Revised version will appear in:

Journal of Multi-Criteria Decision Analysis

e-Democracy and Participatory Decision Processes: Lessons from *e*-Negotiation Experiments

Gregory E. Kersten

School of Management, University of Ottawa, Ottawa, Canada (kersten@management.uottawa.ca).

e-Democracy takes place at different levels, ranging from local to regional to state governments. It also takes different forms: voting, consultation, and the participation in the construction of the alternative course of actions. This paper is concerned with the use of information and communication technologies in participative *e*-democracy at community and local government levels. It postulates that to design participating systems the needs of the potential users must be determined and models of decision-making and conflict resolution that can be used by lay people need to be constructed. A general framework for the design of systems for participatory decision-making is presented. The experiences with the design and deployment of the Inspire *e*-negotiation support system, its use by a large number of people from many countries, and the results of studies of the users and the use of Inspire are presented. Based on these experiences, an example of the implementation of the general framework is given. The paper also stresses the need for the development of aids and materials for lay people who wish to educate themselves in participating in *e*-democratic processes.

Keywords: negotiations, decision support, negotiation analysis, multiple criteria decisions, internet systems, conjoint analysis, participatory decision-making.

Acknowledgements: This work was supported with grants from the Initiative for New Economy of the Social Sciences and Humanities Research Council Canada, and the Natural Science and Engineering Research Council Canada.

1. Introduction

Democracy means that people participate in making decisions either directly or through electing their representatives. With a few exceptions of the regions where referenda are used on an ongoing basis, implementation of direct democracy has not been possible since the Athenian Republic. Not all Athenians could partake in policy formulation and state decisions: women, slaves and poor were excluded. Cartledge (1993) estimates that only about 15% of the total population (including slaves) was entitled to participate in democratic processes. Imperfect as they Athenian system may have been, the principle of the citizens' direct participation and the expectation that all qualified citizens be involved are the two ideas on which modern conceptualization of participatory democracy is built.

However, there is a major difference between the citizens of the Athenian republic and the citizens in modern democracies, namely the level of the involvement in decision-making. While the former participated in discussions about the various possible decisions and their implications *prior* to the actual decisions, the latter are involved in either electing representatives who make decisions on their behalf or approving an alternative proposed to them. One such example are referenda.

To address the issue of all citizens' direct participation referenda became an accepted option in some regions of the world today. And although they meet the requirement of broad and direct participation, they have shown mixed results. For example, in some cases they have delayed democratic decisions: only in 1971 women obtained voting rights in Switzerland; many referenda in California are over frivolous or contradictory issues, results of some led the state close to bankruptcy (Economist, 2003). Providing citizens with efficient voting solutions may lead to decisions that some modern governments would have difficulty accepting (e.g., death penalty, abortion ban or deportation of illegal immigrants).

Participatory democracy, like the Athenian democracy, requires that the citizens be involved in all phases of decision-making rather than solely in the acceptance of an alternative through, for example, a vote. The citizens need, therefore, to learn about the problem, its alternative solutions and their implications, and about their own and other participants' interests and constraints. Because these interests may conflict, the citizens need to be able to identify conflicts and resolve them. It is also necessary that they be able and willing to take responsibility for their decisions.

A truly participatory democracy in which people are engaged in every decision process at each level of government may not be feasible. However, information and communication technologies (ICTs) pro-

vide opportunities to augment and complement the existing democratic mechanisms. These technologies have been used at different levels of government with the focus on providing access to information, facilitating participation in on-line communities and voting (Poland 2001; Rosen, 2001; HM Government, 2002; Leninhan, 2002).

e-Democracy may take various forms of citizens' involvement. At one extreme, ICT may be used in the same way as other media: broadcasting information and providing citizens with a limited ability to voice their opinion. At the other extreme, ICT has been seen as an opportunity for societal decision-making with all citizens engaged in the decision process as the Athenians were (Rheingold, 1993, p. 279; Gaynor, 1996), (with robots, softbots and other bots being the modern slaves (Brown *et al.*, 2000)). In-between are solutions that facilitate discussion and collaboration (Luehrs *et al.*, 2001), help participants to learn about possible alternatives, their constraints and implications, aid them in the specification of their preferences, and provide other support tools. The tools include multi-criteria decision analysis (MCDA) which for many years have been used to aid decision makers.

Traditionally, MCDA has been concerned with providing models and procedures that are used by analysts or decision makers who understand their intricacies. The focus is on: (1) specification of the model of the decision problem and of the model of the decision maker, (2) introduction of a structure to the decision-making process, and (3) facilitation of decision-makers' learning experience mediated by the analyst (French, 1986; Henig *et al.*, 1996). Analysts, who are users of systems in which MCDA models are embedded, share professional culture with the developers, have similar levels of expertise, and have similar rewards for their work. They know MCDAs' underlying assumptions and their capabilities.

In the wide spectrum of decision-aids for societal decision-making there is a need for expert-oriented MCDA-based systems. There is also a need for aids that can be used by lay people who wish to be involved in societal decisions. But there is a huge difference between experts and lay people. MCDA designers and specialists have common professional interests and competencies allowing the former to construct aids for a known skill- and knowledge-level of the latter. This is not the case if everyone is a potential user. A system designed for the general public participation must address the needs of the people whose interests, skills, knowledge and culture vary. Such systems need to be expressive and robust, capable of matching users' skills, and able to engage users in the learning process.

The systems that support active public participation in decision-making can be implemented at the local government and community levels. Many decisions made at these levels are more specific and

tangible than those made at the national or regional levels. Examples of these decisions include infrastructure, sale of property, construction and municipal organization (Rosen, 2001, p. 7). They also involve and affect a significantly smaller number of people; hundreds or thousands rather than millions. Therefore, introduction of decision-aids at local government and community levels seems more promising than at the state level.

If we accept the necessity to create opportunities for local communities' to participate actively, we realize that the provision of the existing decision-aids is not sufficient. Researchers in decision sciences and software developers have both expertise and experience in the construction of models and systems for experts and/or homogenous users (who often undergo the required training), but they know very little about heterogeneous users who would not spend time on training or understanding models embedded in systems. Admittedly, much work has been done in the area of end-user computing and ICT adoption in organizations (e.g., Davis, 1989; Pinsonneault *et al.*, 1989; Etezadi-Amoli *et al.*, 1996; Jackson *et al.*, 1997) but almost none in the use of ICT in decision-making by members of the general public. In other words, little is known about the potential lay users, their needs and abilities. Harrap *et al.* (2001, p. 7) note: "If we intend to build tools that reach a broad audience and build long term understanding of issues, we need to understand how people learn and make decisions."

A percentage of the population fears technology (Creative Research, 2002). This, together with the fact that ICT adoption requires time and effort makes learning about the potential user population necessary. It also calls for preparation of various resources and tools that help people learn how to use decision aids.

Business-to-consumer (B2C) systems provide novel tools to recommend products based on the construction of linear value functions and collaborative filtering (Shardanand *et al.*, 1995; Pennock, Horvitz *et al.* 2000). The construction of linear value functions with tools such as Personalogic's DecisionMaker engine (Afzali, 1998) requires that users select attributes that are relevant to them and they assign weights for the selected attributes. These tools have not been popular and have been withdrawn from *e*-markets (e.g., construction of weights for product or service ranking on dealtime.com, personalogic.com and CarMatch on excite.com). In contrast, collaborative filtering, available on, amazon.com, reel.com and *e*-markets, became very popular, possibly due to minimal information requirements. The users need to select only a product that they like and they obtain recommendation based on customers who had purchased this and other products.

The experiences with B2C *e*-commerce systems may indicate that people are not willing to spend time

on clarifying their preferences and assessing alternatives. We show in this paper that this is not necessarily the case. The user population that we studied comprise university students, managers and researchers, and therefore our results cannot be generalized. However, if community members wish to actively participate in decision-making, they need to devote their time.

It has been shown that people engage in the consultation process (Rosen, 2001; Agostioni *et al.*, 2002). The scope and degree of their involvement in ICT supported decision-making at the local level remains an open question. Clearly more research about the ease of use and efficacy of different aids is required. This means that it is necessary to study the user population as well as the suitability of different aids and other tools for different types of users.

This paper is concerned with the design of, and experiments with, systems designed to educate and support non-experts in decision-making and conflict resolution. It is based on three complementary postulates addressed to the community of researchers and developers:

1. Specific needs and abilities of the potential users, various types of users and their requirements for different aids must be determined;
2. Models and procedures of decision-making, and systems capable of supporting ad hoc groups, need to be constructed; and
3. Aids and materials for people who wish to educate themselves in structuring decision problems, constructing and evaluating alternatives, and identifying and resolving conflicts need to be developed.

The objective of this paper is to address these three postulates. This is done at two levels. First I propose a general framework for system design and implementation and study of its role in societal decisions leading to the specification of user-types and the recognition of the differences among them. At the second, specific, level I discuss Inspire, a decision and negotiation support system used by almost 6,000 people, its role in the process and outcomes, and the results of studies of the relationship between users' characteristics and the system use and its acceptance. This discussion leads to a particular implementation of the general framework.

It should be pointed out that the Inspire system and its current extensions were not designed for the purpose of decision and negotiation support at the community level. Inspire was designed to support negotiations between businesses and between non-profit organizations; it has been used in teaching and training. Yet the experiences with the system's design and its use are relevant to the participatory

decision processes. Mostly, this is because of its usefulness for non-experts but also because observation of the users' activities and perceptions, and studies of the relationships between the users' characteristics, the usage of the system, the process and the results provide insights into the design of systems for participatory decision-making. In that, the study of the Inspire users and their interactions addresses the first two postulates.

The third postulate regarding the need to provide aids and materials for public education is partially addressed. One population of Inspire users are surfers who wish to educate themselves in the conduct of negotiation. Their and other users' comments and suggestions led us to develop a comprehensive set of materials, cases and exercises for on-line training.

The paper is structured as follows. The proposed general framework for system design and study of its use and users is presented in Section 2. The basis for this framework is the proposed integration of behavioural and analytic research to construct systems capable of providing effective aid to a large number of users with different characteristics. One example of such a system is Inspire; an overview of this system and its tools is given in Section 3. The use and users of the Inspire system are described in Section 4. Based on the experiments with Inspire we have developed other systems and a web-based platform for teaching decision-making and negotiation. Experiences with these systems and the teaching platform are presented in Section 4. In Section 5 a concrete implementation of the general framework is discussed, followed by future work and conclusions.

2. A framework for designing societal support systems

In the preceding section, I outlined the differences between users of the traditional decision support systems (DSSs) in which MCDA and other decision-analytic models are embedded, and systems designed for participatory decision-making and conflict resolution. These differences require consideration of decisions made by lay people as opposed to those made by analysts and experts. Acquired knowledge and training of the latter led them to incorporating software in their work. Non-experts would use software only if: (1) it fits the activities they already undertake, (2) gives tools that increase the process' efficiency and/or effectiveness, and (3) creates an advantage over the established practice.

The design and implementation of systems for participatory decision-making require that we take a fresh look at the existing methods, models and procedures of both formal and behavioural theories of individual and group decision making, conflict resolution and negotiations. It requires integration of studies from to-date disparate disciplines, including political decision-making, management, psychol-

ogy, sociology, information systems (in particular, usability and implementation and adoption of technology), and anthropology. These integrative efforts are necessary so that we can design systems that can actively participate in the social processes and are capable of aiding users who have no access to analysts.

Integration of results from these widely disparate disciplines and adaptation of models, frameworks and tools for the purpose of societal decision-making is difficult. Design and implementation of support systems that can be effectively used by many heterogeneous users is one of the most challenging tasks that the scientific and engineering community faces today (Harrap *et al.*, 2001; Bichler *et al.*, 2003; Kersten, 2003). The three key reasons underlying the difficulties in their design and implementation are:

1. The targeted user community comprises individuals, groups and organizations who widely differ in their characteristics, attitudes, roles and perspectives;
2. The decision problems are often only partially described, ill-defined and modified during the decision-making process; and
3. There are typically different perceptions of the problem, objectives and agendas leading to conflicts among the participants.

Studies in anthropology, psychology, sociology and management show that decision and negotiation processes depend on a number of characteristics of their participants (Druckman 1977; Gulliver 1979; Bazerman *et al.*, 2000). If technology is to partake in these processes, the users' characteristics have to be considered.

Decision analysis, game theory and negotiation analysis have been used in the design of support systems for individual and multi-participant decision making (Bui, 1996; Rangaswamy *et al.*, 1997; Holsapple *et al.*, 1998; Hämäläinen *et al.*, 2001). Researchers in computer science recognized the fact that on-line customers would use systems that are easy to use, meet their requirements and are effective (Rogers 1995). They used pragmatic rather than normative perspective and designed simplified models of choice and decision-making based on naïve Bayesian models, linear value functions, genetic algorithms and other mechanisms (see, e.g., Resnick *et al.*, 1994; Shardanand *et al.*, 1995; Breese *et al.*, 1998). Contributions of computer science research also include: (1) software platforms that allow for flexible configurations of services to match different requirements of different users, for example, SilkRoad (Ströbel, 2003) and IBM WebSphere; and (2) software agents that are capable of undertaking activities on behalf of their users-principals (see, e.g., Bradshaw 1997; Maes, *et al.*, 1999;

Wang, 1999).

A framework for the design, deployment and use of systems capable of aiding groups of heterogeneous users takes into account the integration requirement is presented in Figure 1. This framework also addresses the requirement resulting from the three postulates formulated in Section 1. These two requirements are represented by two types of interactions between the framework's components.

The integration aspect is indicated with solid arrows that link knowledge about problems, users, models, methods and tools. This knowledge is utilized in the engineering of social processes of which outcome is a specific societal or community support system. Observations of the implementation and use of the system in experiments and pilot studies give data for the study of its usability, adoption and efficacy of the implemented solutions. The results of these studies provide feedback, indicated with dashed arrows, used to revise the assumptions and knowledge used for the system design.

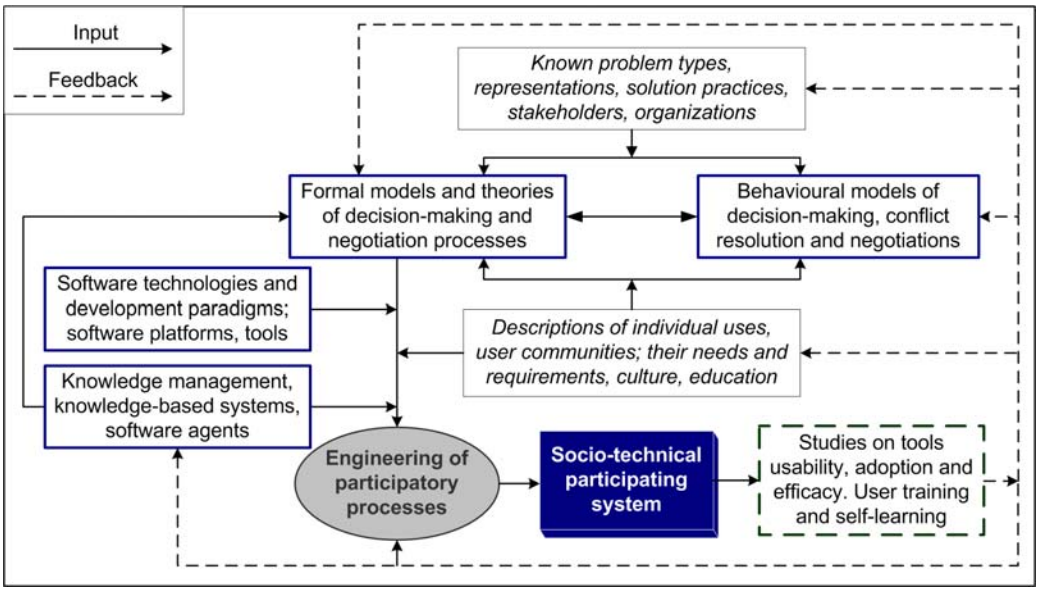


Figure 1. Design, deployment and studies of systems for participatory decision-making

The proposed framework focuses on the engineering of societal decision processes, in particular at the local government and community levels, in which ICTs play active roles. The process takes place through the interaction of technical and behavioural components of a *socio-technical system*. It is a system that comprises people and technological solutions – both actively involved in the participatory processes – rather than a social system that is mediated with technology (Ropohl, 1999). The socio-technical system for participatory democracy resembles 'collaboratories' used in cooperative work arrangement (Schmidt *et al.*, 1992) in that it is an outcome of people, practices, technologies and val-

ues interacting in a given setting (Nardi *et al.*, 1999).

In a socio-technical system, activities are distributed among people and software. It is therefore important that the division of labour and the protocols that govern the activities of, and the interactions among, the system's components are defined. These protocols are necessary for software to interpret input and to be able to interact in a meaningful way with its users and other software. They allow to position decision aids and other active components in the decision-making and negotiation process. They are obtained through the formalization of behavioural models of decision making, conflict resolution and negotiation.

The specification of behavioural models, and formal models and procedures is determined (see Figure 1), based on the assumptions about and knowledge of: (1) the users and user communities, and (2) the types of problems, their representations, solution practices, organizational setting and stakeholders other than the users. These assumptions and knowledge, together with the selected models and procedures may also be used to determine (3) software platforms and tools, and (4) knowledge representation and management methods. Activities (1) - (4) result in the specification of the models, methods and tools used in the *engineering of participatory processes* to construct all technological components of the *socio-technical participating system.*

The purpose of the framework depicted in Figure 1 is to design socio-technical participating systems and deploy them in various experimental settings. The experimental use has dual purpose to: (1) conduct studies on the usability, adoption and efficacy of the implemented solutions, and (2) provide training materials and facilitate users' self-learning. The results of the experimental use allow the designers to learn about the users' needs and abilities. They also provide additional information about the usability, flexibility and expressiveness of the technical components. This, in turn, allows the designers to modify models and software tools.

In the next section an example of integration of a behavioural negotiation model and a formal decision model in a negotiation support system used by non-experts is presented.

3. Overview of Inspire system

Since 1996 we have conducted *e*-negotiation experiments with Inspire, a negotiation support system deployed on the web (Kersten *et al.*, 1999). Almost 6,000 students, managers, lawyers, and physicians from over 50 countries have used this system. The experiments showed that negotiators can use deci-

sion-theoretic and process visualization tools effectively, and employ a structured approach to the conduct of the negotiation. They also showed that the negotiators' characteristics (e.g., culture, education, profession) impact both the negotiation process and its outcomes (Köszegi *et al.*, 2003). These and other characteristics need to be taken into account when we provide support for societal decision-making.

Inspire was designed to allow a large number of lay people to use the system without any training and with help provided on one frequently asked questions (FAQ) web page. Because all web pages and the system's instructions are in English, an effort was made to make them simple and easy to read. Prior to its deployment on the web the system was tested with two groups of international students taking intermediate English as a Second Language course.

3.1 Negotiation model

Negotiations via the Inspire systems are bilateral. They are conducted anonymously with the deadline set three weeks after they begin (upon request of both negotiators the deadline may be extended). Vast majority of the negotiation requests comes from the instructors who use the negotiations as an assignment in various courses.[1] Once every several weeks students from one university are paired with students from a university in another city or country.

Gulliver's (1979) extensive anthropological and sociological studies of negotiations led him to distinguish negotiation phases and activities. Gulliver proposes an eight phase model, which for the purpose of electronic negotiations, has been simplified to five phases (Kersten, 1997).

In the Inspire negotiations the first two phases of the simplified model, namely *Search for arena and selection of the communication mode* and *Agenda setting and agreement on the terminology and the negotiated issues*, are not included because the arena, communication mode and other activities are predetermined. Most users negotiate over the same business problem; they represent two companies, Cypress and Itex which wish to, respectively, sell and buy products.

The third phase of the simplified model: *Exploring the field*, involves analysis of the problem, specification of preferences, formulation of reservation and aspiration levels, and selection of the initial strategies and tactics. This is the first phase in Inspire negotiations and its activities are listed in Table

[1] The instructor's request page is at: http://interneg.org/interneg/training/inspire/instructors_synopsis.html

1 (1st column).

The focus of the subsequent phase *Narrowing the differences and search for agreement* is on the exchange of information between the negotiators including exchange specific and substantive proposals. In this phase they learn about their counter-parts, identify critical areas of disagreement, determine concessions and formulate supporting arguments. This phase involves the negotiators' learning about their counter-parts and, possibly, recognition of the additional issues directly related to the problem or to the relationship between the two companies. This, in turn, may lead to the revision of preferences and aspirations. This phase ends with either an agreement or the termination of the negotiation. The activities supported with Inspire in this phase are given in Table 1 (2nd column).

Table 1. Inspire negotiation phases and activities

Exploring the field	**Search for agreement**	**Agreement improvement**
Learning about the problem	Formulation of messages	Agreement assessment
Reservation and aspiration levels specification	Offer construction and assessment	Efficient alternatives domination agreement
Preference elicitation	Offer and message exchange	Offer construction and assessment
Construction of value function	Value function modification	Formulation of messages
Verification of value function	Negotiation history construction	Offer and message exchange
Preference elicitation	Negotiation process visualization	Negotiation history construction
		Negotiation process visualization

If the conclusion of the previous phase is an agreement then the parties move to: *Agreement assessment and improvement* phase. In this phase Inspire determines the agreement's efficiency. If it is inefficient, then the system identifies efficient alternatives and suggests up to five for re-negotiations. The chosen protocol is that the accepted agreement is the basis for negotiations and only improvements are possible. The parties may either agree on an alternative that dominates the compromise (it need not be efficient) or decide to terminate the negotiation accepting the compromise achieved in the previous phase.

All main activities supported with Inspire are listed in Table 1. The implementation of these activities is briefly discussed in the next three sections.

3.2 Value function construction

Inspire provides decision aids to elicit users' preferences and to construct a value function. We as-

sumed that a system cannot impose significant information requirement on its users and, therefore, chose hybrid (compositional as well as decompositional) conjoint analysis (Green *et al.*, 1978; Angur e*t al.*, 1996).

Hybrid conjoint analysis is easy to use. It allows participants to experiment with it and, if required, to revise their preferences prior and during the negotiations, i.e., during the *Exploring the field* and *Narrowing the differences and search for agreement* phases. This method does not allow for the consideration of the risk attitude and the value function may not precisely represent the decision maker's preferences. Although it allows for the consideration of interactions between attributes (negotiated issues), we assumed no interactions so that an additive model can be applied.

The value function is obtained in three steps. In the first (compositional) step, illustrated in Figure 2, the user distributes 100 points among the four negotiated issues. All issues are described in detail in the negotiation case and users are also informed about the most and least preferred alternatives (options) for each issue.

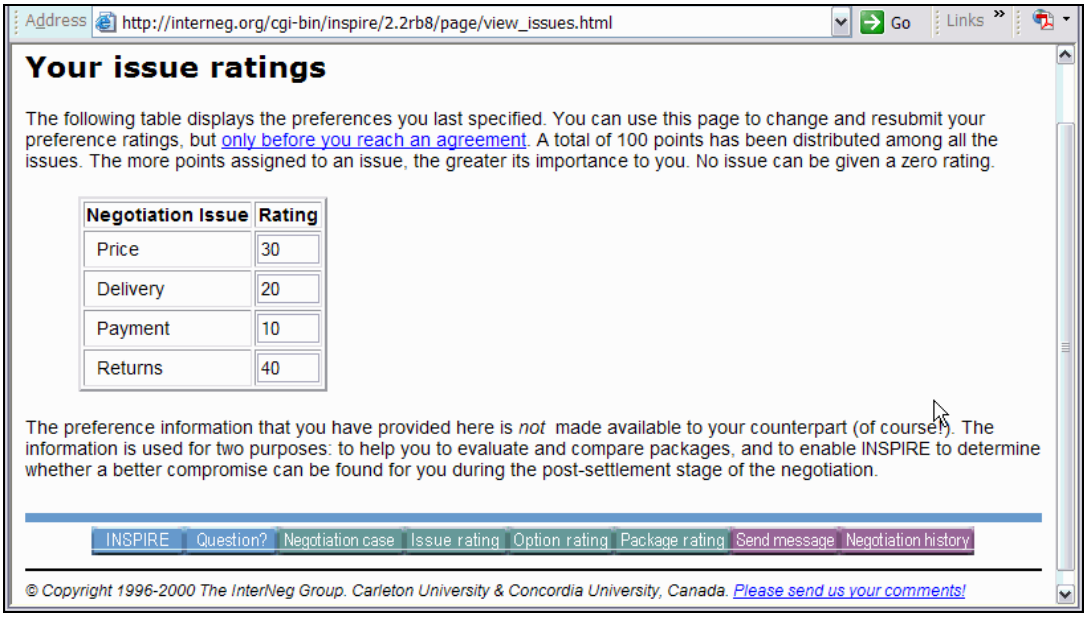


Figure 2. Issue ratings

After completing the issue rating step, the user is prompted to rate all possible options. Note that in this version of Inspire users cannot add issues or options; this limitation allows us to compare negotiation and conduct statistical analysis. The option rating step is also a compositional step; it is illustrated in Figure 3.

The Issue and option rating steps allow for the construction of a simple weighting function and calculation of weights for each feasible alternative (package). In general, the number of alternatives is the product of the number of options for all the issues. In the Itex-Cypress case there are 180 full packages (5x4x3x3) in which every issue is represented by one option.

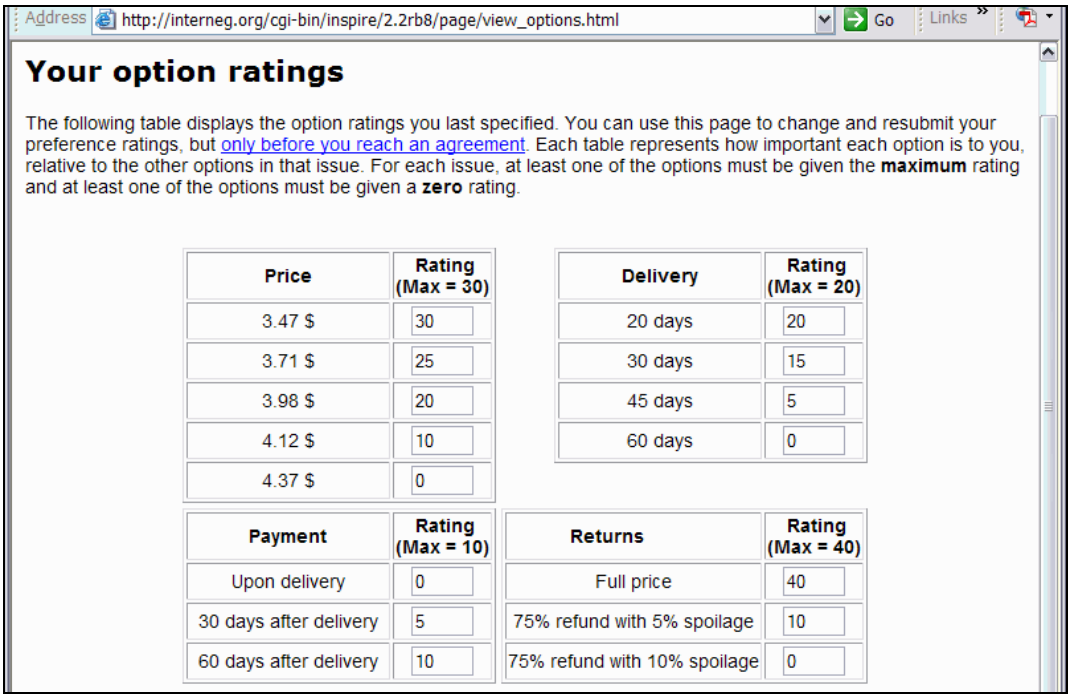


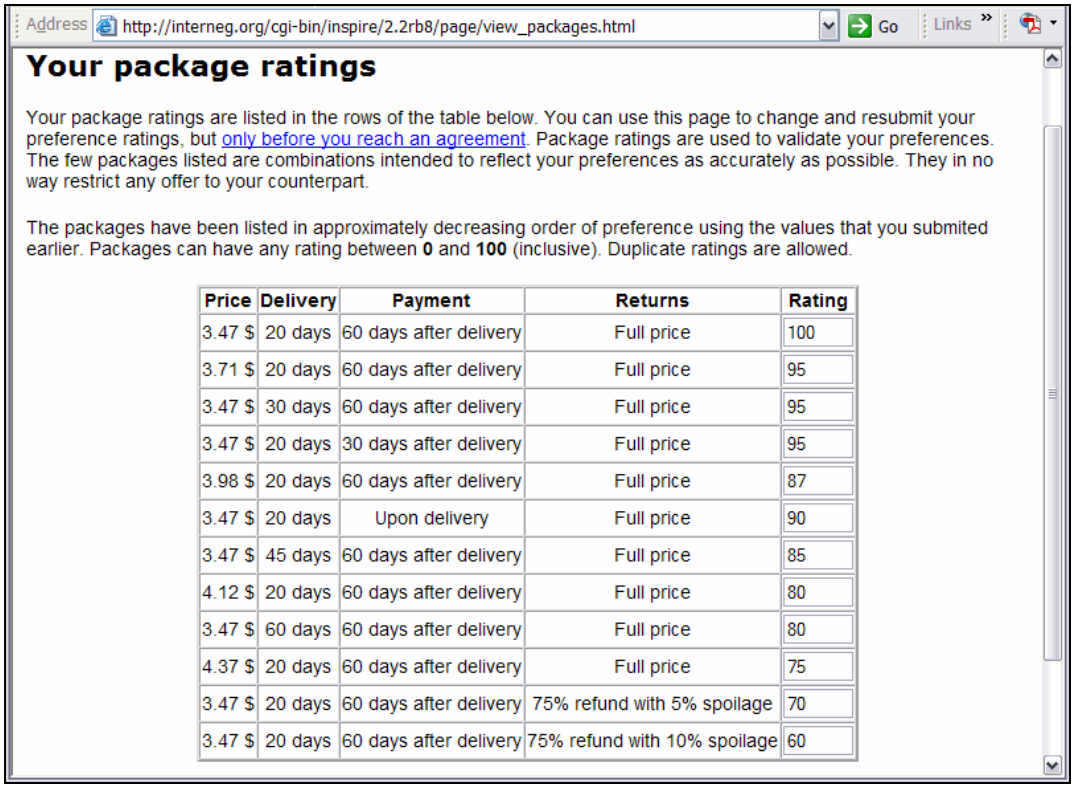
Figure 3. Option ratings

The third step is decompositional; the user evaluates several selected packages and—if required—modifies its ratings. An example of the package rating table is presented in Figure 4.

To select packages for user evaluation matrix X in which all packages are specified is constructed; $X = [x_{ij}]$ where: x_{ij} is a binary variable indicating if an option i is present in the package j, ($i = 1, \ldots, \Sigma_l n_l$, n_l is the number of options in issue l, $l = 1, \ldots, m$, m is the number of issues; and $j = 1, \ldots, \Pi_l n_l$). Each column of this matrix is associated with one full package. In the Cypress-Itex case the size of matrix X is 15 x 180.

It would be impractical to present to the user all packages for his/her holistic evaluation. We need to select a few packages, yet obtain reliable utility values. Because we assume that there are no interactions among the negotiated issues we applied one of the design methods used in fractional factorial experiments (John, 1971; Montgomery, 1997).

One of the most compact and effective designs is the orthogonal design, in which the packages are chosen so that the matrix Y associated with the selected packages is orthogonal. In the construction of an orthogonal matrix we require that every option of each issue appears at least once in the selected packages and that the value (parts-worth) of each issue can be computed with, for example, least-square method (see below). This allows for the construction of a square matrix Y of dimension $n^* = \Sigma_l n_l - n_{l^*}$, where $n_{l^*} = \min\{ n_l, l = 1, \ldots, m\}$. For the Cypress-Itex case the constructed matrix corresponds to 12 packages (5+4+3+3-3), which are displayed in Figure 4.



Price	Delivery	Payment	Returns	Rating
3.47 $	20 days	60 days after delivery	Full price	100
3.71 $	20 days	60 days after delivery	Full price	95
3.47 $	30 days	60 days after delivery	Full price	95
3.47 $	20 days	30 days after delivery	Full price	95
3.98 $	20 days	60 days after delivery	Full price	87
3.47 $	20 days	Upon delivery	Full price	90
3.47 $	45 days	60 days after delivery	Full price	85
4.12 $	20 days	60 days after delivery	Full price	80
3.47 $	60 days	60 days after delivery	Full price	80
4.37 $	20 days	60 days after delivery	Full price	75
3.47 $	20 days	60 days after delivery	75% refund with 5% spoilage	70
3.47 $	20 days	60 days after delivery	75% refund with 10% spoilage	60

Figure 4. Package ratings

Note 1. The packages associated with matrix Y are not balanced in terms of the frequency of options appearing in the list and the distribution of the package values. This may introduce a bias both in the verification of preferences and in the conduct of the negotiation. We are modifying the algorithms to generate several different matrices and empirically test if different designs influence negotiations.

Note 2. In the Inspire implementation all selected packages are displayed simultaneously and their values are given. A possible modification of the method would be implementing an adaptive hybrid conjoint analysis in which two packages are displayed at a time and the user is asked to choose either

the preferred package or provide a rating indicating his/her strength of preference (Sawtooth Software, 2002). We did not implement this design because it would require a number of interactions between the user and the system. However, with the greatly increased speed of the internet communication this approach may now be implemented.

If the user modifies the ratings of the selected packages (Figure 4, last column) the total utility of a package is decomposed into constituent option utilities using an additive model:

$$r_l = constant + \Sigma_i \Sigma_j \; v_{ijl}\, y_{ijl} + error_l \;\; (l = 1, \ldots, n^*),$$

where: r_l is the rating of a package l selected for user evaluation, v_{ijl} is the partial value (part-worth) of option j in issue i present in package l, and y_{ijl} is a binary variable indicating whether the given option is present in this package. Given the ratings for these packages, values v_{ijl} are computed using ordinary-least-square (OLS) regression to minimize the error terms.

Note 3. If the user makes significant changes in the ratings, the values v_{ijl} computed with OLS may cause that the minimum and maximum values of the packages are smaller or greater than, respectively, 0 and 100. We assume that a small deviation of 7% is acceptable; if it takes place, all values v_{ijl} are scaled so that the two extreme packages have values of 0 and 100. If the deviation is greater than 7%, then the user is requested to revise her/his inputs.

3.3 Negotiation process

The conduct of negotiations involves two modes of communication: structured offers and free-text messages. Offers have a predefined format; they contain names of the issues and options (issue values). While constructing or analyzing an offer, users automatically obtain its utility value. This is shown in Figure 5 presenting an offer construction page.

An offer may be accompanied by a message, which allows for argumentation and backing. Users may also send separate messages in order to, for example, set the climate, request explanations, or press their counterpart to reply. These and other activities that can be performed during the conduct phase are listed in Table 1 (Section 3.1).

During the offer construction and message composition, users are provided with the last two offers exchanged (see Figure 5). They also may review all exchanged offers and messages in the negotiation history which displays negotiation transcript and graphical representation of offers. An example of the latter is given in Figure 6.

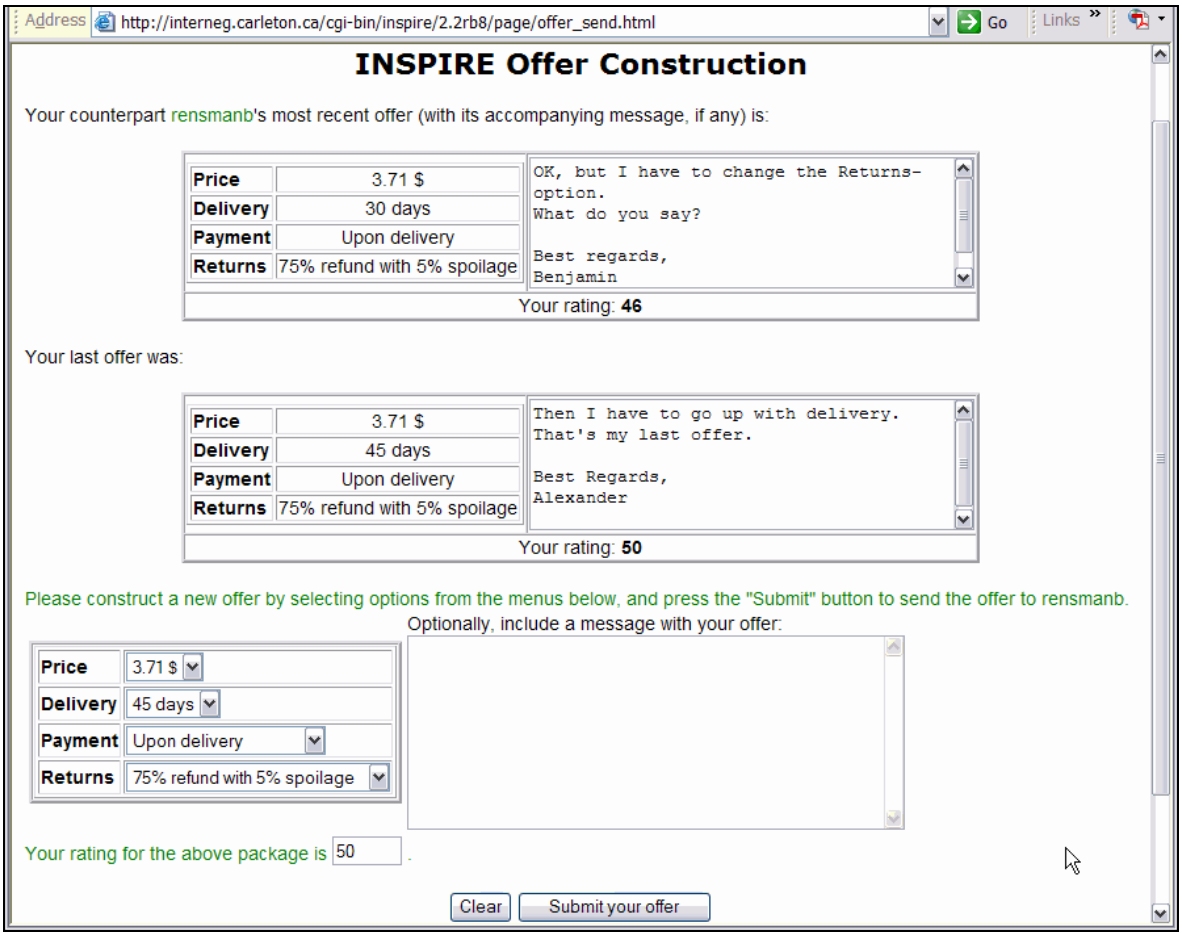


Figure 5. Offer construction

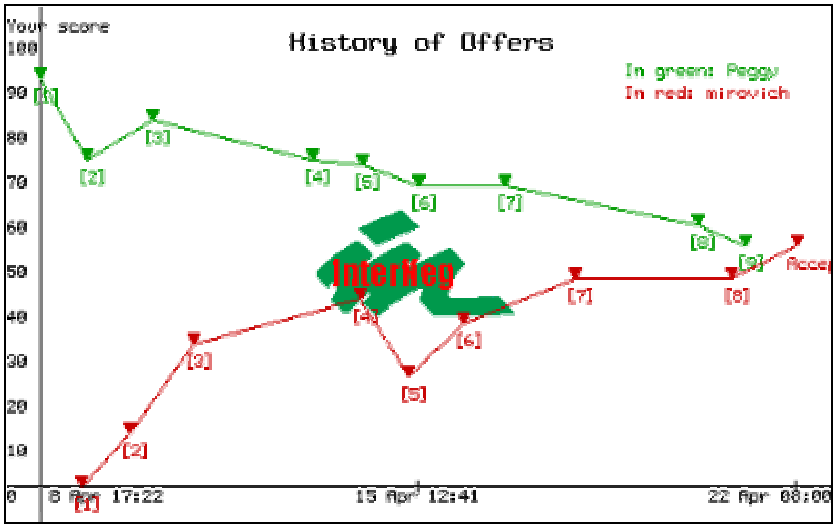


Figure 6. Graphical representation of offers in *Peggy*'s value space

3.4 Agreement improvement

Once an agreement has been achieved during the conduct phase, Inspire checks it for its efficiency (Pareto-optimality). This is the stage when the system acts as a mediator and takes into consideration the utilities of the two parties. Negotiation ends if the compromise is efficient. Otherwise the system computes efficient packages and displays several of them for both users. The displayed efficient packages include those which increase one party's utility alone, as well as the mid-point solutions. This is illustrated in Figure 7.

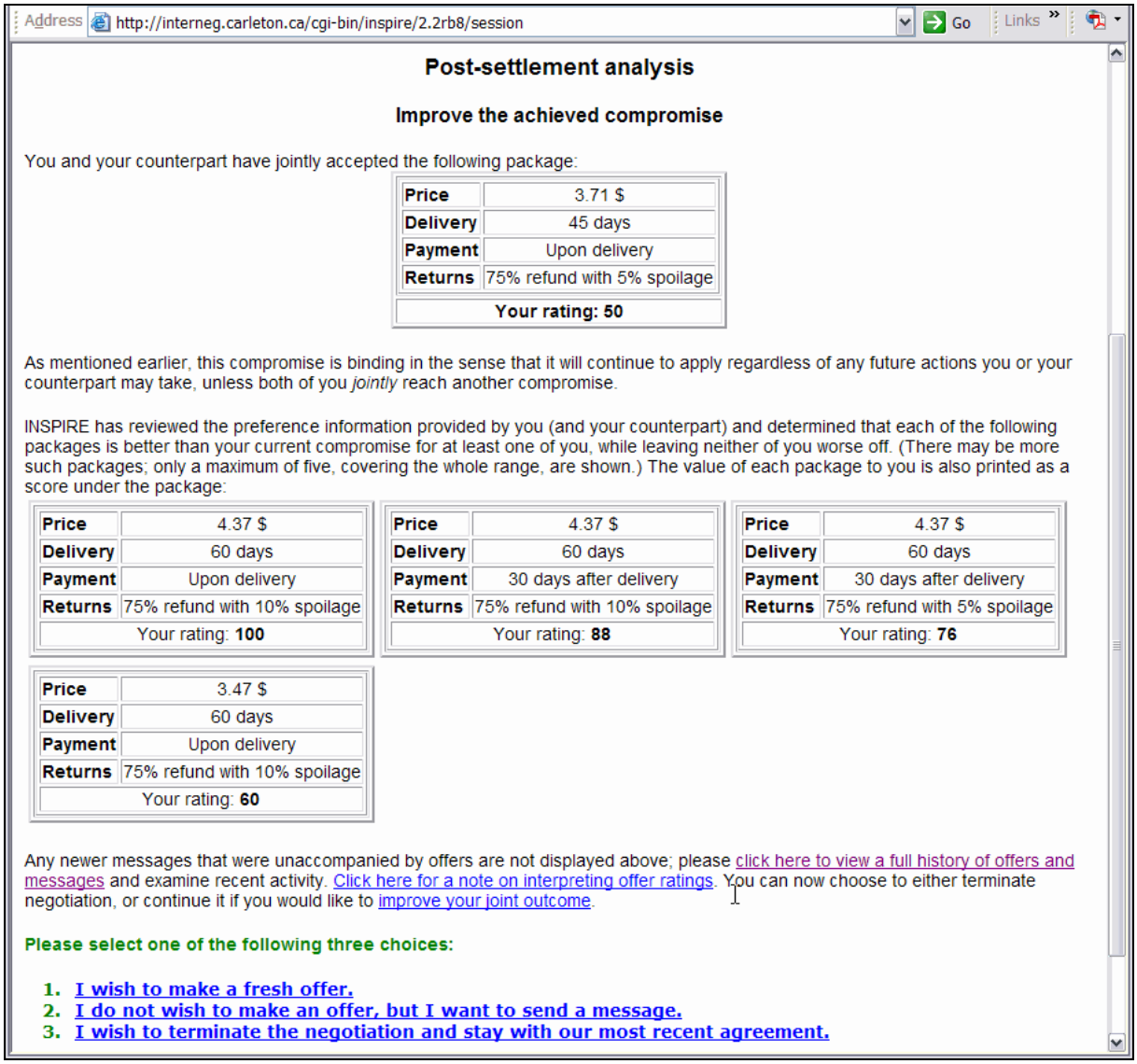


Figure 7. Inspire suggests efficient packages

The list of the post-settlement phase activities is similar to that of the conduct of negotiation phase and

is listed in Table 1 (Section 3.1). The system's additional activity is the computation, selection, and display of efficient offers. A notable distinction is that in the agreement improvement phase, users cannot revise their preferences. This is because in this phase the system uses the preference information to determine and display efficient packages. If either party changes their utility structure, the current efficient solutions may become inefficient; in particular, the last-reached inefficient compromise may turn efficient, effectively terminating the negotiation in a way that would be considered unexpected by the counterpart. Apart from confusion, unilateral transformation of the efficient set under consideration can undercut the acceptability of the mediation process.

4. The use and the users of Inspire

4.1 Users

The Inspire system was developed in the early stages of the web and, therefore, it uses internet technologies that were available in 1995 (Kersten *et al.*, 1999). For the reason of negotiation comparison and longitudinal study we keep the system's interface and its support aids intact.

Several studies of the Inspire negotiation have been undertaken. One stream of research involves the influence of the negotiators' characteristics, such as culture, gender, role-playing, age and education, on the negotiation process and outcomes (Kersten *et al.*, 1999; Kersten *et al.*, 2003; Köszegi *et al.*, 2003). The objective of these studies is to (1) learn about the users and the differences among them, (2) the relationships between the user characteristics and the use of different features of the system, and (3) the reasons underlying differences in the negotiation processes and the achieved outcomes.

The results of the analysis of the Inspire data show that users' characteristics, in particular: previous negotiation experience, the use of internet and culture, influence their perceptions of usefulness and ease of use, as well as their actual use of the system (Köszegi *et al.*, 2003). Previous negotiation experience has a positive influence on perceived ease of use of the system; however, it has a negative influence on the usefulness of its analytical features (Vetschera *et al.*, 2001). The latter result was also reported by Druckman *et al.* (2003) and it may indicate high degree of conservatism on the part of experienced negotiators.

Frequency of internet use significantly influenced the actual use of Inspire, i.e. the more frequently users access internet, the more messages and offers they exchange (Köszegi *et al.*, 2003). The number of offers and messages influences the negotiation outcome and users' satisfaction with the process. With the growing use of internet we may expect that an increased number of future users will be fre-

quent users and thus this characteristic would not have a significant impact on the negotiation process and outcomes.

Culture was found to have significant impact on the users' use of the Inspire facilities and their perceptions of the usefulness of the communication and analytical features (Köszegi *et al.*, 2003). Users from countries classified as low context (Anglo-Germanic, Nordic and Slavic) used the communication tool significantly less than users from high-context (Latin and Oriental) cultures. The extensive use of the communication platform of users from high context cultures can be explained by their need to construct a social context in which negotiations are embedded. As computer-mediated communication restricts social and visual cues, which belong to the context rather than to the task, more information needs to be coded explicitly than in a face-to-face setting.

Another study that uses Inspire data focuses on the adoption of internet technologies for decision and negotiation support. Vetschera *et al.*, (2001) formulate and test the assessment model of internet systems (AMIS) which is an extension of the technology acceptance model (TAM) (Davis, 1989). The purpose of AMIS is to determine the measures of a web-based system success based on its actual and reported system use.

Users' satisfaction and their willingness to use an information system are important concepts for system evaluation (Benbasat *et al.*, 1990; Guimaraes *et al.*, 1992). They are often used to measure the success of implementing an information system. Inspire users report very high level of willingness to use a decision and negotiation support system. The response rate to voluntary post-negotiation questionnaire is 54%. Users' attitude was measured using three questions regarding willingness to use an on-line system for negotiation: 88.2% stated that they would use a system similar to Inspire to practice negotiations, 81.3% - to prepare for actual negotiations, and 61.3% - to conduct actual negotiations.

The AMIS model was used to determine the relationship between the intention to use a system similar to Inspire and the users' characteristics, actual use of the system, experienced ease of use, experienced usefulness of the system, negotiation results, and the system's assessment. The model has been validated, and one important result of the analysis is that the communication and analytical tools need be considered separately in the measurement of the system's ease of use and its usefulness (Vetschera, *et al.*, 2001).

The results of our studies suggest that different aids for different user populations need to be designed. These results are being used in the design of decision and negotiation aids, as well as design of on-line

negotiation training and the experiments.

4.2 Aspire and other applications

The Aspire system (Kersten *et al.*, 2003) is one example of a design that addresses the needs of inexperienced negotiators. The system uses an agent to provide methodological support during each of the three negotiation phases. Aspire will be used to study the negotiation effectiveness (measured with the percentage of users who achieve agreements) and the users' willingness to improve the compromise. In an earlier study we found that 59% of users achieved a compromise and that 82% of those who achieved an inefficient compromise did not want to improve it (Kersten *et al.*, 1999).

Inspire, Aspire and other decision and negotiation support systems are used in teaching and research. We have also designed a negotiation course in which all teaching materials and several exercises and cases are available on-line (http://mis.concordia.ca/negocourse). In 2002 and 2003 the course was delivered to students at the University of Vienna, Concordia University and the University of Ottawa (Köszegi *et al.*, 2003). Through the use of various cases this course will allow us to further study the behaviour of the negotiators and also better relate the participants' negotiation styles and other characteristics to their actions. This is because students fill in several self-assessment questionnaires (e.g., Thomas-Kilman questionnaire and Hofstede questionnaire) and participate in both intra- and intercultural negotiations. We are also using the course platform to study the impact of different analytical aids on the negotiation process and outcomes.

5. Discussion

5.1 The framework implemented

In the three postulates formulated in Section 1 requirements regarding the process of designing systems for lay people, learning about their users, and providing aids and materials for training and self-learning were put forward. The general framework for the design, implementation and studies of systems for participatory decision-making was proposed in Section 2. This framework was based on the premise that these systems are socio-technical comprising people and technological solutions: both active in the participatory democratic processes. This means that decision aids and other support tools have to be seen as components of a system; their roles in the process need to be specified. This specification comes from the behavioural research on decision and negotiation process.

The Inspire system discussed in Section 4 cannot be seen as a component of a socio-technical partici-

pation system. However, its design and use provide insights into the design of such a system. In Figure 8 an implementation of the general framework (see Figure 1) was presented. This specific implementation describes the design process of *e*-negotiation systems (ENSs), such as Inspire. It also shows how the studies of the Inspire users and the system's use led to the construction of the AMIS model of technology adoption by lay people, as well as to the design of Aspire and the on-line negotiation course.

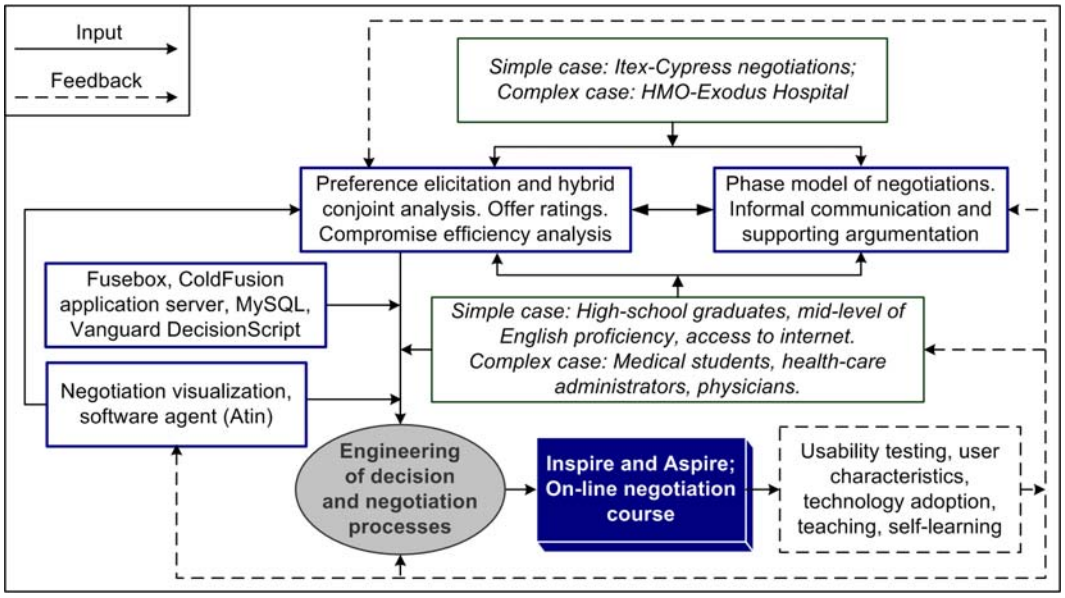


Figure 8. Implemented framework: design and implementation of ENSs, and study of their use

Numerous experiments with Inspire allowed us to learn more about the heterogeneity of users and the differences in the way they used the system and perceived its usefulness. In addition to the experiments with a relatively simple Cypress-Itex business negotiation case, we have conducted experiments using a complex case developed for health managers (7 issues and 13,500 complete packages). The targeted users of this complex case are, as shown in Figure 8, medical students, health care administrators and physicians. The case is based on real-life negotiations between a Health Management Organization and a hospital system, and therefore this negotiation requires that participants understand the US health system. Every year, since 1999, a group of graduate students in health management from the Iowa University Hospital and Clinics have used this case. These users are domain experts but their knowledge of decision making, negotiations and, in particular, the use of decision aids is similar to that of many lay people. They had not used a DSS or NSS earlier, and they did not undergo any training in using Inspire. Nonetheless, "As in years past, the student responses to the negotiation sessions were overwhelmingly positive, with many students acknowledging the unique opportunity for learning

afforded through the Inspire exercise." (Katen-Bahensky 2003).

The framework depicted in Figure 8 provides guidelines for the design of Inspire extensions and the design of new systems. An important aspect of the framework is the selection of software development paradigms, platforms and tools (see Figure 1).

To develop Inspire we used, in 1995, prototyping and traditional system development life cycle, and the available software tools (e.g., algebra libraries, graphic generators). The maintenance and revision of the system was relatively easy thanks to a highly modular system design and the use of a knowledge-base module to control the execution of programs associated with negotiation phases and their activities (Kersten *et al.*, 1999). Nonetheless, lack of software technologies for on-line systems in 1995 made the addition of new modules difficult. Also the system maintenance requires high level of programming skills.

Design of systems for lay people requires a significant degree of flexibility. Such systems need to be easily adaptable to various users' requirements. Studies of their use also require that developers be able to modify the decision and negotiation protocols, and add or replace decision aids. This is possible with *n*-tier architecture used in *e*-business system development (Fournier, 1998; Buffam, 2000).

The *n*-tier architecture is based on the software server concept. In our projects we are presently using the following servers: (1) an application server (Macromedia ColdFusion) for the construction of dynamic web pages and execution of applications, (2) a database server (MySQL) for the execution of decision and negotiation protocols stored in a database, and the storage of users' and programs' inputs and outputs, (3) an application server (Vanguard DecisionScript) for the execution of decision aids and knowledge-based systems, and (4) a HTTP-server (Apache). This tiered architecture was used for the development of the on-line negotiation course platform (Köszegi *et al.*, 2003). Also, the Inspire system is now being redesigned to follow the *n*-tier architecture so that we will be able to generate different system configurations at the runtime. The development methodology Fusebox (http://www.fusebox.org/) provides a high level of modularity and flexibility. These are necessary characteristics of platforms that need to be easily customizable and extendable with support tools and software agents.

5.2 Future work

In the preceding sections I discussed the on-going projects in the areas of bilateral negotiation support and advice which is provided by software agents. Their objectives are to further advance our knowl-

edge of the users and their differences, the impact of various aids on the process and outcomes, the usefulness of methodological negotiation advice, and the possible divisions of labour between the negotiators and software. These projects are based on the experiments with Inspire, its extensions and the on-line teaching platform.

Inspire is an example of a web-based system that allows users with varied backgrounds to take part in electronic negotiations successfully. There are several differences between a system like Inspire and systems designed for participatory democracy. One difference is the user population; Inspire users are mostly university students. The two other important differences are: the decision support is provided for a single decision maker and the supported negotiations are bilateral.

To support participatory decision and negotiation processes we need to design a system capable of aiding groups of users who share similar interests and wish to work jointly on the structuring of the problem and on the formulation of its solutions. The conflict resolution mechanisms have to support multilateral negotiations among many groups and/or individuals.

The multi-participant decision making and multi-party negotiations introduce additional complexities that were not taken into account in the design of Inspire. They require designing a platform, rather than a single system, that is capable of constructing web sites and associating programs at the run time. This is because one cannot predict the number of individuals and groups that wish to collaborate and their preferred approach to solving the problem. Rather, each group needs to be able to spin-off a web site and supporting software at the time one or more participants decide to work on the problem. Groups and individuals need to communicate with others through a joint site. This joint site will make it possible to monitor the overall standing of the whole community and aid groups in identifying and resolving inter-group conflicts.

Another important aspect that was not discussed here is the construction of, and discussion about, the alternatives. In most of our experiments the set of feasible alternatives was given to the users. In real-life situations groups of users may want to construct their own alternatives and propose them to other participants. Systems capable of supporting participatory *e*-democracy need to provide tools for the generation of alternatives, simulation and analysis of the alternatives' environmental, economic and social impacts, and their visualization and comparisons. Examples of systems providing such tools include WebHIPRE (Hämäläinen *et al.*, 2001), Rains (TAP, 2003) and spatial geographic information systems (Reitsma *et al.*, 1997; Harrap *et al.*, 2001).

The framework for the design, deployment and studies of systems for participatory decision-making presented in Section 2 provides an agenda that we plan to follow. Based on the experiences with Inspire and other systems the core set of technologies discussed in Section 5.1 will be used to construct a platform for participatory decision-making and negotiations. Several simple decision models of constructing linear value functions will be implemented to provide alternative aids (e.g., conjoint analysis models and AHP). Similarly, several protocols based on the group decision support and negotiations will be designed to structure the decision and conflict resolution processes. In Section 3.1 we mentioned that the Gulliver's eight phase model of negotiations was simplified for the purpose of Inspire-supported negotiations. Phases involved with the search for arena and the agreement on the terminology and the negotiated issues were not included; they will need to be considered in participatory decision-making.

The purpose of the search for arena phase is to help the community members to decide on the virtual meeting spaces (collaboratories) where they create ad hoc groups. In the participatory decision making this phase involves construction of the electronic arena together with decision and negotiation aids, and other software tools in real-time. In the next phase the participants formulate and/or learn about terminology, the decision problem, its context and constraints, and its issues (attributes).

Along with the specification of the technical solutions we will select a few community-level problems that have been recently resolved. Using focus groups from these communities and also high school and university students we will study the use and usability of the deployed technical solutions. The results of these studies will be used to modify the solutions and develop self-learning and training materials.

References

Afzali C. 1998. AOL makes deal to boost e-commerce. internnetnews.com, (http://www.internetnews.com/finanews/article.php/35191), accessed July 2003.

Agostioni A, Michelis GD, Divitini S, *et al*. 2002. Design and deployment of community systems: Reflections on the Ccampiello experience. *Interacting with Computers* **14**: 689-712.

Angur MG, Lotfi V, Sarkis J. (1996). A Hybrid conjoint measurement and bi-criteria model for a two group negotiation problem. *Socio-Economic Planning Sciences* **30**(3): 195-206.

Bazerman MH, Curhan JR, More DA, *et al*. 2000. Negotiation. *Annual Review of Psychology*, **51**: 279-314.

Benbasat, I. and B. R. Nault BR. 1990. An evaluation of empirical research in managerial support systems." *Decision Support Systems* **6**(3): 203-226.

Bichler M, Kersten GE *et al*. 2003. Towards the structured design of electronic negotiation media." *Group Decision and Negotiation* **12**(4): 311-335.

Bradshaw JM (ed.) 1997. *Software Agents*. AAAI Press/The MIT Press: Cambridge.

Breese J, Heckerman D *et al*. 1998. Empirical analysis of predictive algorithms for collaborative filtering." *Pro-*

ceedings of the Fourteenth Conference on Uncertainty in Artificial Intelligence, Morgan Kaufmann, (http://www.research.microsoft.com/users/breese/cfalgs.html), accessed July 2003.

Brown JS, Duguit P. 2000. *The Social Life of Information*. Harvard Business School Press: Boston, MA.

Buffam WJ. 2000. *E-Business and IS Solutions. An Architectural Approach to Business Problems and Opportunities*. Boston, Addison-Wesley.

Bui TX. 1996. Negotiation processes, evolutionary system-design, and NEGOTIATOR. *Group Decision and Negotiation* **5**(4-6): 339-353.

Cartledge P. 1993. *The Greeks: A Portrait of Self and Others*. Oxford University Press: Oxford.

Creative Research. 2002. E-democracy. Report of research findings. London, (www.edemocracy.gov.uk/downloads/Useful_Pointers.pdf), accessed July 2003.

Davis FD. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly* **13**: 318-340.

Druckman D. 1977. Social-psychological approaches to study of negotiations. *Negotiations: Social-Psychological Perspectives*, Druckman (ed.). Sage: Beverly Hills, CA; 15-44.

Druckman D, Druckman J, Arai T. 2003. Impasse resolution in international negotiation: Evaluating a computer-assisted decision aid." *EURO/INFORMS*, Istanbul.

The Economist. 2003. California in crisis: is the golden state governable? *The Economist* **368**(8331).

Etezadi-Amoli J, Farhoomand AF. 1996. A structural model of end user computing satisfaction and user performance. *Information and Management*, **30**: 65-73.

Fournier R. 1998. *A Methodology for Client/Server and Web Application Development.* Prentice Hall: Upper Saddle River.

French S. 1986. *Decision Theory. An Introduction to the Mathematics of Rationality*. Wiley: New York.

Gaynor D. 1996. "Democracy in the age of information: A reconception of the public sphere, Georgetown University, (http://www.georgetown.edu/bassr/gaynor/intro.htm), accessed July 2003.

Green PE, Srinivasan V. 1978. Conjoint analysis in consumer research: Issues and outlook. *Journal of Consumer Research* **5**: 103-123.

Guimaraes T, Igbaria M, Lu MT. 1992. The determinants of DSS success: An integrated model. *Decision Sciences* **23**: 409-430.

Gulliver PH. 1979. *Disputes and Negotiations: A Cross-Cultural Perspective*. Academic Press: Orlando, FL.

Hämäläinen RP, Kettunen E, Martunen E, *et al*. 2001. Evaluating a framework for multi-stakeholder decision support in water resources management. *Group Decision and Negotiation* **10**(4): 331-353.

Harrap R, Journeay M, Talwar S, *et al*. 2001. Discovering the community of our future. Kingston, GIS Lab, (http://www.gis.queensu.ca/research/semantics/docs/comgis.pdf), accessed July 2003.

Henig M, Buchanan JT. 1996. "Solving MCDM problems: process concepts." *Journal of Multi-Criteria Decision Analysis* **5**(1): 3-12.

HM Government. 2002. In the service of democracy. A consultation paper for electronic democracy. (www.edemocracy.gov.uk), accessed July 2003.

Holsapple CW, Lai H *et al*. 1998. A formal basis for negotiation support system research. *Group Decision and Negotiation*, **7**(3): 199-202.

Jackson CM, Chow S *et al*. 1997. Toward an understanding of the behavioral intention to use an information system." *Decision Sciences*, **28**(2): 357-389.

John PWM. 1971. *Statistical Design and Analysis of Experiments*. Macmillan: London.

Katen-Bahensky D. 2003. Director and CEO, University of Iowa Hospitals and Clinics. Iowa City, (personal communication).

Kersten GE. 1997. Support for group decisions and negotiations. An overview." *Multicriteria Analysis*, Climaco J (ed.). Springer Verlag: Heidleberg; 332-346.

Kersten GE. 2003. The science and engineering of e-negotiation: An introduction." *Proceedings of the 36th Hawaii International Conference on Systems Sciences*, IEEE Computer Society Press.

Kersten GE, Köszegi S, Vetschera R. 2003. The effects of culture in computer-mediated negotiations: Experiments in 10 countries. *Journal of Information Technology Theory and Application (JITTA)*: **5**(2): 1-28.

Kersten GE, Lo G. 2003. Aspire: Integration of negotiation support system and software agents for e-business negotiation. *International Journal of Internet and Enterprise Management (IJIEM)*, **1**(3): in print.

Kersten GE, Mallory GR. 1999. Rational inefficient compromises in negotiations. *Journal of Multi-Criteria Decision Analysis* **8**(2): 106-112.

Kersten GE, Noronha S. 1999. Negotiations via the World Wide Web: A cross-cultural study of decision making. *Group Decision and Negotiations* **8**: 251-279.

Kersten GE, Noronha SJ. 1999. "WWW-based negotiation support: Design, implementation, and use. *Decision Support Systems* **25**: 135-154.

Köszegi S, Kersten GE. 2003. On-line/off-line: Joint negotiation teaching in Montreal and Vienna." *Group Decision and Negotiation* **12**(4): 337-345.

Köszegi S, Vetschera R, Kersten GE. 2003. Cultural influences on the use and perception of internet-based NSS. An exploratory analysis. *International Negotiations Journal*: to appear.

Leninhan DG. 2002. Realigning governance: From e-government to e-democracy. Centre for Collaborative Government**:** Ottawa; 1-40, (www.crossingboundaries.ca), accessed July 2003.

Luehrs R, Malsch T, Voss K. 2001. Internet, discourses and democracy. *New Frontiers in Artificial Intelligence*. Terano T (ed.). Springer Verlag: Heidleberg; 67-74.

Maes P, Guttman RH, Moukas AG. 1999. Agents that buy and sell. *Communication of the ACM* **42**(3): 81-91.

Montgomery DC. 1997. *Design and Analysis of Experiments*. Wiley: New York.

Nardi BA, O'Day VL. 1999. *Information Ecologies: Using Technology with Heart*. MIT Press: Cambridge.

Pennock DM, Horvitz E, Lawrence S, *et al*. 2000. Collaborative filtering by personality diagnosis: A hybrid memory- and model-based approach. *16th Conference on Uncertainty in Artificial Intelligence*, Morgan Kaufann: San Francisco.

Pinsonneault A, Kraemer KL. 1989. The impact of technological support on groups: An assessment of the empirical research. *Decision Support Systems* **5**(2): 197-216.

Poland P. 2001. Online consultation in GOL countries. Initiatives to foster e-democracy, (http://governments-online.org/projects/e-democracy/index.shtml), accessed July 2003.

Rangaswamy A, Shell GR. 1997. "Using computers to realize joint gains in negotiations: Toward an electronic bargaining table. *Management Science* **43**(8): 1147-1163.

Reitsma RF, Carron JC. 1997. Object-oriented simulation and evaluation of river basin operations. *Journal of Geographic Information and Decision Analysis* **1**(1): 9-24, (http://publish.uwo.ca/~jmalczew/gida_1/Reitsma/Reitsma.htm), accessed July 2003.

Resnick O, Iacovou I *et al*. 1994). "GroupLens: An open architecture for collaborative filtering of netnews. *ACM Conference on Computer Supported Cooperative Work* 175-186.

Rheingold H. 1993. *The Virtual Community: Homesteading on the Electronic Frontier*, HarperPerennial: New York.

Rogers E. 1995. *Diffusion of Innovations*. The Free Press: New York.

Ropohl G. 1999. Philosophy of socio-technical systems. *Techné: Journal of the Society for Philosophy and Technology* **4**(3), (http://scholar.lib.vt.edu/ejournals/SPT/v4_n3pdf/ROPOHL.PDF), accessed July 2003.

Rosen T. 2001. E-democracy in practice. Swedish experiences of a new political tool. (www.svekom.se/skvad/), accessed July 2003.

Sawtooth Software. 2002. ACA system accuracy adaptive conjoint analysis version 5.0. *Technical Papers*. Sawtooth Software: Sequim, WA, (www.sawtoothsoftware.com), accessed July 2003.

Schmidt K, Bannon L. 1992. Taking CSCW seriously: Supporting articulation work. *Computer Supported Co-operative Work* **1**(1-2): 7-40.

Shardanand U, Maes P. 1995. Social information filtering: Algorithms for automating ‘word of mouth'. *Computer Human Interaction* 210-217.

Ströbel M. 2003. *Engineering Electronic Negotiations*. Kluwer: New York.

TAP. 2003. Transboundary air pollution. IIASA: Laxenburg, (http://www.iiasa.ac.at/rains/), accessed July 2003.

Vetschera R, Kersten GE, Köszegi S. 2001. Exploratory Analysis of Success Determinants of Web-based Negotiation Support Systems. InterNeg Report, INR02/01, (http://interneg.org/interneg/research/papers/2001/02.html), accessed July 2003.

Wang S. 1999. Analyzing agents for electronic commerce. *Information Systems Management* (Winter): 40-47.