COLLABORATIVE DESIGN IN THE BAMPETRO ENVIRONMENT PRESERVATION PROJECT

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Abstract

Geographic information technology helps the oil and gas industry organize data and develop new prospects for the exploration, drilling, production, refinement, transportation, distribution of the oil as well as the preservation of the environment. . The integration of Geographic Information Systems (GIS), Electronic Meeting Systems (EMS), and *Workflow* concepts, introduces a new approach called **SPeCS**. This system intends to support the aspects of multi-objective spatial analysis within a distributed GIS with tools that can help a group to cope with all activities in this kind of project. It should aid design team members wit coordination features that can vary from workflow facilities to tools that can help them achieve resolutions which shall represent the consensus in a decision-making process. This work presents the use of the SPeCS system in the BAMPETRO project, which explores the coordination in a spatial collaborative system that supports the georeferencing of the argumentations which were produced by the discussion involving the members of the design team. The main task of these groups is to produce a proposal for environmental preservations or changes taking into account socialeconomics, climate, water and soil aspects.

1. INTRODUCTION

The investment in preventive actions of control minimizes the risks that the companies of petroleum can offer to the environment. A form of contributing for the preservation of the environment is to increase the environmental knowledge on the area, supplying larger support to the companies in the administration of their activities. In the attempt of integrating and managing information on the environment related to the oil and gas section, Universities and research institutes of Rio de Janeiro created the Environmental database for the Industry of the Petroleum (BAMPETRO). That database gathers multidisciplinaries studies on the theme as a pioneering initiative in Brazil.

In a first stage, The database will gather information obtained in an environmental characterization study of the Campos basin (Rio de Janeiro), which is the first project in the country to focus the regional aspect, addressed to an entire basin. Those data were dispersed and were integrated by a multidisciplinary research team from the Rio de Janeiro Petroleum Technology Science Net (Redepetro). This Net includes the National Observatory, Federal University of Rio de Janeiro, Federal University Fluminense, State University of Rio de Janeiro, Catholic University of Rio de Janeiro and State North Fluminense University. The main objective of the Net is to form a research line on petroleum and natural gas in an important state which is responsible for 80% of the Brazilian production.

The researchers present in this project have different locations, objectives, skills and behavior, which fits appropriately to use the SPeCS software developed and detailed in former papers (MEDEIROS et al 2000). The multi-objective spatial analysis realized in Geographic Information Systems (GIS) environments present multi-disciplinary characteristics that involve shared data, where issues related to them are not easily qualified /modeled. In this area there is also the problem that the structures are partially known, and the potential solutions are controversial. These perspectives demands synergy amongst the users of GIS, representing the different areas, competencies, political agendas and social interests.

In GIS environment is necessary to stand out that the argument of the meeting should be georeferenced. A series of problems inherent to group activities is present in group spatial decision making, as for example, the emphasis given to social activities, failure to define the problem before the judgment, elimination of the creativity due to established hierarchies, feeling of alienation in the group, etc. As an addition to these problems we may also find, at the time of the meeting, disorganization, absence of objectives or agenda, non-conclusion of the solution, absence of individual

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leadership during the reunion, lack of efficiency in the decision making and redundancy of solutions.

This paper presents the application of SPeCS solution to the BAMPETRO project which is organized as follows. The **second section** presents the requirements for coordination, conflict management of a spatial decision support system; the **third section** presents the SPeCS functionalities; the **fourth section,** the SPeCS architecture and the implemented software, and the **fifth section** the final considerations of this work.

2. REQUIREMENTS OF THE BAMPETRO PROJECT

The BamPetro project has all the requirements proposed for the SPeCS system which offers an integration among emerging disciplines trying to solve the problem of the group decision making where geographical data is necessary. Collaboration concepts were introduced to facilitate the coordination among the participants activities and Workflow facilities should guarantee the decision flow, while and the construction of a dynamically customizable application could assist the constant requirement changes, which is one the most important premises of the scientific environment. These disciplines above allows users to improve their communication, their coordination and consequently their cooperation.

The SPeCS architecture herein proposed allows the integration of complete existent applications with new solutions built for the environment and thus a dynamic support model for the activities of the group. This architecture projected in four layers assists the necessary specialization for independence of the functionalities without losing the focus of increasing the means of the system use. The advantages of this structure can be seen through the obtained transparency when the introduction of a new entity to the data model or when a new module is included to assist a specific user or a new project need.

The decision process conduction versatility obtained through a Workflow tool allows modules to be introduced or substituted since the input and output parameters are not changed or that they are registered in the SPeCS tool. A layer is added to guarantee the necessary isolation of SPeCS from external changes. Phases can be eliminated and new phases can be included without impact in the decision course, as well as a phase can depend on new flows or decisions.

All of the premises used in decision making process are registered and available for user search allowing the reutilization of the experience obtained in a project so it could be reused in similar situations. The capture of the rationale is not only to keep the used information or documents, but also to store all the discussions and the sequence of the workflow executed during the decision process.

The visceral integration between the geographical environment and the decision processes brings a new perspective, where a map feature is geo-referenced to a knowledge and through its own relationships to the any other information of the decisions made through the environment. In the same way that a geographical characteristic is introduced and used in the decision making process, a decision and their associated knowledge are also geo-referenced for future use.

The introduction in the project of concepts of collaboration allows it to enroll when possible, the thought of the members of the group and the reasoning paths that orientated the decisions, as well as the options abandoned so elected solutions could prevail and all the questionings that were generated by the decisions that were taken. These concepts enlarge the capacity of interaction of the members of the group increasing their synergy and consequently increasing the discussion on the approached themes.

The SPeCS structural dynamism allows that requirements and experiences constantly changes as they are assisted in an easy way. This feature helps casual users to implement, in some situations, their own system modifications even if the great majority of them have a minimum of knowledge of the built structures. The graphic tool of Workflow in construction will expand the borders of the available activities for the users without specialization in the environment, allowing the access of an larger number of users and the most intense use in a larger amount of projects, which is the case of the BAMPETRO project.

The SPeCS system makes possible a wide future of studies and new propositions being now implanted in their basic functions. The current system was developed to assist all of the functionalities of a decision in strategic perspective, helping the group to cope with a multi-objective decision. The extension of this work can be measured by the amount of tables of the data model and for the amount of code lines built. This work however doesn't close up in itself only, but it opens new perspectives so that new studies can be made for the SPeCS extension.

This version allows the users to project interactive sceneries, explore a set of temporal-space data stored in a SIG environment and the related documentation, identifying the properties, classifying the data and projecting sceneries in group. It still allows, to evaluate the impact of the decisions, specifying its extension, to evaluate categories, to apply simulation models, to consider the impact of a chosen solution, to analyze results, and to generate maps, texts or graphs. The system was built in order to guarantee means of facilitating the negotiation of the group decision, allowing the development of the decision process, through a participative form among the members of the group.

The architecture validated through the system was shown appropriate and solid, because it legitimated the wide concepts of this work, setting up an environment for the users discussion guaranteeing the interaction and the registration of this interaction for use in future projects. The project of the layers of SPeCS can enlarge the construction versatility and the commitment to the environment needs.

The chosen interface was a browser WWW, that implements the means for users distributed geographically. Additionally, this architecture type doesn't demand software installation at the customer side, who very often doesn’t

have infrastructure for this task, besides facilitating the use of new versions of the applications. This interface type has been spread and is becoming a corporate pattern for its flexibility and simplicity, allowing that users with little knowledge interact with relative easiness.

In the decision layer, a group of functionalities were specified and chosen in the context of the decisions made in the Porto Seguro Project (MEDEIROS 2000), but the structure built allows modules to be increased or substituted without loss of integrity of the system, since minimum rules of coexistence are respected among the other modules of this layer and of the other ones. The service level to these requirements determines the quality of the integration and consequently the benefits obtained with this architecture.

The Decision Tools coordinate the activities involved in a decision, allowing the interaction and control of the users' activities. This layer is responsible for the independence between the application components and the users' dialogues. It should allow the capture, the storage and the use of the data of the geographical system. In this initial version the SPeCS system must assist all the characteristics described for the decision space, that is, aids in a collaborative way so that decision flows from the problem definition to a complete description, specification and documentation of all the solutions created by the representatives of the work group discussion.

The implemented system allows that in the construction of the group decision objectives, a Strategic Planning (SP) can be specified with its Mission, Objectives and Goals so that the decisions can follow a corporate direction. The system can also allow new objectives for the project specified by the users which are not necessarily part of the SP but are important as well. The tool allows that even private and individual objectives of the users are registered and used during the decision process.

The Knowledge Tools modules include mechanisms for the planning and the evaluation of the decision, a visual Chat with low integration level, a conversation module that georeferences the interjections of the discussions integrated into the other layers of the architecture, knowledge administration modules and control of opinion research. These modules are used by the decision layer and they work directly with the integration layers described in the next item. Its construction allowed the existence of certain transparency level in the treatment of the information and of the necessary functionalities for the SPeCS operation.

In this layer a group of basic components exists to allow the operation of a Workflow machine and it is configured as fundamental for the requirements of this work. The current implementation of the developed application allows the work flows to be built, but they demand a knowledge of the SPeCS internal data structure for the creation and use of the Workflow and their items. A graphic tool would facilitate this definition stage and the creation of the Case instances.

The Decision Meter proposed is an original suggestion that could aid in the determination of the success level and of decisions mistakes in a way to avoid the reiteration of incorrectness and to stimulate coherent decisions with positive results. This mechanism could separate, starting from a goal decision model, the comparison attributes and to analyze the factors that orientated the decision. One of the difficulties of this study type is the choice of the criteria, the creation of this model and the quantification of the attributes of decision, but that can be minimized by detailed studies of the circumstances where decisions happen.

The Integration Layer used and implemented by PINTO (2000) through a denominated solution of X-Arc, allows the integration and sharing of heterogeneous sources of data that should use mediation techniques. The architecture X-Arc, in development, is an integration proposal and disposal of environmental data in the Internet. Environmental data are typically heterogeneous (structures, format and metadata) and are coming from different sources. This architecture provides integration services and data publication in a XML (eXtensible Markup Language) pattern. A collaborative system to support spatial decision must offer a cooperative, common, flexible and a easy way to use work environment where the members of a group may be geographically distributed in heterogeneous environments, interacting during the decision making process. This system must also meet the requirements of coordination and management of conflicts.

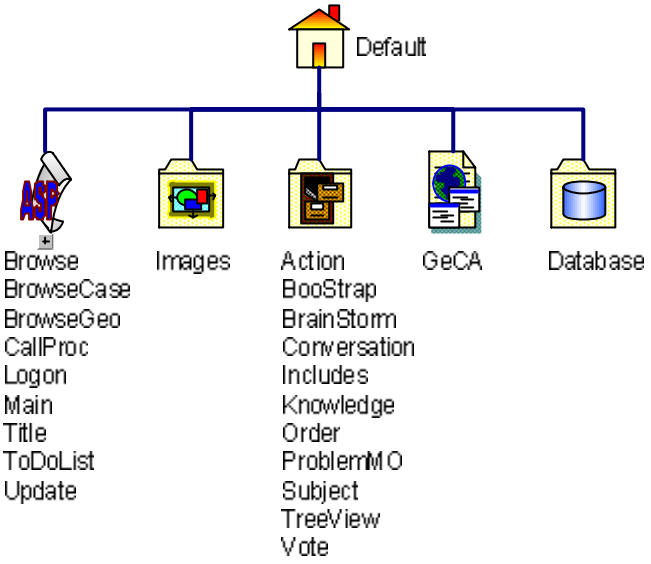
3. COMPONENTS OF THE SPECS IMPLEMENTATION

The framework defined for this system is centered in the problem of the coordination of the working processes . The solution adopted consists in customizing coordination tools for the characteristics of the GIS environment. Within this environment, the coordination shall then meet these three main requirements: *i)* the work process coordination, *ii)* the *rationale* capture by recording the decision-making process and *iii)* the conflict management existing within the scope of the activities performed. To meet these requirements the SPeCS architecture employs a *workflow* system in such a way as to assure the work of the group and the collaboration within the GIS environment. Figure 1 describes the structural model that guided this environment.

3.1. Workflow system within the GIS environment

The *workflow* system guarantees the logic of the processes with their standards and the efficient management of the information flow, allowing the teams to have all the necessary resources. These systems manage and support the negotiation process, assuring that the tasks be executed by the right teams, within the proper time limits and supporting individual task execution. The *workflow systems* automate the steps of the negotiation process, structured or not, managing the coordination activities by the individuals and groups in order to guarantee the objectives of the organization (KHOSHAFIAN, 1995).

The system SPeCS assists several requirements and it intends to supply the User of tools of Workflow, Decision, Collaboration and *Knowledge* in Geographical atmosphere. These disciplines, so heterogeneous, have to be integrated in a single application, what generates a great complexity and it demands special cares in the construction of the programs and in the interface among the several software layers.



The main components of the physical structure of the environment are detailed in the illustration. The solution proposed for the SPeCS SYSTEM uses the CooMan System (SOUZA, 1997), a system developed within the COPPE/UFRJ, which links traditional management techniques to new conversational ideas. The objects used as a base for the system are the Project, the Task, the Partner, the Group and the Conversation. These objects are structurally linked to form a consistent group of types to represent the current scenario where the decisions shall take place. These objects and their relations are presented with the forms of hexagons, due to the intimate interdependency existing among all objects, suggesting the structure of a great beehive. Each part loses much of its base when isolated from the rest.

An initial proposal to extend this system to meet the requirements of GIS environments was presented in SOUZA (1997). This extension presented an architecture based on hypertexts to allow the different types of conversations existing within this environment, structured (group meetings) or semi-structured (documents, memos, messages). The concerns of this new version of CooMan in MEDEIROS (1999) was limited to representing the communications within the scope of geographical analysis, without taking into consideration the other types of interactions that occur in this environment.

The evolution of the conceptual model of the CooMan to the SPeCS , in order to contemplate the above requirements to allow the dynamic creation of workflow, shall cause profound changes especially with the incorporation of geographical attributes and the georeferencing of the data for the workflow. This will cause changes in the scope and the concepts initially utilized in the CooMan.

In the extension herein proposed for the CooMan System we introduce two solutions for the management of conflicts among the components of a group in the distributed environment of the SPeCS : a system to aid the collaborative electronic meeting and consensus devices with a tool to capture the *rationale*, described as follows.

4. THE SPECS SYSTEM

The SPeCS implementation described in this project has one of its screens shown in the next figure and contemplates the necessary functionality for the user needs. A detailed description of the system screens can be found in the system literature, and in this paper only some architecture aspects are described. The developed application can be used in the link http://fênix.del.ufrj.br, where it is available not only the system for utilization, but also all the sources and the necessary operational databases. All of the stages of the decision process were implemented, and can be used since the users are created in the system.

In the page after Logon and the choice of the collaboration environment, the problem definition screen appears as the first activity in the pending activities list for execution. This page can be divided in six blocks of different kinds of information, which are the Title bar, the system Menu, the List of pending activities (ToDoList), the Problem Information, the Geographical area and the one that details the users' of the environment collaborative data.

4.1. Functional levels of the System

The SPeCS system assists several requirements and it intends to supply the User with tools of Workflow, Decision, Collaboration and Knowledge in Geographical environment. These disciplines, so heterogeneous, have to be integrated in a single application, which generates great complexity and demands special cares in the construction of the programs and in the interface within several software layers. The main components of the physical structure of the atmosphere are detailed in the illustration that follow.

The first four blocks of this page shows the generic characteristics that appear in the subsequent pages of the process of decision. The geographical information block has some important singularities, since it allows information search and georeferencing of the user problem. When the Link button is chosen and a point in the map is selected, the application opens a new window containing several options for the moment. This window is represented by a red callout in the illustration and presents options for registering the point, the layer or even the Map. At this moment the user can also associate this point to any knowledge registered in the base. This association is made by using the means of a page built with GeCA, which is a software, to generate applications. Additionally, there is a search option for all

previously associated knowledge. This knowledge list can be used during the decision process in the area called Problem Knowledge as represented in the figure.

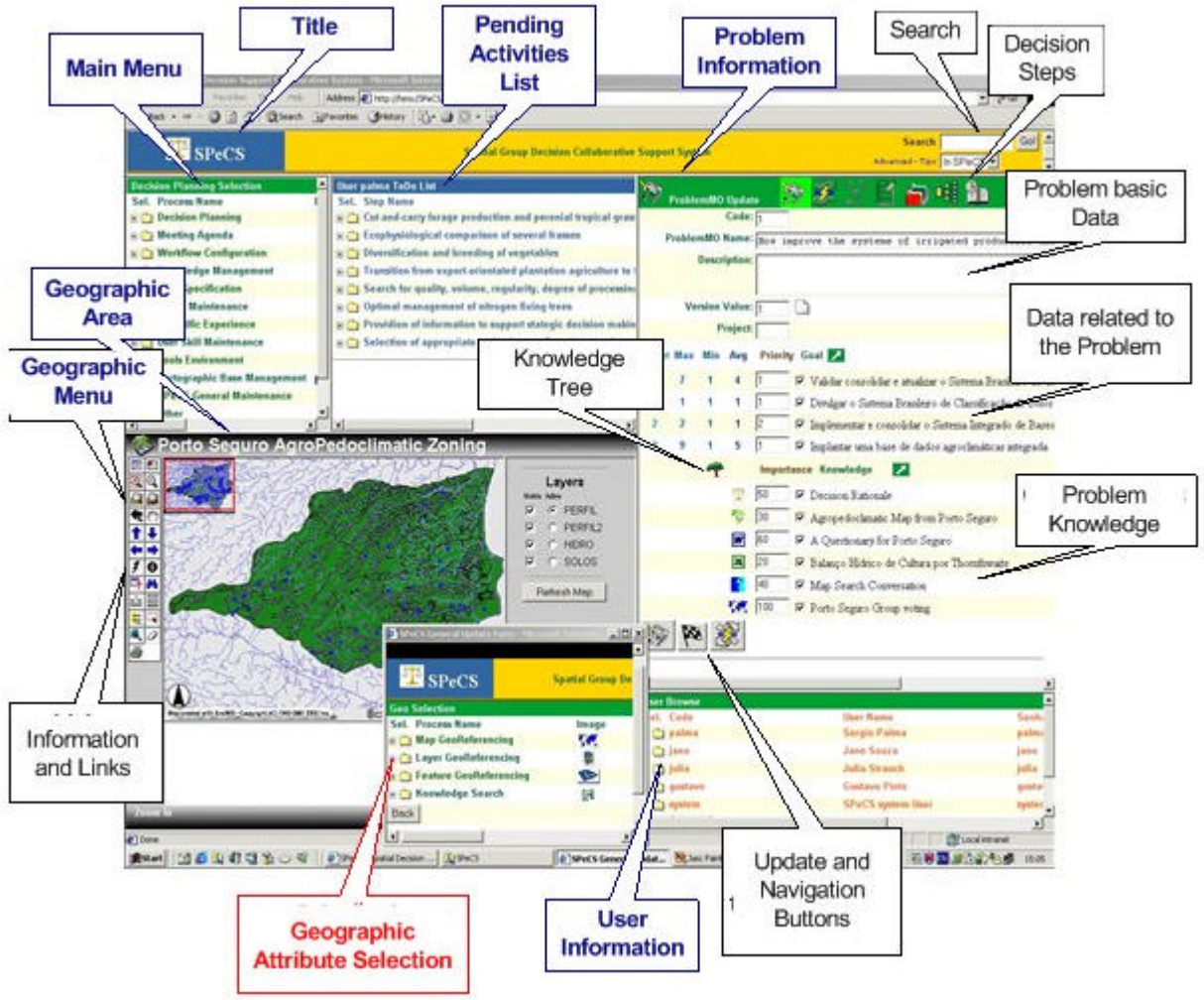


Figure 1 Components of SPeCS System

The Problem Information block allows basic data update and creation of relationships that links the Problem with other entities of the Collaboration Model. For each decision phase, important relationships exist and can be used to build the information net that describes the problem and its possible solutions. A space exists in this block destined to the Workflow knowledge and can be of four types: global to the environment, to the Problem, to the decision step, and for each one of the logged users. The system allows a hierarchy with the knowledge to be built with chosen indexes to allow the members of the groups to an easier access to the associated components of the collaborative space. As can be seen in the above figure, the discussion is georeferenced and can be understood as another layer in the GIS environment. Any geographic attribute can have a discussion associated and all the argumentation is kept structured and accessible inside the GIS database. A zoom view of the collaborative panel can be seen on the bottom of the figure allowing the user to write his opinion or idea and to express his thoughts in a file, an URL or any geographic object.

4.2. The Prototype Implementation

The SPeCS is being developed under a client/server architecture using technologies like Java, MapCafé, XML, which shall offer a common standard interface in order to obtain compatibility at the *software* component level, as follows: GIS, browser, statistical tools, etc…

Figure 3 (????) describes the modular architecture, within the context of the ONDI (Non Scalar Distributed Objects) project, containing all objects necessary for the understanding of the SPeCS implementing aspects. The interface chosen was a *World Wide Web* browser, which is becoming standard for the geographically distributed users. Additionally, this type of architecture does not require *software* installation at the client side, which in many times is a infrastructure harvest, besides the fact that users will be always using the most recent application version. This type of interface has been widespread and is becoming a corporate standard for its flexibility and simplicity, allowing any user to interact with relative easiness, even if the user has little knowledge.

The SPeCS is one of the applications made available at the second level of architecture, and must work together with other tools, such as the GIS tools. These applications shall use the HTTP (*HyperText Transfer Protocol*) above the

TCP/IP (*Transfer Control Protocol/Internet Protocol*) to communicate with the user's interface and the ONDI protocol to interact with the services layer. This last part of the architecture, the applications, shall access the data within the databases in the local GIS environments, security systems and any other services of this lowest layer. The SpeCS system was tested in the Atlantic Forest preservation Project of EMBRAPA, in the region of Porto Seguro, Brazil and its experience will continue in the new Project at São Gabriel do Oeste in the Amazon region and now in the BAMPETRO Project.

5. FINAL CONSIDERATIONS

The integration of GIS, EMS, workflow and Internet concepts into a common architecture allows the interaction and exchange of information among decision-makers without the need to shift between heterogeneous applications. The SPeCS tool aim at helping to establish selection criteria to obtain the solution that will represent the consensus of a group involved in the decision making process. This system will allow the results of the evaluations to be represented as statistical graphics, textual and/or as cartographic representations georeferenced in the GIS context.

In this paper we presented the requirements and specifications of a Spatial Decision Support Collaborative System in environmental projects which aided to understand the complexity of spatial decision making and the need for coordination among the researchers. The SpeCS tool produced supplies the collaborative work environment with several collaborative facilities for remote GIS users and, consequently, introduces new interaction perspectives within the work arena.

The system used in the BAMPETRO Environmental Design Project demonstrated the premises of this paper and opens new perspectives in studying the collaborative interaction among users in a GIS environment.

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