ENTERPRISE MODELLING FOR NETWORKED ENTERPRISE: INTERACTION ASPECTS FOR A TRAINING ORGANIZATION

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Abstract: This paper focuses on enterprise models representing interaction aspects which are very important when modelling networked enterprises. To this aim, a case study concerning an Italian training organization is addressed as a show case, where a re-engineering of the quality management systems where addressed. The main criticalities of cooperation either in the real operative practice and in the related modelling approach are presented. Several interaction requirements at different EM levels and the main factors to be considered in design modelling are also discussed.

Keyword: networked enterprise, interaction, collaboration, training organization

1. INTRODUCTION

Today's dynamic manufacturing environment is characterized by increasing quality not only as conformity to the specifications, but also as conformity to the customer requirements (explicit and tacit); ability to quickly introduce new products (time to market) and costs. According to this inconstant scenario enterprises need to overcome the rigidity of the great dimensions and the scale economies looking for lean organizational solutions and, at the same time, open toward the outside. The optimal solution seem to be the decline of the mechanical model and the success of *reticular ones* because these are more flexible and suitable to operate on complex and segmented markets. In fact according to the mechanical model "functions, tasks, organizational structures, procedures, processes are maximally detailed and rationally interconnected by a specific plan to assure the maximum global efficiency and the maximum predictability and govern ability of the single parts" while in the net model "the single elements are open systems developing specific tasks and at the same time they preserve their autonomy, they are connected in a net of informative and economic exchanges and they interact among them according to the rules of the net".(Butera, 1992)

2. NETWORKED ENTERPRISE

We define a **networked enterprise** as "the system of recognizable and multiple connections and structures within operate high-level self-regulation nodes (as vital open systems) able to cooperate (to conduct various types of effective transactions) for a common goal or shared results". From this point of view (the organizational one), there are four different typologies of networked enterprise in (Butera, 1992):

- "Hierarchical net": the internal hierarchical structure is dominant but there is also a strong relationships of influence and negotiate with other nodes, not only the small ones; *the gravity centre is responsible for the core business;*

- "net with an Assembled Gravity Centre" - the gravity centre doesn't usually manage activities for making products, it is responsible for the financial control of the participating nodes (systems regulated by financial holding, industrial firms no manufacturing, hollow corporations);
- "net with Multiple Gravity Centres - the singular systems rotates around different strategic agencies, with complex and mobile relationships of influence, that cyclically rotate around the most greater nodes;
- "net Without Centre - a nodes leader doesn't exist, the singular systems are based upon their own territorial area, as districts.

From another point of view (Steen, *et al.,* 2002*)* a networked enterprise is "any coordinated undertaking that involves at least two autonomous parties that interact using information and communication technology (ICT)." The autonomous parties can be some physical persons co-operating in some venture or large multinationals co-operating with their suppliers, distributors and third-party logistics providers to streamline their supply chain (Steen, *et al.,* 2002).
It is important here to distinguish the networked enterprise from the network of enterprises; in the latter nodes of the network represent enterprises themselves, therefore with a proper business goal: it is thus possible to refer this kind of enterprises as virtual. In the present paper we will adopt an extended definition of (Steen, *et al.,* 2002*) where* the nodes will represent parts of the same enterprise, thus sharing the same business goal: the networked enterprise cannot be a virtual one.

The major benefit related to a networked enterprise, where often nodes are spatially distributed (delocalized enterprise), is the availability of **autonomous and independent entities** (Hawryszkiewiewycz, 1997), all working together toward some **common goal**. As a consequence networked enterprises are able to quickly **manage changes**, by modifying the connections between the nodes. Indeed, a networked enterprise has the proneness to decentralize functions, decisions, responsibilities and activities, such as that benefits increase the agility, the flexibility, and the adaptability of the net.

There are many possible reasons to create a model of a networked enterprise (Steen, *et al.,* 2002):

- to understand the functioning of an existing NE,
- to provide a starting point for the redesign of an NE,
- to provide a starting point for the development of computer applications to support an NE,
- to serve as a basis for analysis, e.g., answer "what-if" questions, or simulate an inter-organisational business process before implementing it.

The next section provides some key definitions for better modelling a networked enterprise.

3. MODELLING PRINCIPLES OF A NETWORKED ENTERPRISE

In order to model a networked enterprise, a clear definition of its components should be made, according to the decisional purposes of it. This task becomes quite easy as far as the interaction mechanisms are clarified and adequately modelled. This principle is the basis for the approach proposed in the paper: recognising internal and external interactions may allow a better understanding of the networked enterprise. Internal interactions – previously recognised in §2– can be partially influenced by external interactions and vice-versa. By applying this criteria - i.e. modelling interactions – we apply a **decomposition principle** to model of the networked enterprise; this principle can be stated as follow: << any network is a sum of nodes and their interactions>>. Modelling any networked enterprise through this principle will require two main tasks: identification of nodes and their interactions.

3.1 Identification of nodes

The first point to consider when modelling a networked enterprise is to identify the **nodes**: nodes can be either physical or logical, according to their scopes. It is in fact not trivial to identify **"boundaries"** of nodes into **the net**, well-defined criteria should be adopted to this aim.
For instance, in the case study presented in Section 4, nodes are identified by their functional responsibilities: a node manages a definite number of resources, has specific goal and a certain amount of decisional allowances to perform autonomous actions and tasks.

3.2 Interaction mechanisms

As said in Section 2, to perform in modelling a networked enterprise is to represent the nature of the interactions between nodes.
It is appropriate to refer to **nature** of interaction which differs due to the scope of the interaction itself:

- Communication: the scope is simply to inform participants (Glezez, 2003). The exchanged information should have a semantic content for the participants useful for the success of the communicative process.
- Collaboration: the scope is an to pursue a **specific goal**, which is not clearly formalised: in this case there isn't a specific structure of the interactions. The underlying activities of nodes are **group oriented**, and the goal of each node could be different (Glezer, 2003).

- Cooperation: the scope is a synchronisation of activities to pursue a **specific goal**. This interaction is formally managed: roles, phases and goals are rigidly pre-arranged. The coordinator node plays a fundamental role managing the cooperation process. The cooperation can be asynchronous (the involved nodes work on the same information not necessarily at the same time) or synchronous (the node contemporarily work on the same information (reunion).

To summarise, according to the above statements, the nature of an interaction is conditioned by a given scope shared by the interacting nodes

To better model a networked enterprise, we introduce also a specification of the **type of contents** necessary to perform the set of activities which make the interactions among the nodes. This nature is here explicated by recognising the type of generic object exchanged between nodes , which shall occurs if an interaction has to take place:

- orders, and procedures (functional interactions) ;
- rules and practices of the whole working environment (operative interactions);
- formalized information sending by informative nets (informational interactions);
- written communications, recorded or not (bureaucratic interactions);
- costs and prices of commodities and exchanged services (economical or administrative interactions).

According to the above, it is important to remark the correlation existing between the type of contents and the nature of interactions taking place. Recognising relationships between these two entities is not trivial: in the application presented the type of contents are simply highlighted to give some hints to their explicitation. A typical graphical representation will be adopted by representing the exchange of objects via arrows connecting boxes that represent nodes .

4. CASE STUDY: A TRAINING ORGANIZATION

The case study involved a **training organization** (**En.A.P Puglia**) consisting of the following identified nodes (according to their organisation responsibilities):

- an **administration office**, responsible for the core business: taking decisions, giving production orders, supporting continuous improvement;
- several **operative offices**, located in various towns, other than the one in which the administration office is located: operative offices are responsible of the production of the services like training, orientation and working introduction, cooperating together to achieve a common goal, according to the management decision).

The nature of the interactions among nodes is:

- bureaucratic and formalized information (from administration office to operative office)
- formalized information and written communication (from operative office to another operative office).

Following the well-known pyramidal view of enterprise, the interactions are **vertical** for the former type while **horizontal** for the latter.

To a certain extent the nature of the organisation is "net with a Assembled **Gravity Centre**" mentioned in Section 1; the administrative office can be seen as the gravity centre because doesn't usually manage activities for making products, while the operative offices are like nodes managing the operative processes.

4.1 Analysing the interactions between operative offices and the administration office.

Interactions between the **Gravity Centre** and the operative offices are essentially realised by a set of **flows** defined as follows (Figure 1): the

- **Decisional flow**: The nature of the realised interaction mechanism is the **communication** having simply the scope of informing personnel. The exchanged objects functional to communication are management objectives, strategies and goals from administrative office, where they are defined, to operative offices. They also contains the tasks and responsibilities definition, the selection of training programs, the definition of the procedures and the evaluation indexes.
- **Control flow**: The nature of the realised interaction mechanism is the **collaboration** having the scope of assuring conformity and correctness of the activities. The exchanged objects functional to the collaboration are monitoring rules for evaluating results. Whenever and unexpected unconformity is recognised the operative office communicates to the administrative office information about the identified unconformity. The administrative office manage it and communicate the corrective actions to be applied
- **Improvement flow:** . The nature of the realised interaction mechanism is the **co-operation** with the scope of assuring a continuous improvement of the enterprise. The exchanged objects between the centre of gravity (administrative office) and the operative offices (peripheral nodes) are the feedback information from customers.

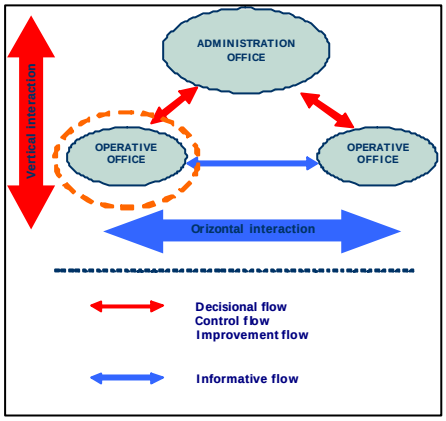

Figure 1

4.2 Analysing the interaction between operative offices

These interactions take place when an operative office needs to *collaborate* with another operative office for a specific process (specific goal).

The collaboration implies information and data sharing, and in some situations physical and human resources exchange.

For instance, let us consider the definition and planning of a defined training project: the specific operative office has to acquire informative material not available in its own office. Then, it is necessary to interact, at collaboration level, with another operative office to support the execution of the activities. Indeed, the specific goal is "to deliver the training service to the customer".

5. INTERACTION MODEL OF EN.A.P.

Among different enterprise modelling approaches our attention is on the I.E.M. (Integrated Enterprise Modelling) (Mertins, *et al.*, 1999) because it allows the representation of the business processes and of the interactions among them, so it could be an useful one for mapping the processes managed by the nodes of the networked enterprise.

The I.E.M. methodology is based upon the relationships between real system elements and model objects. The model objects are assembled in classes, defined as sets of homogeneous elements with common features (Mertins, *et al.*, 1999). Inside these classes it is possible to subsequently gather objects into subclasses, corresponding to real elements of the enterprise. There are three principal classes in I.E.M.:

- Product class *P* (red boxes): corresponding to products/services of the enterprise.
- Resource class *R* (green boxes): corresponding to equipment, organizational units and documents for the activities execution.
- Order class *O* (violet boxes): corresponding to order for an object supply or an activity execution.

These classes are the basic building blocks for designing enterprise models, according to the specific I.E.M methodology (see (Mertins, *et al.*, 1999) for details).

5.1 Interaction between operative offices and administration office

According to our modelling strategy, the identification of the real system elements was firstly done (node identification); afterwards the relationships between nodes and the objects exchanged were modelled (interactions). These process was performed by recurring to the three principal objects classes available in I.E.M. (Figure 2, 3, 4).

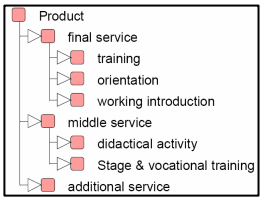

Figure 2 product class

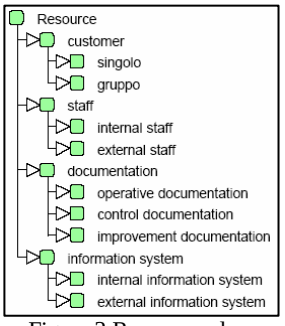

Figure 3 Resource class

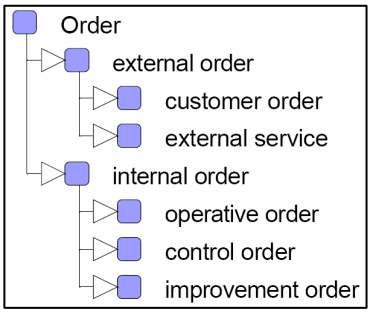

Figure 4 order class

Using the elements of these three object classes, it is possible to model the processes managed in the administrative office and in the operative one. According to the previous statements in the operative office is managed the productive flow, the administrative one process all the activities allowing an effective operation of the whole training organisation. Figure 5 details, at a first level, the principal steps for the execution of the activities

managed by the respective office (a red line identifies the separation between them). As showed in figure 5 modelling the interaction among the two nodes (administrative and operative office) implies:

- Modelling of the activities managed by each office as nodes of the net (see Mertins, *et al.*, 1999 for details about activity model),
- Identification in the model of the demarcation lines corresponding to the boundaries between nodes;
- Characterisation of the interactions among the nodes. It implies modelling of some "orders" (called "control and preventive action" and "improvement action") connecting the administrative office, (*"order source"*) where they are raised, to the operative one (*"order receiver")*. The last office transforms them into another "order" ("result of improvement process") and sends it to the administrative one.

The transferring process of "orders" from a node to another is allowed by EnA.P. Puglia information system and implies *collaboration* among human resources, or better among the process owner, they communicate by asynchronous connection tool (fax, e-mail).

The I.E.M. methodology allowed modelling of detailed activities, so for better understand the interaction a detailed analysis of the activities, managed by the operative office, has been represented in Figure 6. It allows the identification of the specific point where the interaction take place and furthermore it is possible to recognize that the flow involved in the interaction is the control one, for the specific analysed process ("orientation"), as mentioned in § 4.1.

To summarise, the interactions take place by exchange of "messages" that according to IEM methodology, can be represented as objects of the *order class*. Each "order" is the I.E.M. element modelling the interaction between administrative and operative offices.

6. DISCUSSION AND CONCLUSIONS

Modelling networked enterprise is a critical and complex activity to be performed, because it implies the characterisation of each relevant aspects of the enterprise and the internal interactions. Enterprise modelling available so far does not have specific facilities to capture interaction aspects in a networked enterprise, but it simply allows the representation of activities performed by each node. The paper proposes some modelling principle to analyse interactions between nodes. The reference to a networked training organisation has been made to show a potential application made using a standard enterprise modelling tool.

Approach proposed in this paper is tentative and therefore still immature. Further applications on real cases are needed to induct new concept and rules for modelling interactions and their contents.

An open question remain unsolved: the dependency between the type of contents and the nature of interactions taking place. These are quite often interdependent, but the links is not trivial to make explicit. In this sense, in the application presented the type of contents are simply recognised by the expertise of the analyser, without any predefined rule.

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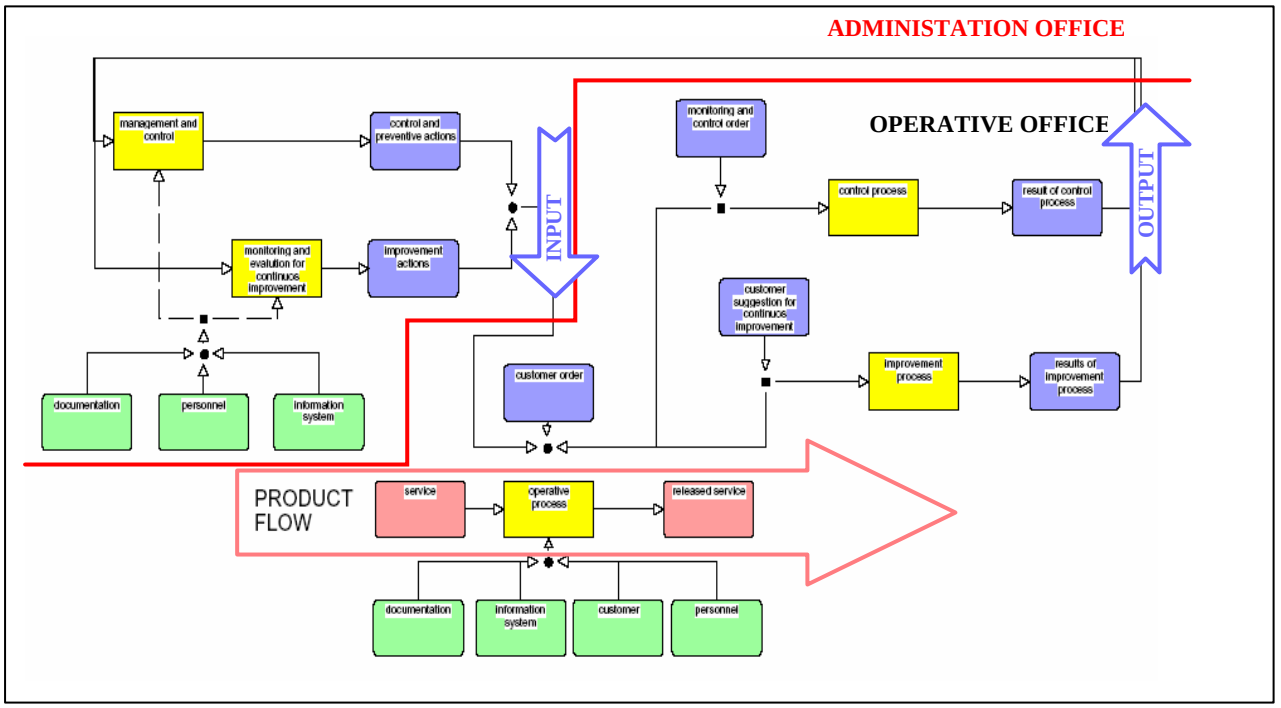

Figure 5 Process model for administrative office and operative one (first level of detail)

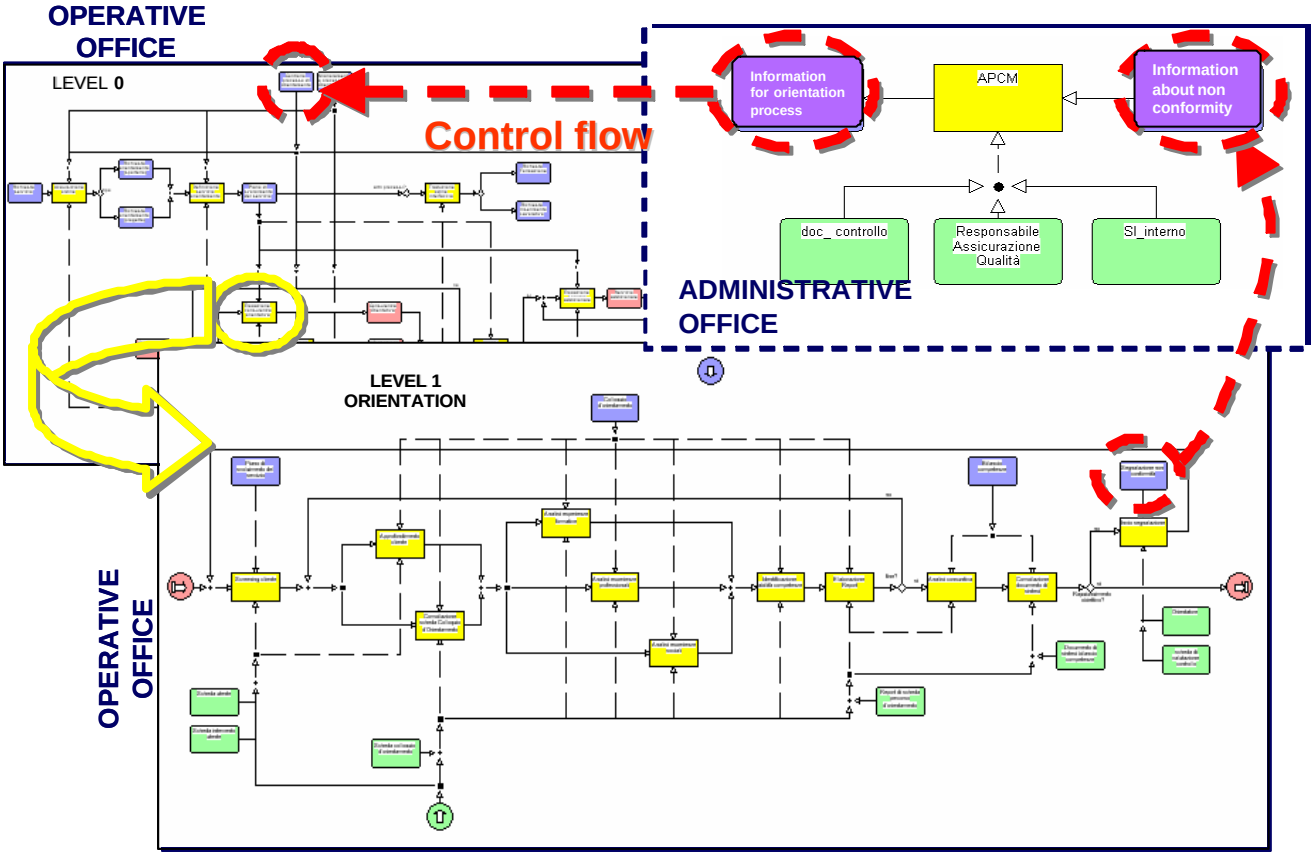

Figure 6 Process model for operative office and administrative one (second level of detail)