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Negotiation Support Systems and Negotiating Agents

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Negotiation support

Negotiation support systems (NSS) cover a wide range of individual and group decision support technologies. Many NSS have been developed and used in training and research but they have been rarely used in practice. Among notable exceptions one can list the simulation system used in the deep sea negotiation (Sebenius 1984; Nyhart and Goeltner 1987), and the RAINS system used in EU transboundary air pollution negotiations (IIASA, 1998). These two systems were developed to provide negotiators with the verification of offers through scenario construction and simulation. Both were used by experts who acted as intermediaries between the system and the decision makers. Geographic information systems, data visualization tools, and spreadsheets have been used in a similar manner.

NSS used for training and research embody methods and techniques developed from decision science and negotiation analysis (Kersten, Michalowski et al. 1991; Wierzbicki 1993; Bui 1994; Shakun 1994; Teich, Wallenius et al. 1994; Kilgour 1996; Holsapple, Lai et al. 1997; Kersten 1997). These methods include multi-attribute utility theory, multi-objective linear programming, multi-criteria methods, restructurable modeling, game theory, and non-linear optimization. Because most, in not all, of the NSS based on decision and negotiation analysis are not used in real-life negotiations one could state that these types of systems have no practical potential. We argue that this is not the case for the following four main reasons:

1. managers and professionals are becoming sophisticated users of decision support systems that embody many of the above methods and techniques,
2. e-commerce, globalization of markets, and electronic communication lead to virtual negotiations,
3. time pressure, vast amounts of data, and increasing problem complexity create new pressures that can possibly be partially alleviated with the use of DSS and NSS, and
4. increasing user friendliness of NSS, and the employment of the data visualization and multimedia techniques as well as the integration with other systems.

A large experiment conducted within the InterNeg project provides further justification to the above claim. We have developed a Web-based NSS INSPIRE that has been used by over a thousand people around the world. Conjoint analysis technique has been used to construct utility functions that users employ in offer construction and evaluation (Kersten and Noronha 1998). The system allows for the verification of compromise efficiency, provides graphical

representation of negotiation dynamics, and has a message facility. Most INSPIRE users did not have any prior training yet, as shown on Fig. 1, they found the system very easy to use.

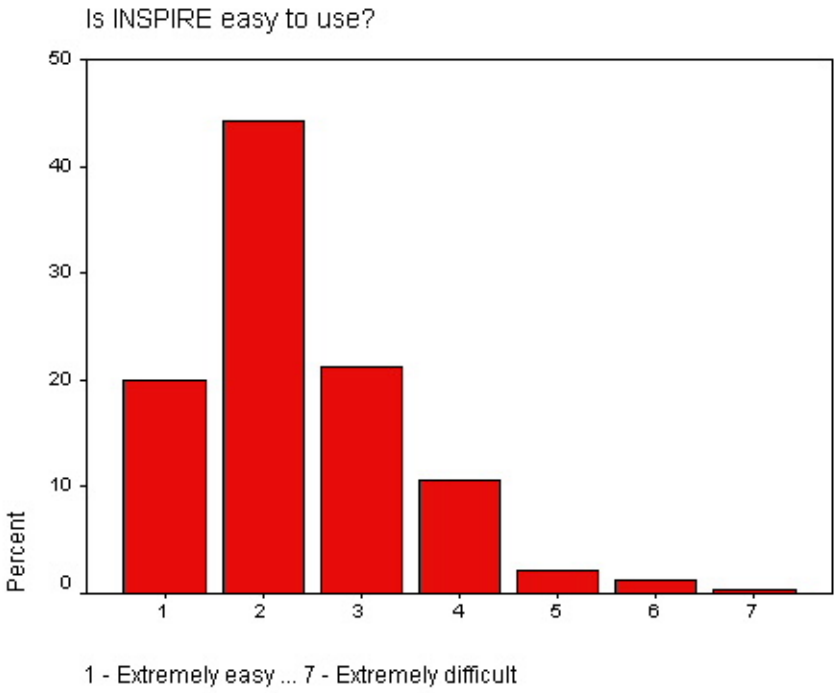

Figure 1. User acceptance of the INSPIRE system

We have also asked the INSPIRE users about the potential of this type of an NSS and their response is given in Table 1.

Table 1.

	Would you use a system like INSPIRE in:		
Response	Training and practice	Preparation for negotiation	Real-life negotiations
No	46 (10%)	74 (16%)	158 (35%)
Yes	410 (90%)	382 (84%)	298 (75%)

Data given in Fig. 1 and Table 2 indicate that NSS that are based on decision and negotiation analyses can be very easy to use and accepted by users in preparation for, and conduct of, real-life negotiations. INSPIRE has been used by students and also managers and engineers taking executive and professional development courses.

There are also other developments that indicate he potential of NSS use in practice (Thiessen and Loucks 1994; Hamalainen 1996; Rangaswamy and Shell 1997). They give ground for renewed

interest in these systems and their roles beyond research and teaching (Kersten and Noronha, 1997).

Negotiator's workbench and interface

NSS, similarly to DSS in the eighties, are often seen as stand-alone and conceptually complex systems. They were often built by researchers and were an implementation of a particular decision analytic method. This contributed to the limitation of DSS to a specific domain and their use by consultants and analysts. Despite the claims made since the mid seventies, when DSS were introduced, these systems were not used by decision makers.

There are several developments that have changed perspectives on DSS and contributed to their growing popularity among software companies and end-users. Some of the factors pertain to new technologies and interest of software developers to provide new functionality in their products and embed decision analytic capabilities in management and executive support systems.

New technologies such as data warehousing, middle-ware, data visualization, and data mining contributed to the increase in the decision makers' interest in DSS. This interest increased with the focus of developers on the user friendliness of these systems as well as their integration with others systems. In effect, managers and executives accepted DSS as decision support tools. They are now viewed as a natural extension of information services. They are not anymore stand-alone systems that require analytical and technical knowledge of the user nor a significant effort to solve a particular decision problem. Instead, they are now flexible tools that can be used in different configurations and applied to different problems.

A similar approach should be undertaken in the development and implementation of NSS. We believe that a new generation of negotiation support may be a collection of tools that are based on decision and negotiation analyses and can be easily configured by users to reflect their approach to negotiation, as wellas organizational, strategic, cultural, and other conditions. For example, users may select different preference elicitation schemes, conduct mock negotiations with themselves, use reservation prices, the best alternative to the negotiated agreement (BATNA), or aspiration levels. Users may select tools that monitor the progress in negotiations measured by the number of offers, the level of concessions, type of argumentation, etc. These tools may facilitate adoption of an NSS to the specific organizational and individual culture and facilitate communication between different organizations.

Using our experiences with the INSPIRE system we are developing the InterNeg Negotiation Support (INSS) system based on the "workbench" approach. We call it a workbench rather than a toolbox because the availability of tools depends on both other tools selected and the specific activities undertaken by the user in the negotiation process. That is, the user does not encounter all tools incorporated into the system, but is offered these that can be used with earlier selected tools, that can process available information, and are applicable to the activity the user is undertaking.

The second key aspect for an NSS to be used in real life is its ability to communicate with other systems and its integration. In this case the NSS performs two roles; it acts as an interface between users and other systems, in addition to providing negotiation support. There are many possible configurations in which such an NSS can be positioned; three of them are presented in

Fig. 2.

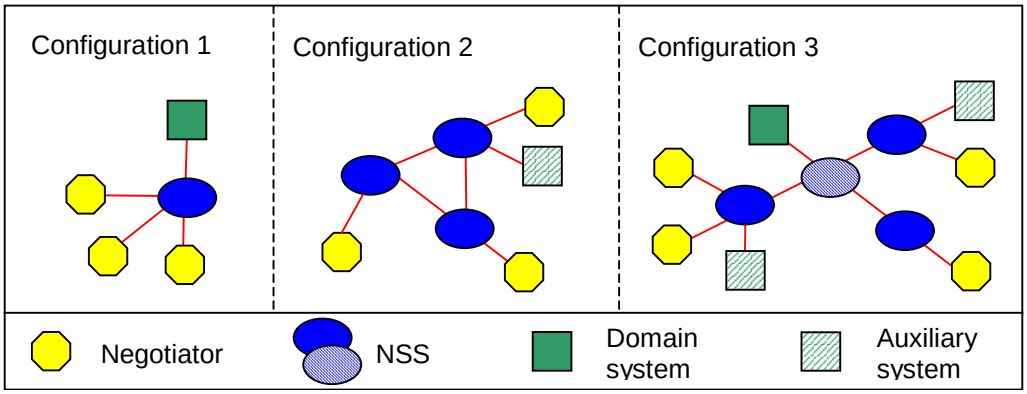

Figure 2. Three NSS configurations

In configuration 1 there is one NSS through which users negotiate and interact with other (typically remote) systems. This NSS would be under the control of a "third party" or the organization for which all the parties work, and it would not be controlled by any of the negotiators.

An example of configuration 1 is a group of people who need to prepare a joint plan, project, or design. The NSS is used to determine and analyze the design's attributes and parameters and exchange proposals and arguments. The parameter values and specific proposals are obtained from the "domain system". This system can be a simulation system, legal document preparation system, optimization system, or any other that is used to obtain and evaluate a whole or a part of a proposal (offer), and to simulate and assess the proposal's possible implications. In the first configuration all negotiators use the same negotiation support and domain systems. This does not mean that one negotiator cannot access and use resources individually and without consulting the others.

Configuration 2 involves several NSS, each supporting one party and under the party's control. Parties communicate among themselves via individual NSS. An individual NSS may use an auxiliary system that has access local databases and process proprietary information. This configuration assumes that there is no "third party" or impartial organization that can provide services to all the negotiators.

Configuration 3 also involves several NSS. One of them, however, supports the overall negotiation process; it may be used for the purpose of communication and common repository of messages and offers. This is the approach that we plan to undertake in INSS development; part of the system resides on the Web server and it communicates with sub-systems controlled by users and residing on their local machines.

The domain system is, for example, one similar to the RAINS (IIASA, 1998) system that simulates changes in air pollution in Europe caused by agriculture, industry, cities, etc. Negotiators are representatives of different European countries who prepare proposals based on the scenario generated from RAINS, possibly augmented with a region or country-specific financial accounting system, forecasting system, etc. These region (country, organization, negotiator) specific systems are the auxiliary systems.

One can envision many different configurations being set up for different types of negotiations. The flexibility of the tools should allow the negotiating parties to create a configuration that best matches their organizational, cultural and other requirements.

With the increase of the use of regional and multi-country simulation systems the demand for NSS that allow for the communication with domain systems and facilitation of negotiations between parties that represent different regional interests, should also increase. Such domain systems are being developed by many international agencies. Their number is rapidly increasing.

The use of Configuration 3 or its variant is not limited to environmental negotiations. One can envision a legal document preparation system that parties can use in international trade negotiations for joint preparation of documents. Joint venture negotiations can utilize a market simulation system offered by some consulting agency.

Negotiating agents

We have discussed two directions for the development and use of NSS. The third direction involves negotiating software agents. Some or all negotiators indicated in Fig. 2, need not be human but they may be autonomous software agents that engage in negotiations with others. Internet connectivity and the steadily increasing bandwidth open up exciting possibilities, in particular content-rich interactions including e-commerce and virtual markets.

The availability of e-commerce tools allows individual and organizational customers to search for suppliers anywhere and make deals electronically (Andersen Consulting 1997; Doorenbos *et al*., 1997; Jango, 1998). The complexity of decision making and negotiations will further increase as software agents become more adept, electronic markets (where an increasing number of companies post services and products) get broader, and bidding systems proliferate. There will be demand for systems that not only seek deals, but also engage in business negotiations and make business decisions (Kersten and Szpakowicz 1998).

Certain negotiation services via software agents are already available. Sun's Matchmaker allows customers and vendors to post offers (at various level of detail) and to receive prompt notification of close matches. PersonaLogic (1998) allows consumers to learn about products they wish to purchase and provides support by reducing the number of products through the introduction of constraints and bounds on the product’s features.

Current work on the technologies that support consumers and businesses in making purchasing decisions includes the development of software agents and electronic markets populated by multiple interacting agents (Guttman *et al*., 1998; Guttman and Maes, 1998). These programs are very simple from the point of view of decision making and negotiations. Most of them do not allow multi-issue negotiations, and typically employ one mechanism for offer evaluation.

Another approach to business negotiation with the use of software agents is based on the value chain model (Kersten and Szpakowicz 1998). The NSS plays the role of a front-end, interacts with the user and provides specifications for the agent that, in turn, interacts with other agents or sellers. In Fig. 3 the organization and roles of the entities in the negotiation process are presented from the buyer’s perspective, but this can be easily adapted to the seller's perspective.

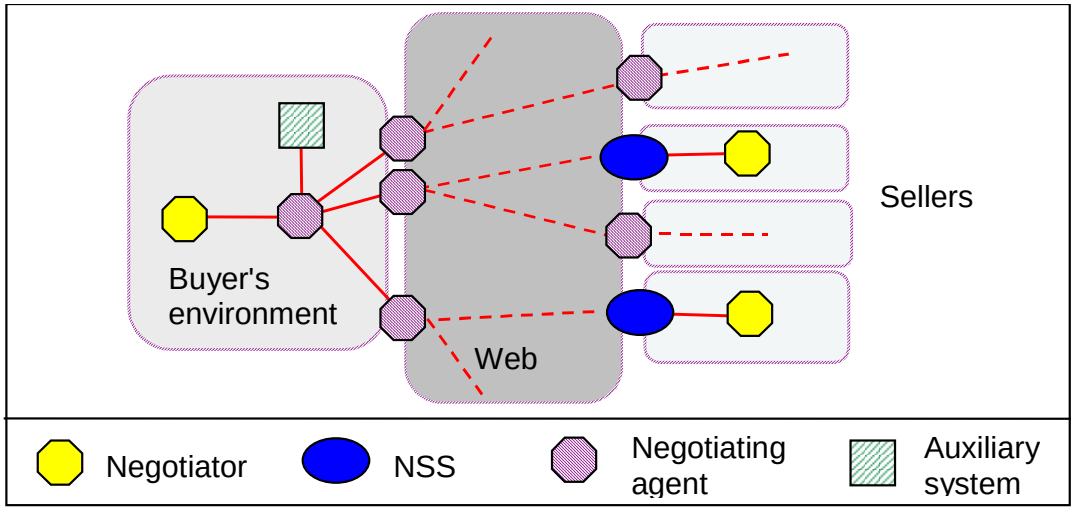

Figure 3. Negotiating agents and NSS

The configuration presented in Fig. 1 comprises of negotiating agents and systems that provide distinct functionalities in the buying/selling process. The buyer interacts with an agent that represents his interests. The agent is local and resides on the buyer's machine with its autonomy being defined by the buyer. This agent obtains the buyer's request, constraints and preferences, possibly constructs his utility function, level of autonomy in making deals, and the negotiating strategy. It then invokes agents that roam the web in search for the potential sellers. These agents carry offers and counter-offers between localized agents and NSS. Using the Negoplan system we have built a prototype of such an environment and conducted simple experiments (Kersten and Szpakowicz 1998).

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