Co-ordination of management activities – mapping organisational structure to the decision structure

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Abstract

The GRAI Grid is used for the presentation of co-ordination in a virtual enterprise. A set of examples are presented which show how the organisational structure and decisional structure interrelate, making it possible to evaluate the two structures in conjunction. The technique can be used to design organisations which take into account the individual as well as organisational objectives of the individual organisational actor thus leading to a better management structure.

Keywords: decisional modelling, enterprise co-ordination, organisations modelling

1.0 Introduction

Production management, and on a more general level, enterprise management is a function carried out by management personnel. Management personnel includes organisational players from the CEO down to the foreman on the shop-floor. Doumeingts *et al* (1985,87) model the enterprise as consisting of a production system and a decision system, interconnected by the management information system. The decision system is then modelled according to the time horizons for which decisions are taken and according to the types of decisions that need to be made.

Once the decision model of an enterprise is created (Bernus *et al*, 1996) there are two questions to be answered:

1. Is the decision structure adequate for co-ordinating all activities of the enterprise to achieve the overall enterprise objectives?
2. Is the management organisation which implements the decisional structure adequate?

This article aims at demonstrating the interplay between the two structures. This is an important consideration, because a perfect decision structure can still be working below its expected performance, if the organisational implementation does not take into account the following two factors: (a) the individual organisational player's objectives, and (b) the decisional objectives which the organisational player is supposed to achieve in the role played in the decisional structure.

In Section 2.0 we present the GRAI Grid modelling language (Doumeingts *et al*, 1985)which will be used for modelling the decisional structure of the enterprise. In Section 3.0 we present how organisational structure can be mapped to the decisional structure. Section 4.0 presents the particular problem of decision structure in the co-ordination of virtual enterprise (4.1) and the problems of mapping organisations to the decisional structure (4.2).

2.0 Decisional Modelling using the GRAI-Grid

2.1 The natural hierarchy of decisions.

Any management decision that needs to be taken is made with reference to a horizon of time. This is the span of time at which the decision maker is looking ahead and expects the decision to be

valid for. For example, a strategic decision is intended for a longer horizon, say 2-5 years, while a tactical decision may plan ahead for a horizon of one to four months. Because of the changing nature of the environment decisions which have been made for a given horizon, have to be re-considered. This is either because an *event* occurs that invalidates (or is likely to invalidate) the assumptions underlying the decision made for the given horizon, or at planned *periodic* intervals to adjust decisions based on the new information which became available since the last time decision was made. The length of this period is typically two to three times shorter then the horizon for which the decision has been made.

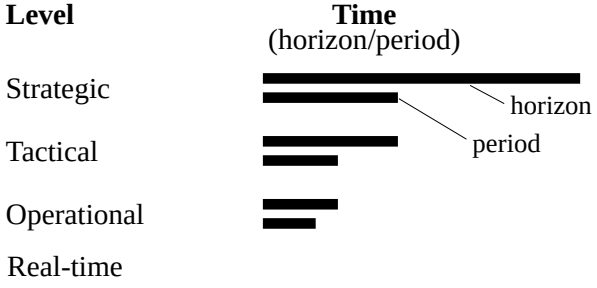

FIGURE 1. Natural hierarchy of decisions

Those decision functions which have a shorter horizon are provided control by management decisions taken for the longer horizons in order for the entire enterprise to act in a co-ordinated manner to achieve higher level objectives (i.e. objectives of longer horizon). The horizon of the lower level decision function is the same, or shorter than the period of the higher level decision function (see Fig. 1). The real-time level does not have an overall horizon or period; the frequency and speed of intervention (control) functions is individually determined by the needs of the controlled process-component. This hierarchy of horizons (periods) defines a *natural hierarchy* of decision functions. It is customary to define strategic, tactical, operational and real-time levels, although in practice more levels are often practical – according to periods and horizons which have a special meaning in the given business domain (e.g seasons in agriculture).

2.2 The three major categories of decisional function

The primary aim of any enterprise management should be that the operations of the enterprise (i.e. all service- and production functions) are carried out in line with the current enterprise mission. We can consider the enterprise's service and production functions as a transformation (see Fig. 2), in which the input (information and material) is transformed into output (information and material) by the application of human and machine resources. (Note that in service enterprise the transformation is often applied to the customer, i.e. the customer is both input and output of the service process, and the customer undergoes a transformation while the service is consumed.)

The functions of management can be categorised on the basis of this model, distinguishing

- Product management (section 2.2.1)
- Resource management (section 2.2.2)
- Co-ordination / planning (section 2.2.3)

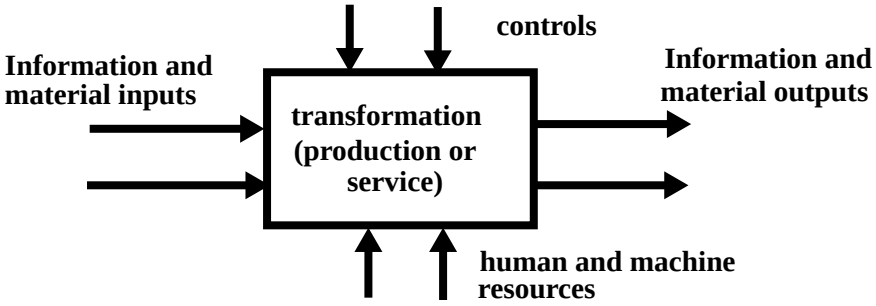

FIGURE 2. Service and production as a transformation process

2.2.1 Product management

The aim of product management functions is to make sure that information and material inputs are available for the service and production (transformation) process

- When and where needed
- Accessible to the resources of the enterprise
- In the quality and quantity needed

Also, product management is to make sure that information and material outputs as produced by the service and production (transformation) process of the enterprise become available

- When and where needed (i.e. reach the customer)
- Accessible to the resources of the enterprise (no additional resources are needed to reach the customer)
- In the quality and quantity needed

2.2.2 Resource management

The aim of resource management is to make sure that human and machine resources[1] are available for carrying out the service and production (transformation) process.

- Resources must be available when and where needed
- Resources must be available in the quality and quantity needed
- Resources must be reachable by the operational and real time resource management functions

Operational and real-time level resource management is responsible for giving operational / real-time *control* to the resources to achieve the necessary transformation. Thus process control is the lowest level resource management function in the natural hierarchy of decision functions.

Informally: product management takes care of the inputs and outputs, and resource management takes care of the resources and the controls for the transformation process (Fig. 2).

2.2.3 Co-ordination and planning

Product management and resource management functions alone are incapable of providing the necessary controls for the enterprise. This is because the product-related and resource-related

1. Human and machine resources include both hardware and software.

objectives are mutually constraining, with many possible courses of action available to satisfy these constraints. There are usually many possible solutions to harmonise the product-related and resource-related objectives and to balance these two in an optimal manner, and the way this balance is achieved depends on the overall objectives of the enterprise.

For example, if the overriding objective is to provide some service or product then the resource management task should follow suit to make sure that the necessary resources are available. If, on the other hand, resource constraints are given precedence then product-related objectives must be adjusted accordingly.

Co-ordination and planning is therefore the third type of management task, which covers those management tasks which co-ordinate among product and resource management.

This co-ordination is necessary on all levels of the decisional hierarchy. On the strategic level this type of management function decides on the general direction of the company, e.g. whether to keep the existing resources and use them in the best possible way, or to use every possible product / market opportunity and make sure the resources are available for being able to meet the demand. On the lower levels this management function plans or schedules the production and service activities balancing product requirements and resource requirements.

There is *no* operational / real-time level activity in co-ordination and planning; on the operational level direct control is exercised through allocating resources to tasks and giving them the necessary controls to execute these tasks.

Horizon/period	**1. Manage products**	**2. Co-ordinate / plan**	**3. Manage resources**
strategic			
tactical			
operational			
real-time			

FIGURE 3. The three types of management function

Fig.3 shows the three types of management function repeated on the strategic, tactical and operational / real-time levels. In real situations there are more levels then three, depending on the horizons and periods for which the given enterprise needs separate, meaningful management tasks.

2.3 The decision centre model

Definition: For each type of management task and each horizon it is possible to define a so-called Decision Centre (**DC**). A decision centre makes its decisions on the basis of its Decisional Framework, which is handed to it by some other DC (see Fig.4).

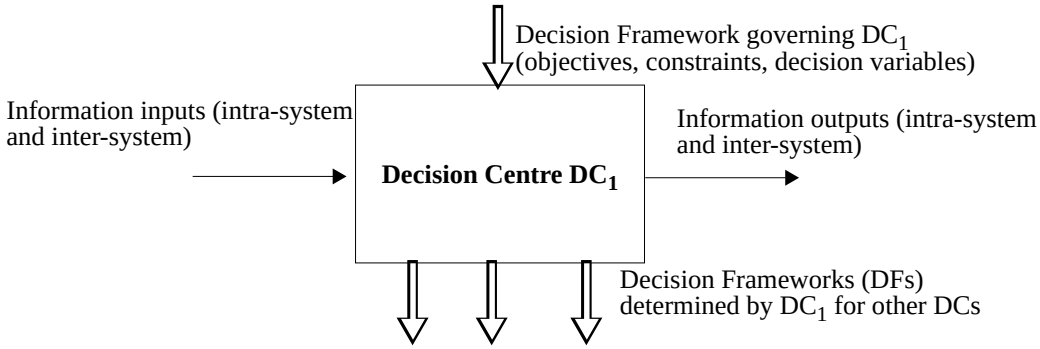

FIGURE 4. The Decision Centre model

Definition: A Decisional Framework (**DF**) is defined as the collection of the following elements (**DO, DV, DConstr**):

- Objectives – Decisional Objectives (**DO**) (management objectives) are the aims that the DC is supposed to achieve.
- Decision variables (**DV**)

  a) for all but the operational management/control level the DVs are the means through which the DC is allowed to manipulate other DCs below it;

  b) for the operational control level management/control the DVs are the means through which to manipulate/control the service / production process;
- Decisional constraints – Decisional constraints describe the limitations under which the DC is allowed to manipulate DVs to achieve the objectives. This includes the amount or quality, or timing of resource usage both for the DC's own use and the resources that the DC is allowed to make available for DCs which the DC manages / controls.

Definition: Management of DC by another DC – A DC_1 manages / controls DC_2 if DC_2 receives its DF from DC_1.

DCs exchange information within the enterprise and external to it, i.e. with

- Other DCs anywhere in the DC hierarchy;
- The management information system (MIS) which aggregates operational or other lower level information such that it becomes usable for the given DC's level of decisions
- The environment (customers, other enterprises, government agencies, professional bodies, individuals of influence etc.).

Definition: resources of DC – A DC has resources that make it possible to carry out the decisional task to achieve the objective of the DC. These resources include:

- Human resource: including the decision maker and its helpers (e.g. administrative helpers)

- Machine resource: including all the hardware and software resources utilised by the human resource to carry out its decision making task (hardware and software here extends to both information processing hardware / software, such as copying machines, computers, word processors, as well as other machine resources, including those for communication, and transport)
- Monetary resources (funds) that support the decision making task.

It is to be specifically noted that the resources of the DC are not to be confused with the resources managed by the DC (provided that the DC is a resource management function –otherwise it does not even dispose over other resources than those needed to carry out its own management task). These latter *managed* resources are described in the decisional variables of the DC which the DC has the authority to manipulate (and thereby to allocate, distribute, or control them).

2.4 The co-ordination of decision centres

2.4.1 Information links of DCs

In addition to the DF provided to a DC by another DC above or on the same level of the decision hierarchy DCs obtain information from

- the management information system;
- from other DCs (via information links);
- from the management information system (MIS) that collects, aggregates and presents information about the operation (service and production);
- from the external environment, (via information links);

Similarly, a DC provides information output, which includes the DFs determined by the DC for another DC, and information to

- other DCs (on either level of the decision hierarchy);
- the MIS;
- the outside environment.

2.4.2 The control of DCs

Functions of DCs are either period- or event driven (or both). Period-driven functions are executed regularly, according to the horizon and period of the decision function. Event-driven functions of a DC are triggered by externally or internally generated events.

The source of internal events may be directly in the operation, (the event being generated through the mechanism of the MIS), or in other DCs.

At any moment in time the current content of a DF codifies the agreement between the controlling and controlled DC. The DF may remain unchanged over a longer period of time as long as the agreement is extended beyond its original period.

The controlling DC may change the DF of the controlled DC. The form of conversation between them may take various forms, depending on wether the two DCs are implemented by the same agent or by two separate agents. In the first case a ‘private conversation’ develops the acceptance of the new DF, in the second case an overt conversation takes place between the two agents, with the aim of achieving an agreement.

The DFs of resource management and product management are not independent (they are mutually constrained) and as earlier described, there exists a separate type of decision function (co-ordination / planning) to satisfy these constraints.

Co-ordination and planning type decision functions therefore:

- obtain information, via information links, from the DCs to be co-ordinated (such as initial – intended – product plans and present resource plans);
- investigate the constraints and the possibilities to satisfy these, so as to achieve the objectives as determined by the co-ordinating DC's own DF;
- determine mutually consistent Dfs for the DCs to be co-ordinated.

Note, that because of the possible information links the DCs so co-ordinated the DF may only have to determine the rules of constraint satisfaction (e.g. precedence rules) and delegate the details of the actual constraint satisfaction to a conversation between the co-ordinated product- and resource management DCs. (This form of co-ordination allows management with much less intervention then explicit constraint satisfaction by the co-ordinating DC.)

DCs have two type of co-ordination link: non-hierarchical and hierarchical (see Fig.5) A non-hierarchical link assumes a conversation that does not involve the changing of DFs of either DC, hierarchical co-ordination links involve on DC imposing a DF on the other, but based on information links for conversation (e.g. negotiation).

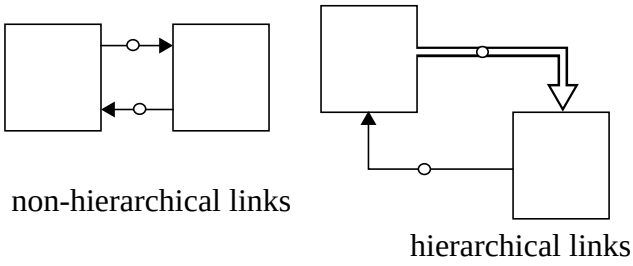

FIGURE 5. Co-ordination links

2.5 The aim of co-ordination of management functions

Individual members of the enterprise behave as agents, in the sense of AI planning agent, i.e. they have a set of objectives (including 'personal objectives' and 'imposed objectives') and as planning agents are able to plan their activities (or an outside observer can describe them as if they were planning their activities), as well as are able to change the plans if activities appear not to progress toward the objectives believed at any one time.

The principal aim of production management is to achieve that the enterprise behave as an agent, in order to achieve the objectives of the whole enterprise. Since the activities of the enterprise are composed of activities of its individual agents (organisational players) the production management system must co-ordinate the decisional objectives within the enterprise (i.e. to achieve a mutually consistent set of objectives on all levels of decision).

Also production management must co-ordinate the objectives of the individual agents (i.e. personal objectives) with the organisation's decisional objectives – although personal objectives are not under the co-ordination / control of the management system, they can not be ignored.

2.6 The decision centre as an organisational role

DCs are functionally defined, and various ways exist to assign management personnel to DCs. Therefore a DC is, from the point of view of organisational design (Mintzberg, 1989, 1993), is a *management role* to be assigned to an organisational entity, or actor / agent – such as an individual, committee, or board.

3.0 Mapping organisational structure to decisional structure

Any management entity justifies its existence in the organisation through the decisional roles it is playing. Furthermore, only those organisational roles are necessary which determine at least one DF, or which provide direct operational control (this latter can be through of as a special case of DFs).

Traditionally DCs are covered more-or-less permanently by designated organisational entities – although these entities may not permanently exist at all times (e.g. a committee is available only at set times).

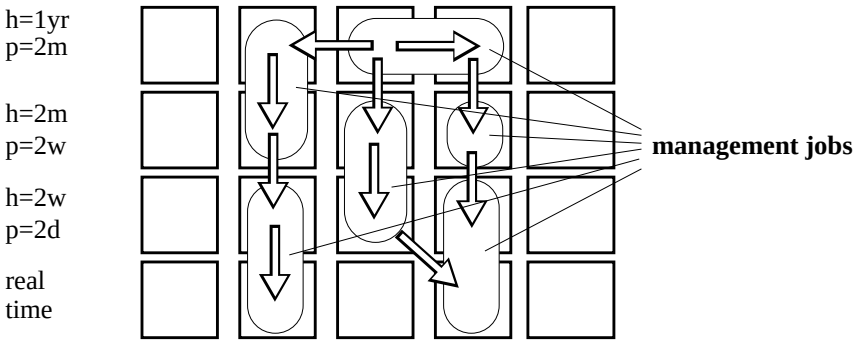

FIGURE 6. A management job consist of the decisional centres (roles) assigned to the manager

Figure 6 shows how management jobs cover a number of decisional roles in the decisional structure. Each management job is a collection of decisional roles. The arrows on the figure show those DFs which cross boundaries of jobs, i.e. where a management entity provides a DF for another management entity (one is the ‘boss’ of the other).

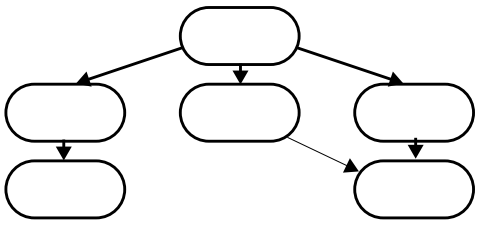

FIGURE 7. Organisational structure abstracted from Fig. 6.

Figure 7 shows the organisational structure (which is in this case hierarchical) that corresponds to the decisional structure in Fig. 6. The organisational hierarchy is determined by the decisional links (DFs) crossing boundaries of organisational entities. As examples demonstrate in section 4.0 the same decision structure can be satisfied by extremely different organisational forms.

Neither the decision structure nor the organisational structure alone can ensure good management of the enterprise, therefore we set out demonstrating how the two can be considered in conjunction.

4.0 Forms of organisation and corresponding co-ordination problems

Co-ordination possibilities and problems stem from either decisional structure inadequacies (section 4.1) or from problematic mapping of organisation to the decisional structure (section 4.2).

4.1 Co-ordination of decisional systems

We present decisional structure problems on the level of a value chain (i.e. co-ordination of multiple or virtual enterprises). We do not treat in the present article the more local problem of decisional structure within the enterprise.

Fig 8 shows the traditional value chain, where two enterprises interact on the operational level. Clearly, the 'virtual enterprise' that is supposed to implement the value chain of the product supported by these two enterprises, does not exist, since there is not decisional mechanism to create the strategic or tactical level decisions, either for the product or for the resources.

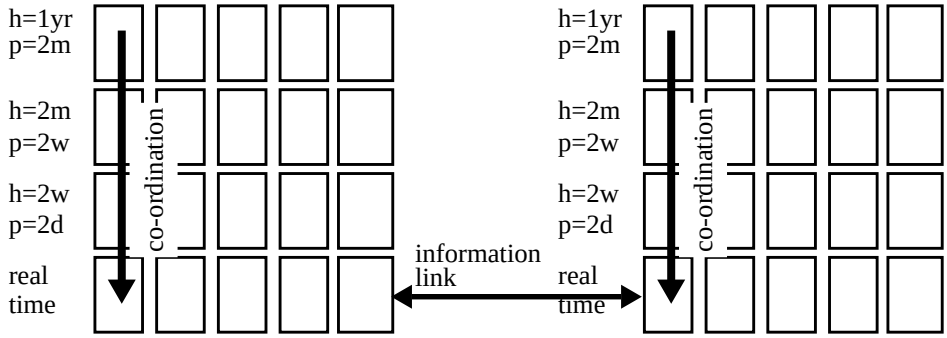

FIGURE 8. Un-coordinated value chain (operational co-ordination only)

An integrated value chain supposes that there are information links on all levels of the decisional hierarchy. This arrangement is necessary to ensure that the integrated enterprise act as an agent (Fig 9).

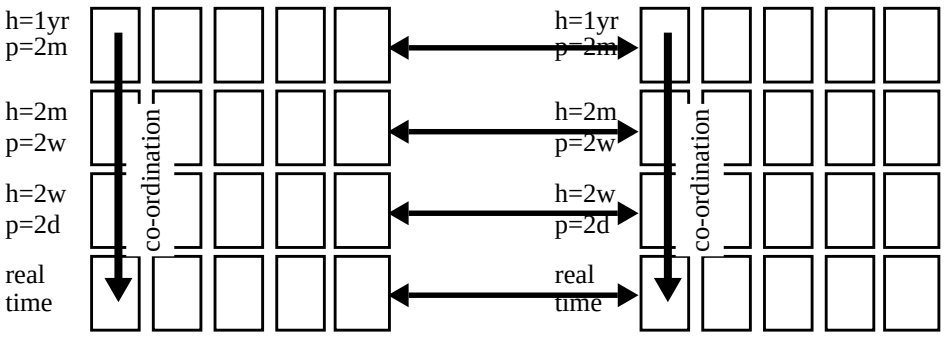

FIGURE 9. Integrated value chain (information links on all levels of decision)

One form of the integrated value chain is the consortium. The consortium form limits co-ordination to a defined domain of action and acts as an agent appearing as a virtual enterprise in its defined domain. (Fig 10).

The reader may notice that this kind of analysis would allow the development of a detailed typology of virtual enterprise.

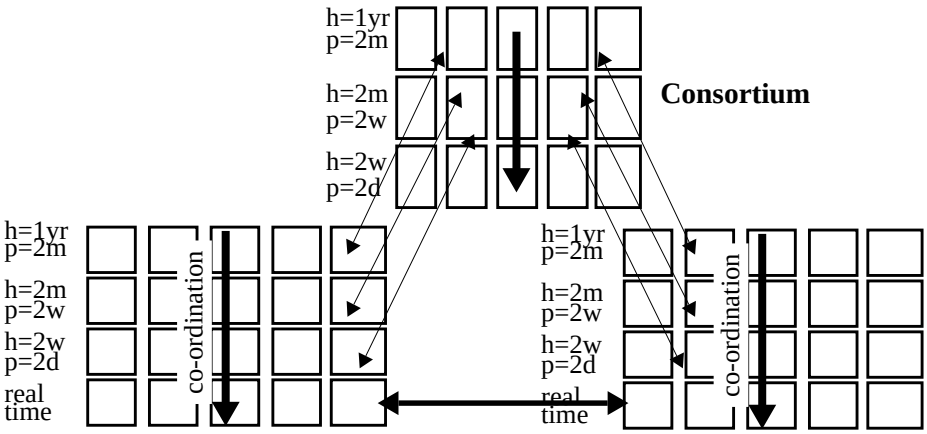

FIGURE 10. Consortium with limited co-ordination

4.2 Mapping of organisations

We shall demonstrate through examples various forms of organisations. In particular we are interested in identifying rules of organisational design to make the best use of the designed decisional structure.

Fig. 11 shows a characteristic flat hierarchy, where three managers have distributed among themselves all higher level management, except operational (real time) control. DFs indicated in this figure suggest that co-ordination is achieved from the top (there are no hierarchical control links between the three areas of management). This is acceptable as long as the DFs leave enough freedom for the lower levels to engage in non-hierarchical co-ordinating conversations via their information links.

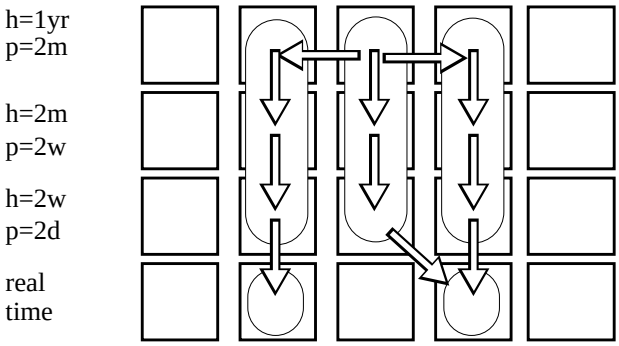

FIGURE 11. Flat hierarchy

Fig. 12 shows a strong decentralised hierarchy, with too many management layers in the organisation.

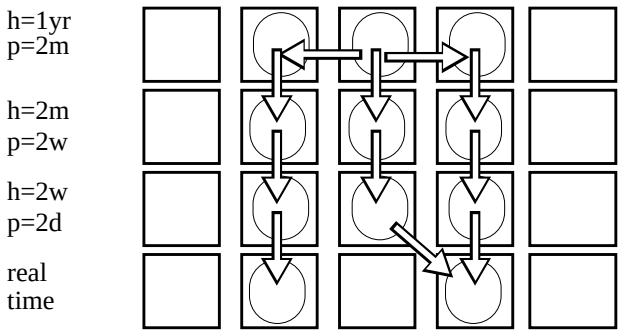

FIGURE 12. Strong decentralised hierarchy

Fig. 13 shows a case where conflict is created through the way in which organisational roles are assigned to organisational actors. Manager *A* in 'one hat' dictates to *B* while in 'another hat' *A* obeys *B*.

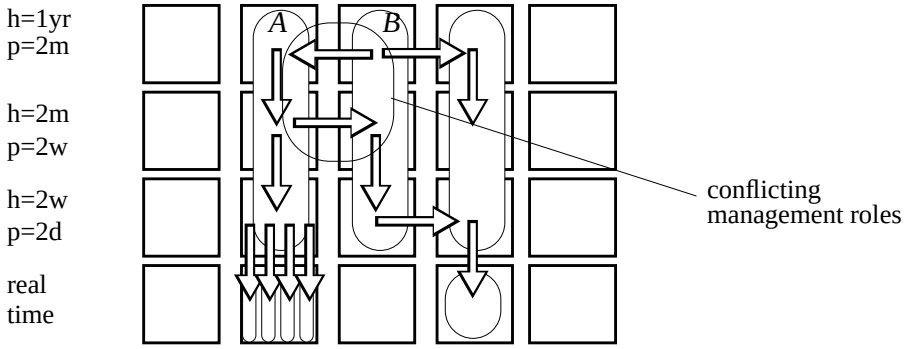

FIGURE 13. Conflicting management roles *A* and *B*

Fig 14 shows 'narrow' management, strategic level management should be lateral and not compartmentalised into too many small functional areas. This figure also demonstrates the case of skill mismatch; managers are allocated tasks on both strategic and operational levels. For many organisations this is not appropriate, because of the mismatch of skills needed for operational control and strategic management. However, for the professional organisation' (Mintzberg, 1993,1994) strategy making may involve the operational level personnel, in which case there is no skills mismatch.

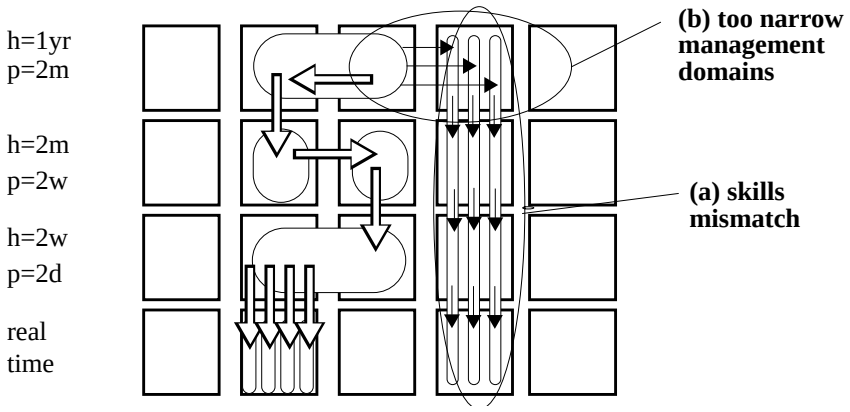

FIGURE 14. Skills mismatch (a) and narrow management domain (b)

Fig. 15 shows 'paternalistic' management; the person in job *A* is not given enough autonomy; manager *B* is involved in low level decisions which would better be made by person *A*.

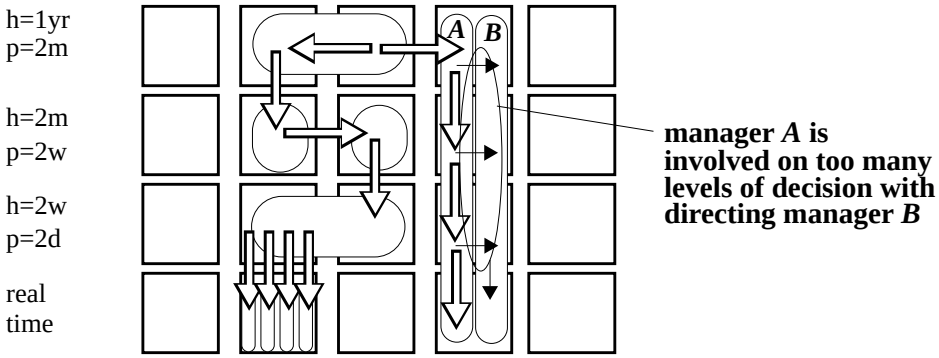

FIGURE 15.

In this section we have given an introduction to the analysis of organisational properties that organisational mapping is able to identify in the management of the enterprise.

5.0 Conclusion

We presented a brief overviuew of the GRAI Grid modelling language to model the decision system of an enterprise. We demonstrated the use of multiple grids for the co-ordination of a virtual enterprise and showed that the same decision structure can be implemeneted by different organisational structures. The mapping of organisation to decision structure allowed us to identify typical organistaional problems in the enterprise.

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