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# Multi-Screen View and GRAI GRIDS to model decisional process of manufacturing IS alignment

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**Abstract:** Today, manufacturing companies evolve in a competitive and changing environment that drives continual change. These changes and related evolution generally concern the organization as the whole and influence the company strategy, its business processes and its information system (IS). The focus of this paper is on the coherent evolution of the manufacturing IS, that is to say on its alignment with the strategy, the environment and the evolutions. Because of IS manufacturing specificities, one interesting approach consists in using the multi-screen view, which relocates the IS under study on a systemic and a time scale. However the related exploitation procedure is too general to be efficient. Therefore it is proposed to model, with GRAI-GRIDS, the decisional process required to perform these alignments by working out the multi-screen view model of a specific IS. It emphasizes the combination of bottom-up and top-down analysis as well as the relevance of the systemic and time views on the IS.

## 1. INTRODUCTION

Today, manufacturing companies evolve in a competitive and changing environment that drives continual change. In order to survive and to remain competitive they have to evolve in coherence with their environment. This evolution generally concerns the organization as the whole and influences the company strategy, its business processes and its information system (IS). In this paper it is proposed to focus on the coherent evolution of the manufacturing IS.

In the IS field, the research has mainly focused on the so-called strategic alignment of the IS that is to say the linkage of the firm's IS and business plans (Premkumar et al., 1992). However, the importance of achieving coherence between the organization's strategy and its environment has been also acknowledged for example in (Porter, 1980) and (Andrews, 1987). Therefore, in (Camponovo *et al*., 2004) it is suggested to study the IS alignment not only from the strategic alignment point of view, but to add two other levels (alignment with the environment and alignment with uncertain evolutions) enabling to achieve a global and complete alignment of the IS. .

As it is exposed in (Goepp *et al*., 2006b), for manufacturing IS these three levels take specific shapes.

For manufacturing IS, the alignment with the environment implies to involve various stakeholders, to assess numerous expectations and to integrate numerous uses. Indeed, the actors involved are various from the workshop manager to the operators. Each has different background, skills, knowledge, perceptions and is generally not a specialist for the IS but only a user. This variety is a major difficulty to tackle in order to perform relevant alignment of manufacturing IS.

Last but not least, alignment with strategy and alignment with uncertain evolution have to take the "integrating" role of manufacturing IS into account. Indeed, manufacturing IS ensures, with computer and peripherals, the logical integration of manufacturing facilities. Such an IS enables to coordinate all the manufacturing activities and integrates heterogeneous facilities, whose consistency has to be ensured at the present time and in the future. The relationships between the IS and the manufacturing facilities has to be managed carefully in order to perform alignments with the strategy and the evolutions. Here the desynchronisation between the IT life spans (3-8 years) and the manufacturing facility life spans (10-15 years) is a problem.

To tackle the above mentioned difficulties it is proposed in (Goepp et al., 2006a) to perform a coarse alignment of the manufacturing IS by working out an "aligned" IS architecture. This approach is based on:

- The instantiation of a key-problem framework, enabling the various stakeholders to share and mutually negotiate the requirements in order to perform efficiently the alignment with the environment;
- The use of the "multi-screen" view, including future concerns of studied systems, in order to support coarse alignments with the uncertain evolution. and with the strategy.

Even if the instantiation of the key-problem framework brings an efficient support for the alignment with the environment, the use of the "multi-screen" view has to be improved. Indeed, the procedure proposed to exploit it remains too general. Therefore, this paper addresses the formalisation of the decisions to be made in order to build the "multi-screen" view model of a specific manufacturing IS. To do this it is proposed to use the GRAI-GRID formalism (Doumeingts et al., 1992). It was initially designed to model the decisional process that controls a manufacturing process, and has proven its efficiency to address this stake. Here, GRAI grids are exploited to model the decisional process that controls the alignment process of manufacturing IS. Therefore, the occurrences of GRAI concepts are adapted. Relevant management functions (Álvares-Ribeiro *et al.*, 2004) corresponding to the columns of the GRAI grids have been selected according to the classification provided by (McCarthy *et al.*, 2002).

In section 2, a brief overview of the key-problem driven approach is introduced. It emphasizes the lack of formalisation of the exploitation procedure and the model for the "multi-screen" view. Based on this model, the section 3 details the GRAI-GRIDS intended to support the alignment decisional process of manufacturing IS. In section 4, conclusions, perspectives and further research directions are discussed.

## 2. KEY-PROBLEM DRIVEN APPROACH AND MULTI-SCREEN VIEW MODEL

### *2.1 Key-Problem driven approach*

The main principle of the key-problem driven approach is to base the working-out of an "aligned" manufacturing IS architecture, on the formulation of key-problems. To support these tasks, this approach is composed of a key-problem framework, exploited through a procedure. The key-problem framework is fully detailed in (Goepp *et al.*, 2003), it is composed of three "evolution" contradictions (cf. Fig. 1) defined as:

- The contradiction for a class of systems to limit the study field,
- The contradiction associated to a generic function to be fulfilled by this class of systems,
- The contradiction between two performance parameters of this function,
- The contradiction expressed through a characteristic element of the function.

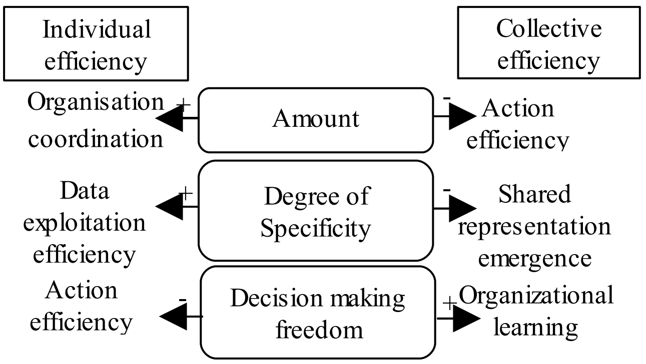


Fig. 1. Key-problem framework overview

These key-problems represent a set of generic problems, which, if at least one of them exists, implies to make evolve the existing manufacturing IS. The formulation shape of each key-problem is the following: A must increased because C and A should not increased because D. A is an action of the characteristic element, C is a reason linked to collective efficiency of the IS and D is a reason linked to individual efficiency of the IS. For example: The amount of information made available to each person must be increased to enhance coordination and the improvement of the organisation, but it should not be increased because too much information harms the efficiency of the action.

The procedure associated to the key-problem framework enables to work out architectures of the manufacturing IS. It has been fully developed in (Goepp *et al.*, 2006a) and is composed of three stages: (1) Search for acknowledged contradictions, (2) Definition of 'extreme' architectures, (3) Moving to one 'target' architecture.

The first step starts by identifying the "individual" and "collective" roles of the manufacturing IS under study. It enables to transform the three generic contradictions of the framework into three specific contradictions, corresponding to the specific context of the project. IS users are then able to set the state of these three potential contradictions: acknowledged or not.

The second step aims to design so-called preliminary 'extreme' architectures for the studied IS. These 'extreme' architectures correspond to possible combinations of basic intensifications of the acknowledged contradictions. Two basic intensifications can be imagined for each acknowledged contradiction: one focusing on the collective aspect of the IS under study, and the other on the individual aspect. For n acknowledged contradictions, 2n 'extreme' architectures aiming to implement these intensified aspects are possible.

The architectures defined during the second step are asymptotical architectures to real situations. Therefore, sometimes the absurd nature of certain extreme architectures is highlighted. In a particular study having set aside these architectures, the remaining architectures are made to converge towards a target architecture. To do this at the third step, we use the "multi-screen" view (cf. Fig. 2) to relocate the system under study both on a time scale (present ,next term, long term) and on a systemic scale (business organisation, IS, functional units). This graph offers a structuring support to carry out IS manufacturing alignment.

Even if the operational use of the "multi-screen" view shows its efficiency to mutually share alignment concerns, the proposed procedure remains too general. The existing guidance is too weak and therefore does not enable to pinpoint precisely the links between the elements gathered in a specific "multi-screen" view model and the alignment process. To improve the working out of a specific "multi-screen" view model, the underlying concepts of this tool have first to be clarified.

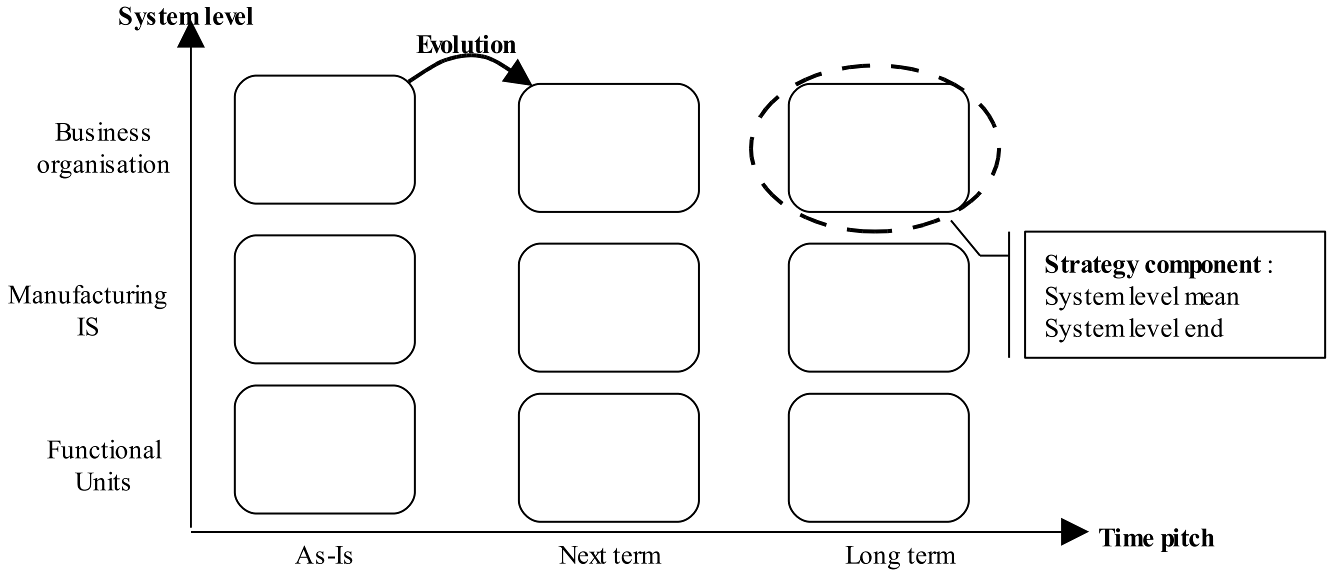


Fig. 2. "Multi-screen" view model

Then based on this model, fully detailed in (Kiefer *et al.*, 2007), it is proposed to model the alignment decisional process corresponding to the key-problem approach, to outline sourcing of information that are collected and processed in the multi-screen view model. In the next sub-section the underlying concepts of the "multi-screen" view are briefly exposed.

### *2.2 Underlying concepts of the "Multi-screen" view*

The "multi-screen" view is a two dimensional diagram, that organizes relevant concurrent evolutions of company sub-systems along time. Its dimensions are:

- the time, the corresponding concept is a time pitch. A time pitch corresponds to the time span between two releases of the studied sub-system of the company: here the manufacturing IS of the company. The last time pitch corresponds to the longest time at which evolutions can be imagined.
- the systemic scale, the corresponding concept is the system levels at which the company and its environment could be observed.

In addition to the time pitch and system levels concepts the underlying concepts of the "multi-screen" view are:

- strategy component;
- evolution.

The different concepts of the "multi-screen" view are illustrated in Fig. 2 in bold.

The **time pitch** concept models the time span between two releases of the system. Indeed, between the as-is time and the longest time at which evolutions can be imagined, the "multi-screen" view tool aims, at least, to identify the next release of the system. Therefore, there are at least: (1) as-is, (2) next-term and (3) long-term time pitches. However their number is not limited.

The **system level** concept models the studied system levels. The upper level is the Business Organisation corresponding to the company and its relations with the market. This level is required to ensure, for the studied manufacturing IS, the alignment with the strategy. The lower level should be at least the level of Functional Units of the Company. Indeed, this level is understandable by all manufacturing IS users and therefore can support the alignment with the environment. These system levels could be detailed in the "multi-screen" view by adding some intermediate system levels: at least the Business Process level, required for IS design (IS support business processes) but also, for instance, Enterprise Activities and Functional Operations according to the CIM-OSA Framework (Berio *et al.*, 1999).

The third concept is the **strategy component** (cf. Fig. 3). It enables to model the content of each "screen" (intersection between a given time pitch and a given system level). This concept is adapted from the Business Rules Group model (Kolber *et al.*, 2000), which proposes a taxonomy of strategy components to model a business strategy. There are two kinds of components: the goals of the strategy (system ends), and the corresponding tasks (system means). It is suggested that not all system ends used to model business strategy are similar. Therefore, the following taxonomy of system end is proposed: vision (end-state towards which the organization strives), goal (statement of intent whose achievement supports the vision), and objective (a specific and measurable statement of intent whose achievement supports a goal). Similarly, system ends possess qualities that provide an understanding of the type of system end to which it contributes, and include mission, strategy, and tactic. Initially dedicated to model the business strategy it is proposed to extent the strategy component to each system level of the "multi-screen" view. It enables to model in an unified and consistent manner the elements required to perform alignment with strategy and with environment.

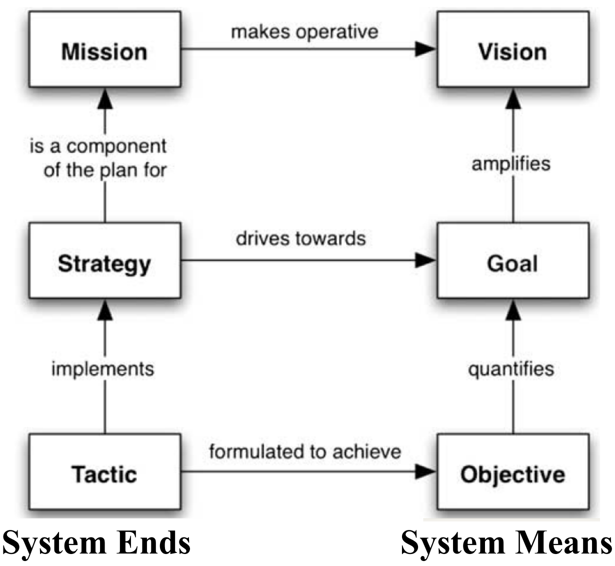


Fig. 3. Strategy components adapted from (Kolber *et al.*, 2000)

The last concept is the concept of system evolution. It models the links between "screens" from different time pitches. Modelling these relationships is essential to tackle alignment with uncertain evolutions. Therefore, evolutions modelled in the "multi-screen" view are linked to a time pitch, a system level and a strategy component.

From the key-problem approach point of view, evolutions are changes in variable or element of performances of the IS. Alignment of the IS with strategy is performed by linking evolutions to strategy components: variable to system means, and elements of performance to system ends.

## 3. ALIGNMENT DECISIONNAL PROCESS

### *3.1 GRAI GRID formalism*

The GRAI model, developed in the late 1970's at the LAP-GRAI laboratory of the University of Bordeaux (Doumeingts *et al*., 1992), is composed of two tools: GRAI grids an GRAI nets. GRAI grids are dedicated to describe the macro-structure of the decisional process, showing links between "decision centers" (Chodari *et al.*, 1994). Columns describe "decision centers" taken in some "decision domains", initially related to the manufacturing planning and control process. Rows are used to define the hierarchy level of the "decision centers". Each level is characterized by a "horizon" for which decisions are taken, and by a "period" at which these decisions are reviewed. Levels are classified by decreasing period. The classical GRAI hierarchy of three levels is suitable for our alignment process. They correspond to the classical "as is", "next step" and "long term" time pitches of the "multi-screen" view.

Relationships between decision centers are indicated by two symbols: single or double arrow. A single arrow indicates transmission of a simple flow of information between two decision centers. A double arrow, or "decision frame", indicates orders, goal and performances to reach, and decision variables. Decision variables must be used within the receptor decision center, to reach expected goals and performances.

### *3.2 Decision domains of manufacturing IS*

To address our manufacturing IS alignment problem, we propose to extend the use of GRAI grids with some additional decision domains involved in this alignment.

Core decision activities of the procedure of the key-problem approach, and participating to the alignment of the manufacturing IS, are modelled in the: "to perform alignment" decision domain (central column of the proposed GRAI grid (cf. Fig. 4),. as GRAI "decision centers".

Decision domain "technology" underlying behind the alignment subject "IT" proposed in (Gmati *et al*., 2007), is involved through "to manage information technology" column, and extended by "to manage manufacturing technology" columns.

The target component of the company is the IS. Therefore, decision activities of the "Organization" decision domain are modelled in the "to design the IS" column.

### *3.3 Decision process that supports manufacturing IS alignment process*

The first step of the key-problem approach - identification of collective and individual role of the IS – begins at the Business Organization level, through analysis of the fundamental role of IS as support of Business Processes. It consists in a Top-Down alignment (light grey path on the GRAI grid). It is an operational way to process the company strategy (in terms of product to address the market) (top) in a user adapted manner (down), by instantiation of specific potential key-problems. These can be understood and shared by IS stakeholders.

The second step of the key-problem approach – design of extreme architectures - begins at the Functional Unit level, through elicitation of user requirements. It consists in a Bottom-Up alignment (dark grey path on the GRAI grid). The structure of acknowledged contradictions (bottom) helps the analyst to map respectively: project specific design parameters to system ends, and specific performance parameters to system means (up).

The third step of the key-problem approach – moving to the target architecture – is supported by the multi-screen view model (black path on the GRAI grid). Some extreme architectures are put aside at the outset because they do not fit to strategy of the company. Some others because they do not solve acknowledged contradictions (to close to as-is IS architecture). Highlighted relevant extreme architecture are then detailed according to information technologies and manufacturing technological considerations. IS components to be updated, added or deleted are specified. This leads to the preliminary architecture of the next IS.

## 4. CONCLUSIONS

This paper highlights the relevance of the key-problem approach to support a complete alignment of manufacturing IS with the strategy of the company, with the specific environment of manufacturing IS as well as with uncertain evolutions.

The time scale forces to project the manufacturing IS and its corresponding alignments towards long term and not only towards short term, as it is often the case. This mechanism enables to adjust the next IS generation towards long term evolutions. This integration of alignment with uncertain evolutions leads to a controlled and coherent evolution of the IS along time.

The combined top-down and bottom-up steps of alignment, supported by formalized:

- Key-problem approach procedure,
- Corresponding concepts gathered in the multi-screen view model,
- Alignment decisional process,

are usable and applied, mainly in SME context.

These experiences in SME have also underlined current limits of the approach. The influence of IT and manufacturing strategies are not completely clear, even if the scope of their influences on alignment decisions is spotted. However the way these influences operate on decisions is not detailed. At the moment it is informally handled in the decisional process. Further research to understand generic alignment concerns, along time, between strategy of the company, IT strategy and manufacturing strategy are required. A first step would be to study existing alignment frameworks in order to highlight generic alignment execution sequences.

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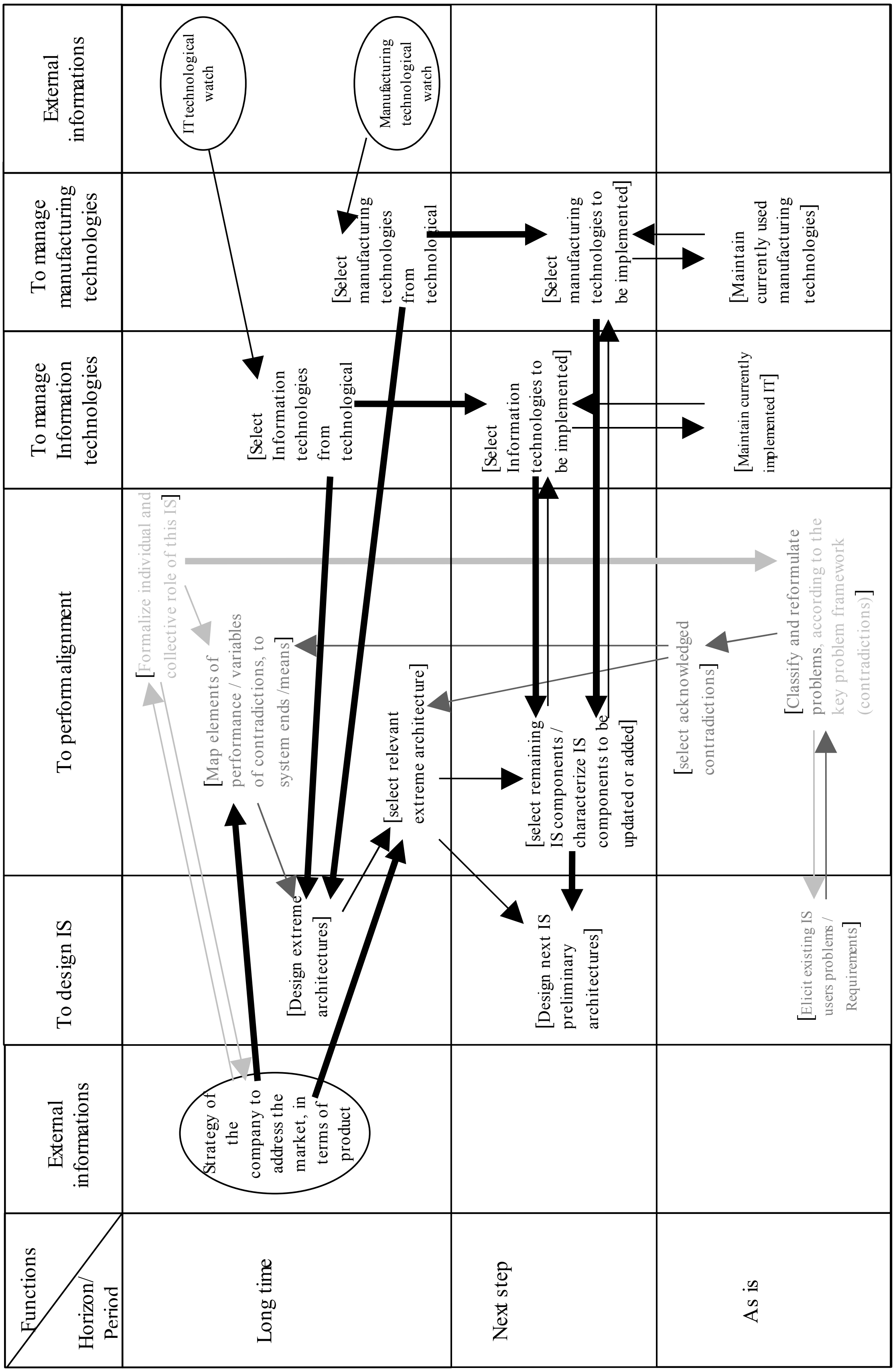


Fig. 4:GRAI GRID of the IS alignment decisional process with the "multi-screen" view