

The development of an Internet forum for long-term participatory group learning about problems and solutions to sustainable urban water supply management

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Abstract

This paper reports on the planned use of the Internet in an ongoing participatory process targeted at developing solutions for the sustainable management of an urban water supply system. The foundation of our participatory methodology is face-to-face group communication within regular meetings of the principal stakeholders. During such meetings we are developing multi-media (paper-, boardgame- and computer-based) multi-agent models of the water management system in order to allow the stakeholders to explore possible management scenarios and to learn about other stakeholders' often conflicting perspectives and goals. However, another forum is required for stakeholder interaction, model testing and the exchange of views, outside of the necessarily rare platform meetings. A facilitated Internet forum is therefore under development.

Since the stakeholder group contains a heterogeneous mix of people ranging from those experienced in using computers to those who are computer-naïve and resistant to them, care must be taken when introducing a computer into the hitherto computer-free sessions. A multi-stage approach to introducing the Internet-based model into our participatory process through game playing and other acclimatization methods is being developed. This paper describes this approach and provides a planned architecture for the Internet forum.

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1. Background to problem

In a major European city, the existing supply-oriented water management policy is increasingly perceived as unsustainable. The dominant policy over the 20th century has been characterized as risk-averse "worst-case planning" (Tillman, 2001) in which past increasing demand patterns have been expected to continue and supply capacity has been built to meet a level of demand based on the "upper side" of possibility. This policy worked well until the 1970s in that it met the legal requirement for water supply security and, while demand increased as expected, it also met the city norm for high water quality. However, problems began when there were two contradictory responses to a particularly dry summer in 1976 in which demand peaked to near supply-capacity levels. On the one hand, this crisis resulted in demand falling in an unprecedented fashion due to increased water saving as well as a general decline in water-using industries. On the other hand, it led to the water utility increasing supply capacity to avoid future problems. The result was that whilst demand fell, supply capacity increased to the point that capacity is now approximately 2.5 times daily demand. Such over-capacity increases the standing time of the water in the supply network and therefore puts at risk the sustainability of the hitherto high standards in water quality that the city has enjoyed. Additionally, the city politicians who are faced with a large city budget deficit have begun to reduce the credit available to the water utility for infrastructure. The water utility and the city as a whole are therefore in the position of having to investigate new ways of managing the system that can resolve the stakeholders' conflicting goals of maintaining water security and quality, saving money and saving water.

2. Multi-staged, multi-media modelling within a participatory process

A participatory discussion platform has been established which incorporates the principal stakeholders involved in the city's water management system (water utility; politicians; consumers; and manufacturers). The goals of this participatory process include the exploration of more efficient management strategies in response to possible demand scenarios and to increase communication and the sharing of perspectives among the various stakeholders. A multi-staged, multi-

media "model-building-as-learning" (Lane, 1992) approach has been adopted that is tailored for long-term stakeholder participation and for the introduction of computational and Internet-based models into computer-naïve groups.

In Stage 1, the stakeholders' own mental models (Doyle/Ford, 1998) of the system, its perceived problems, their goals and possible scenarios are elicited and the stakeholders then discuss paper versions of these models as a group. In Stage 2, these mental models are converted into a single multi-agent model⁴ in the form of a board game with which the stakeholders, as players taking on the roles of other stakeholders, can explore possible scenario outcomes from the others' perspectives. As in (Barreteau/Bousquet/Attonaty, 2001), the game is used at this stage for model validation and stakeholder acclimatization purposes, i.e. to enhance future comfort with, ownership and legitimacy of the models. In stage 3, the findings and adaptations made to the game are then used to implement a computer simulation model of the system in which the users can either opt to view alternative scenarios passively or to take on roles and interact with the simulation. Use of the computer model in the discussion platform allows the stakeholders to become comfortable interacting with the computer in a social atmosphere in which they can readily get support. In stage 4, stakeholders are encouraged to use the simulation model within an Internet forum. The proposed Internet forum is, in essence, an "interactive, multi-player computer game", as defined by Bartle (1990), with facilitated discussion support. Discussion between stakeholders can occur both through their role playing activities and outside those roles. Player roles are heterogeneous and all unassigned roles are simulated. The role of the human facilitator is to help with game playing problems; to join in discussions arising amongst players; to adjudicate on issues that arise and to monitor stakeholder behaviour for later protocol analysis and knowledge elicitation. Maintenance of turn-taking schedules and rule observancy is carried out automatically by a game-master software component.

Findings from the Internet interactions are then summarized by the facilitators and presented back to the stakeholders in a group session.

⁴ see (Gilbert/Troitzsch, 2000). for definition.

3. Internet forum requirements

The requirements for the Internet forum were derived from the two groups of potential users: stakeholders who will play the game and the facilitator (members of the project team) who will monitor the game and discussions, and provide online help where necessary.

3.1 Stakeholder Requirements

Initial stakeholder requirements have been gathered from an analysis of a video protocol of their behaviour whilst playing the board game version of the model, as well as from question-answer sessions. More requirement sessions are planned.

The first requirement is that the game be interactive and multi-player, thus continuing the group communication and learning process. Due to the limitations of stakeholders' availability to play the game, the forum will be designed to be used in short, multiple sessions over many days rather than one session. Additionally, simulated players will be required in the event that time constraints forbid a stakeholder from taking up a role. The need for a facility for negotiating both privately and publicly with each other was readily apparent from the activities of the stakeholders playing the board game. The complexity of information needed to be reviewed and monitored during the game means that an information browser is also required for game rules, possible actions, resources etc.

3.2 Facilitator requirements

The facilitator also had a number of requirements for the Internet forum. A logging facility is needed to track the activities of the players and to facilitate protocol taking. Additionally, a facility is required to allow players to write down developing ideas or plans. During the board game playing, the players had been asked to make notes during the game in order to help the facilitator understand their changing planning strategies. Such a facility in the Internet forum would provide a permanent record of idea development as the game progresses, thus helping to provide a qualitative description of the degree of learning that is occurring.

4. Proposed architecture of Internet forum

The forum is maintained on a server that is accessible through an ordinary web browser from any location with an Internet connection. The game software lies on an Apache web server which carries out all game computations. The interaction language between server and player is HTML, enhanced with PHP4, a web scripting language that allows the server to generate web pages dynamically in order to display results graphs and other information. Cookies, small blocks of data that are transmitted to and stored on the user's machine by the server software, are used to link web page requests to players thus making sure that players receive the correct pages during and between sessions. The game software's PHP code includes embedded SQL statements that are used to interact with a relational database (PostgreSQL, <http://www.postgresql.org/>), also running on the server. The database has a dual function: first, it maintains the state of the game and of each player across sessions and, second, it accumulates a log of all significant actions by the players for later analysis. The advantages of using a database are manifold. Many users can access it simultaneously; it will hold larger amounts of data than a cookie; standard functions for database access are built into PHP, and the data can later be extracted for use in analysis programs such as SPSS or Excel.

4.1 Use case descriptions

The following use case descriptions (Harmon/Watson, 1998) describe the interaction between the players and the Internet forum (Figure 1).

Player log-on - The player enters a name, password and the type of game to be played (new or continuation of existing game) on a form in the login page. When this is submitted, the name and game choice data, together with a string identifying the name of the form that has been submitted, is transmitted to the game server. When the server has confirmed the identity of the player, it presents the switchboard page, which acts as a portal to all the other game pages and retrieves data from the database relevant to the player.

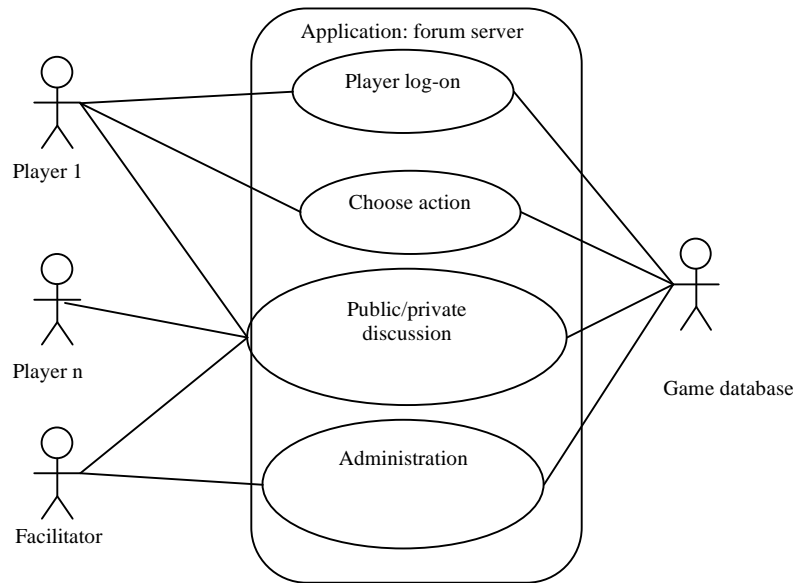


Figure 1

Use case diagram for the Internet forum.

Notation⁵: figures represent users or external software applications; lines represent communication links; ovals represent use cases.

Choose action - When the player clicks on the "play" button (which has the effect of submitting a form), the game page appears. The design of this page and the move options available on it depend on the role being adopted by the player, details of which are retrieved from the database. The player interacts with the page to specify the move that they wish to make and the user's choice is returned to the server, which serves the appropriate next page, and so on.

Private/public discussion - One of the options available to all users (players and facilitator) on all versions of the game page is to send a message to one or all of the other users. If this option is selected, the users are presented with a form that resembles a web-based email browser to compose a message. The main page also lists the messages

⁵ standard notation used for use case diagrams (Harmon/Watson, 1998).

that the user has received. The feature operates in the same way as a private email network, but logs all messages on the server for later analysis⁶. The users can broadcast messages asking for or offering help, privately to individuals or publicly to all. The users can also use this facility to log developing ideas.

Administration - In addition, there are 'administration' pages that allow facilitators with the necessary authorisation to access the game database, for example, to list the players on-line and their current state, and to reset the game to its base configuration.

5. Related systems

The design will benefit from the wealth of literature on interactive multi-player games, CSCW (Computer Supported Cooperative Work), Group Decision Support Systems and business simulation games. Such literature can be of particular help in finding solutions to the problems of maintaining user awareness of what is going on (e.g. in tools such as DIVA: (Sohlenkamp, 1999)) and of synchronizing players' activities within a gaming forum spanning several days or weeks.

Interactive multi-player games involving some form of moderated online social interaction have a long pedigree dating back to the MUDs (Multi-User Dungeons) of the late seventies (Bartle, 1990). More recently, board games such as "The Beer Game" have been translated into computer-based games to act as Management Flight Simulators, i.e. to educate people in business and systems. Langley and Larsen (1995), for example, have developed a single user, multi-media version of the game. From here, however, it has been a small step to the development of networked interactive, multi-player business games in training and education (Hardman /Rossum/Bolhuis, 1995). In the latter, there is a tutor who oversees the play but the tutor's role is limited to administration and the alteration of simulation parameters. There is no inter-player discussion facility built into the design; all negotiations are carried out between human players and the simulated players, limiting the use of the tool as an online discussion forum.

⁶ players are informed that all their interactions with the system are recorded, for the confidential use of the research team.

Whilst the system proposed in this paper actively encourages such discussions under the facilitation of a human, other computer forums designed for discussion support for decision-making groups (Zeno:(Gordon/Karacapilidis,1997); CIMAT: (Haggith/Prabhu/Purnomo/Rizal/Taylor/Yasmi/Sukadri, 1999)) have used automated mediators. Both these latter systems use automated reason maintenance techniques to structure and guide the ongoing human debate.

6. Conclusions

The work presented here illustrates how the Internet will be used as a further forum for stakeholders in an environmental arena to explore and learn about a model of their system and, by so doing, share perspectives and insights with each other. The novelty of the approach proposed is that it embeds such a forum into a much larger multi-staged group innovation and learning process that includes face-to-face problem-solving and discussion supported by multiple model media. One assumption of the process is that, without the other media, the uptake of the Internet forum by the stakeholders would be poor. Currently, the project is at the end of stage 2 and the computational models are being designed ready for stage 3 and a pilot Internet forum for stage 4. Of particular research interest is a comparison of the stakeholders' experiences gained from face-to-face board-gaming with those gained from the Internet forum, due to differences in the level of social facilitation afforded by each medium.

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