EURO WORKING GROUP ON DECISION SUPPORT SYSTEMS

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Editor : Pascale Zaraté

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Sommaire

Introduction

It is my pleasure to introduce the proceedings of the workshop of the Euro Working Group on DSS, LSE, London, UK, June 28th 2006.
This workshop is hosted by the CIDMDS 2006 conference, LSE, London, UK, June 29th-July 1st 2006 and is organised by the IFIP 8.3 group devoted to DSS.
The objective of this workshop is to offer the possibility to the Euro Working group on DSS and the IFIP 8.3 on DSS group to meet together and to exchange their work around the Decision Support Systems. I hope that this event will be the occasion of fruitful discussions.

15 participants coming from 8 countries would be present.

We selected 8 working papers, they will be presented from 9:00 in the morning to 15:30 in the afternoon.

A business meeting is scheduled in order to define the future of the group, organisation team of the next meeting, edition of the newsletter, etc…

I would like to specially thank the organisers, Patrick, Humpreys, Frederic Adam and Daniel Linehan of the CIDMDS 2006 conference for the great logistic that they offer for this workshop.

The edition of the proceedings is sponsored by the Institute of Research on Computer Science in Toulouse, the IRIT laboratory.

Hoping that this event will match with all yours attempts, I wish you all the best for your researches around the Decision Support Systems.

DSS yours,

Pascale Zaraté

Chairperson of the Euro Working Group on DSS

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Program

Time	Title	Authors	Email
9h-9h30	Complementary aspects of a conceptual model and an architecture tool for Collaborative Decision making	Marija Jankovic Pascale Zaraté Jean Claude Bocquet	marija.jankovic@ecp.fr
9h30-10h	On specifying a Framework for Intelligent Cooperative Decision Support Systems	Fatima Dargam	F.Dargam@SimTechnology.com
10h-10h30	A Distributed architecture for Cooperative Intelligent Decision Support Systems	Kader Adla Jean Luc Soubie Pascale Zaraté	adla@irit.fr
10h30-11h	Coffee Break		
11h-11h30	Enabling the Inventive Enterprise through Networked and Systematic Inventive Thinking	Thorsten Roser Ralph Rettler Felix von Held	t.roser@lse.ac.uk
11h30-12h	Selecting Decision Criteria for Outsourcing: Regression Analysis Versus	Claudio Huyskens	claudio.huyskens@uni-koeln.de
12h-13h30	Lunch		
13h30-14h	An intelligent Decision Support Tool for Contingency Management	Rita Ribeiro Pedro Sousa Joao Pimentao	rar@uninova.pt
14h-14h30	Supporting Modelling Phase in Process Engineering	Florian Fabre Gilles Hétreux Pascale Zaraté Jean Marc Le Lann	Florian.Fabre@ensiacet.fr
14h30-15h	Tea Break		
15h-15h30	e-Voting process for e-cognocracy	Jose Moreno Juan Aguaron Alberto Turon	moreno@unizar.es
15h30-16h15	Discussions and EWG-DSS Business Meeting		

Complementary aspects of a conceptual model and an architecture tool for Collaborative Decision Making

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Introduction

Recent years we can hear a lot about cooperative decision-making, group or collaborative decision-making. These types of decisions are the consequences of developed working conditions: geographical dispersion, team working, concurrent working, etc.
Pascale Zaraté and Jean-Luc Soubie [1] develop a matrix of collective decisions taking into account two principal criteria: time and place (figure 1). In their work, they also give an overview of several supports and their correspondence with different types of collective decision-making.

	Same time	Different times
Same place	GDSS	
Different places	Videoconference Telephone meeting EMS	Co-operative DS framework

Figure 1. *Support for Collective Decision Making Situations.*

In this paper, we will present the complementary points of two developments: model development and architecture development. First work concern conceptual model of collaborative decision-making, and will be explained in the first part. The second is a proposition of architecture or platform for cooperative decisions in generally. In the third part, we give an overview of complementary aspects of these studies.

Conceptual Model of Collaborative Decision Making

If we consider the matrix mentioned in the previous part, the collaborative decision-making is synchronous decision-making where decision makers meet in order to decide. It is a very rich way for information and opinion exchange in big and complex project like vehicle development projects. Nevertheless, this type of decision-making has many difficulties like conflict management, different preferences of decision makers, information retrieval, and different objectives in the process [2].
In collaboration with PSA Peugeot Citroen, we developed a conceptual model of collaborative decision-making (figure 2) based upon systems approach [3]. The aim of this model was to identify the intrinsic elements necessary for good decision-making, where objectives are non-existing and/or contradictory. However, complex processes as new product and process development processes require a possibility to manage collaborative decision-making. Therefore, the model is also management oriented.

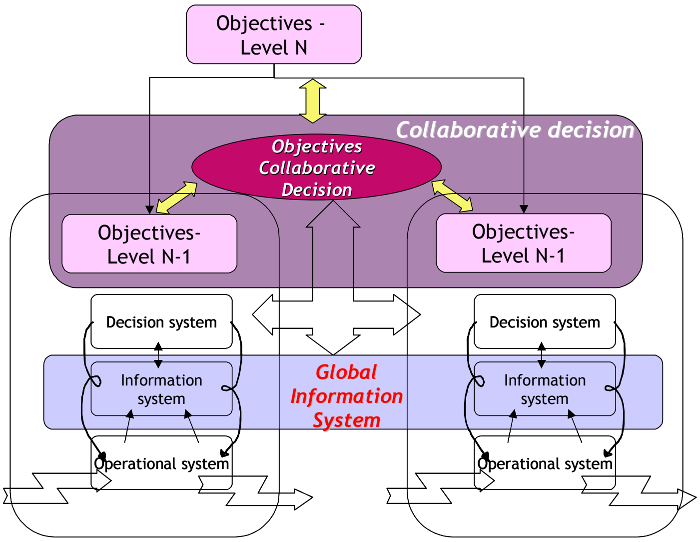

Figure 2. *Collaborative decision-making*

According to system's definition, we developed a model with four different views: Objectives View, Process View, Transformation View and Environment View. Objectives View concerns different objectives in collaborative decision-making, relationships between them and preference influence. Collaborative decision-making process along with the phases and resources are modelled in the Process View. Transformation View considers different transformations in the process, thus considering information flow, tasks to be done before and after the decision, the responsibilities, etc. Environment View defines three different environments of collaborative decision: decision, project and enterprise environment. Every environment has its own context and actors working in these environments. We identify also different roles in the collaborative decision-making in this view.

A Decision Support Framework for Cooperative Decisions

In her work, Zaraté [4] proposes a Cooperative Decision Support framework. It is composed by several packages:

- An interpersonal communication management system,
- A task management system,
- A knowledge management tool,
- A dynamical man/machine interactions management tool.

This framework is described in the figure 3.

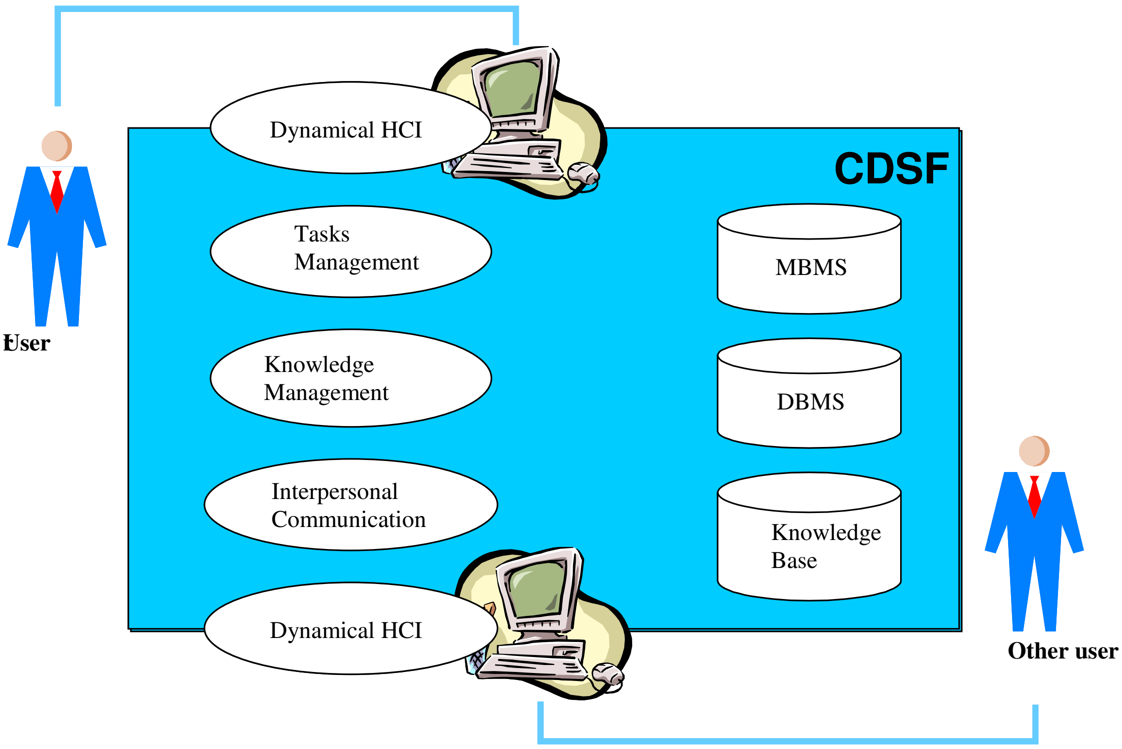

Figure 3: Cooperative Decision Support Framework Architecture

Complementary Study of Model and Decision Support Framework

The two-presented studies adopt different approaches: one is focused on development of decision support tool [4] and the other one of conceptual model. Naturally, the results are not the same. Nevertheless, as we intend to show it further in this paper, these two research studies corroborate the same conclusions and propose complementary solutions.

Communication tools are very important for cooperative decisions, but also for collaborative ones. Event though these tools are not participating in the actual process of collaborative decision-making, they are indispensable before and after decision-making process. That is, we consider that these tools participate in expanded collaborative decision-making process.

Task management tools support task management and control by task definition and their assignment to different actors in the process. These tools fully support collaborative decision-making and are very important for the companies. As we see it, they are very adapted for the Transformations View of collaborative decision-making model. Transformations View contains information of tasks before and after decision-making, deliverables necessary for good decision-making and important in the implementation, responsibility assignments, etc. Nowadays, it is not just necessary to optimise decision-making, but also to manage and control the realisation of what was decided.

Collaborative decisions are very complex because of existence of multitude of objectives, influence of different environments, participation of different actors, etc. Knowledge management tools have real utility in this process and can support Objectives and Environment Views.

In Objectives View, it is very important to know what are different objectives in collaborative decision-making and their relationships. In this kind of decision-making, decision makers do not have the same objectives [2]. It is important to have all these information in order to manage this process and its inevitable conflicts.

Information in the Environment View relate to different contexts influencing decision-making, as well as different actors and their roles in the decision-making process.
All these information are essential for good and quality decision-making. Some projects and their contexts are very similar, so examination of previous experiences can be very helpful.
The Interaction Human/Machine tools constitute the last module of the architecture proposed by Zaraté.
As we exposed in this part, almost every part of our conceptual model has its support in the architecture. There are also parts that are not directly correlating because of the very nature of collaborative decisions. For example, collaborative decision-making process is mostly done in the scope of face-to-face relationships, so there is no need to develop a support for this part of model. Nevertheless, we could imagine a support for decision structuring due to complexity of collaborative decisions (for example structuring of different elements of one decision, decomposition of the problem in order to have a better insight, etc.). Besides these elements, there are model parts like decision maker's preferences or Groups of Influences in the company, appertaining to the domain of human relations that rest difficult to captivate in the support tool.

Conclusions

The work described in this paper aims to show the complementary aspects of the conceptual model of collaborative decision making and the cooperative decision support framework. The next step of this work will consist in defining a global conceptual model for collaborative decision-making including the functionalities proposed by the cooperative decision support framework.

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On specifying a Framework for Intelligent Cooperative Decision Support Systems

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Abstract

This position paper describes the initial work on the specification of a framework for supporting decision systems, with the intention of gathering partners for the proposed research work. Within the main area of Intelligent Decision Systems, the scope of this current research work lies in the investigation of appropriate approaches for designing intelligent distributed-collaborative Decision Support Systems (DSS). Such systems are expected to handle cooperative processes of multi-participant decision-making. Main features of Intelligent Cooperative Decision Support Systems (Cooperative IDSS) are that they operate on knowledge-bases; they use Artificial Intelligence (AI) techniques to help the process of decision-making; they are based on distributed architectures; and they are designed to facilitate collaboration and communication among decision-making groups. Hence, Cooperative IDSS are suitable for the increasingly dynamic and mobile areas of real cooperative applications, including also negotiating environments and knowledge management (KM). Due to their distributed nature, they urge for solutions that go beyond centralized client/server DSS designs.

Motivations & Main Aims

Decision-making is mostly used as a multi-participant process, which is increasingly interactive. The interactions among the decision-makers may happen in many different ways. The decision-making participants may agree towards a common goal, or they may have different arguments and points of view, which lead the process to contradictory objectives. Another important aspect of the interactions is that decision-makers may know each other and work together, or they may work in different places and even in different times. Their influence on the decision-making process may also vary, according to their individual levels of responsibilities at work.

As organizations move towards a more knowledge-based structure, their business success relies more and more on how productively and efficiently they develop and apply knowledge. Knowledge Management (KM) is considered a key issue for the generation and sustainability of organizational success. It plays a central role in the overall business improvement, as well as in executive decision making and organizational adaptation and renewal. Combining the use of knowledge management with decision support solutions may contribute to successful results. Decision-making requires both information and knowledge. Information can be made explicit, while knowledge resides within its possessor and can only be made explicit via its articulation, that is, via the generation of "explicit knowledge". As proposed in (Zack 2004), before implementing KM solutions to (perhaps not appropriate) knowledge problems, organizations should face four particular representations of information or knowledge-based indeterminacy, namely: uncertainty; complexity; ambiguity; and equivocality. Uncertainty deals with the state of absence of information. Complexity caters for the case of having more information than one can easily process. Ambiguity reflects the fact of not having a conceptual framework for interpreting information. Equivocality deals with the state of having several competing or contradictory conceptual frameworks. These four information indeterminacy problems are often present in many knowledge-based structured business applications, and they deserve to have more adequate solutions.

Considering the stated problems, the proposed project is mainly motivated by a general concern for devising adequately-modeled and contextual-dependent decision support systems, which embed the appropriate needed intelligence, aiming at improving knowledge management within dynamic knowledge-based structured applications. In order to efficiently face the information problems of uncertainty, complexity, ambiquity and equivocality cited previously, we need the support of a multidisciplinary framework, which can take into account mathematical methods successfully used in Operations Research combined with Artificial Intelligence approaches and techniques.

Cooperative Decision Support Systems

By Cooperative Decision Support System, it is understood that the scenario implies human users and an automated system jointly working towards a solution. Cooperative DSSs offer support for collective decision-making situations, in which the participants involved in the decision process, may be in different places and may work in different times. The work in (Gachet 2003a, 2003b) identifies very clearly the overlapping areas between the research fields of computer supported cooperative work (CSCW) and collective decision-making (CDM), as well as the existing confusion of their concepts. This identification of the *Fallacy of Collaborative Support Systems* recalls the fact stated already in (Zaraté 2002), that collaborative and communications systems, which did not even have the denotation of decision systems, were classified in the family of DSS, when they were designed to support other kinds of collective tasks, but not the specific task of decision-making. Following the line that the convergence path between CSCW and CDM should integrate CSCW techniques into DSS, and not the other way around, a feasible concept of Cooperative DSS is introduced in (Gachet 2003a, 2004). This concept is based on the premise that "*if a Cooperative DSS aims at supporting the cooperative process of multi-participant decision-making, it is essential to provide the underlying technical concepts modeling this form of interaction*" (Gachet & Haettenschwiler 2003a, 2003b). His approach encapsulates the traditional method-based decision support approaches into decision support objects (DSO), which can be reusable within the system, increasing the efficiency of the decision-making tasks. This concept of DSO, as well as its extended distributed version (DDSO), is considered for the specification of a framework for Intelligent Cooperative DSS for taking advantages of various distributed architectures. According to (Gachet & Haettenschwiler 2003a) and (Gachet 2003a), centralized system-configurations are not appropriate to model multi-participant decision-making. A distributed DSS should be, in essence, decentralized in terms of servers, model bases and knowledge engines; and should make the best use of the available knowledge to offer optimal cooperation capabilities for the users.

Basically, Intelligent Cooperative Decision Support Systems can act as group decision support systems (GSS), or as Negotiation support systems (NSS), to which Artificial intelligence techniques have been applied to help the process of decision-making. Main features of the Intelligent Cooperative DSS that we consider in this project are that: they operate on knowledge-bases; they are based on decentralized distributed architectures; and they are designed to facilitate collaboration and communication among decision-making groups. The idea of developing a framework that is appropriate for the development of Intelligent Cooperative DSS is strongly supported. Such a framework should include mathematical methods which are well known in Operations Research (OR) for supporting decision-making (e.g.: probability calculus; decision analysis; optimization theory; simulation; and multi-criteria analysis, among others, combined with AI strategies and techniques (e.g.: base-revision; fuzzy logic and possibilistic logic; probabilistic reasoning; case-based reasoning, among others) for the design of Cooperative IDSS. With this combination, a practical framework for Cooperative IDSS can be specified, in order to provide not only means for experimental and quantitative analysis of the problem, but also some qualitative ways to deal with the domain knowledge, in the presence of uncertainty and possibly inconsistent information. Such research work also brings a significant contribution to Knowledge Management, since it tackles some of the information indeterminacy problems, which are present in most of the knowledge-based structured business applications.

For the specification of the framework it is taken into account the basic requirements for designing Cooperative DSS, planned to be identified during the first specific aim of the project. The methodology proposed in (Gachet 2004) will be taken as the design basis of the proposed framework for intelligent cooperative decision making. In (Soubie & Zaraté 2003), cooperative decision support frameworks are seen as cooperative knowledge-based systems, for which decision-making is a particular case of problem solving. In this project, the main concern behind designing such a framework, is to provide ways and architectures' specifications for developing DSS, in order to augment the decision-making skills of the involved parts, by offering an intelligent assistance capable of providing the information needed to make the best possible decision in a cooperative way. Cooperative decision support involves addressing multiple objectives, and integrating multiple problem-solving approaches with the domain expertise of the decision-makers. One way to enhance cooperation within the decision process, is to produce a set of high quality candidate solutions, evaluated with respect to multiple objectives. This allows decision-makers to gain important insights into the tradeoffs between multiple, possibly competing goals.

Remarks & Considerations

By combining some selected mathematical methods used in Operations Research with some relevant approaches and techniques of Artificial Intelligence, we aim to develop a practical framework for the specification and design of Intelligent-Cooperative DSS, which provides not only means for experimental and quantitative analysis of the problem, but also some qualitative ways to deal with the domain knowledge, in the presence of uncertainty and possibly inconsistent information. The planned detailed study of the mathematical methods most applied in Operations Research, for identifying adequate models for Cooperative DSS, include, so far, the following topics: Decision Theory & Decision Analysis; Multicriteria Analysis; Optimization Theory; Simulation; Probability Calculus, and others still to be defined. The planned detailed review on Artificial Intelligence strategies and techniques for selecting adequate approaches for the design of Cooperative DSS, include, so far, the following topics: Belief-Revision Approaches for Finite-Bases; Fuzzy Logic & Possibilistic Logic Approaches, dealing with uncertainty and inconsistent information to review knowledge bases; Probabilistic Reasoning, dealing with uncertainty and incomplete information knowledge bases; Case-Based Reasoning, and other relevant AI approaches dealing with uncertainty & inconsistency (still to be defined). The AI approaches that are closer to the intuitions that we want to prevail for supporting knowledge-based decision-making, are the ones concerning non-monotonic reasoning (Gabbay et al. 1994). Other approaches of this sort (Default logic (Reiter 1980); Fuzzy logic (Zadeh 1978), etc.) are also planned to be studied, in order to be added as part of the proposed framework.

At a first stage of its implementation, the cooperative IDSS framework of this project will most likely exploit web-based architectures, taking advantage of the web technologies available. This will be useful to test some of the (by then already selected) AI and OR approaches (and maybe a combination of them), with simple case-studies. Nevertheless, as shown in (Gachet & Haettenschwiler 2003a, 2004), web-based DSS architectures are developed on a centralized network topology, which does not provide the characteristics needed for improving cooperation within DSSs. Hence, at a more advanced project stage, a peer-to-peer[1] decentralized platform will be exploited for the framework, so that more flexible distributed IDSS can be designed.

[1] Peer-to-peer systems allow users to connect and collaborate without a central server, controlling all the underlying operation (Gachet & Haettenschwiler 2004).

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A Distributed architecture for Cooperative Intelligent Decision Support Systems

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Abstract: We consider, in this work, the paradigm of distributed decision-support systems, in which several decision-makers who deal with partial, uncertain, and possibly exclusive information must reach a common decision. We propose, to this end, an integrated framework, based on a distributed architecture where both the facilitator (respectively each decision-maker) uses an individual cooperative intelligent support system allowing him to carry out his facilitating tasks (respectively decision tasks). The individual DSSs are viewed as a set of computer based tools integrating expert knowledge and using collaboration technologies that provide decision-maker with interactive capabilities to enhance his understanding and information base about options through use of models and data processing, and collaborate with him.

Keywords: Group Decision Support System, Cooperation, Group Decision Facilitation

1. Introduction

Decision making is considered one of the most critical activities done in organizations [16]. To support this complex process for individuals, a variety of independent, standalone information systems called Decision Support Systems (DSS) have been developed in the two last decades. However, in many organizational or social settings, a decision does not appear as an outcome given by a "single" decision maker, but as a compromise between various divergent interests and points of views. In the early 1990s, a shift from a mainframe based DSS to a network DSS occurred.

At present, the need for GDM techniques and support is greater than ever before. This is due to the complexity of business relationships, the greater number of decision makers and organizations that are involved in the decision process, online access to multiple external information sources, and the decreasing in the time allowed for decision making. Thus, complex economic, social and political structures require the decisions to be made in a framework of sophisticated processes involving many stakeholders, who more or less directly participate in the decision-making process.

This study aimed to create a Distributed Group Decision Support System (DGDSS). In particular, we envision to further extend traditional DSS by embedding expert knowledge with the DSS to provide intelligent decision support, by integrating cooperation to put the decision maker effectively in the loop of such a decision support, and by developing the cooperative group decision support system over the network to provide many advantages such as any-time-anywhere access, anonymity, ease of use and centralised collective data storage.

The rest of the paper is organized as follows: Fist we take an overview of some related work in section 2. Then we propose a distributed architecture for cooperative intelligent decision support systems in section 3. Finally, we conclude with a summary and future research direction in section 5.

2. Group Decision Support systems: literature review

A number of frameworks or typologies have been proposed for organizing our knowledge about decision support systems [13]. The two most widely implemented approaches for delivering decision support are Data-Driven and Model-Driven DSS. Data-Driven DSS help managers organize, retrieve, and synthesize large volumes of relevant data using database queries, OLAP techniques, and data mining tools. Model-Driven DSS use formal representations of decision models and provide analytical support using the tools of decision analysis, optimization, stochastic modelling, simulation, statistics, and logic modelling. Three other approaches have become more wide spread and sophisticated because of collaboration and web technologies: Document-Driven DSS integrate a variety of storage and processing technologies to provide managers document retrieval and analysis. Finally, communication-Driven DSS rely on electronic communication technologies to link multiple decision makers who might be separated in space or time, or to link decision makers with relevant information and tools. Knowledge-Driven DSS can suggest or recommend actions to managers.

We can use a space/time grid (including same-time and same-place or different-time and different-place scenarios) to classify various collaboration technologies. Tools that support distributed teams which have been empirically tested are mainly synchronous computer conferencing systems (i.e. discussion forum software); these systems do not have explicit support for decision-making processes and often do not provide tools for alternative evaluation. GDSS products, such as GroupSystems [11], are LAN-based client-server applications often supporting same-time and same-place groups working in face-to-face settings. An audio/video conference system is a major example of a collaboration technology that supports groups working at the same time but at different places. This category of tools focuses on enhancing the virtual presence of meeting participants. The support for group processes and decision making are mostly missing from products in this category. Asynchronous technologies, such as e-mail and discussion forums, are commonly used as in the business world by distributed teams [11]. Asynchronous technologies tend to focus on supporting group information exchange and sharing [20]. However, these tools do not have strong support for group decision-making processes comparing to traditional GDSS.

Research that studied group decision support systems in the existing literature used mainly face-to-face facilitated GDSS. Some of its results may not apply to distributed teams [11] that, it is difficult for distributed teams to arrange face-to-face meetings or to meet at the same time virtually. Furthermore, the current group decision support systems do not integrate the user in the whole decision making process. They provide generally the participants a toolkit helping them to submit their ideas and alternatives and to assess these by means of various mechanisms (vote, multiple criteria analysis, and negotiation). In addition, the available group decision support systems lack expert knowledge and are mostly PC-based software components.

On the other hand, there have been numerous studies in the literature about distributed facilitation during the past decade [22]. Facilitators are most likely to either adapt a generic process or select one from a toolkit. Both the generic and toolkit approaches require prior experience with a large range of problems and thus are not applicable in the context of an experienced facilitator. Another question is raised, of how inexperienced facilitators are enabled to successfully facilitate GDSS.

To this end, we view that the benefits of the traditional DSS can be further leveraged by embedding expert knowledge and implementing the DSS using collaboration technologies. Embedding expert knowledge with the DSS provides intelligent decision support, and implementing the intelligent DSS using collaboration technologies puts the decision maker effectively in the loop of such DSS and provides many advantages, such as distributed decision, anytime-anywhere access, anonymity, ease of use, and centralized data storage. In addition, distributed decision means that several entities (humans and machines) cooperate to reach an acceptable decision, and that these entities are distributed and possibly mobile along networks. Distributed decision making must be possible at any moment. It might be necessary to interrupt a decision process and to provide another, more viable decision.

To these requirements, we propose an integrated framework, based on a distributed architecture and in which both the facilitator (respectively each decision-maker) uses a cooperative intelligent support system allowing him or her to carry out his or her facilitating tasks (respectively decision tasks).

3. A distributed architecture for cooperative intelligent decision support systems

We consider here the paradigm of distributed decision-support systems, in which several decision-makers who deal with partial, uncertain, and possibly exclusive information must reach a common decision. To this end, the use of a cooperative system makes possible the collaboration of distant users dispersed over a network and important volumes of data. The cooperative work so initiated can be synchronous or asynchronous. A small group or a whole organization can be supported. The application can be carried in several sites over a common information base.

We will view the individual DSS as a set of computer based tools integrating expert knowledge and using collaboration technologies that provide decision-maker with interactive capabilities to enhance his understanding and information base about options through use of models and data processing, and collaborate with him. Automation may be more important for distributed group decision making in which group members are dispersed geographically, where coordination and control through traditional means of facilitation are very difficult, if not impossible.

3.1. A proposal of GDSS Architecture

The consequently development of a GDSS was based on the distributed approach, building upon the following assumptions: (1) Prospective users of DSS are involved in the decision making process and should be assisted locally, particularly in generation stage; (2) The user may be expert or non experienced in decision making; so embedding expert knowledge help both to generate alternatives; (3) The tools should allow for generate, submit and selection of alternatives and present consequences of selected decisions in a meaningful way; and (4)

Time intervals between formulation of a query and receipt of response should be minimal to allow for an effective on-line experience while using the DSS.

In this perspective, we envision to implement two types of co-operations (Fig. 1):

Man-machine cooperation allowing every decision maker to solve problem and to generate an alternative. Here, each man-machine association is considered as a whole and indivisible entity within the cooperation network. There must be at least one communication protocol between the two components of the cooperative entity, as well as a machine, and formal data and information are directly available for computing.

Mediated man-man cooperation allowing the group of decision makers and the facilitator to make collective decision. This kind of cooperation uses a machine as an intermediate communication medium.

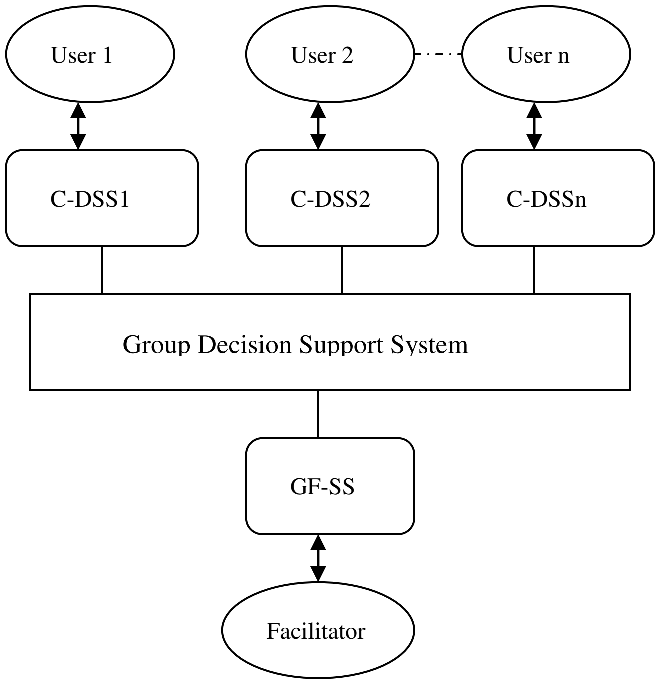

Fig. 1: Architecture for Distributed Group Decision Support System

This perspective enables reaching decisions by combining personal judgement with information provided by these tools. Within this framework, decision-makers undertake environments assessment and strategic analysis and provide data, judgement, intuition and personal vision as inputs to the process. An intelligent reasoning process is performed by individual DSS to generate alternatives. Decision-makers review their overall viability and make a final decision.

In the proposed architecture the group is constituted of two or several decision-makers (participants) and a facilitator. Each participant interacts with individual DSS (C-DSS) integrating local expertise and allowing him to generate one or several alternatives of the problem submitted by the facilitator. The group (facilitator and participants) use the group toolkit for alternative generation, organization, and evaluation as well as for alternative choice which constitutes the collective decision. To this purpose, several techniques are available (vote, consensus, arbitration, multiple criteria analysis, etc.). The facilitator role is also aided via a Group Facilitation Support system (GF-SS).

3.2. The GDSS components

To support the group (decision makers and facilitator) in the decision making process a group toolkit is made at their disposal. The major components of the GDSS architecture are the following (Fig. 2):

A session planning made at facilitator disposal to manage the meeting (Session planning): a facilitator can use the meeting manage function to set up a meeting. Meeting setup involves the following tasks: create a meeting agenda which consists of agenda items. Invite existing users or create new users to participate in the meeting.
A set of tools (Group System Tools) to support group activities that can be classified into three major categories: (a) idea generation: each decision maker tries to generate alternatives using an individual cooperative intelligent decision support system that integrate a local expert knowledge; (b) idea organization: the facilitator uses tools organize the ideas submitted by participants (e.g. remove redundant alternatives); (c) idea evaluation tools: a set of tools are made at the group disposal to rate, rank, select and evaluate the alternatives. Each group tool has two versions: (a) participation version, it is used by a meeting participant engaging in a meeting activity; (b) facilitation version: it is used by a meeting facilitator to set up parameters or data items associated with a meeting activity.
A meeting repository (organizational memory) used to implement the meeting repository storing all the meeting related information including meeting setup information, data relating to different users (e.g. @IP), the trace of previous sessions, intermediate results saved as organizational memory;

A dialog manager allow the facilitator as well as the participants to interact across a like type client-server network which may be web-based to allow distant decision makers to participate.

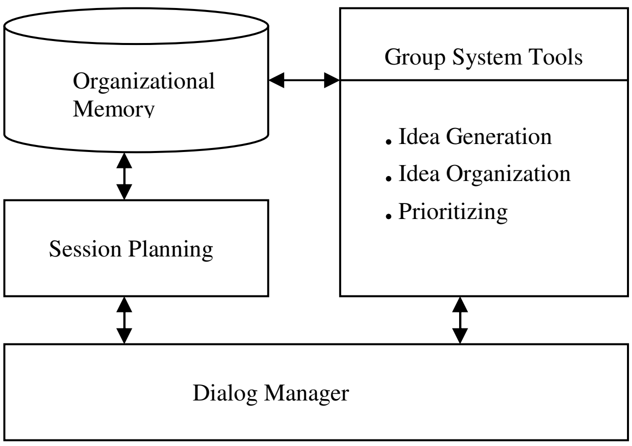

Fig. 2: GDSS Components

3.3. Cooperative Decision Support System (C-DSS)

Many industrial expert systems have been realized. However a feeling of doubt about their successfulness has emerged these last 15 years. This is due essentially to the fact: the user's ability is not taken positively into account. The relevant systems developed in the past, are mainly restricted to assist with individual users using standalone PC-based programs, which may limit users' access to computerized models and support systems. Putting the human expert operator effectively in the loop of such a decision support system represents the major guarantee of mastering efficiently the inherent complexity of the problems.

We have to take into account: (a) A decision maker, facing a singular decision situation, is not familiar with the decision task, and (b) an expert decision maker, who is familiar with the decision problems, has to face and already has strategies compiled in his long term memory. To this end, embedded expert knowledge and software tools are used to learn the expert decision maker strategies in order to assist him (possibly continuously), help him to improve his performance and to capitalize his know-how.

The task that is the subject of cooperation must be decomposed in consistent subsets. The task distribution among the two agents (user and system) is dynamically made, according to the performances of the couple man/machine and of the workload of the user. Competences of the user and the system are sometimes complementary, sometimes "redundant". In the latter case, user and system are often able to play the same role. The choice question of the appropriate agent which will have to play one role settles therefore. According to the context, different indications could be made to direct this choice. The set of indications on the manner to allocate different roles to the agents defines the cooperation modes.
To implement the man-machine cooperation, we use a structure principally based on conceptual models of expertise: conceptual model of domain and conceptual model of reasoning (both of the system and user). This structure creates a resolution environment based on models. The definition of new concepts and strategies is possible, it is therefore progressive.

Fig. 3 illustrates the proposed architecture to design an intelligent cooperative decision support system [1] which extends that of Soubie [17] developed for cooperative KBS. Several models are proposed: Conceptual Application Model (KB: Knowledge Base; DB: Data Base; MB: Model Base), User Conceptual Models (UCM) and Solving Control Model. The application model integrates a representation related to the domain (an object-oriented based representation) and a representation of the reasoning expertise based on the task-method paradigm. The conceptual expertise model is expressed therefore by means of tasks, methods and domain knowledge.

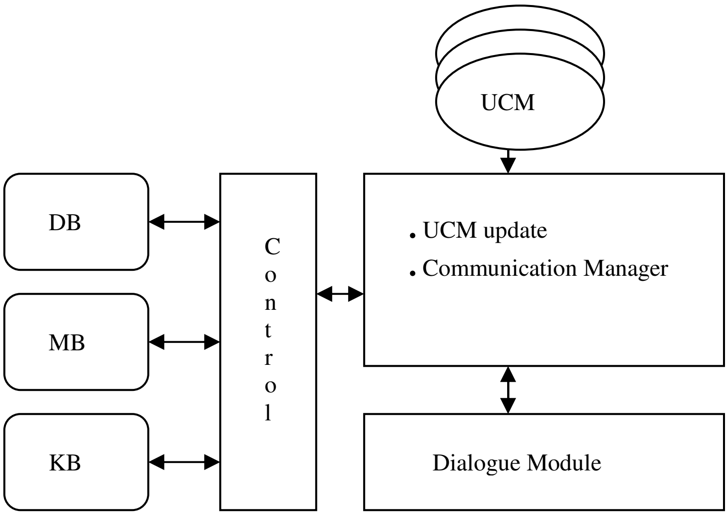

Fig. 3: Architecture for Cooperative decision support system

3.4. Group Facilitation Support System (GF-SS)

An expert system approach capable to develop facilitation skills is suggested. It considers the support to inexperienced facilitators by incorporating a decision making process model in the support system which will be used by the facilitator in a cooperation mode.

The model of the decision-making process, we are developing, is based on task-method paradigm: (a) Task, the unique task that must be performed; (b) Method, the technique (s) or the tool(s) that must be used to perform the task. It is currently under construction.

4. Conclusion

The Decision support Systems (DSS) aimed to assist decision makers in solving ill or non structured decision problems. Traditional DSS predefined the agent roles by giving the pure execution role to the system while the user is confined in tasks of input of data, or even resolution of conflicts.

We defined, in the present paper, a cooperative architecture for distributed group decision system that takes into account user abilities and integrate him in the loop of decision problem solving process particularly while generating alternatives. The different components of the group decision support system allow the group of decision makers and the facilitator to submit the alternatives (suggested decisions), to aggregate, organize and evaluate them, and so make a collective decision. Several mechanisms may be integrated, to this purpose, such vote, arbitration, multiple criteria analysis, negotiation.

Currently, we are developing a model of decision process to be incorporated in the system. This will allow expert and non-experienced facilitators to facilitate group meeting in a cooperative mode.

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Enabling the Inventive Enterprise through Networked and Systematic Inventive Thinking (Networked-SIT™)

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Abstract

Currently, much hype is circling around the idea of creating innovating organisations as well as facilitating innovation processes. As recent research has shown, conventional approaches take a linear perspective on innovation processes (Love, 2001). As a consequence, most R&D activities remain detached from the value chain and lack to focus on the development of customer oriented products and services. Moreover, critical knowledge and employee expertise is not exhaustively transferred and applied across the various value creating business processes of a company. In this paper, we reflect on the use of Systematic Inventive Thinking (SIT™), a TRIZ based method for facilitating innovation processes (Altschuller, 1996, 2000). During the last decade, SIT has been applied in more than 600 firms. As experience has shown, facilitating new product and service development based on existing problems and solutions, successfully supports the development of new inventions that produce direct value for organisations. Furthermore, implementing methods such as SIT not only seems to change the way people think and talk about innovation, it changes how people innovate. This shift in innovation practice can be seen as an important factor for building and fostering inventive collectives, such as communities of practice (Wenger, 1998). Moreover, facilitating inventive practices may also enable a knowledge supportive organisational culture that supports the development of new organisational forms and ways of organising, potentially increasing organisational responsiveness and capacity to deal with change in a turbulent environment (Haeckel, 1999). We argue however, that we need to develop organisations beyond the adaptive enterprise approach (ebd, 1999). Since, organisations have to be considered as Complex Evolving Systems (CES), which inter-actively co-evolve with their environments (Mittleton-Kelly, 1998), organisations have to continuously innovate and (re-) shape the market in which they are operating. Moreover, from a knowledge-oriented perspective, organisations can be seen as distributed knowledge systems (Orton and Weick, 1990, Tsoukas, 1996) and loosely coupled networks (Brusoni, Prencipe & Pavitt, 2001) in which knowledge is inherent in social practice, constantly (re-) produced and shared by its members through their social inter-actions (Garcia-Lorenzo et al., 2003). As a consequence, to release a firms´ full innovation potential and inventive capacity, we propose to synchronise SIT™ with the value creating processes and across the inherent innovation networks of an organisation.

Key works: Innovation networks, methods for facilitating creativity and innovation, building social innovation systems

The new hype: Creating innovating organisations

In today's global economy, organisations are never at rest. The current processes of globalisation and the internationalisation of markets have lead to the acceleration of change and increasing complexity of organisations and their environment. These processes have generated new organisational forms based on more fluid and emergent organisational structures, such as networks (Hilthred & Kimble, 2004). During the last decade, how to develop new and innovative forms of organising has become one of the most important and pertinent questions in the organisational literature (Fenton & Pettigrew, 2001). Considering increasingly shorter product lifecycles, diversification of markets and global competition, organisations need to constantly innovate and learn how to generate value beyond their present core areas to respond to new and future challenges of the market. They need to respond to customer demands quickly and constantly develop new and innovative products, as well as, high quality services to create a strong brand image that increases their market share and recognition among competitors. To strategically achieve competitive advantage organisations therefore need to continuously reinvent themselves building cumulative knowledge bases and learning from past experiences (Dierkes, Natal, Child, Nonaka, 2001). Hence, much hype is circling around the idea of creating innovating organisations as well as facilitating innovation processes. At present, we can find manifold writings in the organisational literature announcing the advent of new forms of organising potentially improving organisational innovation and performance (Fenton and Pettigrew, 2001). Yet, however, there is no general theory or unified framework on how to develop innovating organisations based on more dynamic and emergent organisational forms. Most approaches remain conceptually underdeveloped and even seem to bear practical risks, such as organisations "bouncing back" into patterns that initially interlocked them. In fact, during the last decade the proliferation of writings in the organisational literature has simply shown "…that the form, process and role of organisations on the brink of the twenty-first century have fundamentally changed and continue to do so" (ebd., 2001, p.4).

However, in a turbulent environment particular large and multi-organisational firms seek to find new more flexible forms allowing them to better adapt to the market. Many companies are therefore fragmenting themselves into smaller, quick-response units in order to relinquish important advantages of scale and scope. The "sense-and-respond" approach formulated by Haeckel (1999), for example, follows the idea that companies need to react quickly amid change. It is often argued that when unpredictability is a given, the only strategy that makes sense is a strategy to become adaptive and to sense early what customers want. In fact, it seems that organisations need to know how to adapt to their customers even before they know themselves what they want. The aim of implementing sense-and-respond units usually is to increase organisational adaptability and flexibility by gathering and processing important data, information and knowledge about customer demands, claims and future trends, which is fed back to the strategic or decision making units of a firm.

Unfortunately, there is no reliable way to generate secure market data and the only advantage of such approaches may be that it sensitises organisational leaders towards managing their organisations as adaptive systems. Moreover, many of such practitioner-oriented strategic models remain rather theoretical and lack a more holistic thinking, repackaging existing conceptual ideas using new catch phrases. In fact, the idea of increasing organisational flexibility and adaptability, based on appropriate strategies and business models is nothing new. The problem with traditional approaches is now that, organisations have to be considered as Complex Evolving Systems (CES), which inter-actively co-evolve with their environments (Mittleton-Kelly, 1998). Thus, organisations do not only have to become more flexible and adaptive. They have to continuously innovate and (re-) shape the market in which they are operating. In order to do so, organisations have to learn how to systematically improve innovation, anticipate risks and set future trends, rather than following them. In order to do so, organisations have to first improve their understanding of organisational knowledge, as well as, their inherent knowledge processes and second, to critically examine and improve the way they innovate. The impact of inventive practice becomes particular clear in the group decision processes in organisations. A group rather "creates than discovers their future (Humphreys and Jones, 2004, p. 21)". The decision process moves in a narrative in which the group discovers what innovation means to them (Humphreys, 1998; Humphreys and Jones, 2004). Hence the narrative forms the possibilities the group will explore, as the process aims to develop a single representation of ideas. It progressively strengthens constrains until a course of action is pre-described (Humphreys & Jones, 2004). Inventive practices and thinking methods therefore need to foster a group´s possibility of shaping its future and provide groups with a common mode of thought and language to explore and share their possibilities until a single representation is created.

Innovation from a practice-based view: (Re-) turning to the practice of successful inventions

In a knowledge driven economy, organisational performance and innovation seems to largely depend on improved knowledge processes and systematic innovation practice. As recent research has shown, conventional approaches take a linear perspective on innovation processes (Love, 2001). As a consequence, most R&D activities remain detached from the value chain and lack to focus on the development of products and services that actually add value to the customer. Moreover, critical knowledge and employee expertise is not exhaustively transferred and applied across the various value creating business processes of a company. From a knowledge-oriented perspective organisations can be considered as a loosely coupled and distributed knowledge system (Orton and Weick, 1990, Tsoukas, 1996). Indeed, organisations are loosely coupled networks (Brusoni, Prencipe & Pavitt, 2001) in which knowledge is inherent in social practice, constantly (re-) produced and shared by its members through their social inter-actions (Garcia-Lorenzo et al., 2003). According to Argote and Ingram (2000) knowledge transfer is a basis for competitive advantage in firms. Furthermore, the dissemination and transfer of knowledge is likely to be the most important knowledge process, because it triggers the creation of new and the (re-) use of available knowledge (Roser, 2004). Therefore, we need to particularly focus on how people work, which thinking tools they apply and how they collaborate when innovating. To systematically generate new and future pathways to value, organisations therefore need to strategically shift from focussing on the knowledge intensiveness of their processes and the imposing new organisational forms and ways of organising. They need to become more knowledge-reflexive and realise that they co-evolve within a wider networked social innovation system that enables them to create new and sustainable pathways to the future creation of value. Hence, as a first step towards an innovating organisation, they need to (re-)shape their innovation practice and (re-) turn to what actually enables them to innovate: the practice of successful inventions.

SIT™ as a structured approach for facilitating innovation processes

Systematic Inventive Thinking (SIT™) is an alternative approach that changes how people create, process and combine new ideas. From a practice-based view, knowledge is what people do (Orlikowsky, 2002). Innovation practices, however, are somewhat specific in the sense that most inventions depend on how people do what they do. Hence, methods and tools supporting innovation processes have a major impact on whether facilitated creative thinking leads to new inventions or simply results in new ideas (as is e.g. the case with usual brainstorming techniques). As Weinert (2002) outlines, "…creative achievements depend not only on the level of cognitive abilities of an individual but also require an intelligently organised base of knowledge in order to become effective in solving problems which are demanding in content..." (Weinert, 2002, p. 196). Since creative thinking refers to how people approach problems and solutions "…it is very important how a person thinks and works and habitually turns problems upside down and combines knowledge from seemingly disparate fields." (Amabile, 1999, p.5). The ability of creative thinking can be fostered by mental models and methods, because these algorithms provide the mind with a structure to work with. SIT equips individuals or a team with the capacity to put existing ideas together in new combinations and therefore enables change from within an organisation. Therefore, SIT is not only assisting people to think differently, it changes innovation practice and thus how organisations innovate. Furthermore, SIT builds on existing products or services as a source for new ideas and inventions. In essence, SIT is based on TRIZ as method for facilitating innovation processes (Altschuller, 1996, 2000). At the heart of SIT is the crucial idea that inventive solutions share common patterns. Most inventors unknowingly follow these patterns when coming up with new product ideas. Such patterns can be identified by observing thousands of products and their evolution (Stern, Biton and Maór, 2006). Finally, a majority of new and inventive products can be categorized according to only five patterns: *Task Unification, Attribute Dependency, Division, Subtraction and Multiplication* (see table 1).

The Tool	Definition	The Concept	Example	Especially Useful
Task Unification	Assigning a new and additional task to an existing resource	To view everything as a potetnial resource that has multiple users	One piece defroster + antenna in cars.	Cost reduction
Attribute Dependency	Creating a new relationship or eliminatingt an existing relationship between two variables of a products	To create, change or eliminate dependencies between variables of a product and its environment.	Toothbrush that changes colour once the child has brushed long enough	To segment in a saturated industry
Division	Dividing the product and/or one of its components and rearranging them in time or	To increase the degrees of freedom within a product so that it can be rearranged to	Detachable panel in car audio	For product packaging

	space	create a new product.		
Subtraction	Removing and essential component from a product	To remove from the product a component thought to be so essential that it seems impossible for the product to exist without it.	Placebo	Highly complex systems
Multiplication	Adding to a product a component of the same type as an existing component in the product, but changing the copy in some way.	To transcend a mere change in quantity in order to achieve a qualitative change.	Gillette razors in which the 2 blades are angled differently to provide a new advantage.	When there are few components in the starting product

Table 1: Taken from Stern, Biton & Maór (2006)

With Subtraction for example, instead of adding components, you remove them, particularly those that seem most essential and indispensable. This stands in opposition to the conventional approach to new product development whereby components, attributes or features are added in line with the perceived wants of consumers. The traditional process of new product development usually builds on the identification of new consumer needs, typically through intuition, market surveys, focus groups and the like. The ensuing stages are, not surprisingly, the planning and the production of new products that satisfy the identified needs of the customer. SIT™, however, forces innovators to “listen to the voice of their products.” (Stern, Biton and Maór, 2006, p.15). Subtraction, however, is only one of the five patterns that form the core of the SIT™ method for innovation. We look at those patterns as "thinking tools" for developing new ideas. However, it is important to apply these tools in a systematic fashion to ensure the creation of new and future innovations rather than simply categorising existing ones. We therefore apply a systematic process called Function Follows Form as developed by cognitive psychologist Ronald Finke (Finke, Ward & Smith, 1992). Instead of innovating by identifying a “function” or need and then creating a product accordingly, one first manipulates the existing product and then considers how the new form could of benefit (Goldenberg, Horowitz, Levav & Mazursky, 2003).

Designing the innovation process as outlined (see figure 1) has a number of key advantages. First, newly invented products build on the professional experience and implicit knowing of an organisations employees and experts regarding products, customers, as well as, organisational structures and processes. Second, the new product ideas are generally based on existing products, thus contributing to low manufacturing costs and quick market release. In addition to changing the way people innovate, unidentified and unanticipated customer needs are discovered, which often grants a company a considerable competitive advantage.

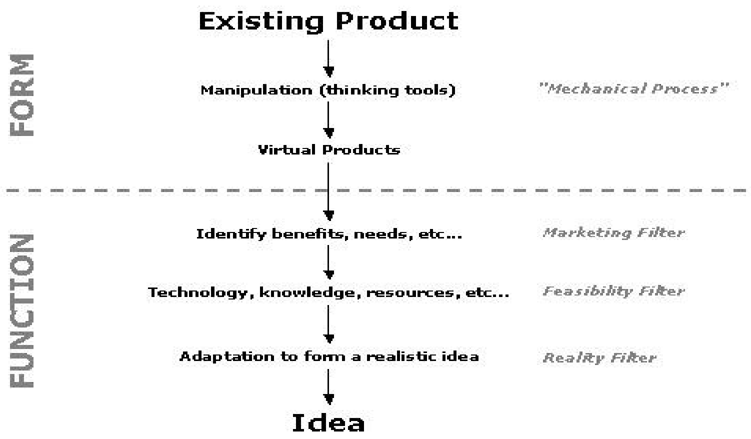

Figure 1: Form follows function as one of the SIT principles

Networked SIT™ - Enabling the Inventive Enterprise

During the last decade, SIT has been applied in more than 600 firms. As experience has shown, facilitating new product and service development based on existing problems and solutions, successfully supports the development of new inventions that produce direct value for organisations. Implementing methods such as SIT not only seems to change the way people think and talk about innovation, it changes how people innovate. This shift in innovation practice can be seen as an important factor for building and fostering inventive collectives, such as communities of practice (Wenger, 1998). Moreover, facilitating inventive practices may also enable a knowledge supportive organisational culture that supports the development of new organisational forms and ways of organising, potentially increasing organisational responsiveness and capacity to deal with change in a turbulent environment (Haeckel, 1999). Practicing SIT usually increases an organisations reflexivity towards knowledge and innovation, which sensitising them towards systematic innovation lead change. SIT not only change innovation practice, it changes how people think and talk about innovation and change, which holds important implications with regard to organisational sensemaking and becoming (Weick, 1998). Furthermore, thinking methods and naming as supported by SIT provide employees with the possibility to exchange and understand the various ideas and perspectives of each other and thus make innovation and collaboration more likely to be successful. To release a firms´ full innovation potential and inventive capacity, we propose to apply method such as SIT in a networked fashion. SIT needs to be synchronised with the value creating processes and across the inherent innovation networks of an organisation.

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Selecting Decision Criteria for Outsourcing: Regression Analysis Versus Mean Comparison

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Keywords: Selective Outsourcing Decision, Empirical Research, Logistic Regression Analysis, Comparison of Means, T-Test

Much of research on outsourcing decisions has been conducted quantitatively. Some researchers (Ang, Straub 1998) have attempted to find determinants to the outsourcing decision, whereas others (Gilley, Rasheed 2000) have tried to explain the variance in performance outcomes with the occurrence of a number of decision criteria (Dibbern et al. 2004).

Research Context and Objective

In 2004, we conducted a research project on criteria of the so-called 'selective outsourcing decision', i.e., of outsourcing some but not necessarily all software applications (Loebbecke, Huyskens 2005; Huyskens, Loebbecke 2006; Loebbecke, Huyskens 2006 forthcoming;). Separately, we conducted both, a logistic regression analysis and a comparison of means on the data collected. In this paper, we aim to compare the requirements, the assumptions, the results, and the relevance/ suitability for the development of a decision model and a subsequent DSS design of both alternatives.

Research Approach

To develop a model of criteria supporting the selective outsourcing decision, we modelled seven decision criteria and one dependent variable. We explored whether all those criteria are important to practitioners in their decision context in order to fine-tune the model. A set of hypotheses was developed, consisting of one hypothesis per criterion's relationship with the dependent variable. To confirm those hypotheses, 333 systematically sampled CIOs out of the 500 largest German companies were surveyed using a questionnaire. From the sample, 88 CIOs filled in and returned the questionnaire.

The questionnaire contained one question that asked whether the company was pursuing selective outsourcing. Possible answers (yes / no) were binary coded [0;1]. Concerning possible selective outsourcing decision criteria, respondents were confronted with seven statements each describing one criterion. Possible answers were given on a Likert scale reaching from '1' to '5'.

We considered two methods, *logistic regression analysis* and *comparison of means* for testing the hypotheses concerning the criteria of selective outsourcing decisions. The objective of this research is to analyze which of the two methods would be most suitable to design a DSS for selective outsourcing decisions, which would lead to the most relevant decision criteria and subsequently would be most useful for practitioners to consider in their upcoming selective outsourcing decisions.

Both methods involve entirely different assumptions and requirements. For a brief description of each see the inserts:

Logistic Regression Analysis

The logistic variant of regression analysis is utilized in settings, where the dependent variable shows a dichotomous outcome. Statistics literature recommends for explorative research at least four times the number of criteria as number of cases necessary to obtain valid results (Steyerberg et al. 1999). 'Cases' refers to the number of data points contained in the smaller of the two categories of responses (grouped according to dichotomous dependent variable). For confirmative research, a rule of thumb recommends 50 plus eight times the number of criteria cases (Green 1991; Tabachnick, Fidell 1996). With 88 datasets, but only 34 cases, we missed the requirement of 105 (50 + 8 * 7 criteria), but managed to overcome 28 cases (4 * 7 criteria) required for explorative research. The general regression function utilizes the regression coefficients as predictors of the logarithmized outcome:

$$\ln[\text{Outcome}/1 - \text{Outcome}]_{\text{Selective Outsourcing}} = c + \beta_1 \cdot \alpha_1 + \beta_2 \cdot \alpha_2 + \beta_3 \cdot \alpha_3 + \beta_4 \cdot \alpha_4 + \beta_5 \cdot \alpha_5 + \beta_6 \cdot \alpha_6 + \beta_7 \cdot \alpha_7$$

Besides the regression coefficients, a constant 'c', representing external influences unaccounted for, is integrated. Positive regression coefficients are validated by a significant Wald Statistic ($SIG_{Wald} < 0.05$), which calculates the squared regression coefficient over its asymptotic variance. Valid and positive regression coefficients indicate a positive influence on the outcome, whereas valid and negative regression coefficients indicate a negative influence on the decision.

Comparison of Means

T-test validates differences of means in two independent samples. Dichotomous categorization due to a binary dependent variable returns two independent samples. Further, approximately normal distributed samples are required (Gardner 1975). Normal distribution can be approved by either Kolmogorov-Smirnov (recommended for larger samples) or Shapiro-Wilk test (recommended also for smaller samples). Finally, the homoscedasticity assumption, meaning that variance within both samples needs to be similar (Gardner 1975), is met if the Levene's test is insignificant ($SIG_{Levene}>0.05$). The t-test calculates the difference in parameter values minus the difference in means over the covariance between both samples.

$$t = \frac{(\bar{x}_{1_1} - \bar{x}_2) - (\mu_1 - \mu_2)}{\hat{\sigma}_{(\bar{x}_1 - \bar{x}_2)}}$$

Logistic Regression Analysis versus Comparison of Means: Suitability for Selecting Decision Support Criteria

Possibility of Ordinal Versus Rational Results

Besides differing assumptions and requirements for quantity of data points of the two methodologies, further differences exist with regard to the quality of statements the methodologies allow.

The main difference is the level of explanatory power of the resulting statement. While comparison of means only allows for an ordinal statement, indicating that the mean of a parameter value in one sample is higher than the mean value in the other, logistic regression analysis allows for a rational statement, which is qualified to deterministically predict a decision. Such a difference in statements includes important implications for the corresponding hypotheses, as the statements resulting from applying the methodologies are used to either confirm or deny those hypotheses. Thus an ordinal statement only allows for an ordinal hypothesis and a rational statement for a much more deterministic hypothesis.

Application for Outsourcing Decision Criteria Selection

Applying the datasets with the logistic regression analysis, we could test rather deterministic hypotheses. Those hypotheses all have to obey the following style:

> Hypothesis: The stronger a decision criterion is developed, the more a company tends to selectively outsource.

By comparing the means we could investigate whether there were significant differences in the criteria of the selective outsourcing decision with regard to different outcomes. Hypotheses for this analysis were ordinal and formulated as in the following example:

> Hypothesis: Companies that selectively outsource show a stronger developed decision criterion than those that do not outsource.

Result Discrepancies

Logistic regression analysis returned only two criteria as significant, thereby confirming only two out of seven hypotheses[2]. Using the same criteria and the same datasets, five out of seven hypotheses were confirmed.

The difference in number of criteria, which were found to be significant can be ascribed to the difference in the hypothesized relationship. Logistic regression analysis was used to confirm the hypothesized directional influence of a group of criteria on the dependent variable. Utilizing regression analysis, an exhausting explanation of the dependent variable is approached. T-test for comparison of means was used to attest a hypothesized significant difference in the parameter value of the criteria between those pursuing selective outsourcing and those who do not. However, using this method, we did not claim to find criteria which

[2] Significant means: A positive regression coefficient, a significant Wald statistic, Nagelkerke's (1991) indicator for sufficient variance explained (R_N>0.2), and a discriminating power hat exceeds the chances of a guess (Hosmer, Lemeshow 2000).

exhaustingly explain the dependent variable. Based on this difference in explanatory power, it can be argued that three criteria differed between companies selectively outsourcing and those not selectively outsourcing, but did not have a significant directional influence on the decision to selectively outsource.

A possible explanation for the difference in means could be an ex post change in the hypothesized criterion. In the aftermath of outsourcing decisions, parameter values of outsourcing-related criteria may change due to outsourcing-related adaptations. However, the decision to selectively outsource is not influenced by such posterior adaptations. Still those adaptations could be reflected in the survey results. The discrepancy in criteria found to be significant could also be explained by the fact that t-tests for comparison of means only test relationships of individual criteria with the dependent variable, whereas logistic regression analysis tests the influence of all seven criteria on the dependent variable. Thereby, collinerarity among criteria is only accounted for in logistic regression analysis. Additional criteria found to be significant in t-testing could adhere to the same effects already covered by other criteria.

Recommendation for Selective Outsourcing Decision Support Criteria Selection Methods

The advantages and disadvantages of the two methodologies suggest a trade-off between precision and robustness of the decision model. While the focus of logistic regression analysis is on precision, comparison of means results in robust results.

While quantitative research often aims at a high degree of determinism for its statements, practitioners may favor ordinal statements as they present to be more robust against environmental uncertainties and slight changes in parameter values, which might change the statements resulting from rather deterministic approaches.

Thus, for selecting the relevant decision criteria for a DSS to be used by practitioners, i.e., for preliminary testing for relevancy and qualification of criteria for inclusion in a decision model and subsequently in a DSS, a comparison of means may be better suited. Logistic regression analysis, instead, should not be neglected in decision model and DSS development. Allowing for deterministic statements, logistic regression is above all best qualified for validation of theory development efforts. However, following selection of criteria, logistic regression analysis could also be applied in a mature stage of DSS development, for the purpose of precisely computing decisions based on the given parameter values of the selected and validated criteria.

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An Intelligent Decision Support Tool for Contingency Management

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Abstract

In this paper we introduce an interactive intelligent decision support system (I-DSS) for Contingency Management (CMT) under incidents/disaster contexts. It is a software tool aimed at tackling operational risks in organizations. There are very few proposals in the literature (Gadomski et al.1998) to deal with this type of problem and to our knowledge the capabilities of this product and the approach followed, are unique in the global market. The CMT capabilities are: 1) incidents/threats tackling; 2) equipments/components repair priority determination; 3) Assignment of teams to incidents and preventive tasks; 4) Training and instruction; 5) provides support under critical and stressful situations, in real-time, supporting efficient reaction in faulty and crisis/disaster situations; 6) allows analysis of consistency for emergency and contingency plans, through what-if processes; 7) ensures quality of information during critical/stressful situations.
Intelligent decision support systems (I-DSS) aim at developing effective intelligent systems for problem solving and decision-making (Dahr and Stein 1997), (Guerlain et al. 2000), (Turban 2000). These systems can deal with complex, imprecise and ill-structured situations. In general, the need for I-DSS derives from: (i) the growing need for relevant and effective decision support to deal with a dynamic, uncertain and increasingly complex management environment, (ii) the need to build context-tailored, not general purpose systems; (iii) standard support technology is becoming obsolete as a way to improve decision quality and work productivity.
Human understanding, decision and actions drive the operation of complex systems. The usage of I-DSS improves the ability of operators and decision makers to better perform their duties and work together. Under contingency conditions, such as: crisis, natural disasters and other threats (e.g. terrorist attack), critical factors like time and the inherent stress of the situations, affects the capabilities of decision makers. A software intelligent decision support system like the Contingency Management Tool (CMT) is a fast and stress immune-free tool for supporting the decision making process.
The CMT model is based on a fuzzy multi-criteria inference using a hybrid approach of operational conditions (top/down) and technological conditions (bottom/up). The operational conditions are described by the following components: Contexts, Tasks, Special Tasks, Threats, and Risk (determined by severity-level and possibility of occurrence). The technological conditions are described by: functional lines, systems, sub-systems and equipments. All components are related to each other, for instance a task depends on a specific context, hence we propose to use fuzzy relations to express the degree of relevance/risk/importance between components. For example, an air conditioner system has three sub-systems: cooling, temperature control and electrical sub-system and each one has different degrees of relevance/importance for the general system.

Moreover, the decision process under contingency conditions is extremely complex due to the high number of parameters involved and the necessity of reasoning over knowledge represented by imprecise and uncertain concepts that characterize situations. Imprecise concepts, implicit in linguistic expressions such as “severe limitations”, “very degraded” etc., and imprecise assets classifications for specific tasks (e.g. “important equipment”, “fundamental for air support”) are essential for human assessment of incidents. This is the reason why we use a model based on fuzzy logic.

There are many approaches in the literature for fuzzy multi-criteria inference (a good overview is provided in (Chen and Hwang 1992)) but in our case, since the knowledge is expressed in terms of relations (somewhat similar to an entity-relationship model), we propose a novel hybrid approach. Furthermore, the motivation for using fuzzy relations and fuzzy concepts to express them is due to the intrinsic imprecise nature of the concepts and their relationships.

In summary, the CMT is an interactive real-time, distributed, robust and fault tolerant system aimed to support decision-making processes. Assistance is provided to support decisions taking into consideration uncertain and vague information, under constantly changing scenarios where operational priorities change according to the operational scenarios and/or to the status of systems. The CMT is adaptable, in real-time, to changes on operational scenarios driven by changes on the environment and by changes in the controlled system (often complex).

Keywords : fuzzy multi-attribute, contingency management

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Supporting Modelling Phase in Process Engineering

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KEYWORDS: DSSs, human machine interface, computer-aided modelling environment, object oriented software components, knowledge management

1. Introduction

Flowsheet design plays a significant role in the process engineering industry. The modelling tools are strongly linked with the considered mode of production. In this context, the prevalent mode of production for low volume of high added value products (such as pharmaceutical or food industries) is handled with batch or semi-continuous process systems. The analysis of this kind of processes necessitates dynamic simulators which solve differential and algebraic equations system coupled with discrete aspects. However, process engineers not only have to optimize existing process but must propose innovative solutions. In order to study new processes, they have to create their own models. But this task is generally difficult to achieve without a global modelling support system. In a first part, this paper presents the different kind of modelling supports offers currently to engineers to develop their own models. In a second part, a computer-aided modelling system for the dynamic hybrid simulation environment PrODHyS is described.

2. State of the art

Three approaches for supporting user are found in the literature:
-*Pre-processing*: this approach consists in developing mathematics tools to support the user in order to test if the mathematical developed model is consistent enough.
-Automatic methods: these methods are developed to support the user in solving well-defined problems. They are based on the use of experience. The Case Based Reasoning for example imitates human reasoning trying to solve new problems by reusing earlier experience. Experience is necessary for the automatization of methods developed in research teams to solve particular kinds of problems. These methods are only applied, at this time, to conception problems, nevertheless it could be interesting in the future to study how to apply such methods in the modelling phase.
-*Development of Design Support Systems (DSSs)*: A DSS combines models and data in an attempt to solve semi-structured problems with extensive user involvement (see Keen P. and Scott Morton M.).
The evolution in supporting the user is strongly linked to the structural development of simulation software. It is possible to distinguish three different stages in the evolution of simulation software in process engineering: the development of equation oriented simulators, the knowledge representation through the object oriented approach and finally the development of decision support systems. So, the computer-aided design tools have been

evolved to propose solutions for the users' needs adapted to each stage of process simulators development.

Classical architecture of DSS and Simulators

A DSS combines models and data in an attempt to solve even non structured problems with extensive user involvement. The adaptation of this definition to simulators dedicated to PSE is quite easy. Indeed the "Data Management System" focuses on the thermodynamic and chemical data of simulators, and the "Model Management System" deals with mathematics models of simulation (Figure 1).

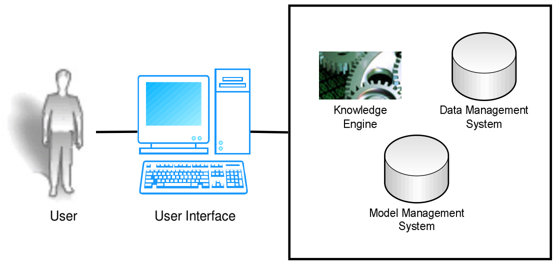

Figure 1. Marakas architecture of DSSs

It is important to note that there could be multi-level models: the first level is a device model that could be seen as a basic component whereas the other levels are more or less complex part of process, process or complete plant made up combining various level models.

Recent development in DSS for process engineering

Among the existing environment for chemical engineering, the particularity of the computer-aided modelling language MODEL.LA (Stephanopoulos et al., 1990 II) lies in the evolution of object oriented programming that includes different abstraction levels. These levels are linked; as a result a hypothesis can be propagated from a specified level to a global one and vice-versa. Different hypothesis can also be studied in parallel and saved as various "CONTEXTS". An important aspect of this work is also that computer aided modelling systems must produce fully articulated declarative models and they should allow complete decoupling between declarative and procedural knowledge (Stephanopoulos et al., 1990 I).

To support the chemical engineer in the resolution of ill-defined problems, other computer aided-modelling and simulation environment PROMOT / DIVA (Tränkle et al., 1997) has been developed. It must support the user in facilitating modelling procedure, suggesting modelling assumptions, and guaranteeing the consistency of the process models being developed (Tränkle et al., 1997). The software is based on two interfaces: one to support the user and the other to help the expert to implement the knowledge base.

The knowledge based user interface includes the following functional blocks:

Flowsheet-oriented editor for simulation models of chemical plants

Physical property supply for the selection of calculation methods and for fetching required parameter sets from physical property databases Simulation experiment control for the interactive performance of simulation.

3. The environment PrODHyS

Developed in our laboratory since several years, PrODHyS is an environment dedicated to the dynamic simulation of industrial processes. Based on object concepts, it offers extensible and reusable software components allowing a rigorous and systematic modelling of processes.

Description of the environment

The primal contribution of these works lied in the determination and the design of the foundation buildings classes. The last important evolution of *PrODHyS* is the integration of a hybrid dynamic simulation kernel (Hétreux et al., 2003, Hétreux et al., 2004). This hybrid feature is managed with the *Object Differential Petri Nets* (*ODPN*) formalism, which combines in the same structure, a set of differential and algebraic equations (*DAE*) systems and high level Petri nets (defining the legal sequences of commutation between states). Thus, this environment offers an equation-oriented dynamic hybrid simulator, which has the ability to detect *state* and *time events*.

PrODHyS is built as a library of classes (design with *UML*, coding in *C++*) designed to be derived through object mechanisms (polymorphism, composition, inheritance, genericity). Currently, it is made up of more than one thousand classes distributed into seven packages and two independent functional layers (simulation/modelling).

Process modelling with PrODHyS : The ODPN formalism

A more detailed description of this formalism can be found in (Hétreux et al., 2003). Let us only notice that the object concepts and the Petri nets have been exploited through an *extended combined approach*. It consists in making interact these features either by "introducing objects into Petri nets" (use of individualized object tokens carrying properties and methods) or by "introducing Petri nets into objects" (description of the internal behaviour of an object). For example, this mechanism is used to dissociate the model of material from the model of devices which contains the material. Thus, object tokens are reusable and reduce the complexity of the devices Petri nets.

In accordance with the *ISA/SP88* norm (which defines a view for the procedural aspect split into five hierarchical levels: see *www.isa.org*), the notion of macro-place has been added in the *ODPN* formalism. It consists in replacing a sequence of places/transitions relating to an *operation* or a *phase* by only one macro-place.

HMI and tools for PrODHyS

PrODHyS is a development platform of dedicated or general hybrid dynamic simulators. Various tools and HMI were developed (or are still under development) according to the context of use of the library (Figure 2).

Let us notice however that whatever the mode of acquisition used, the modelling of a process always follows a well defined and systematic process.

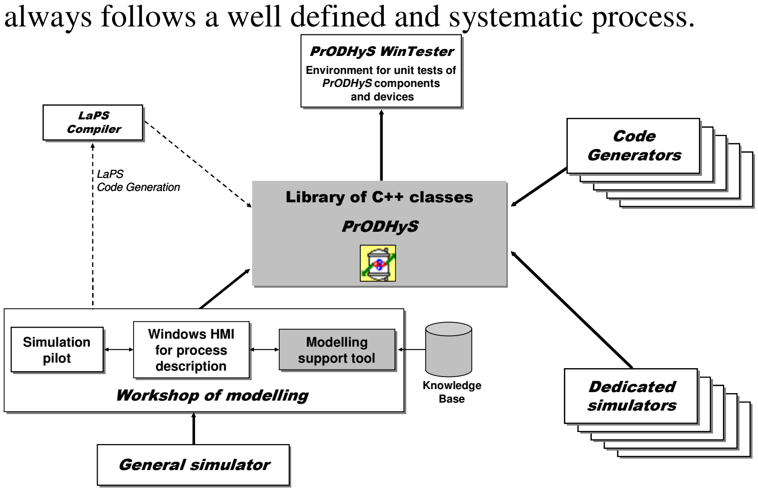

Figure 2. PrODHyS development platform for Process Simulators

Conception of a "dedicated simulator" with PrODHyS

The most direct form of use of PrODHyS is the writing of a C++ code.

The developer can thus create dedicated simulators in the form of executable (possibly coupled with a specific HMI) or of a COM component. The description of the system to be simulated (recipe, process and materials) is carried out according to a general procedure comprising several distinct stages:

1. Creation of the three general objects structuring the simulation model: the thermodynamic universe, the process (*Flowsheet* type object involving the automatic creation of the composite device made up of simulation and surrounding) and the supervisor (whose type object is a specialization of the RecipePN class containing recipe and devices PN of each apparatus in the form of a tree).
2. Declaration of the characteristics, properties and laws associated with materials: components, thermodynamic models, and possible chemical reactions.
3. Creation of process devices and definition of their configuration (when they are created, devices and their PN are added to the composite device of simulation and the supervisor).
4. Drawing up of the process topology: connections between devices (material, energy, information) and hierarchical composition.
5. Description of the recipe: specification with the ODPN formalism of the operating sequence to follow.
6. Application of the total configuration of the materials to all the process elements,
7. Initialization of the operational parameters of the devices (pressure, temperature, composition, flows, etc.)
8. Installation of the initial marking of PN.

Here, no help is provided to the user for this task. The definition of the process carried out, simulation can be launched.

<u>Conception of "general simulators" with PrODHyS : Modelling workshop</u>

Today, a graphic interface appears the best option from the point of view of accessibility with a complex tool. This is why the development of a modelling workshop seemed necessary to us. In adequacy with the commercial applications currently suggested, its use is rather intended to an end-user or to a modeller not having an expertise in development.
Nevertheless, the combinatorial induced by the various structural choices of the process and the evolutionary character of a study impose the use of an open and flexible environment.

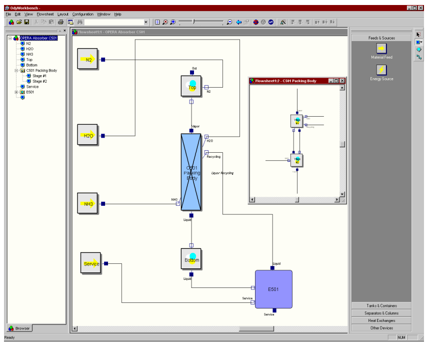

Figure 3. A window of the workshop of modelling (process

In this context, a prototype of modelling workshop is under development. This tool is a Windows application based on a multi-windows system (Figure 3). It allows to create the process to be simulated graphically thanks a base of components. These components can obviously be preset real devices, but also elementary objects making possible to create new devices by assembly.

Concerning the analysis, the user can choose the variables which he wishes to visualize during the simulation run among the whole variables (organized hierarchically) of the global model through displays, curves (for the continuous variables), or chronograms (for the discrete variables). All the functionalities associated with this type of tool have not been developed yet, these developments not having really priority from the research point of view. However, through the design of these tools, the need for a methodology of modelling appears necessary. Currently, the user is helped in his task thanks to a "pre-processing" which makes it possible to check, on all the topological levels, feasibility and the coherence structural of the built system (for example, checking that each entry or exit of flow of matter or energy is connected, detection of undesirable cycles, checking which the active elements are ordered, validity of the initial conditions, etc). For that, an analysis of the resulting global mathematical model is often sufficient to detect these anomalies. On the contrary, a diagnosis on the cause of the failure is often more difficult to establish. For complex situations such as for example, an inconsistency in the phenomenological models used for the various devices of the process, the user can be sometimes found more helpless. So, it seems relevant to develop a active HMI, able to guide the user in the modelling task.

Its first function would be to help him to modify its system in the event of failure of the pre-processing by providing a minimum diagnosis on the possible causes. In the second time, it would be interesting to propose to the user a knowledge capitalization functionality of already existing and reusable solutions. Indeed, having passed the test of the pre-processing successfully, he could capitalize this new solution in a data base developed for this purpose and possibly provides his own comments on this model. This expertise could be useful to a beginner modeller on this type of operation and would be used as a modelling guide. The made up data base would be a useful warehouse of reusable solutions (in entirety or partly) during the development of a new process. In fact, the realization of this system is based on a previous study concerning a tool of decision-making aid implemented for answers to invitation to tender within the framework of a project Esprit: DECIDE. More precisely, the EPPMR module would be exploited (module being used for capitalization of knowledge for the re-use of technical solutions within the framework of answers to invitation to tender) for more details about this module see (Sebal S. et Al, 1999). A second way to use this kind of tool is to generate new creative solutions for users having an expertise in process modelling. The system will propose to differently schedule the steps defined in a flowsheet design. The system will propose new creative solutions, and if the users agree, will test the feasibility of these new creative solutions. The creativity is here supported thanks to the capacity of composition of the proposed system, for more details about composition tools see (Shneiderman B, 2000).

4. Conclusion and perspectives

The object approach brings many advantages in terms of software quality but also in terms of modelling thanks to a hierarchical description at the same time abstract and close to reality. In this objective, PrODHyS provides software components intended to model and simulate more specifically the chemical processes. Its exploitation allowed the installation of dedicated or general simulators. Its flexibility makes it possible to imagine and to test various configurations in an easy and fast way and makes it an operational and evolutionary tool. This work is also the outline of a prospect for a more extended study in the development of dynamic HMI able to support the user with extensive involvement. These systems are based on the exploitation of castes of language and require a preliminary work of modelling and analysis of the activity of the process modeller. Thanks to this necessarily, primarily step of analysis and modelling of the activity of the process modeller, a new expertise could be reused in order to generate new creative solutions and / or generate new solutions for non expert users. The main problem staying to test the feasibility of new proposed solutions, the frontiers between creativity, knowledge and Information Systems are not very well defined and it still remains a large subject of investigations, for more details about this subject see (Nov O. and Jones M, 2005).

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e-Voting Process for e-cognocracy

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