can be used to achieve the intention of the node. Since there can be multiple edges entering a node, the map is capable of representing many strategies that can be used for achieving an intention.

An *intention* is a goal that can be achieved by the performance of a process. For example, the MM map in Fig. 1 has *Purchase Material* and *Monitor Stock* as intentions. Furthermore, each map has two special intentions, *Start* and *Stop*, to respectively start and end the process.

A *strategy* is an approach, a manner to achieve an intention. In Fig. 1, *By reorder point planning* is a manner to place an order to *Purchase Material*, any time the stock of this material falls under the reorder point.

A *section* is a key element of a map. It is a triplet as for instance *<Start, Purchase Material, Manual Strategy>* which couples a source intention (*Start*) to a target intention (*Purchase Material*) through a strategy (*Manual strategy*) and represents a way to achieve the target intention *Purchase Material* from the source intention *Start* following the *Manual Strategy*. Each section of the map captures the condition to achieve a business goal and the specific manner in which the process associated with this goal can be performed.

Sections of a map are *connected* to one another. This occurs:

(a) when a given goal can be achieved using different strategies. This is represented in the map by several sections between a pair of intentions. Such a map topology is called a *multi-thread*. In Fig.1, the three strategies to achieve the Purchase Material intention, namely *By reorder point planning, by forecast based planning* and *manually* constitute a *multi-thread*.

(b) when an intention can be achieved by several combinations of strategies. This is represented in the map by a pair of intentions connected by several sequences of sections. Such a topology is called a *multi-path*.

In general, a map is a multi-path from *Start* to *Stop* and contains *multi-threads*. Fig.1 contains several paths from *Start* to *Stop* to handle the "normal cases" and complete the process (i.e. to achieve the *Stop*) through the *Purchase Material* and the *Monitor Stock* intentions. This map also allows to manage exceptions as for instance with the path that directly allows to *Monitor Stock* following the *by bill for expanses* strategy.

As a consequence of the multi-path and multi-thread topologies, a map does not represent a flow of tasks but a non deterministic ordering of goal / strategy selections.

MAP AS A UNIFORM REPRESENTATION OF BUSINESS GOALS AND SYSTEM FUNCTIONALITY

In this section we use the MM map to show how the coupling between business model and the system functionality model is achieved in the map by *simply relating each section of a map to a system functionality*. Therefore any section can be regarded from two viewpoints: the *business viewpoint* and the *system viewpoint*. As a result, a map section expresses a direct relationship between a system function and a business process.

For example, the MM map in Fig. 1 shows that the SAP management module can be abstracted in 12 sections, C1 to C12. Every section of the map represents both (a) a SAP's MM function and (b) the business goal that can be satisfied using this function.

From the *business viewpoint*, material management deals with supplying materials in the right quantity, at the right place and time, and at the minimum cost. The map identifies that the former requires two intentions: *Purchase material* and *Monitor stock* to be achieved. It also makes explicit the different manners by which each intention can be satisfied. For example, there are four strategies to *Purchase material*, namely *Reorder point planning strategy, Forecast based planning strategy*, *Manually* and *By reminder strategy*. The *Reorder point strategy* and the *Forecast based strategy* are planning strategies to automatically issue purchase orders whereas *Manually* allows the buyer to manually enter a purchase requisition leading to the generation of the purchase order. Finally, if the delivery is not made in due time then the *Reminder strategy* can be followed to remind the vendor to deliver material.

From the *system viewpoint*, the map indicates which SAP function helps to achieve the *Purchase material* and *Monitor Stock* goals, and how. For example, the SAP MM module contains a "Create purchase order" function (or 'transaction' in SAP's terms). At the operational level, this function entails the identification of material requirements. The material requirements are defined by references to the needed materials, their vendors, their prices, the dates and plant at which they should be delivered, etc. The function contains variants depending of the purchase situation. For example, the map planning strategies correspond to the SAP functions of MM-MRP (Material Requirements Planning) Forecast Based Planning and Reorder Point Planning whereas the manual strategy is part of the MM-PUR (Purchasing) component. These variants are referred to in the four sections C1, C2, C3, and C4, as documented in Table1. For each of the four sections, the table outlines the variant of the SAP function that is to be used.

The same two viewpoints apply to the other sections of the map. Let us comment the sections related to the *Monitor Stock* intention. The intention represents the management goal of ensuring effectiveness of material logistics while maintaining financial propriety. It gives rise to a number of sections as shown in the Fig. 1 each of which is a way by which this management goal can be fulfilled.

Effectiveness of material logistics requires

- Control of material movement to/from warehouses
- On-time transfer of material to consumption points
- Quality control of the material transferred

These correspond in the map to the *In-In*, *Reservation*, and *Quality inspection* strategies.

The *In-In strategy* represents a function provided by the SAP MM-IM (Inventory Management) and MM-WM (Warehouse Management) components to post material withdrawal and update warehouse stocks accordingly.

Table 1: Documenting MM Map sections as SAP_MM functions

Code	Name	Description
C1	Purchase material manually	Create a purchase order based on a purchase requisition manually defined with information about the material, vendor, date, price, etc. If the information is correct the purchase order is created with a unique identification number.
C2	Purchase material based on reorder points	Automatically generate purchase requisitions any time a stock event that causes the stock of a given material to fit the reorder point criteria occurs. The purchase requisitions can then be transformed into purchase
C3	Purchase material based on forecast	Automatically generate purchase requisitions at the dates defined in the forecast scheduling the purchases that shall be made for a given material. The forecast is computed based on former purchases of the material. Once generated, the purchase requisitions can be transformed into purchase orders.
C4	Purchase material by reminder	Automatically remind of a purchase order for which no delivery has been noticed within due date.

The *Reservation strategy* allows to deliver goods to the appropriate consumption point at the appropriate time and is handled by the SAP MM-IM.

The *Quality inspection strategy* reflects the needs for inspecting stocks and is handled by a function which update the status of the stock to 'unrestricted stock' if the inspected stock conforms the requirements.

Financial propriety requires

- Physical stock taking of the material
- Valuing the stock for balance sheets

These are respectively represented in the map by the *Inventory balance* and *Valuation* strategies.

The verification between the physical stocks and the book inventory balance can be done by periodic, continuous or sample-based inventory which constitute a bundle under the *Inventory balance* strategy.

The *Valuation strategy* allows the stock to be valued for preparing a balance sheet. This is achieved by a bundle of strategies such as LIFO and FIFO and represents a SAP function in MM-IM to assign and record values on an on going basis.

As illustrated in part of the SAP-MM map above, our experience showed that the multi-thread topology of the map is useful to reason about alternative BM/SFM alignment relationships. The multi-thread (a) makes explicit the different business strategies to achieve a goal and (b) identifies the variants of the SFM that can be selected depending on the situation at hand, thus highlighting the alternative alignment relationships.

REFINING BUSINESS & SYSTEM VIEWS

In order to present the BM/SFM relationship at different levels of detail, it is necessary to have a *refinement mechanism* by which a given entity is viewed as a set of interrelated entities. Refinement is a means to handle complexity. Our belief is that such *refinement mechanism* is required for *handling the alignment relationship* in *a systematic, controlled manner*. Indeed, it would be inconvenient to view in one shot, an alignment as one monolithic, flat structure. A layered approach may help mastering progressively the complexity of the relationship.

In the map approach, we defined a refinement mechanism in order to *refine a section* of a map at level *i* into an *entire map* at a lower level *i+1*. Therefore, an alignment (captured in a section of the map) is refined as a complex graph of sections, each of them corresponding to sub-relationships between the business and the system.

Let us illustrate refinement with section C5, *Monitor stock by Out-In strategy* of the MM map. The refined map is shown in Fig. 2. From the *business viewpoint*, the map shows that stock entries shall not be permitted unless they have been checked. This is reflected in Fig. 2 by the ordering of the two goals *Accept delivery* and *Enter goods in stock*.

There are two ways of achieving the *Accept Delivery* intention, the *Okay strategy* and *Reconciliation strategy*. The latter comprises three strategies, *Reconciliation by PO recovery*, *Reconciliation of unit difference*, and *Reconciliation of under/over delivery*. Each of these provides a way of accepting delivery that are within specified tolerances. The *Okay strategy* of accepting deliveries applies in the case where delivery conforms to the purchase order. Finally, the *Rejection strategy* provides a way of rejecting a bad delivery. This strategy allows a flow from *Start* to *Stop* in recognition of the fact that a bad delivery does not cause a stock entry.

There is a multi-thread from *Accept Delivery* to *Enter Goods in Stock* based on two strategies, *Out-In direct consumption* and *Out-In storage based strategy*. The former is for entering goods in stock when delivery is made directly to the consumption location whereas according to the latter, the goods are stored in the warehouse.

The *Monitor Stock* intention of the C5 map component of Fig. 1 is fully satisfied when *the Completeness strategy* of its refined map is used to reach *Stop*. This strategy takes into account all the consequences of entering goods in stock.

Fig. 2: Refined map of section C5 of the MM map

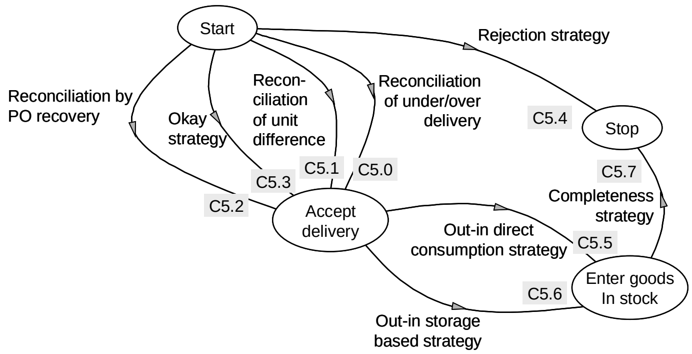


Table 2: system view of the refined map

Code	Name	Description
C5.0	Reconciling under / over delivery	Automatically checks under / over delivery tolerances and generates goods receipts.
C5.1	Reconciling delivery with unit difference	Automatically converts unit of measure differences, checks for tolerances and generates
C5.2	Recovering missing PO for delivered	Automatically searches for an open purchase order matching the delivered material.
C5.3	Accepting delivery	Automatically checks the compliance of the delivered goods with the purchase order and generates goods receipts.
C5.4	Rejecting delivery	Records rejection of the delivery in the purchase order history.
C5.5	Posting goods to direct consumption point	Posts goods to direct consumption account.
C5.6	Posting goods to storage point	Posts goods to storage location account.
C5.7	Completing housekeeping	Completes data update related to delivery in Financial Accounting, Controlling and Asset Management modules.

The following table outlines, from a *system viewpoint*, the different strategies represented by functions of the SAP MM-IM and MM-WM components and that are used for monitoring stock.

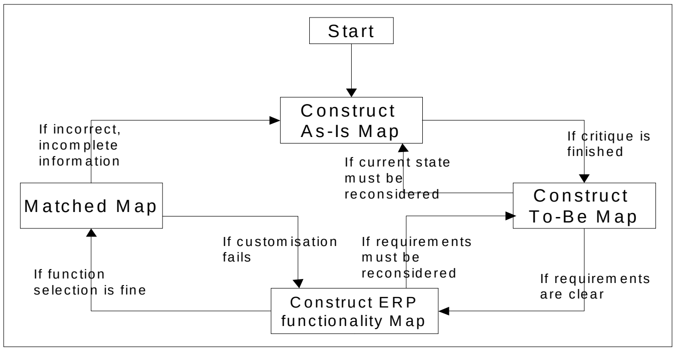
To sum up, since refinement results in a map, it produces a multi-thread, multi-path structure at level *i+1*. Therefore, section refinement is a more complex structure than a simple composition structure such as AND/OR goal decomposition. Indeed, it provides at the same time (a) several alternative decompositions of the initial alignment relationship into its constituents, and (b) different alternatives to its constituents themselves. We found the refinement mechanism useful in practice as a means to clarify the selection of the adequate system sub-functions in a customising process as discussed in the next section.

MAPS TO SUPPORT THE CUSTOMISING PROCESS

In this section we address partially the problem of aligning ERP functionality to organisational requirements during an ERP system installation process using maps. We view the customising process as a change handling process that creates a movement from an existing situation, captured in the *As-Is model*, to a new one reflecting the set of user requirements for the future, captured in the *To-Be model*. We propose to express these models as maps. This is reflected in Fig. 3 by (a) *Construct As-Is Map* and (b) *Construct To-Be Map*. Furthermore, we extend this position to cope with the specificity of ERP installation by introducing (c) *Construct ERP functionality Map* and (d) *Matched Map*.

The *As-Is map* resulting from (a) abstracts current practice from the organisation to describe the currently achieved goals. It serves as a support for critiquing the current situation and thereby identifying customer requirements for the *To-Be map*. Additionally, it also serves as a reference to evaluate the new solution against current practice. The *To-Be map* reflects the customer requirements that the organisation would like to satisfy by acquiring and customising an ERP. The *ERP map* specifies ERP functionalities in terms of intentions and associated strategies that the ERP supports. It might be seen as the set of business requirements that the ERP system is able to satisfy.

Fig. 3: The customising process



The heart of the customising process is to construct the *Matched map* which is the output of the customising process and the input of the installation process. Most of intentions and strategies of the *Matched Map* are obtained from the ERP map and match the *To-Be* requirements. Others may not be available in the ERP map and will require in-house development. In such a case, the *Matched map* helps in their identification. On the contrary, all the intentions and strategies of the ERP map may not be included in the *Matched map*. This corresponds to the ERP functionality that is not matching the requirements in the *To-Be map*.

Reasoning with maps as introduced above helps concentrating on strategic decisions about the parameterisation of the ERP system to fit the organisation needs. It avoids dealing with too many details that are not relevant at the first place. Those will be considered progressively using the refinement capability associated to maps.

In constructing the *Matched map*, the multi-thread topology of the map helps in reasoning about alternative alignments as the multi-thread (1) makes explicit the different business strategies to achieve a goal and (2) identifies the variants of the system functionality that can be selected depending on the situation at hand, thus highlighting the alternative alignments. Pay-off analysis can be used to evaluate alternatives, then providing a rigorous way to qualitatively and quantitatively decided which alternative is the best fitting the organisation needs.

Finally, the construction of the *ERP functionality map* by abstracting from the ERP system description provides a post-traceability link between the ERP map and the system functionality. This link is useful during the installation step in order to identify the system functionalities that correspond to the *Matched map*. In this step the link are used in the top-down direction, from the sections of the *Matched map* to the corresponding system function.

CONCLUSION

By expressing system functionality in goal-strategy terms, the map provides a representation of the functionality in a language that is easily understood by an organisation. This helps to make the decision on whether or not to adopt the ERP approach and to agree on the issues that need to be resolved before ERP installation is done. It nudges an organisation to looking at its systems in a holistic way rather than in narrow operational terms. The map also helps in customising the ERP offer but in high level goal-strategy rather than in low level functionality terms.

The map provides a basis for a two-way interchange between SFM and BM; for example from the ERP functionality to organisational requirements and vice-versa. This is facilitated by the level at which the interchange takes place, organisational goals-strategies and SAP goals-strategies. As a result, the map has the potential to better align organisational needs with ERP offerings.

Finally, it is clear that the map needs to be supported by a guidance mechanism that systematically takes an organisation through the range of facilities offered by an ERP package. This mechanism would present the different choices available for achieving an intention and aid in selecting one or more of these. This will form the topic of future work.

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