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Needs for methods and models rationalizing work of the actors of an organization implied in an innovation process: basic principles and examples

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Abstract: The processes of innovation can be considered before all as business processes; those generally relate to more or less complex organizations. It is possible to understand and improve these processes by exploiting methods and models coming from various fields. Basic principles and examples are provided in the paper.

Keywords: innovation process, innovative services and processes, models, innovative organization modelling, tools.

I. Introduction

The innovation is a wide, rich and multi-disciplinary field, which made the object of many studies and works, studying the innovation according to various points of view: institutional, scientific, organisational, and so on (Hage and Meeus, 2006; Allen and Henn, 2006). We are interested in it under the angle of organization modelling, with the aim of improving the effectiveness of the actors of the organization, and of integrating in this one assistance systems (relating for example to economic intelligence). Let us note that economic intelligence and innovation are closely dependent (MEDEF, 2006). Indeed, if one refers to success key stages of an innovation approach¹: (1) to find and to conceive the innovation (to analyze the innovation potential, to define a strategy, to inform themselves on technologies, the markets, concurrence, to seek the financings, to find solutions, to reinforce the potential of innovation, to innovate in partnership), (2) to evaluate the innovation (to check the freedom of exploitation, to integrate the standards and laws, to respect the environment, to study technical feasibility, to validate the assumption of market), (3) to develop the innovation (to ensure the viability of the innovation, to use technology transfers, to ensure the financing of the innovation, to establish a plan of development, to create an innovating company, to set up a technological watch), it proves that tools coming from the economic intelligence can be of a capital contribution. Let us note that in the processes of innovation, the study and proposition of innovative processes have been included, i.e. those profiting from an innovation, coming for new solutions or new services. For example, in the hospital field, new innovating processes appear; they tie profit of new information technologies: actors of the organization can be seen like nomadic users of new devices likely to help them in their activities; however new problems appear, it is important to identify and to solve them (Beuscart-Zépher et al., 2005). Actually, when the global approach used is participative, processes of innovation and innovative processes are or must be closely dependent.

The paper is first focussed on analysis, modelling and simulation of organizations implied in such processes, these processes being seen as business processes (under the angle of the quality standard ISO 9000, generation 2000, cf. Mathieu, 2002). Then, we underline a whole of ideas related to models issued from multi-agent systems. Models from Software Engineering (SE) and Human-Computer Interaction (HCI) are also currently studied with a view of organization modeling; a concrete illustration is provided. A conclusion and research perspectives are given in the last part of the paper.

¹ Selon : <http://www.dijon.cci.fr/fr/entreprises-developpement/developpement-3050.jsp>

II. Analysis, modelling and simulation of organizations implied in innovation processes

The human factors play an essential part in the effectiveness of the innovation processes in companies. The majority of the human organizations committed in such processes are based on creation, handling and exchanges of information, knowledge and documents (numerical, paper...) between actors constituting the organization. The emergence of new technologies and powerful, simple computerized tools often contrasts with the lack of methods for implement and integrate them in the concerned organization. In addition, according to Adam et al. (1998), if solutions are sometimes found to solve local problems of generally technical nature, it does not exist systematic ways to solve complex organisational problems where the human factors are critical.

The analysis, modeling and simulation of organization (according to static and dynamic aspects), figure 1, often makes it possible to identify factors of blocking, errors, waste of time, and so on. Initially, the analysis must allow, after identification of the principal objectives of the organization, to specify the role of the various actors and to describe the tasks assigned with each role. The analysis of the external interfaces must be also carried out in order to identify the inputs and outputs of the organization, for example the interaction links with the suppliers, the customers or other organizations. As regards modeling, numerous models, coming mainly from Software Engineering (UML models, SADT actigrams ...) or derived from existing models, can be very efficient (Bernonville et al., 2005). The selected models must for example reflect the importance of the data in the human organization, to be able to underline the points/places of communication and co-operation. They will have to be presented at the actors, in order to propose in a participative way one or several computerized solutions as well as solutions related to the organization itself. Simulation must then play a major role, by exploiting the potentialities of the selected models. For example, the simulation based on the use of Petri Nets can make it possible to model the interactions between actors finely and to highlight possible improvements concerning them: during a study concerning organizations engaged in innovation processes in a large company, simulations have led to decrease several weeks of the durations of certain processes related to industrial patents (Adam, 2000). In the healthcare field, and particularly in projects concerning integration of new interactive systems in the process of therapeutic prescription, the use of UML activity enabled us early in the project to highlight important differences in the role of the nurses, and thus to identify potential problems of co-operation between various actors of this process (Beuscart-Zéphir et al., 2005 ; Kolski and Bernonville, 2006) ; an illustration will be given in the fourth part. This global approach goes in the same direction as the quality standard ISO 9000, generation 2000, recommending the improvement of the whole of the processes in companies.

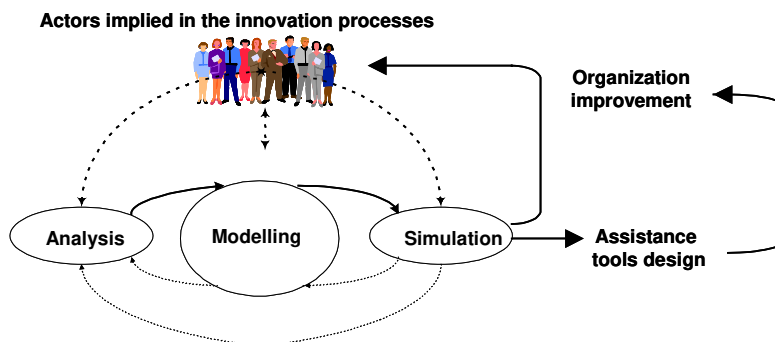


Figure 1. Global principle of organization analysis, modelling and simulation

III. Modeling of organization for the innovation: potential contribution of agent oriented models

The comprehension and the improvement of the innovation processes in the companies are in our opinion dependent on the description and the study of the organizations. We think that the

multi-agent systems (MAS) research field can propose promising solutions for such studies (Mandiau et al., 2002; Boissier et al., 2005). In particular, the organizations can be defined like a whole of roles concerning the various actors and their interactions.

III.1. Multi-agent oriented models for human organization

While being based on the concept of agent and by generalizing an organization like being able to integrate human agents as well as software agents, it seems that two possible axes can bring methodological elements to the study and global comprehension of such systems.

The first axis consists in describing several role plays where various actors try to explain their steps of decision-making in order to improve reciprocal understanding of the objectives of each one for a better convergence of the decisions and working methods. Of these role plays, conflict situations can thus be highlighted and then solved; new ideas can appear with respect to the functions, tasks or constraints associated with each role (of oneself and others in the organization). For example, works of (Guyot and Shinichi, 2006) propose situations applied to processes in company or operations of collective behaviors. In the same way, the CIRAD (cf. <http://cormas.cirad.fr/en/demarch/demarch.htm>) carries out a similar work for human organizations in developing countries; the objective is to improve their effectiveness by (1) identifying and discussing problems without inhibition due to the hierarchy because of presence in a play, (2) by giving an outline of the global vision (non-existent in the reality because for example of the ignorance of the total functioning of their environment). We think that such steps can bring a new glance on the improvement of the innovation processes, but our research does not relate to this axis.

The second axis consists in the analysis and the improvement of the existing organizational structures. The multi-agent systems research field is interested in it particularly under the angle of the multi-agent organizations. Within this framework, works on the modeling of holonic systems (which can be seen as particular multi-agent systems) can bring interesting contributions and points of view. Holonic systems were proposed by Arthur Koestler around 40 years ago (Koestler, 1969). The underlying principle is the fact that, in real life, an entity must be considered both as a whole made up of other entities and as being part of a set. Koestler's ideas have already been applied in various fields, notably in Intelligent Manufacturing Systems (in order to form one of the models on which the factory of the future could be built), robotics, transport planning, cognitive psychology, and so on. A Holon is defined by Koestler as being a part of a whole or of a larger organization, rigorously meeting three conditions: to be stable, to have a capacity for autonomy and to be capable of cooperating. Several conferences are now dedicated to such new multi-agent and holonic systems and organizations, see for instance (Marik et al., 2005). We have exploited the holonic concepts for holonic modeling of organizations implied in innovation processes; the application field concerned patent rights in the chemical domain (Adam, 2000 ; Adam et al., 2001) ; the objective was to provide the actors of the organization with computerized tools adapted to their tasks (Adam and Lecomte, 2003 ; Adam and Mandiau, 2005).

III.2. Design of a MAS into a human organization : application to an Information Multi-Agent System

Our research aims to set up an information management assistance system in watch cells or in laboratories. In order to take into account the human factors, such as the notion of the group or even the human-machine co-operation, we have developed a method (AMOMCASYS, meaning the Adaptable Modelling Method for Complex Administrative Systems) to design and to set-up multi-agent systems within human organization, more precisely in the cooperative processes of these organizations (Adam, 2000). We have reused this method to develop multi-agent systems for helping cooperative information management within a team of technological watch. The main advantage of our method, and of our system, is that it takes into account the cooperation between actors of workflow processes. Indeed, we have noticed that most of human organizations are based on a holonic model (each part of the organization is stable,

autonomous and cooperative and is composed of sub-holonic organizations whose it is responsible) and we have built our method by integrating these notions.

Regarding the system's modelling, the selection criteria for the proposition of AMOMCASYS, are: the clarity (primordial for the confrontation of the models with actors of the system); the representation of the communicated objects (the documents), the data flows, the cooperation between actors, and the responsibility levels. So, AMOMCASYS uses four models: a data model (by data model of UML), a data flows model (by adapted actigrams of SADT method), which allows representing responsibility levels), a data processing model (by the processing model of CISAD method), and a dynamic model (by parameterized Petri nets). Each of these models brings a complementary view on the modelled system. They are not all necessary: in some cases, it is possible to use only a data flow model or a data processing model. It is in this sense that AMOMCASYS is an adaptable method, but in all cases it is indispensable of building the data model, representing all the data, or the most important types of data, used during groupware processes. Before the setting up of groupware software, AMOMCASYS proposes to actors of the complex administrative processes to simplify them (that is to say decrease number of communications, of database duplications, data controls...). It has been then necessary to provide processes' managers (department managers and/or quality managers) with a CASE Tool (Visual Basic layer based on the commercial software VISIO), easy to use, allowing them to model the processes.

Three steps are necessary to set-up a MAS with AMOMCASYS (cf. figure 2): (1) an analysis has to be done in the department; (2) next, the processes where the multi-agent has to be set-up are modelled by using the data model and the dataflow model (and sometimes the data processing model). Actors are confronted to the models in order to involve them in the setup of the project and in order to validate the model. Some organisational optimization of the processes are sometimes made at this stage (for example, the time for dealing with one procedure involving about 15 actors was halved, by improving cooperation and increasing the responsibilities of the actors). (3) Finally, the data exchanges and the working mechanism of the multi-agent system are modelled with the processing model and the data model is used to represent classes that compose the MAS. A simulation of the human activities can be used to determine the opportunity to use agents on particular points of the process.

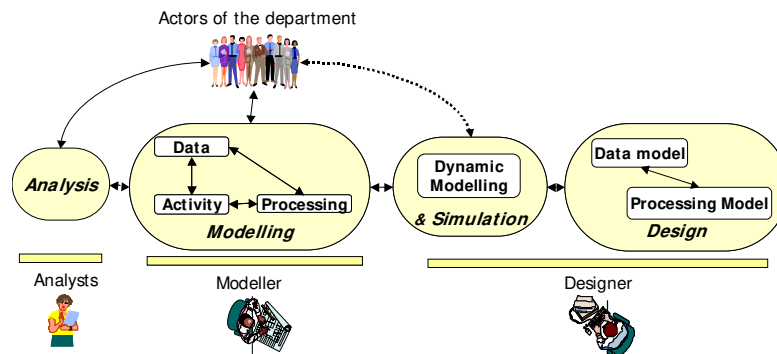


Figure 2. Steps of the AMOMCASYS method

Although the definition of our MAS structure has been facilitated by the use of holonic principles, the modelling of the system organization and the characterization of the functionality of the agents remain problematic. We propose a specification in two stages: the first stage concerns the individual functioning of each role played by the holonic agent; the second concerns the functioning of the group, describing communications between agents and between actors and agents. Regarding the design of the MAS to be integrated to the human process, AMOMCASYS data model allows us to represent the principal Holon class (which describes the general agent structure) as well as the classes associated to the knowledge on the environment (representation of the process, the actor, the workstation, the responsible, the subordinates). Each holonic agent has some roles, that implies co-operations between holonic agents and sometimes between the agents and the actors (the users). The models of the AMOMCASYS method can model these co-operations (cf. Figure 3).

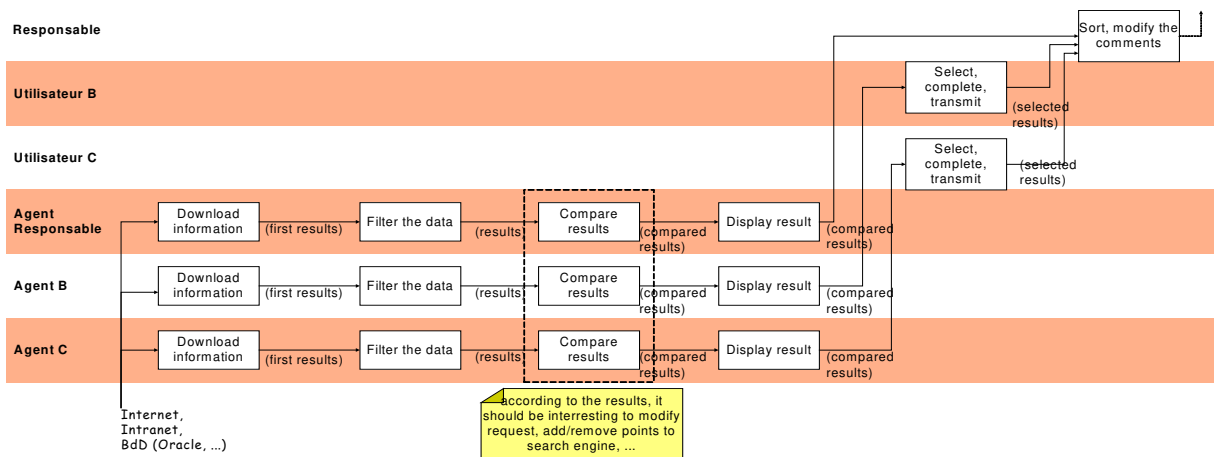


Figure. 3. Example of integration of software agents into a cooperative processes

Figure 3 presents the integration of software agents in an information retrieval process of a technological watch team. Each agent is linked to an actor. Agents search information, filter them, compare them and transmit them to actors, which check them to record them into a database. The integration of agents in the process has been done in cooperation with the actors by using the dataflow model and corresponds to the second step of our method. So, each agent helps the user, to who it is dedicated, to search relevant information and to communicate it with other actors. In order to maintain or create the feelings of community or group among the actors, which is often forgotten with the use of new technologies (the individuals are isolated with their workstation), we have proposed to develop self-organizing capacities in order to generate communities of CIASTEWA, which have to answer at the same kinds of requests. This reorganization is indicated to users in order to encourage them to cooperate, if they want to do it, with other users having the same centers of interests.

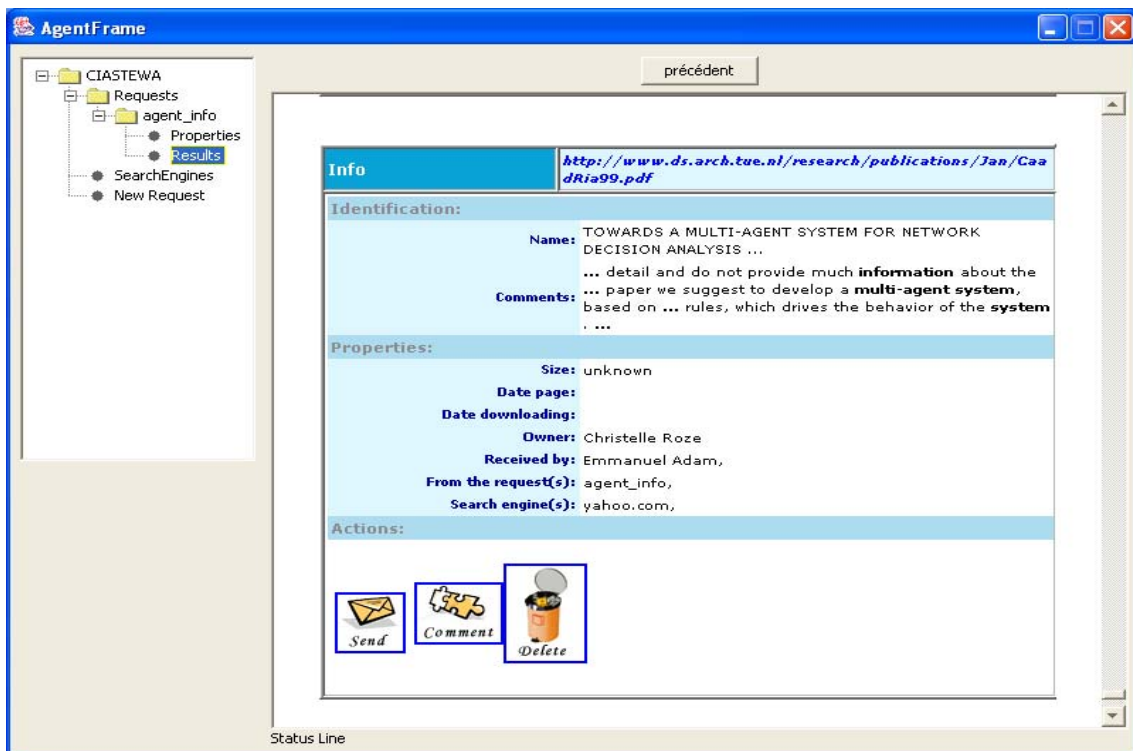


Figure 4. Screen copy of a CIASTEWA.

So, to specify a co-operative information agents' system into a human organization, we have to follow three steps: a step of analysis and modelling of the human organization; a step of

modelling the insertion of agent systems into the human organization; and a step of design of the MAS. The first prototype of the MAS that we have proposed for the technological watch department has been setup in short term (few months), and has been particularly well accepted by actors, thanks to the participative design that we propose. Currently, we develop a more flexible multi-agent system, which integrates most of the holonic concepts, in order to let the agents able to choose among a set of strategies according to the system goal, their roles and their personal goals. Agents are able to: add, remove, change their roles; delegate tasks to assistants or to agents of their teams; ask for new assistants. To manage roles and agents of the multi-agent organization, we use notion of Holonic Ressources Agents (which act like Human Resource managers). Flexibility that we give to our holonic agents allows a role to have variations of its definition in sub-parts of a large system.

IV. Modelling of organization for the innovation: potential contribution of SE and HCI methods and models to create common work supports helping the integration of innovative system in complex organization

Our first approach of organization modelling, described in the preceding part, exploited explicitly agent oriented models. In a second approach, we study in a global way the contribution of methods and models from Software Engineering and Human-Computer Interaction, with for application framework the introduction of new interactive systems in hospitals. Thus, various types of innovating systems are currently planned to support the organization concerned with the activity of ordering - dispensation - administration; this activity is complex and involves risks. With an aim of concrete illustration, we are interested here primarily in the management by the nurse of the requests about samplings (blood tests, biological analyses) ordered by the physician for several patients.

Following the observations carried out on the field, the ergonomists collected information on the current situation in an hospital. In addition, they worked in collaboration with a IT company specialized in CPOE (Computerized Physician Order Entry) applications and studied the possible integration of a future software (in design phase) within the current organization. They thus analyzed mock-ups and functional specifications in textual form provided by the company. Then, the ergonomists wish to describe the current situation observed and the possible situation with the software suggested by the company in order to highlight the possible differences. This information could be transmitted to other actors to be analyzed. However, the methods and models used by the ergonomists are too limited to describe deeply this type of situation. We thus propose the use of a model from Software Engineering meeting the needs of the ergonomists. Figures 3 and 4 present two common work supports carried out starting from the UML activity diagram. The first diagram (figure 3) illustrates the task chaining carried out by each actor or system for the situation observed on the field. While the second diagram (figure 4) illustrates the task chaining carried out by each actor or system for a possible situation with the future software. The comparison of the two supports makes it possible to highlight organisational changes to take into account (sets surrounded and numbered on figures 3 and 4). The first unit (numbered 1 on figures 3 and 4) shows that there would be no more orderings in paper form and that the software would manage the orders that the physician keyed (regrouping, creation of lists for the nurse). The second unit (numbered 2 on figures 3 and 4) shows that the nurse would not key any more the requests of samplings. The nurse would have only to consult on the screen the list of the samplings to be carried out. The third unit (numbered 3 on figures 3 and 4) shows that the nurse would have an additional stage, i.e. he or she must initially validate the samplings carried out and then validate the sending of the samplings carried out.

In conclusion, the comparison of these two models puts forward important changes in the organization which could have consequences on the workload of the actors (ex: more or less tasks to perform), supports used (for instance suppression of the paper media)... This is why these supports will be able to help the various actors to understand the work situations, to take the organisational decisions and to design interactive applications adapted to the work situations.

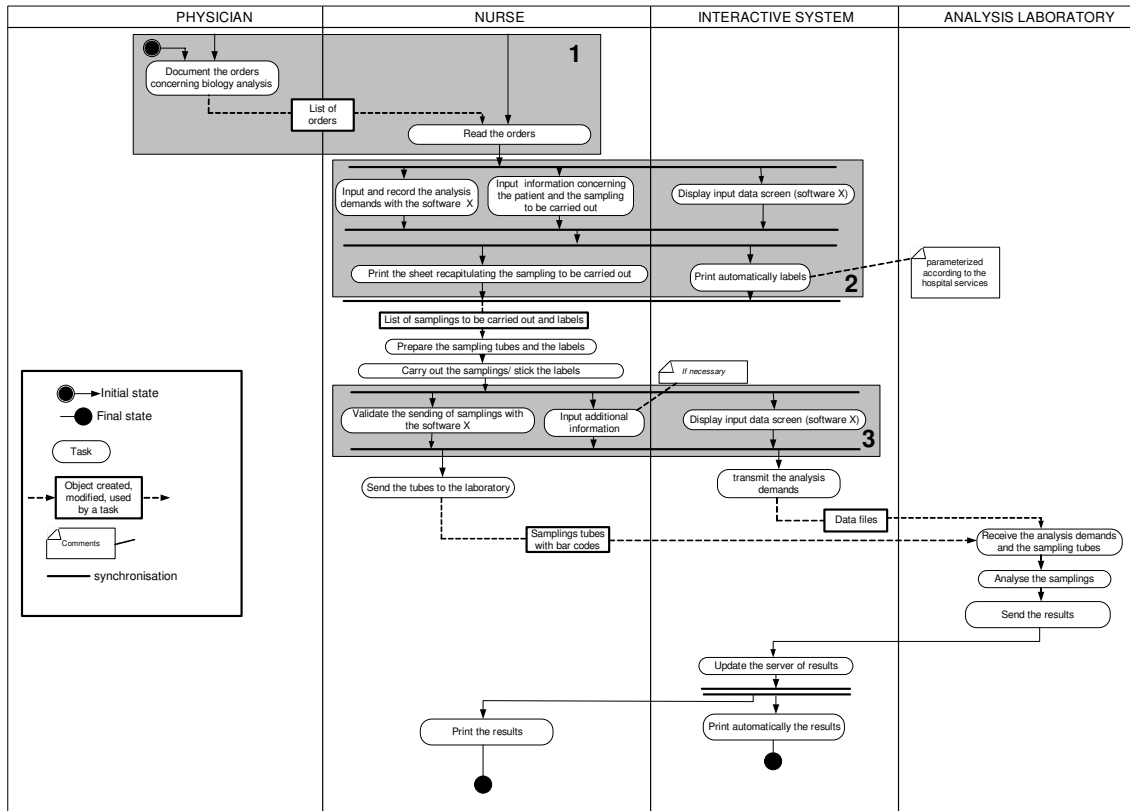


Figure 3. Example of common work support completed using the UML activity diagram (observed current situation)

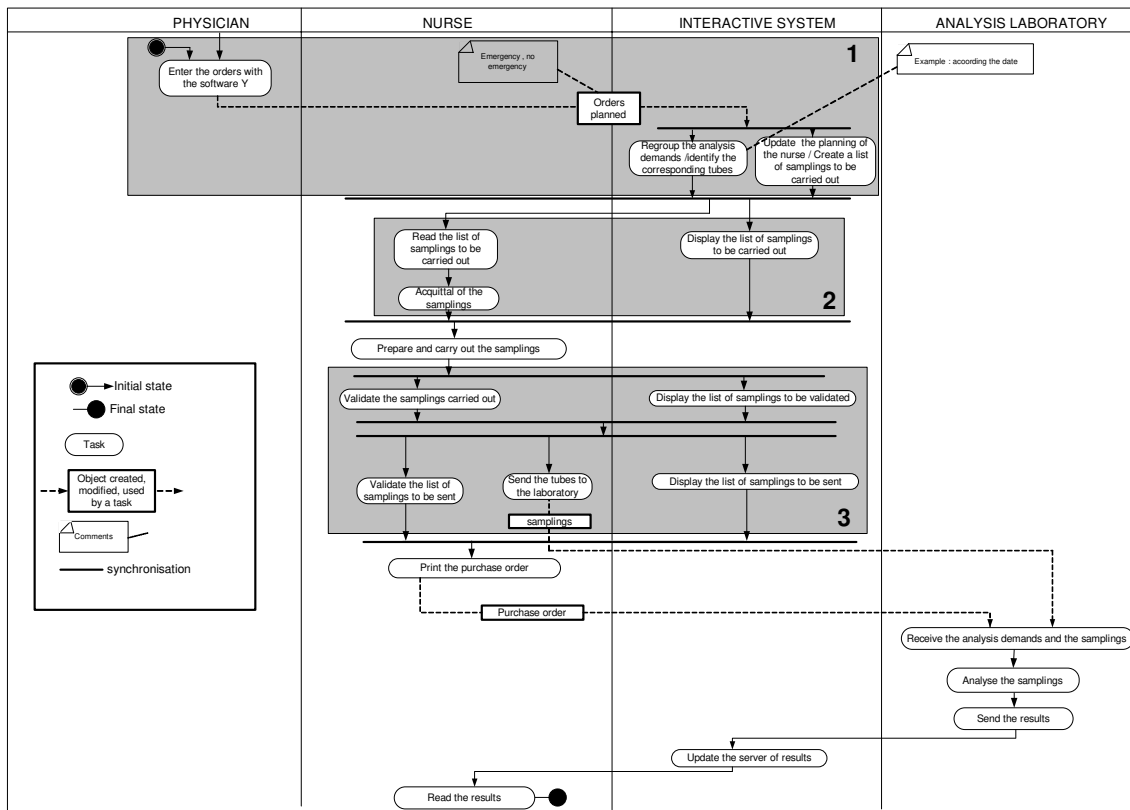


Figure 4. Example of common work support completed using the UML activity diagram (possible future situation)

We have showed a concrete example of common work support. This support contributes to the communication between the various actors of a project concerning the design of new systems of CPOE type. Other supports were carried out on other specific cases concerning the activity of ordering – dispensation - administration of the drugs in hospitals (Cf. Bernonville et al., 2006).

Conclusion

For the understanding and the improvement of innovation processes, the use of adapted methods and models prove to be necessary. The Software Engineering and the Distributed Artificial Intelligence (Systems multi-agents) fields offer a whole of possibilities on this subject; in fact it is possible to exploit directly or to adapt some of them. We used and/or adapted several models in various fields (implying complex organizations) in connection with innovation or innovative processes.

Our research perspectives relate to the study of new models and methods and their application in various application domains. We also wish to gather in the same tool a maximum of models; this tool would allow the creation of common work supports dedicated to the various actors of a project (whatever the domain) and meeting their needs.

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