Using Enterprise Modelling Methodologies for Modelling Agricultural Activities and Identifying Information Requirements. A Case Study of a Livestock Farm

Vincent Abt, Frédéric Vigier, Henri Pierreval, Jean-Baptiste Bigeon, Cédric Durand

Abstract

The new requirements of the society, the changing organisation of the agricultural sector and the reform of the Common Agricultural Policy (CAP) impose an increasingly complex farm management. To face this evolution, the challenge is to achieve a real integrated farm management, capable of providing a successful production, environmental, quality and information management. This enterprise integration requires the development of appropriate management tools and the integration of farm Information Systems (IS). Modelling methods used in agricultural sector and for software engineering are not sufficient to provide enterprise and IS integration. In the industrial sector, enterprise modelling methods have been developed in this aim, but have never been applied, as far as we know, in the agricultural sector. These methods are particularly useful to define requirements models, characterising enterprise operations in a business sense and terminology. They could be very helpful to adopt an innovating viewpoint regarding information in farm enterprise. We propose to investigate the use of 3 different modelling approaches (IDEF0, GRAI, AMS) through the example of a livestock farm. This article presents examples of models and a first discussion of the potential contributions of these methods to the modelling of agricultural activities, information requirements and software definition.

Key words: farm management, enterprise modelling, production system, information system, livestock farm.

1 Integrated farm management, information requirements and enterprise modelling

The new requirements of the society (e.g. traceability, multi-functionality, risk management, etc), the changing organisation of the agricultural sector, the reform of the Common Agricultural Policy (CAP) are typical factors that lead the farmers to an increasingly complex enterprise management. Nowadays the challenge is to achieve a genuine integrated farm management, providing a successful production, environmental, quality and information management.

In the industrial sector, the integrated enterprise management is performed through the development of appropriate management tools like the ERP softwares (Enterprise Resource Planning) providing interoperability and coordination between services and functions in the enterprise. In the agricultural sector, the lack of a global integration in terms of management tools and Information Systems (IS) have led agronomical research on decision models to develop as many tools as management modes. It results in a significant division of the farm IS and in a difficult integration of farm management (Goense et al., 1994; Steffe, 1999, Del'homme et al., 2004).
A better understanding and representation of the functional and organizational aspects of the farms is necessary to achieve the enterprise integration and to identify the information requirements. Our aim is to find appropriate methodologies to model farming activities and represent their coordination and their organisation into workshops, processes, functions, etc. It turns out to be very useful to adopt an innovating viewpoint regarding information (Chalmeta et al., 2001).

Modelling methods from the agricultural sector meet only partially these needs of enterprise representation and information requirements (Abt et al., 2005). They focus on specific aspects such as decision objectives and rules, strategic or operational management and do not permit also the description of the entire enterprise (Aubry et al., 1998; Papy, 2000). In addition the use of common formalisms and structuring concepts is limited (Coléno, 2002; Martin-Clouaire et al., 2003). They are thus less efficient when the objective is to identify enterprise information requirements.

Modelling methods from the software engineering community such as UML (Universal Modelling Language) are also not sufficient. UML is a family of graphical notations that help in describing and designing IS. It is used to get design and implementation models in software engineering. Nevertheless it is less appropriate to develop requirements models in order to specify and communicate important aspects of the whole enterprise system, such as enterprise information requirements. (Kim et al., 2003).

In the industrial sector, enterprise modelling methods have been developed to facilitate enterprise and IS integration (Fox et al., 1998; Chalmeta et al., 2001; Vernadat, 2002; Aguilar-Savén, 2004). The systemic approach used by these methods and the proposed formalisms enable the enterprise to be represented at various aggregation levels in accordance of different points of view. In particular, they allow requirements models to be defined, which describe enterprise operations to be done in a business sense and terminology, in terms of enterprise operations, information, resource requirements, responsibilities, and authorities without any reference to implementation options or decision (Vernadat, 1996).

The enterprise modelling methods were mainly designed for studying industrial production companies from primary and secondary sectors. More recently, the uses of these methods have been extended to service companies from tertiary sector. As far as we know, their application to the agricultural primary sector has not been studied in the literature yet (Abt et al., 2005).

We propose to investigate the use of these methods in the agricultural sector. Through the example of a livestock farm, we propose to investigate the use of 3 different enterprise modelling approaches (IDEF0, GRAI, AMS). Examples of obtained models are presented in this article. The potential contributions of these methods in terms of agricultural activities modelling, information requirements and software definition are discussed from the experience of this example.

2 The enterprise modelling methods used

Each enterprise modelling methods covers an aspect of the production system. We decided to use 3 different and widely used methods to represent the livestock farm. The IDEF0 method allows the functional aspect of the system to be described (NIST, 1993). The GRAI method enables production management and control decisions to be identified and organised into time periods and horizons (Roboam, 1993). The AMS method enables production operations and controls to be identified and organised into workshop units (Mélèse, 1984). We will not present more precisely this last method here. The reader is referred to Mélèse (1984) for more details.

2.1 The IDEF0 method

The IDEF0 method was developed in order to represent in a standard manner activities or functions that are typically carried out in an enterprise. The IDEF0 definition of a function is “a set of activities that takes certain inputs and, by means of some mechanism, and subject to certain controls, transforms the inputs into outputs”. Functions are represented by boxes. Each box has a label: an active verb or verb phrase that describes the activity. Inputs, controls, outputs and mechanisms are represented by arrows and can be used to model relationships between different activities (Figure 1). Arrows do not represent flow or sequence as in a traditional process flow model.
IDEF0 modelling starts by defining a context diagram. This represents the overall purpose of the system and its interfaces with an external environment. IDEF0 models comprise a hierarchy of related diagrams that are hierarchically decomposed thereby encoding semantic information at so-called lower levels of modelling. This hierarchical decomposition results in both wide-scope and detailed representations of system activities. IDEF0 methodology includes procedures for developing comments on models by a group of people. The reader is referred to NIST (1993) for more details about methodology.

2.2 The GRAI method

The GRAI method was developed in order to analyse production management decisions and specify production management system. The method is based on GRAI grid and GRAI nets techniques which model processes that focus on the decisional flow. We will neither describe the GRAI nets techniques nor the GRAI methodology in this paper. We will focus on the GRAI grid formalism.

The GRAI grid is the expression of a global and macroscopic vision of the studied system structure. It organizes the various decision-making centres in the enterprise. The decisional activities are gathered according to their functionalities. The decision-makings are characterized by a couple Horizon/Period (H/P): the Horizon represents the expiration of the decision, the Period its frequency of questioning. The intersection between a function (column) and a level H/P (line) is called a decision-making centre. The decision-making centres are connected the ones to the others by 2 types of links: information (simple arrow) or objectives transmission (double arrow) (Figure 2).

3 Case study and models

3.1 Presentation of the livestock farm

The proposed example consists in a mixed crop-livestock farm located in the French Department of Lot. In this example we experiment the methods mentioned above. The farm employs two full-time persons and one part-time person. It works 85 ha of agricultural area (crops and grassland) and owns a herd of 90 suckler cows. The cropped areas and the grasslands produce maize ensilage, cereals, hay and grass. Concentrates are bought to supplement livestock feeding and fatten animals. This farm sells 3 main beef productions: milk fattened calves, fattened calves and fattened cows.
3.2 Illustration of the obtained models

This farm analysis has been carried out by specialists of industrial engineering and agricultural sciences. It has focused on the production management of the breeding unit (calves birth, herd replacement, fattening). Figure 3 shows an IDEF0 diagram. It represents the decomposition of the activity “exploit a suckler herd”. Figure 4 presents the GRAI grid of the studied system. A detailed attention was given to animal production control (calves birth, fattening), resources management (suckler cows allocation) and “maintenance” (suckler herd replacement and feeding). Livestock feeds supply and human/technical resource management are not represented in this grid.

4 Discussion

From these first models, we can point out different possible contributions of enterprise modelling methods to classical agricultural activities modelling and information requirements identifying. Each method enriches the traditional description of the livestock farm by proposing well established graphical formalizations.

IDEF0 provides an useful functional decomposition of the enterprise. It proposes a simple formalism to identify the main activities, to represent the most important physical flows in the farm, and to highlight relevant information for their control and their execution.

GRAI provides a farm management analysis. It clarifies the difference between decision-making and operational activities. It introduces structuring concepts like Horizon and Period and leads us to think about the regrouping of decision-making activities into enterprise functions.

AMS, whose first results are not presented here, provides a conceptual framework to enterprise organization and control activities modelling. It proposes a rich graphical formalism to represent simultaneously organization units, physical and informational flows and control indicators.
4.1 Contribution to agricultural activities modelling

These methods allow different aspects of agricultural activities to be represented thanks to structuring concepts and rich graphical formalisms. They organize activities hierarchically by functions and production units. They clarify differences between decision-making and operational activities. They allow us to think about their management and control and their information requirements.

For example, the GRAI method leads us to group decisional activities into established functions. The adaptation is not evident, but the led reflection gives structure to agricultural activities. It enables production management system to be better characterized and relations between resources, maintenance, supply management in farm enterprise to be better established. In addition, the definition of different Horizon/Period (H/P) levels allows us to structure the decisional system and precise what are connections between strategic, tactical and operational levels. However, this H/P concept has to be used carefully: it can be sometimes not relevant to model farming activities seasonality (Abt et al., 2005).

4.2 Contribution to information requirements and software definition

In terms of information requirements, these methods allow different informational aspects to be identified and represented. The use of different concepts and formalisms allows us to define different generic information types such as plans, controls, indicators and their way to be used and produced. For example, the IDEF0 method enables directives, controls, constraints, plans, products and resource information to be represented in a same diagram. This is not provided by UML. The use of IDEF0 decomposition and graphical language allows information requirements to be defined at different precision levels using an “end-user” terminology. IDEF0 models can constitute in this way a semantically rich picture of requirements, intelligible by different communities, that potentially can be complementary to other approaches and be reused by system designers, and particularly in UML design models (Kim et al., 2003).

Furthermore, in terms of software engineering, these methods allows us to introduce conceptual frameworks that “structure” enterprise organization and could help to define appropriate IS integration and architecture. For example, the GRAI method, as we said above, clarify the organization of generic enterprise production management functions. This organization could correspond to different functional software modules. This could facilitate management tools integration, and particularly Decision Support System (DSS) integration, by defining and organizing precisely decisions-making centers. We plan to investigate this architecture point in our future works.
5 Conclusion

We used enterprise modelling methods for three aims: agricultural activities modelling, information requirements and software definition. Through the example of a livestock farm, first models and reflections encourage us to further investigate these methods in the agricultural sector.

We noted that enterprise modelling methods provide interesting multiple views of the entire farm enterprise. They propose interesting graphical formalisations to represent agricultural activities. These methods suggest in addition an innovating viewpoint regarding information in farm enterprise. They propose generic modelling formalisms and structuring concepts, well-known in the industrial sector, that structure informational aspects and facilitate enterprise and IS integration.

In this way, enterprise modelling methods could enrich methods from the agricultural sector in order to better represent farm management organisation and information requirements.

Our future works will investigate other enterprise modelling methods. We will study in parallel their contributions to farm management representation and better software definition. We will study together livestock and crop production systems, for which concepts and singularities could be very different.

6 References


NIST, 1993. Integration Definition for Function Modeling (IDEF0) - Publication 183, Springfield, VA, USA.


