WEB MODELING-SIMULATION: TWO STRATEGIES

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Carlos Domingo IEAC/FACES/ULA, CESIMO/FAI/ULA e-mail: carlosd@faces.ula.ve

Marta SananesIEAC/FACES/ULA ,CESIMO/FAI/ULA e-mail: sananes@faces.ula.ve

Giorgio Tonella CESIMO/FAI/ULA, e-mail: tonella@ing.ula.ve. Univ. della Svizzera Italiana, e-mail: Giorgio.Tonella@eco.usi.ti-edu.ch

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ABSTRACT

The paper presents an approach on how to exploit the benefits of Internet and the Web for promoting and improving the application of model and simulation techniques to a wide range of problems, specially in developing countries, where experts in this field are rather rare.

The approach is to use the Web for consulting services to offer choices of simulation paradigms and model development tools. Two complementary strategies are suggested: the Modeling-Simulation Consulting service and the Model-Simulation Diversity. The first includes, among others, the use of general information through the net, possibility to open a real and/or virtual dialogue between consulting and client, client oriented model database tools, client oriented model design editors, etc. The second uses the multi-paradigms approach offering modeling and simulation from the traditional off-line approach to run models in a standalone computer to on-line model building and simulation using net languages such as Java.

1. THE TWO STRATEGIES

During the 80s and 90s in many third world countries, in particular in Latin America, the demand of consulting in modeling and simulation has grown faster than the consulting offer. This trend will continue during the next years and the gap between demand and offer on simulation and modeling consulting will continue to increase. It seems, that the demand could not be satisfied by local consulting companies or researchers. However, new approaches of consulting for simulation and modeling can help in reducing the gap. The present paper is a first step in this direction. It will summarizes some points on how to offer consulting service in modeling and simulation based on the extensive use of Internet and the new communication tools that will be available everywhere in the near future, such as virtual environment, sound, videos, interactive distributed simulation, etc. The idea is to use two strategies, one for modeling-simulation consulting service and the other for taking into account the diversity of clients' needs, that will subsist during the next years.

The first strategy - Modeling-Simulation Consulting service - will be discussed in details in the main section of

the present paper (section 2). Here Web will be use as a window for a modeling-simulation consulting service, in a cooperating environment involving *humanware*, that combines software and hardware tools. One side of the window is the client side and the other is the consulting service side. On the client side, client users make a request of a consult on modeling-simulation and present their problem and their knowledge of the associated system; in other words, they introduce the problem domain. On the other side, the consultants offer the first of a several stages structured consulting dialogue, going from a verbose initial one through structured forms for information gathering, model building, etc., until the last stage of simulation and experimentation.

The objective of the consulting dialogue is to integrate the knowledge extracted from the clients with the expertise of the consultants in system modeling for simulation. The dialogue proceeds from an informal or verbal expression of the problem domain to a formal expression as a conceptual model built using a kind of CASE tool for models definition. The dialogue aims to jointly define an appropriate common conceptual schema for the problem domain with dynamics characteristic included. The service includes, depending on the users needs, programming, validation, planning of experiments and analysis of the simulation experiments.

The second strategy -Modeling-Simulation Diversity- means to offer public as well as private Web distributed tools for modeling and simulation not only for different simulation paradigms but also for different platforms and modalities of use, according to different needs and grades of involvement of users with the modeling-simulation process. The grades of involvement ranges from occasional use of modeling-simulation tools to extensive and intensive use of them. Involvement with the problem model could range from just input or output handling to full understanding with ability to modify and redesign. Section 3 will shortly introduce the main points of this second strategy.

Finally, section 4, will give some ideas of the implementation of both strategies using the Glider simulation language (Glider Development Group 1996), developed by the authors. Details of this implementation will be given in a future paper.

2. MODELING-SIMULATION CONSULTING SERVICE

A problem of modeling and simulation involves normally two partners: the consulting client -a group of people in general- and the consultant -also a group of people in general. The aim of the clients is to have a model designed or even programmed as soon as possible and with minimum effort on learning and working, but having the confidence on the accuracy and quality of the product. The aim of the consultants is to get the best understanding of the problem and to use all their learning capacity and accumulated experience in order to release a product in which they are confident and that is accepted by clients. They need the participation of the clients to get the needed understanding. The clients participation is needed also during all phases of the design process. This participation will facilitate the understanding and approval of major steps by the clients and the final acceptance of the model. Thus, there is a trade off between the time and effort the clients are disposed to expend and the participation the consultants demand. The process can be speedup with the use of the Web. For example, there is no need for real meetings and moving from one place to another. All the needed information can be obtained through the Web, either by video conferences, including virtual conferences, or simple Web sessions or even just e-mail communication. The Web sessions have to be kept very pleasant and interesting, using all capabilities of Web presentation as possible, accordingly with users resources, including for example, virtual reality for problem scenarios displaying and discussion. In addition, an educational environment is offered simultaneously so that users could learn by themselves on the field for future use.
In other words, a web-based modeling and simulation consulting service is a dialogue between client and consultant that can be broken in a sequence of progressive cycles such as :

Client Web session -> Consultant work -> Consultant next Web session preparation -> Consultant-client dialogue

The consultants -similar to any expert system- must be able to present, at request of clients, a resume of the knowledge and experience applied and the reasoning path which led to each step of the model design. This resume may help also to the user learning process. The consulting service will consist of the following three parts, that will be analyzed below:

- General information
- Dialog plan
- Tools for model building and model simulation (only two examples of these tools will be given below)

a) Public General Information in the Web

This is the starting point of the dialog. Web sites (for example, the consultants specific Web page with links to others Web pages) will present among other public general information on modeling and simulation and the main consulting service features. Example of such general information will include:

- For beginner users:
  - Information on simulation model (tutorial, Web exhibition of simulation cases, etc.).
- For all users:
  - General information on the state of the art in modeling and simulation presentation, Web exhibition of simulation cases, modeling and simulation consulting service presentation. Most of this information must be presented in hypertext multimedial form.
  - Active bibliography (links to: texts, references, simulation sites, mail lists).
  - Active glossary (hypertext).
  - Client registration for consulting service, if wanted.

b) Consulting dialog plan

The following plan involves an undetermined number of Web sessions by the client and the same for Web pages preparation by the consulting service, each of them dedicated to a particular client. Thus, the consulting service may restrict the number of clients that can be attended simultaneously, according with its human resources capacity.

The Web pages for clients must be private and protected, unless otherwise stated by some clients. For example, an educational client may want the consult to be open for all students. Nevertheless, open queries or group queries may be required to have a person responsible for final decisions.

The possible steps of the dialog for a modeling-simulation consult include among others:

- Client problem definition.
  - Informal chat (e-mail, lists, video-conference).
  - Tutorial and Web exhibition of cases on what is a conceptual model of a system
  - Presentation by consultant of similar case studies (real or using virtual reality).
  - Structured chat (forms to be filled, construction of scenarios with descriptive tools ranging from textual to virtual reality presentations).
  - Terms of agreement (extent of the consult. Cost in case of commercial service).
- Conceptual model design.
  - Use of the Model Oriented Design Editor (MODE) (tutorial, Web exhibition of cases).
  - Alternate client/consultant use of MODE until conceptual model design approved by both.
- Model building (if included in agreement).
  - Establishing model uni-paradigm or multi-paradigms agreement (discrete, continuous, mixed, qualitative, agents, system dynamics, distributed, parallel, simulation games, Petri nets, bond graphs, etc.).
  - Establishing platform agreement (Web, server, client, Intranet).
  - Establishing model development tool agreement (simulation language, simulation environment).
  - Establishing client level of involvement agreement.

For experienced clients the dialog could continue with:

- Joint client/consultant model building.
- Consultant model building, client approval requested.

While, for not experienced clients.

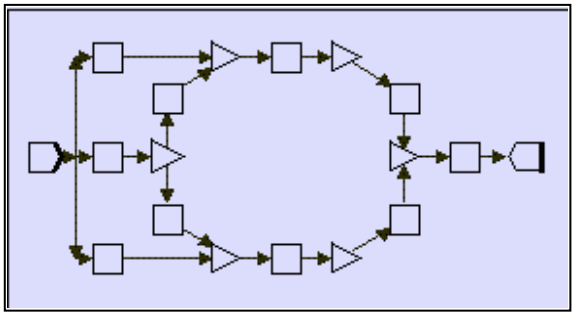
- Consultant model building, client details requested.
- Total consultant model building.

- Model validation.
  - Data validation scenarios request using model database tools.
  - Conceptual model revision if needed for adjustment.

- Experiments (planning).
  - What is an experimental plan (tutorial).
  - What is a statistical experimental design (tutorial).
  - Developing experimental plan (model database tool).

- Simulation of the experiments.
  - For clients running in consultant platform.
    - Experiments data request (model database tool).
    - Statistical analysis of experiments (statistical analysis tool).
  - For clients running in clients platform (autonomous, Web sessions or intranets sessions).
    - Model users manual.
    - Error consulting service offered for recovery or model adjustment.

c1) Dedicated Tools: The Model OrientedDesign Editor (MODE)



This is the main tool for the consulting dialog. It is an interactive graphic editor, similar in appearance to CASE tools or object oriented interfaces of RAD systems (such as the ones of Visual Basic or Delphi), but oriented to models conceptual design. The tool allows for a simultaneous development of a model graphic schema and the corresponding textual model specification in structured natural language. The graphic schemes are constructed using palettes containing modeling symbols, including objects and events. New palettes may be added to allow for representation of specific object or event classes of different problem domains. The tool also allows for registration of different versions of the conceptual modes classified by client, type of query, time, ownership, state, stage, etc. MODE is being developed in Delphi and also in Java language for distribution to clients of the consulting service trough the Internet.

The first proposition of a model conceptual schema for a client will be prepared by the consultant team with this tool. With their local versions of MODE, the client team may interact and respond with the schema approved or with the schema modified at its best. MODE is a generalization and improvement of the Glider graphic editor, Gliderin, (Sananes 1992; Sananes and Tonella 1993), a tool developed for the original PC/DOS version of the Glider simulation language.

c2) Dedicated Tools: Model Database tool

The consulting service has to offer a database interface tool to access a consulting service database where the consultant team keeps versions of input/output data of model validations or experiments running in house. The actual database content for each model may be replicated to clients for use at their will. The interface must use active forms for two ways data communication.
For clients running autonomously their models, a simulation dedicated database management tool is on the process of development, including statistical and worksheet facilities for analysis and cooking of data, based in an existing PC/DOS tool, ADAN, Ambient for Data Analysis (Sananes and Torres 1996) developed by one of the authors.

3. MODELING-SIMULATION DIVERSITY

An ideal modeling-simulation consulting service might be able to offer the full range of simulation paradigms and tools. A more realistic one might at least offer a good selection and/or specialization, redirecting users with specific needs to other consulting services. The main modalities in regard to how to build the problem model and how to run the simulation experiments are:

- Build in a Web server, run in the server
- Build in a Web server, run locally in a Web session
- Build in a Web server, run in an autonomous platform or Intranet
- Build and run in an autonomous platform or Intranet

Other modalities may exist, for example, open game like model to be run in the Web. For the sake of a consulting service, client privacy is a main issue and that is why we restrict the modalities to the list above.

In many domains of services the collective-shared and the individual-autonomous approach have subsisted and coexisted. In the transportation service domain, massive units for "batch" transportation coexist on ground and air with personal, familiar o group transportation units. In the entertainment world, broadcast TV and cable coexist with personal VHS and CD ROM recorder-players devices. This is so because they satisfy people. Something similar is happening now and will continue happening in the future in the computer world. A computer, as a TV set, can be connected to the public net, to private ones or not connected at all but being fed by disks, tapes or CD's. These types of input media themselves may be public, commercial or of propriety production at personal or enterprise scale.

The approach of diversity favors creativity on the side of software production. On the side of software consumption, it respects the freedom of choice and the right of privacy for users. Furthermore, diversity may favors evolution of computing in general and in simulation in particular, in the same sense that biodiversity is considered the strategy of nature for evolution of life.

4. IDEAS OF THE IMPLEMENTATION

An in-house developed simulation software (Domingo & Hernández, 1989; Domingo C. et al., 1993) was chosen as the starting package for the implementation of these simulation-modeling consulting service strategies. The software includes statistical analysis, animation, syntactical editor, graphic input editor and the Glider simulation language (Glider Development Group 1996). The simulation language is object-based. It allows for simulation of different types of modeling (discrete-events, continuous, etc.). It uses the network concept to represent system structure. The nodes of the network are objects with the capability to process information. The exchange of information can be done using common data structures or/and using messages passing. Messages are objects (active objects) with methods and data. They are stored in internal and external list of nodes, where they wait for being processed. The language allows the free use of a general purpose computer language (Pascal), giving a great flexibility to the language. The class node includes general nodes, user defined nodes and predefined nodes such as generators, destroyers, queues, gates, resources and branches. The nodes instances can use private and public variables and local and global data. In addition to methods of nodes and messages, the language includes a large library of mathematical and statistical function. Other functions libraries can be easily plugged-in.

Glider is one possible candidate for Web consulting services. For the moment it is the only tool included in the developed web modeling-simulation consulting environment, however, others can be included in the future. In the near future, Netscape and other Web browsers may become full operating systems, with powerful and easy facilities for users and programmers, contrarily to what has been Unix and other operating systems. In addition, they may support more languages well suited to achieve greater productivity, contrarily to what have been C or C++. The new Web languages may apply -as Java does- the distribution strategy devised by N. Wirth, based on a low level standard or virtual machine interpretable code.

The development and root language for Glider (Pascal in Object Pascal, Turbo Pascal and Sparc Pascal flavors) poses many conceptual and some syntactic similarities with the now popular Java. These facilitate also the porting of the current code to Java based versions in the Web. For this task, the following two strategies were selected: to port the compiler and library directly to Java language -to have the compiler distributed as any other autonomous version- and to distribute only Java *applets* for modeling and interactive simulation through a server that generates them. Both version are in process of development. In other words, the on-going development includes Glider versions for three current platforms, to put Glider on the road for modeling-simulation diversity and the parallel development of new tools and extension of tools such as MODE and ADAN, presented above.

5. CONCLUSIONS

Internet and the Web are in process of changing most of our daily activities, including the way how consulting services in the field of modeling and simulation are carried out. These changes will open new opportunities and new ways for modeling and simulation, together with new methodologies and new tools. The web-based modeling process will change the ways how to develop model and how to interact with clients. Virtual reality, groupware, interactive modeling, etc., will play here an important role. On the other hand, the web-based simulation will ask for the development of new tools in areas such as: distributed interactive simulation, agents simulation, parallel simulation, simulation web languages, etc. The present paper introduced ideas to show in which direction the authors are moving for dealing with these problems. The two strategies of the above sections are in process of being implemented by adapting and expanding the Glider simulation language. For the moment, the on-going research is oriented towards the preparation of the methods and tools to deal with these new opportunities of web-based modeling and simulation consulting services. However, it is very likely that soon a first application will be carried out using part of the above methods and tools.

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ADDRESSES

Instituto de Estadística Aplicada y Computación. Universidad de Los Andes. La Hechicera Ed. B. 5101 Mérida, Venezuela. e-mail: ieac@faces.ula.ve

Centro de Simulación y Modelado. Facultad de Ingeniería. Universidad de Los Andes. 5101 Mérida. Venezuela. http://cesimo.ing.ula.ve