JOURNAL OF MULTI-CRITERIA DECISION ANALYSIS
J. Multi-Crit. Decis. Anal. **7**: 242–262 (1998)

Problem Formulation for Multi-Criteria Decision Analysis: Report of a Workshop

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ABSTRACT

This paper reports on a workshop on *Problem Formulation in Multi-Criteria Decision Analysis* held at SPUDM97. The focus of the workshop was the problem formulation phase which occurs between the analyst meeting a person with a 'mess' and the time he or she begins to analyse a structured problem with several alternatives scored against several attributes or criteria. The objectives were: to share experience on procedures which might be transferable between the methodologies; to demonstrate different skills used by the analyst in structuring decision problems; and to catalyse a discussion on the problem formulation phase of an analysis.

Three analysts, who generally approach problems using multiattribute methods, addressed the same problem. The problem used was constructed to be realistic to three decision makers, who had been trained in the issues of concern. There were two sessions. Each analyst was assigned a decision maker and formulated the problem independently in the first session, held in parallel. They were each observed by two observers and many of the audience at the workshop. The three formulations were presented along with the comments of the observers and discussed at a second plenary session.

This paper reports the three formulations and observations, remarking on the 'tricks of the trade' employed by the analysts in formulating the problem. The analysts also describe their thinking and their aims in adopting their approach and style of interaction. More general remarks on the process of decision analysis are also offered.

KEY WORDS: multi-criteria decision analysis (MCDA); problem formulation; process of decision analysis

1. INTRODUCTION AND FORMAT OF THE WORKSHOP

A workshop on *Problem Formulation in Multi-Criteria Decision Analysis* was organized by Simon French and Lisa Simpson at the *Subjective Probability, Utility and Decision Making* (SPUDM97) conference held in Leeds in August 1997. The idea behind the workshop was to look at the problem formulation phase which takes place when an analyst and client explore a 'mess' of concerns and issues and structure these into a decision problem with several alternatives scored against several attributes/criteria. In the early planning of the workshop we had hoped to draw together analysts from very distinct schools of decision analysis. We hoped to see if their differing methodologies led to distinct approaches to problem formulation. However, the diaries of some of those invited precluded their attending SPUDM97. The three analysts who took part

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CCC 1057–9214/98/050242-21$17.50

Received 9 June 1998
Accepted 10 July 1998

approach problems in roughly the same manner using value trees (attribute hierarchies). Accordingly, the purpose of the workshop became to share experience on problem elicitation and formulation. In the event the observation and discussion of these sessions brought out many points ranging from 'tricks of the trade' through observations on the management of the social interaction to the philosophy and ethics of decision analysis.

The decision analysts who kindly agreed to take part and formulate a problem in front of an audience were Valerie Belton, Freerk Lootsma and Raimo P. Hämäläinen, who was assisted by Mari Pöyhönen. Each was introduced to a decision maker (DM)[1]. The DMs were three lecturers from the School of Computer Studies at the University of Leeds. They had no prior training or experience in decision analysis. The DMs had been schooled in a problem 'mess', related to a real issue within the School of Computer Studies but with additional hypothetical events to increase urgency and raise the complexity. Simon French and Lisa Simpson briefed the subjects in this 'mess', but held back from suggesting alternatives or objectives or any other aspects that should be established during the formulation of the mess as a MCDA problem.

The workshop was run in two 2 h sessions on the 19 and 21 August, respectively. The first session comprised three parallel events in which each decision analyst met one of the DMs and discussed the issues in order to formulate a decision model. The analysts had been given a very short briefing note (see Figure 1) a few days before which outlined the 'mess', but other than that they arrived at the session completely unaware of the situation before them. In this way we tried to ensure that the analysts were observed in the very first stages of problem elicitation and formulation. It was, to draw upon a metaphor used by one of the analysts, an 'unseen examination'.

The analysts were encouraged to push the analysis as far as they could in the 2 h, actually a few minutes less since there were a number of opening announcements at the beginning of the session. Each session was observed both by delegates at SPUDM and by two designated observers. All observers were forbidden to interact at all during the session. They just watched.

The second session was plenary in which all analysts, observers and audience met together. Each analyst presented his or her approach to decision analysis and 'guiding principles' in problem formulation. They also presented their initial formulation of the issues in the scenario, indicated how the analysis would have progressed, what judgements would need to have been elicited, what further data would be needed, etc. The observers each made a short presentation on their thoughts. The remainder of the session was an open discussion.

In the next section an outline of the problem is given. Subsequent sections describe the formulations of the problem produced by the three analysts and the comments made by the observers. The penultimate section records the general discussion at the workshop. We close with some tentative conclusions.

2. THE PROBLEM 'MESS'

The problem was set in the School of Computer Studies at the University of Leeds, where the three DMs actually lectured. In that way it was hoped that they would share a common context which would help in their role playing. Moreover, the problem was related to a real problem. Aspects of it had occurred a couple of years back. Nevertheless, the scenario we set up involved many hypothetical aspects, particularly hypothetical actions of certain others in the School. We would like to emphasize that the current system for providing

The system for providing morning and afternoon coffee and tea in the School of Computer Studies has broken down rather dramatically and the common room committee has resigned *en bloc*. Three lecturers have been asked by the Head of School to prepare a report on ways forward. They have been told to think very widely. A number of issues have been bubbling in the background for some time and the Head is willing to take advantage of the current crisis to address these at the same time.

Figure 1. Outline of problem 'mess' sent to the DMs in their briefing note.

coffee is not in crisis and those organising it have no reason to resign *en bloc*. The School is very grateful to them. That being said, the remaining text in this section is a verbatim copy of the summary of the scenario given to and discussed with the DMs before the first session.

The School of Computer Studies at the University of Leeds is relatively large among UK universities. There are 6 professors, 52 academic and research staff and over 60 postgraduate research students. The undergraduate programmes have an enrolment of about 550 full time equivalent students: in number of bodies, this means about 1000 students are taught in various lectures, laboratories and classes by the School. In addition, there is a growing Masters programme, currently with some 40 students. The School is sited in rooms and laboratories on Levels 6, 7 and 9 in the E.C. Stoner building, with some staff and postgraduates accommodated in an Annex some 400 m away. There are plans to move the staff from the Annex to further rooms on Level 6, but this move is at least a year in the future. The main administrative area of the School is on Level 9 and most senior staff are accommodated near there.

The common room is on Level 7. It is a relatively large room with several small tables, 40 or so comfortable chairs and a small kitchen area with sink, refrigerator, dish washer, cupboards and kettle. In addition, on Level 9 there is a small kitchen with sink, refrigerator, microwave and kettle. On Level 10, in the nearby Mathematics Department, there is a coffee bar run by the University Refectory, which provides a range of snacks and beverages between 10.00 h and 16.00 h. There are a number of cold and hot drinks machines on nearby staircases and corridors.

The School common room is open to staff and research postgraduates, but not taught postgraduates (i.e. Masters students). Taught postgraduates may use the Level 9 kitchen to make their drinks. There are no common room or drinks facilities for undergraduates within the School. They may use the Mathematics coffee bar or the drinks machines. A coffee and tea club is run by the School's common room Committee. Staff pay a subscription to this and can make tea or coffee as they wish. Supplies are put out each morning in the common room. (Few supplies make it overnight, either because of consumption or 'acquisition' for use at someone's home.) The School pays the subscription of all research postgraduates to encourage them to mix with staff other than their supervisors. The School investigated paying staff subscriptions, but the Tax Office insisted that this would need to be taxed as a benefit-in-kind and thus would require a very complex accounting system. The School also pays for a cleaner to straighten the common room each morning and wash up cups, etc. Many staff make drinks with their own supplies, either in the School common room or Level 9 kitchen.

For some time now there have been a number of issues rumbling in the background. Firstly, the level of social interaction in the School is low. In particular, only about 25% of staff use the common room regularly and then seldom every day. Attendance is at its highest for the Friday Morning Doughnut Club. On a weekly rota someone buys 50 doughnuts, which are consumed on a first come first served basis. The Head of School and many senior staff feel that, if there was more interaction, there could well be benefits in developing new research. Informal discussion often leads to new insights. However, it should be noted that the proportion of senior staff who go to the common room is well below 20% because, they plead, of the continual need to attend administrative meetings. The clerical and administrative staff would be very welcome in the common room too, but they claim that the time to get from Level 9 to Level 7 (by a contorted set of staircases) is too great. Moreover, the route from Level 9 to Level 7 is not easy for the disabled, of whom there are a small number.

Taught postgraduates have indicated their wish to be invited to the common room to mix with staff and research postgraduates. Undergraduate students have long campaigned for a 'social centre' in the School where they can meet each other. Many Departments at Leeds have some area where students may congregate, chat and drink coffee.

There have been heated debates in the School over the use of the microwave on Level 9, mainly occurring after someone has prepared an aromatic meal. A dish of curried cabbage and the literal stink it caused are part of the School's folklore. Only marginally less heated are the discussions about the source of the coffee used by the coffee club and by others using their own supplies. Firstly, some are concerned at the price paid to the Third World growers by the food conglomerates. Secondly, some are concerned at other trade

in baby milk carried out by the largest instant coffee manufacturer. On the other side of the coin, are discussions of price and quality.

Last week two things occurred which have led to the problem. Firstly, the kettle in the common room blew up. One member of staff complained rather unpleasantly to a couple of members of the common room Committee. It was unfortunate that this came on top of a growing number of demands upon them and also at a time when perchance they were all frantically trying to complete a project report. Whatever the cause, the complaint blew up into a row and the Committee resigned *en bloc*, claiming no one appreciated the amount of effort they put in. Thus, there is no kettle in the common room, no replenishment of supplies and no one willing to take on the task. Secondly, the University Refectory has notified the Head of School that the Mathematics coffee bar is too small to be viable and they will be closing it at the end of the calendar year.

Three lecturers have been asked by the Head of School to prepare a report on ways forward. They have been told to think very widely and report in 2–3 weeks.

3. THE FORMULATION CONSTRUCTED BY VALERIE BELTON

3.1. Her formulation

My interpretation of the remit for the workshop was to focus on the formulation, or problem structuring, phase of the decision aiding process. At this stage there is no assumption about what type of analysis, if any, would best help the DM, Matt Morley. The process is initially relatively unstructured in order to encourage divergent thinking. An understanding of whether or not multi-criteria analysis is an appropriate tool for more detailed evaluation should emerge from this problem structuring phase. If the answer is 'yes', and given the situation it seemed reasonable to presuppose that some aspect of this issue would be amenable to MCDA, then the problem structuring should lead naturally into a more structured phase of multi-criteria model building and analysis. Indeed, much of the structure of the multi-criteria model should emerge from the more general model of the problem structure (Belton *et al.*, 1997).

Facilitation of the problem structuring discussion was guided by the following objectives:

- to establish the key issues: What were the causes of the problem as outlined? Was the immediate issue symptomatic of a longer term problem?
- to identify stakeholders and the extent of their power and interest in the problem;
- to identify key uncertainties;
- to explore possible ways forward;
- to establish the values of important stakeholders.

The process adopted was influenced significantly by the specific situation. The most important objective was to be able to capture the discussion in a flexible way which would allow for interactive structuring of ideas as they emerged. A significant constraint was the need for the process to be visible to the audience. Given these factors I decided to make use of *Post-Its* to capture aspects of the problem as they arose, organising these on the whiteboard to reflect the areas of interest outlined above. An alternative, more hi-tech approach would have been to map the discussion live using *Decision Explorer* (Banxia Software, 1996). However, this would have focused the attention of both the facilitator and the client on the computer screen, largely excluding the audience (in the absence of projection facilities). Also, as the workshop was a one-off occurrence the benefits of having the problem structure in electronic form would not be realized in the longer term.

The client was soon at ease with the use of the *Post-Its* and participated in recording ideas and building the picture emerging on the whiteboard.

Figure 2 shows the problem representation as it stood at the close of the problem formulation session. The first hour was spent primarily on building a picture of the current facilities for the provision of tea and coffee and the users of those facilities, together with issues surrounding their use including the recent events. From the discussion to this stage it emerged that in addition to the immediate problem, which was to restore a satisfactory system for the operation of the coffee room facilities, there were also a number of longer term issues which should be addressed. The longer term issues included opening up the coffee room to use by other stakeholder groups, but also broader issues relating to the geography of the department and a wish to encourage greater inter-

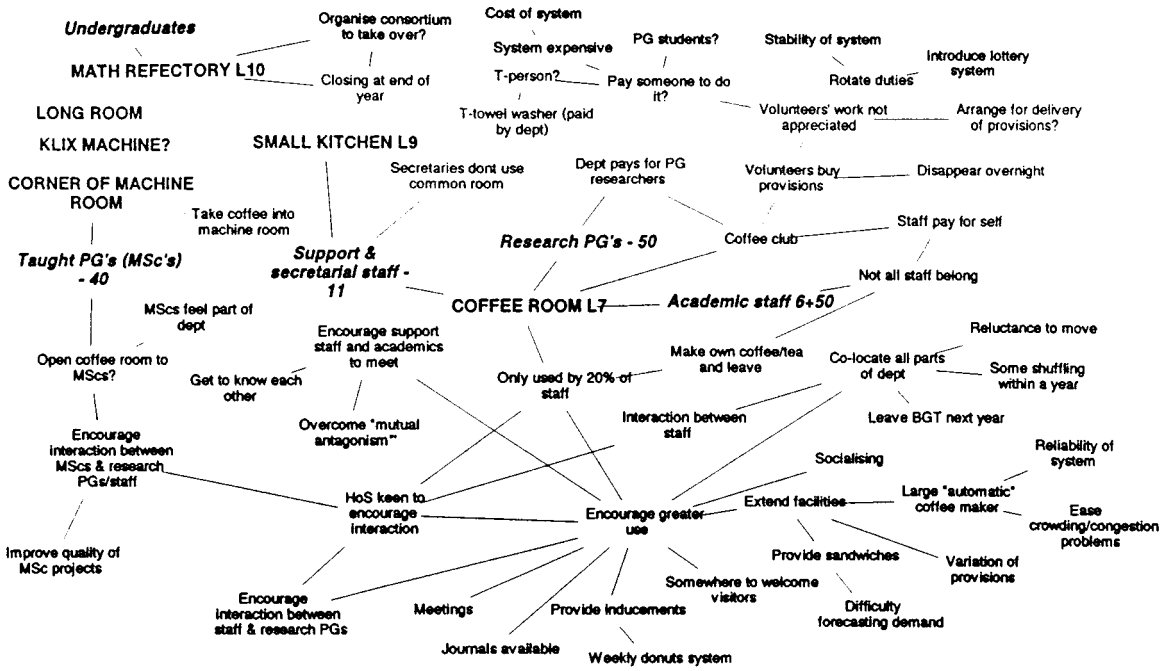


Figure 2. Problem representation as captured with *Post-Its* (and subsequently drawn in *Decision Explorer*).

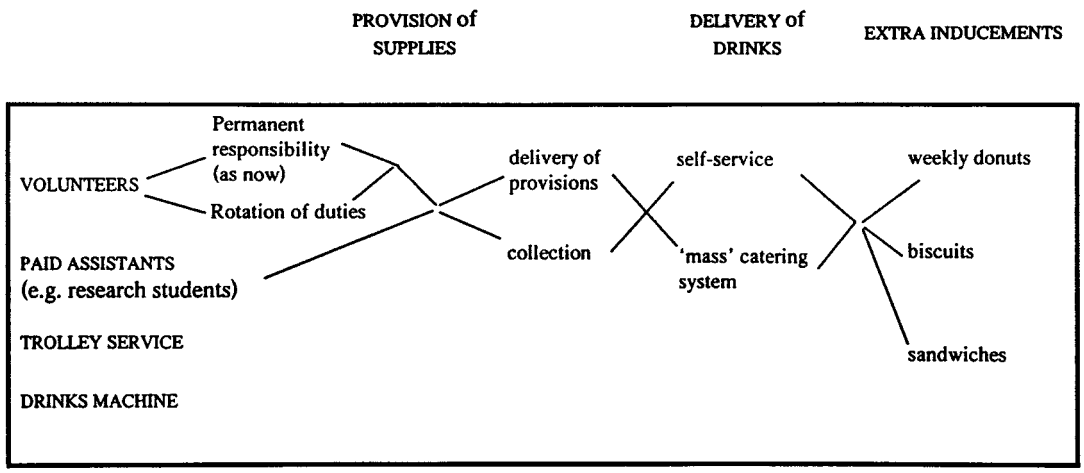
action amongst staff and students, a view held strongly by the Head of School. At this stage, the client was asked whether he would prefer to focus on issues relating to use of the coffee room or on the broader issues. He opted for the former. (He was also offered the opportunity of a break, but declined.) From that point the discussion centred on alternative ways of operating the coffee room facilities and factors which should be taken into account in deciding a way forward. The needs of the different stakeholder groups were also considered.

The options which were identified are illustrated in the table at the bottom of Figure 3. The main emphasis is on ways of restoring the current system, perhaps at the same time encouraging its wider use by staff and postgraduate research students. Options for provision for Masters (taught postgraduate) students and undergraduate students are listed separately. For the Masters students one possibility is to invite them to make use of the coffee room, thus interacting with decisions about the current system. It was not considered feasible to invite undergraduate students to join the coffee room scheme and thus provision of facilities to meet their needs could be considered as an independent issue.

It is clear from the presentation of the options in Figure 3 that rather than being a choice between a number of clearly defined discrete alternatives, the decision is comprised of a number of, possibly inter-related, sub-decisions. It is not clear that this decision would be best handled by the classical approach of identifying all possible feasible ways forward and evaluating each independently according to specified criteria. This would give rise to at least 70 possible combinations and to evaluate these individually would seem to be unnecessarily clumsy. An alternative approach may be to use an EQUITY type of model (Hall, 1986), but this would ignore any potential synergies or complications that might arise from particular combinations of subdivisions.

A number of goals or criteria pertinent to the evaluation of different ways of organising the system emerged naturally during the discussion. The client was prompted to add to these by considering the relative strengths and weaknesses of different ways of working. The following key factors were identified:

- the extent to which the system encouraged participation;



TAUGHT POSTGRADUATE (MASTERS) STUDENTS	Invite to use Coffee Room Provision of extra space
UNDERGRADUATE STUDENTS	Do nothing Use drinks machine Take action regarding closure of the Maths Refectory (e.g. form a consortium to keep open)
SECRETARIAL & SUPPORT STAFF	??

Figure 3. Common room facilities—options available.

- the extent to which the system encouraged interaction;
- the 'quality' of the service provided, including
  - choice offered
  - reliability of the system
  - degree of congestion/crowding;
- the possibility that service providers would feel their work was not valued;
- the cost of the system, to individuals and to the School.

To close the workshop it was suggested that there were two ways in which the work could progress. Firstly, a more detailed evaluation of the options outlined in Figure 3 against the criteria identified above would serve to highlight the strengths and weaknesses of different systems with the aim of identifying the best way forward for the School. Some preparatory work to establish the feasibility and costs of particular aspects would be required. Secondly, in order to explore the broader issues in more detail it would be worthwhile bringing together a cross-section of interested parties in a problem structuring workshop.

3.2. Remarks by Elizabeth Atherton

One of the most notable aspects of the analysis was the relaxed way in which it was conducted. Valerie guided the focus of the DM while allowing him to speak freely and explore aspects of the problem. The DM was allowed to write when he felt motivated to and participated in the process in a relaxed and open way. This approach enabled the DM to consider the issues at his pace and in his way rather than being ruled by the analyst. The process was controlled by the analyst, in that the DM's attention was focused on different aspects of the problem, but once focused the DM was encouraged to explore the aspects in his own way.

To start the whole process off Valerie asked the DM to describe the problem as he saw it. I believe this helped the DM to realize that Valerie was interested in his feelings and thoughts and gave Valerie a background to the problem. During the analysis all the main points were placed on *Post-Its* which were put on a whiteboard and moved around as the analysis progressed. The *Post-Its* were grouped into stakeholders, alternatives and

attributes. This helped to structure the problem and identify how the different aspects related to one another.

During the discussion Valerie focused the DM's attention on different aspects of the decision problem and their interaction. The analysis began by focusing on the stakeholders, their role in the system and the resources available to them. Aims were then established and the means to meet the aims were discussed. This helped to create new alternatives which were then related to the stakeholders. The DM was encouraged to think of ways of combining the alternatives and altering available resources to improve them. This also helped to create new alternatives.

The analysis started off quite generally and focused in on the important issues. As the analysis progressed it was clear that there were two important aspects to the problem: the immediate problem of restoring the coffee club and the long term problem of the coffee facilities available and how they are used. As time was limited Valerie asked the DM which part of the problem he wanted to focus on. He decided to focus on the immediate problem in the system. In this way the problem structuring focused on the issues which the DM thought were important, and gave him power in the decision process. At several points in the analysis Valerie reviewed the information uncovered. In this way she checked her understanding of the DM's comments and enabled him to recap on what had been said. The process helped to clarify the issues. Valerie asked the DM to think about how other stakeholders may feel about aspects of the decision and the alternatives available. This encouraged the DM to look at the problem from different perspectives and to focus on other people's opinions. The DM was encouraged to think widely and was asked about other coffee systems he had experienced. This helped to create new alternatives.

The process ended with a summary of what had been discussed and possible ways forward, which helped to clarify what had been achieved and what could be done in the future. During the second session comments were made about the problem structuring and the DM was quick to defend the analysis. This shows that he felt that he played an active part in the analysis and so any criticism of it was a criticism of him.

3.3. Remarks by Robyn Dawes

Valerie's attempt to structure the problem by eliciting relevant considerations in a non-directive manner illustrated the difficulty—if not the impossibility—of using a totally non-directive approach to structuring a decision problem in a hour and a half's time. Consideration after consideration was mentioned by the person reporting the problem, but Valerie did not 'force' the reporter to make a judgement of which were more important than which. Assigning weights is, of course, the final—not an initial—step in constructing (formally or informally) a decision tree, but in my view the approach taken led to a divergent analysis that never came together at the end. This divergence was reflected in 53 *Post-Its* notes involving possibly important considerations stuck to the whiteboard, notes that were occasionally moved around and regrouped, but which were never discarded as specifying unimportant factors. Thus, in the absence of a formal weighting system, the conclusion was—in my view—a 'weak' one.

Specifically, it did not appear to address the problems that led to the resignation of the committee. Kettles fail ('blow up') all the time, but such failure does not usually lead to a social 'blow up' of the group sharing the kettle, especially not to the point of mass resignations. I was frustrated watching the interaction Valerie structured, because I wanted to shout at the reporter 'for real, what the hell is going on?' and then subsequently assess his response for indications of its potential inaccuracy, or the role he himself might have played in the social (as opposed to the kettle) blow up. (I had the distinct impression that he was 'too glib' and so prone to bringing up new issues—rather than pursuing issues already mentioned—that I was suspicious of his motives.) But of course, I wouldn't give into this impulse, either as a decision analyst or as a therapist. And Valerie certainly didn't make any such confrontational inquiry, and shouldn't have, whether she felt an urge to or not. I believe, however, that in the absence of such direction, I and others never had sufficient information to make a judgement about 'what the hell went on'. The reporter kept bringing up a new factor, and then another new factor, and then yet another one that might be relevant to setting up a new system. If the analysis (or 'therapy') could have gone on for weeks, then the approach of allowing the reporter to reach the conclusions about the problem on his own with-

out confrontation would—many (Rogerians and others) believe—have been superior to a confrontational one. But we had an hour and a half.

The considerations brought up during this period were equally relevant whether an old system had existed and broken down or no system at all had existed. Often, it is helpful to frame a problem as if there were no history. 'Just starting from now, as if nothing had happened before, what do you think the relevant issues are and what might you do if indeed you had happened upon this problem—or your life—straight off a spaceship from a distant planet?' Such reframings can be valuable (like the 'why aren't things worse?' or 'given what you've told me, why don't you commit suicide?' reframings I just discovered I had filched from the late Victor Frankel). My concern is that relying exclusively on an historical frame, as Valerie did, when the interaction is limited to an hour and a half, leads to a lot of vague and sometimes platitudinous considerations. Concentrating on this possible function of a coffee club, another possible function, a location here, a location there, and so on may have avoided the *critical* factors that led to the problem in the first place.

A personal note. In the debriefing session Simon assured us that while aspects of the scenario were historically accurate, others were not. Moreover, there are no serious residual problems in the department. So perhaps my concern that we never got to some less than pleasant 'guts of the issue' is just a reflection of a type of paranoia that is too often reinforced elsewhere.

4. THE FORMULATION CONSTRUCTED BY FREERK LOOTSMA

4.1. His formulation

When I prepared the session with the limited amount of information which was given to us, I planned to proceed as I would have done in Delft with a new project. I assumed that an appointment had been made via the phone, for instance, and that the speaker had very briefly sketched the purposes of the visit. The discussion should be informal since a project had not yet been defined.

So, at the beginning I offered Tony Jenkins something to drink, and thereafter I asked him to give a more detailed sketch of the problem. He told me that there was a serious conflict about the common room in the School of Computer Studies. After some unpleasant incidents the volunteers who organized the coffee and tea service and who collected the financial contributions refused to continue their activities.

The conflict might have deeper causes, however. Otherwise it would be incomprehensible why the volunteers so suddenly dropped what they had been doing so far. I first tried to find out who the users of the common room were. Postgraduate students frequently came to drink coffee, and they consumed the doughnuts which were usually available on Friday mornings. Staff members, however, came less frequently. Certainly those who had many commitments did not show up. They even resented the common room because of the predominant presence of the students. The collection of the contributions was irregular, and there was a feeling among staff members that the students did not really pay their fair share. Moreover, the location of the common room was far from ideal. The offices of the School were on different floors, so that some staff members almost never came to meet their colleagues around the coffee kettle.

At this stage, I had to be careful. Otherwise I would be swept away by my prejudices. It seems to me that volunteers should not run a common room. If a clear allocation of the responsibilities has not been made, if there are no staff members or if there is no (elected or appointed) committee exclusively responsible for the common room, difficulties will always arise. Secondly, although many university departments assert that a common room is essential for informal communication, there are sometimes empire builders who keep their subgroup isolated from the rest. The reasons are not always clear, but it happens. Therefore I had to follow the track and to verify whether my assumptions were correct.

First, I tried to get an idea of the atmosphere. I asked Tony to tell me some anecdotes. He mentioned again the explosion of the coffee kettle and the smells in the building because someone used the common room for the preparation of a spicy meal, but he did not say that the conflict was due to the actions of certain characters in the School.

Next, I tried to explore the problem by discussing alternative options for solving the conflict. This step sometimes shows the boundary conditions in the client organization. I asked Tony whether it would make sense to maintain the status quo. The Head of School could ask the

	Status quo, with volunteers	Committee, elected or appointed	Common room relocated	Zero option, don't do anything	Vending machines in the School	Several common rooms
Clear definition of tasks	- -	+				
Collection of fees for coffee, tea						
Improved social contacts						
Total cost for common room(s)			- - -	+ + +		
Improved coherence of the School			+ +			

Figure 4. Freerk Lootsma's formulation.

volunteers to take up their job again. He could also try to find new volunteers, but the system would not change. That seemed to be a feasible option. Thereafter, I suggested that the common room could be run by a committee elected or appointed by the School. That was also feasible. Furthermore, the common room could be relocated to a more central position, possibly an expensive operation but, given the importance of improved contacts within the School, not totally unacceptable. Again, Tony agreed that this was an option to be considered. Then I introduced the zero option: don't do anything. The common room could be closed, no coffee, no tea, there might be enough coffee shops on campus, and the coherence of the School was perhaps already too low to maintain the coffee and tea service. So, we jointly tried to view the problem from different perspectives, that is, we set up various options and we came up with several criteria to judge them. At this stage, I started to use the whiteboard in order to set up a tableau which would show the strengths and the weaknesses of the alternative options. Of course, this is precisely the start of the screening phase in MCDA, where we draft the performance tableau which shows the performance of the alternatives under the respective criteria. Eventually, we had the survey shown in Figure 4.

Some cells in the tableau contain tentative plus or minus signs in order to indicate the performance of the options under the criteria listed in the first column. Of course, this would not be the starting tableau for a complete analysis. The options still had to be combined into possible strategies for the School, and the criteria still had to be defined more carefully, but the drafting of the tableau gave me some idea of the room to play, and it hopefully gave Tony some idea of the approach. I told him that the DMs in the School could all be invited to make up their mind. We could ask them to fill the cells of their own individual tableau and to weigh the criteria. Thereafter we could analyse the tableaux in order to identify the predominant criteria as well as a compromise solution. We could even carry out the analysis in a group decision room with ample opportunities for electronic brainstorming and weighted voting.

Lastly, I arrived at the crucial questions which I always have to ask at the beginning of a project. Who is (are) the DM(s), and what could be my role? Thus, I asked Tony whether the Head of School would take the final decision or whether the decision would be made somewhere else. He thought that the Head of School would submit a proposal to the Staff Meeting. 'Do you expect the decision to be difficult', I asked him. 'Yes, I guess so', he said, but he could not sketch me which members would object to which possible solutions. Then I suggested to him that I could support the decision process if the Head of School would define a project and if he would open a budget for it. I did not specify something like a

lump sum or a daily rate because that is mostly unimportant. What matters is the commitment of the client organization. The decision to hire an outside analyst is enough to give him/her a specific role in the decision process, at least in my experience.

In summary, although I might have an idea of the feasible alternatives, I did not have a clear picture of the power game in the School. I did not know whether the Head of School was clever and/or powerful enough to impose his solution to the problem, or whether there were other key figures in the School who had to be handled with care. Perhaps I should have asked Tony to draw the building on the whiteboard, to show the locations of the subgroups, and to describe the leading personalities. The first meeting with the representative of the client organization is not decisive, however. Usually, I have to wait and see whether the client returns in order to set up a joint project. The second meeting is more important. It enables me to work out a full-scale MCDA with variants of SMART and the AHP (possibly with weighted DMs), in the particular role of an outside consultant hired by the DM(s) in the client organization.

Afterwards, when I saw the case description, I felt sorry for Tony Jenkins because I asked him several questions for which he was really not prepared.

4.2. Remarks by Oleg Larichev

The organization of the workshop around an imaginary problem created some challenge to the analysts. The analysts represent different schools in decision analysis and have different personal skills. It was assumed that they would try to use different strategies at the stage of the problem analysis. In order to examine this assumption we consider how the analysts used the available information. They were all provided with the following:

(a) a short description of the problem which could be called the 'coffee room problem' (CRP);
(b) a face-to-face meeting with a substitute for the DM.

My personal evaluations of how Freerk worked with the data are as follows.

4.2.1. Positive features

(a) Freerk clearly understood that the initial requirement was to structure the problem. He did not try to use any particular techniques (e.g. the AHP method) at this stage of the problem's solution. He posed question after question trying to make clear the relationship of the DM to the other participants in the CRP, to find alternatives, criteria, evaluations of alternatives and so on. The discussion looked very natural from my point of view. Freerk used the language of the DM without giving him artificial tasks like 'define the weights of criteria' and so on.

(b) Freerk finally found the main alternatives of the problem's solution. They could be represented as:

Status Quo (SQ): to find the way to support the existing system of organization.
Vending Machines (VM): to install vending machines in the School.
Small Coffee Rooms (SR): to organize many small coffee rooms in different places.

There were also some unrealistic alternatives such as: to have no coffee room at all or to take a room from the Mathematics Department. But my impression is that they were introduced by Freerk to support the discussion.

(c) Freerk found the list of criteria important for the CRP:

- Relationships between the members of staff (R). There were professors who did not give any value to the coffee room. They had the impression that other people behaved in inappropriate ways: preparing 'an aromatic meal', taking milk home and so on. They mistrust other people.
- Money (M). 'Staff pay the subscription' but some professors are too busy with administrative meetings to visit the coffee room. They do not want to pay for others.
- Relation to personal habits (PH). Some professors are not in the habit of using the coffee room to discuss research and teaching activities. They prefer to have short talks with only their students.

4.2.2. Negative features

(a) Freerk asked again and again: 'Please, give me a new alternative'. It is useless from my point of view to ask the DM about new alternatives. He/she is usually restricted by a traditional vision of the problem. What is possible for an analyst during this stage of analysis? To define the requirements for new promising alternatives and

organize the search for ideas for their development (Larichev *et al.*, 1994).

(b) Freerk did not make a clear representation of the three-dimensional box: alternatives–criteria–stakeholders. There are three stakeholder groups, different in terms of their relation to the CRP: two kinds of staff (users and non-users of the coffee room) and postgraduate students. It was possible to describe their relation to SQ, VM and SR. It was also possible to find for each group the evaluations of each alternative in the terms of R, M, PH. Having such a presentation would make it easier to see the essence of the conflict in the CRP. It would be possible to find the possible changes in the existing situation (SQ) desirable for all stakeholders.

Finally, I see the similarity between the task given to the analysts in this workshop and one of retrospective protocols used to study medical decision-making (Patel and Groen, 1991). This latter approach gave interesting results in a different field. Maybe, it would be interesting to repeat such a task in the future again on a wider scale: to give to several analysts the description of a problem (history of a 'patient illness') and ask them to structure it using given information in the best possible way.

4.3. Remarks by Alan Pearman

My comments on Freerk's formulation of the coffee club problem address principally the modelling process, but also to some extent the resulting model structure itself. In the problem formulation phase, there is a clear interdependence between the two, in this application and more generally.

4.3.1. Confidence, relaxation and a little bit of irrelevance

Freerk's time with the DM was split into three approximately equal phases. The first was an entirely oral exploration of the surface issue, leading on to a gradual deepening and widening to probe for more fundamental concerns. Critical to success in this key early phase is to build the confidence of the DM. This is in part a personal confidence, the analyst as confidante, but also a professional confidence. The analyst was in this case (and needs to be seen to be) confident in the direction in which she/he is taking the analysis, without appearing unduly prescriptive or hurried.

A few irrelevant, peripheral and particularly open-ended early questions proved a good investment of time in developing an effective and free-flowing conversation about the problem. Listening is every bit as important as asking. As time passed and an initial formulation of the problem began to develop, a useful technique was to ask 'Can you tell me any general anecdotes about the School which in some way relate to the points we have touched on?'. A question like this lightens the tone of the conversation, breaks the mould and potentially opens up new insights beyond the surface appearance of the problem. 'Why is this *your* problem?' was another useful way to induce a change of perspective.

4.3.2. So what are we talking about?

A point is reached where the momentum of the initial conversation starts to flag. When it did so, Freerk moved into the second phase, a white-board-based approach towards a formal problem specification. He used the change simultaneously to do three things, essentially by setting down an understanding of the problem in terms of the matrix-based alternatives and attributes formulation which would ultimately be used to guide choice. Firstly, this process enabled him to check the accuracy of his own understanding of the problem. Secondly, it served to introduce the DM to the formal analysis procedure. Thirdly, it began to identify alternative solutions to the problem. Overall, this was a very effective and time-economical way of shifting from discursive mode to more structured and formal analysis.

During this phase, Freerk was willing to suggest alternatives, in a general way. He specifically introduced the *zero option*, 'Why bother to do anything?'. Although there may be an argument for the analyst not suggesting alternatives, my feeling is that a total ban on such activity is excessive. Surely part of facilitating the DM in identifying good options is to suggest possibilities? As options were introduced, so too were attributes against which the alternatives might be assessed, usually through exploring their 'feasibility'.

Again, eventually the impetus from this line of development started to flag. A final check with the DM for further options was made and the analysis moved into the final phase of the initial session.

4.3.3. A stab at evaluation

'Who is the final DM?'; 'Can you guess which option would gain majority support?' were useful ways of better understanding the decision in ques-

tion. Then pairwise comparison of alternatives was used as a basis to score alternatives on a $--/-/0/+/++$ scale. Although in principle this might have led to the identification of a preferred option, it did not and was not really expected to. In this particular case, the analysis was in fact halted prior to a full evaluation of all alternatives on each attribute.

4.3.4. How far is far enough?

Freerk's formulation was notable in using only about 1 h of the total time allotted. This was deliberate, essentially a recognition that, after an introduction, a period for quiet reflection can now be useful to both parties. The DM can reconsider matters in the light of potential solutions which have been aired and on the basis of a more formalized structuring of the problem. She/he can even consider whether examining the problem in this way deserves any further investment of time and possibly money! The analyst can reflect on the nature of the problem presented and on how analysis might best be pursued in any subsequent session.

Although circumstances will clearly differ, and the pure practicalities of operating as a consultant within an organization may preclude it, there is much to commend this approach of a rather brief initial meeting, followed by a period for reflection.

4.3.5. Discussion and suggestions

Overall, the analysis was professional and effective. However, some possible avenues for improvement are:

1. The analyst could perhaps have set down initially a 'route map' of broadly how and where he saw the session going. This would have clarified things for the DM and perhaps have encouraged further confidence in the process as a whole.
2. Some time devoted to probing the DM more deeply for potential options might have been fruitful.
3. Inevitably, given the short initial session, some of the attributes derived were somewhat ambiguous and potentially overlapping. Clarification in subsequent sessions prior to any formal evaluation would be necessary.
4. Although to some extent an artefact of the workshop situation, having a one-to-one initial meeting with a single DM was arguably less helpful in many respects than a one-to-many meeting between the analyst and a full cross-section of stakeholders from within the School.

5. THE FORMULATION CONSTRUCTED BY RAIMO P. HÄMÄLÄINEN

5.1. His formulation

5.1.1. Background

It is very important to note that the session was started with almost a complete lack of advance information about the case problem. This is a setting which has received very little attention in the literature. Yet, it is quite realistic to seek and benefit from decision support in such cases too. We have recently observed this in the parliament of Finland. In our study (Hämäläinen and Leikola, 1995, 1996) small groups of parliament members were offered the opportunity to get support by spontaneous decision conferencing about topical issues. They were assisted in problem structuring and prioritization by using multiattribute value models. This approach was very positively received.

In a standard facilitation setting I would do homework beforehand to get an understanding of the problem area and potential interests of the relevant stakeholders. In the current case we could not be prepared at all and thus the situation was like a spontaneous decision conference.

5.1.2. Goal driven approach

In the following description I will summarize the main principles and steps of the approach which I tried to follow in this session. I assumed the role of a decision analysis consultant who had been invited to help the customer in his problem solving. Thus, there was no need to sell my ideas and services to the customer, but to start the process directly. My facilitation process was very strongly driven towards the goal of problem solving and producing some kind of deliverable. This is an approach which I use when the DM or customer can specify the task in which help is needed and when there are tight time constraints present. I felt that we had a situation like this, however, very often this is not the case. The facilitator can also be invited at a phase in which the DMs, stakeholder groups and the problem scope are still very poorly understood. In that case, I would

start with a different process which would have longer brainstorming and scenario generation sessions at the beginning.

Keith Hobley was my customer whom I refer to as the DM even if he would not be the final DM in this case. I had received a very short problem description where his task was defined to be the preparation of a report to the Head of the School within 2 weeks. I decided to try to use this as the goal. The report would not need to include a recommendation. It could equally well turn out to be a problem description as the DM saw it.

In the beginning I explained to Keith the working goals I had set for myself and the session:

- He is my customer and the king of the session and I will try to advance and serve his interests unless he wants to take another perspective.
- Introduce the value tree analysis approach.
- Create personal credibility and a confidential relationship with the DM. This would hopefully be transferred into the methodology to be used, as well.
- Emphasize the DM's problem solving, i.e. help him produce the report to the Head of School.
- This first session should answer the following questions and result in the first definition of the problem framework.
  - what are the issues creating the need to do something?
  - who is the true DM?
  - who else is involved, who are the stakeholders?
  - what are the scales and ranges of impacts and interests?
- Keep the time constraint of 2 h in mind and produce some useful deliverables. This would guarantee that the DM would be well motivated for the next session and could feel that the time was not wasted and that he had achieved something.

5.1.3. Procedural method

The facilitation technique used could be called an interactive computer supported decision analysis interview (Marttunen and Hämäläinen, 1995) or a spontaneous decision conference (Hämäläinen and Leikola, 1995, 1996). It was a face-to-face dialogue between the analyst and the DM. I am used to running such sessions together with a technical assistant. Such help is essential in situations when time is a limiting factor. It also helps in general as the customer is not distracted from the dialogue by technicalities. The assistant keeps a record of the issues and keywords identified during the session and visualizes the value trees according to the structures arising in the facilitation. He/she also operates the computer. An assistant needs to have basic knowledge of the value tree methodology. He/she should not actively participate in the process, although this happened a little in our session. The assistant was my doctoral student Ms. Mari Pöyhönen and I would like to acknowledge her efficient help.

The session followed the steps listed below:

- Problem/task statement.
- Identification of the true stakeholders and their general goals and values.
- Option screening and generation by scope expansion.
- Formulation of an ideal solution and candidate alternatives by the win-win philosophy.
- Re-specification of the problem.
- Searching for stakeholder criteria to be included in a preliminary value tree.
- Rough performance estimation to learn the ranges of the attributes.
- First attempt in numerical weighting of criteria to find out the essential discriminating ones and to learn the scope of the problem.
- Produce printouts of the model as deliverables.
- Describe future steps and what would be done in the next session.

5.1.4. Task statement and issues defining the problem

The most important step of the process was to identify the problem task which would then determine the angle of attack, i.e. the perspective of the analysis. What really is the problem and who are the true DMs?

Keith seemed to see his role as a representative of the staff members who had come to be interviewed by me. I did not find him a strong interest holder himself. I suggested that a possible objective statement might be to help him produce a report in such a way that the staff reach their goals maximally. Keith accepted this as the preliminary working principle. We would always refer to this task when discussing the decision-making problem. It seemed that originally Keith had not thought that the preparation of the report for the Head of School was so important, although this was clearly stated in the problem description. To me it looked as if he had not

thought that he was responsible for the report and that 2 weeks was very little time for it. Even though I emphasized this perspective, it did not have a strong effect on the development of our session.The primary issues which arose in the discussion included:

- Location of the staff and the coffee room and the way of operating it. The coffee room is currently at Level 7 and the rooms of staff members and postgraduate students are both at Levels 7 and 9, Level 6 is likely to be used in the future.
- The users of the coffee room are staff members and postgraduate students. The undergraduates also had an interest in a socialising space.
- Administrative questions: What is the role of the staff room committee? Who is paying what for the coffee?
- What are the possible location solutions: new building, cafeteria, different levels? Could the School provide free coffee?
- The decision-making procedure: the Head of the School is making the final decision based on the recommendation given by the School Management Board (SMB).

5.1.5. Identification of stakeholders and their objectives

The identified groups of stakeholders were: the staff members located at the two levels; postgraduate students; undergraduate students; and the SMB. The objectives of each group were listed as they appeared during the discussion:

- The actual DMs, Head and the SMB, seem to be interested in the costs only. They are willing to accept any economically reasonable solution proposed by the staff members. The SMB also includes staff members.
- The main issue for the staff members is the location of the coffee room and kitchen which are used frequently. The location of the staff room is not as important. Yet, these two facilities are likely to be the same room. The location has an effect on the communication and socialization among all staff members as well as with student groups. The staff members also require an efficient system to collect payments because they have to pay for the coffee themselves.
- The postgraduate students get free coffee. They would like to improve the socialization with staff members. They are also worried about the space issues. They do not have much room at this moment and new arrangements may take space away from their other activities.
- The undergraduate students want to have coffee machines and they would probably not use a coffee room. The socialization with staff members, however, is considered to be important.

Overall the main objective turned out to be the improvement of the communication and socialization among staff members and between staff members and student groups.

5.1.6. Scope expansion with ideal and win-win solutions

The first thing discussed was the problem. I tried to change the perspective from the alternatives to the goals with the question 'Is this really a coffee room problem?'. To me the real ultimate goal seemed to be the improvement of the working and communication atmosphere in the department. I asked Keith to think of the possibility of having a completely new building or location for the School with a special design emphasis on the social areas. Could this be a realistic, even if, an extreme policy alternative? This idea seemed to be too radical and it was left for future sessions. The alternative of a coffee shop or cafeteria run by an outsider was brought up. This alternative was also included to get a clearly different reference for the evaluation. I tried to emphasize that the specification of the alternatives is a crucial point because it defines the problem scope.

Based on the stakeholder interests we started to think what an ideal staff room would look like. If we are able to present a set of alternatives for the report which all have a built in win-win philosophy then Keith's goals are guaranteed to be met to some degree at least. By win-win I mean solutions which would have some positive elements for each of the stakeholders. Based on the discussion it was clear that it would be possible to design a staff room and coffee delivery system that would satisfy most of the people involved. The issue raising conflicts between the interest groups seemed to be the location: whether the staff room should be on Level 9 or on Level 7. The pros and cons of these two solutions were listed and evaluated with respect to the objectives identified earlier.

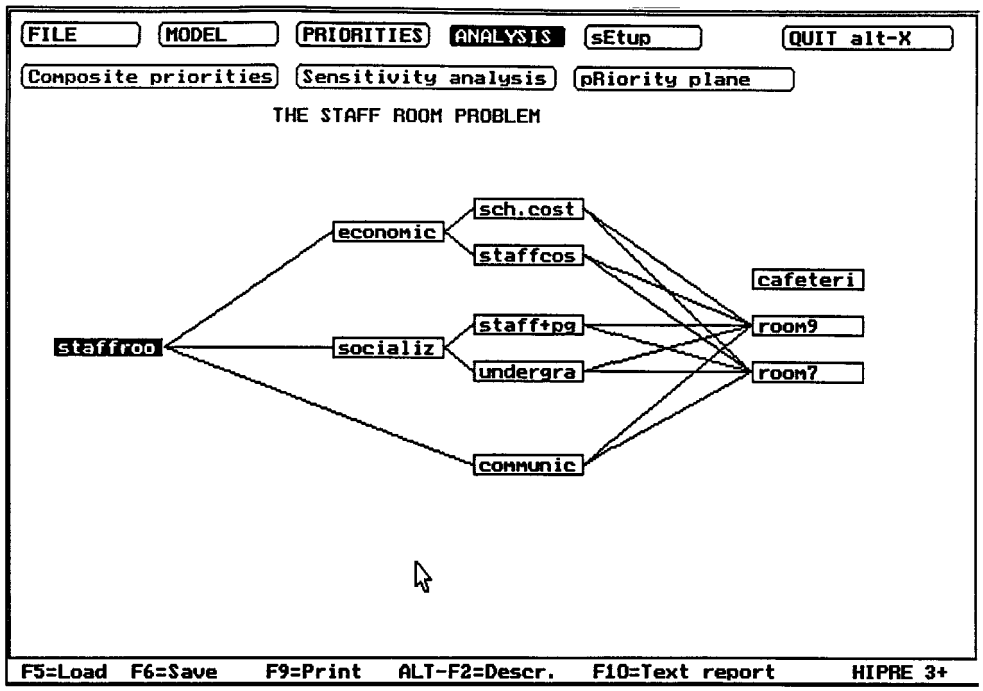


Figure 5. Raimo P. Hämäläinen's value tree for the coffee room problem.

5.1.7. Value tree and deliverables

We tried to capture the stakeholder's objectives in a simple value tree to be included in the report. Next we tried to come up with some clear measures, like money for costs, and their ranges for each objective. It was hoped that the value tree would clarify the problem and alternatives to the true DM. We had very little time for the prioritization but I wanted to carry it out to get a preliminary feeling of the relative merits of the alternatives. If one of them would turn out clearly superior then this fact should direct our next session. We used the HIPRE 3+ software (Hämäläinen and Lauri, 1996) running on a portable computer accompanied with a portable printer. The main objectives in the value tree (see Figure 5) are costs, socialization and the effectiveness of communication. The attributes are costs to School and costs to staff members, socialization among staff members and between staff members and undergraduate students. The three alternatives evaluated were a cafeteria, a coffee room either on Level 7 or on Level 9.

The performance of the alternatives with respect to each attribute were estimated subjectively and very quickly (see Figure 6). The first idea of the relative importance of the objectives was also asked and thus we could produce weighted performance scores for the alternatives. Direct weighting was used. This initial analysis showed that both coffee room alternatives are realistic. There can be more interest in moving the staff room to Level 9 because that would improve the communication among the staff members. However, the differences are not very strong. The printouts from the value tree model showed this and they would remain as the direct deliverables from this session.

5.1.8. Future steps

In the next session we would rethink the alternatives keeping the improvement in communication in mind as one of the main goals. Yet, we should still also look for measures that could improve the coffee delivery system.

A more complete value tree may need to be generated to give credibility to the report. This would show that the objectives of all the stakeholders have been considered. Representatives of stakeholder groups should perhaps be given an opportunity to do the weighting of objectives to improve joint problem ownership and commitment to the report and its recommendations.

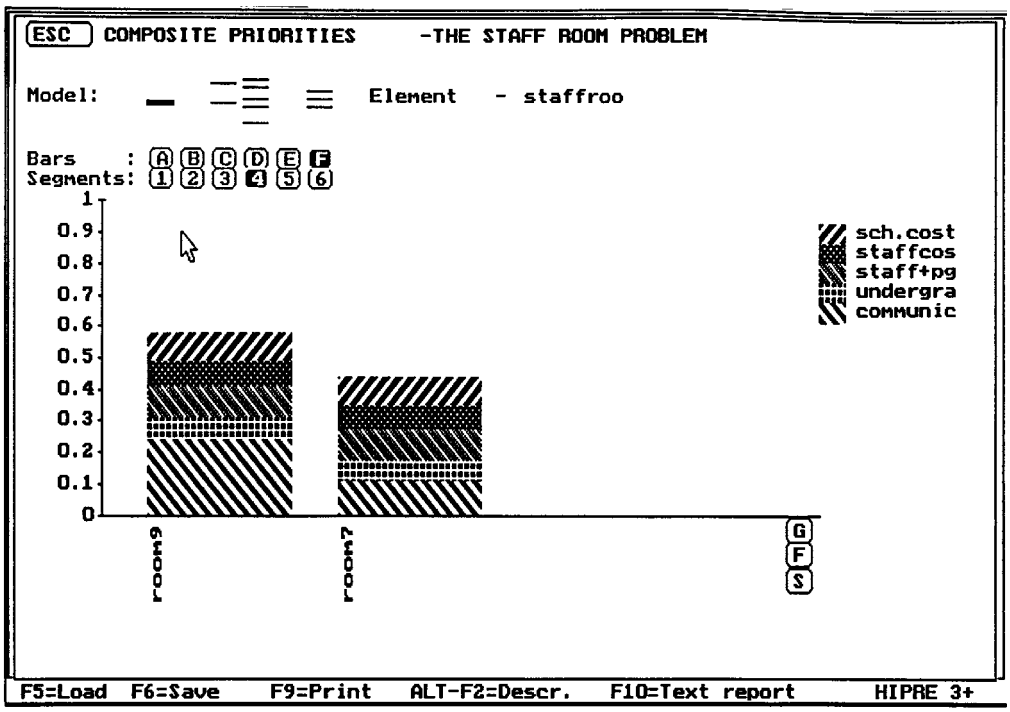


Figure 6. Raimo P. Hämäläinen's comparison of coffee room alternatives.

We should interpret the model results verbally and explain the benefits of each alternative. Keith should prepare a summary of these points as well as a final recommendation and explain the merits of this alternative by the win-win philosophy.

5.2. Remarks by Ward Edwards

As I watched Raimo toiling away at a quick elicitation of an MAU, my overwhelming impression was of the differences between what I was seeing and what I have seen when doing MAU elicitations for real, with real clients. Some of the differences:

1. Raimo was working under intense time pressure, and showed it. He did a minimum of structure elicitation, and it was never clear to me that his elicitee understood what a value tree is or why it is useful. He had no time to do cross-checks of his elicited numbers.
2. The 'stakeholder' didn't have much real stake, and indeed it wasn't even apparent that a real decision needed to be made. It was quite clear that there was no organizational commitment to the elicitation I was watching. In most real contexts an organizational commitment is implied by the elicitation because a commitment has been made to pay for the elicitation.

Given all that, I thought Raimo did a quite creditable job. He got to number elicitation rather quickly; I think that, even in this artificial situation, I might have tried for more situational and structural underpinnings. But if Raimo had done that, he couldn't have finished in time.

As happens every time I do or watch a weight elicitation, I am struck with the importance and slipperiness of the notion of 'importance'. Raimo used that word a lot, and explained it very little. In similar situations, I do much the same. No advocate of swing weighting (like myself) has ever found really good language to replace that word in explaining what weights mean to an elicitee or to the users of MAUs.

All in all, a very creditable and hard-working effort on Raimo's part. It is simply amazing how pervasively relevant the techniques of additive MAU elicitation have become in many, many psychologically savvy decision analysts' hands.

5.3. Remarks by Charles Vlek

5.3.1. Decision theory, support and psychology

Three points to begin with concern decision theory, decision support and decision psychology. Classical decision *theory* primarily is a theory of task environments rather than of cognitive processes, and it revolves around individual rather than social representations, probabilities and utilities. Thus, both the individual and the social psychology of decision-making are not accounted for in the classical theory which is normative only in so far as the underlying axioms are accepted.

Decision *support* may be practically divided into information provision, problem structuring and option evaluation, where any former stage conditions any latter (Vlek *et al.*, 1993). Thus, problem structuring underlies option evaluation, while information provision underlies problem structuring. Without an overall model of good decision-making it is difficult to tell the difference between relevant and irrelevant information, as well as the difference between useful and useless elements of the problem structure. Obviously, a specific decision rule is needed to evaluate 'good' against 'bad' decision alternatives.

Decision *psychology* rests upon descriptive models of human decision-making, for different types of problems, DMs and social contexts. Individual decision psychology deals with limited information-processing capacities, the guiding role of goals and values, cognitive and behavioural effects of decision stress, and the fundamental distinction between cognitively controlled (reasoned) versus automatic (habitual) choice behaviour. Social decision psychology deals with inter-individual differences in problem definition, values and expectations, with power relations among concerned individuals, and with conflict management and consensus formation among differing stakeholders. These and other individual-cognitive and social-deliberative variables and mechanisms play a role in any multiparty decision situation.

5.3.2. Problem formulation on the common-coffee issue

First of all, Raimo's attempts to 'formulate' the common-coffee decision problem at the University of Leeds, were remarkable for the great amount of time spent on *gathering information* from the DM. This was aimed at determining the nature and the background of the current problem situation, the various ideas about it which seemed to exist among different involved groups (staff, graduate and undergraduate students, and the Head of School), and the value objectives which one seemed to be cherishing. During this information acquisition, it became clear that valid empirical knowledge about the many stakeholders' own problem diagnoses, goal-directions, and feasible solution-scenarios was missing, whilst the DM could only provide his own perceptions and impressions of what the others found problematic and/or desirable.

A second outstanding phenomenon during Raimo's interrogation was his apparent background model of 'a well-defined decision problem' as optimally structured in terms of an options by attributes matrix. Here, the presumption seemed to be that a multiattribute evaluation model would be most effective, and that, for example, no major uncertainties (requiring some kind of expected-utility analysis) were involved. In fact, major uncertainties seemed to be there all right, in association with future housing rearrangements and the degree to which any stakeholder group (staff, graduate and undergraduate students) would actually make use of any new arrangement for the provision of coffee and tea. These and other uncertainties cannot be explicitly accommodated in an options by attributes structure.

Thirdly, in his attempts to identify feasible options Hämäläinen reminded me of an essay by the Polish philosopher Szaniawski (1980) who emphasized the goal-driven character of decision-making in general and of option generation in particular. Szaniawski specified two conditions for any alternative to be included in the choice set: (1) it must be acceptably feasible, i.e., the DM must be reasonably able to implement it, and (2) it must be goal-relevant, i.e., there must be a causal connection between the alternative and the goal to be achieved. These two conditions imply that the DM validly knows his or her own capabilities for carrying out what he/she has decided to do, and that he/she also has valid expectations about the likely future situation emerging from any choice alternative. Particularly the latter should have been, but could not sufficiently be explored during the workshop session.

5.3.3. Scope of problem and goal-set

Related to the previous point is the scope of both the problem diagnosis and the desired goal situation. To the extent that these are both limited to the operational level of 'regularly having coffee together', a wider problem context and a broader set of goals may remain obscure. During the analysis it appeared, for example, that socialization and communication were important putative effects of 'regularly having coffee together'. However, no diagnosis was performed of the degree of informal work-related socialization and communication that actually took or would take place under different past and possible future coffee-having arrangements. Also, no alternative socialization and communication strategy was considered in which the words 'coffee' and 'tea' did not figure prominently. Perhaps the deeper goals and values of the departmental staff and students would have been served at least as well (for the time being) by leaving 'coffee' and 'tea' out of the debate.

Finally, the value attributes considered for the options identified were also set on the initial goals of the problem-formulating operation. Again, socialization and communication seemed important, next to practical and financial feasibility. But missing were individual-actor attributes such as work efficiency and small-group embeddedness within the larger department. As already noted, perhaps the scope of the problem and of the goal state was too restricted for more strategic value attributes to emerge. For one thing, an attribute like 'future controllability of common-coffee strategy' was not considered, so that the risk could arise of a strategic decision that would set irreversible meeting conditions for some time to come.

5.3.4. A post-hoc suggestion

In pondering over the common-coffee problem of the School of Computer Studies at Leeds I myself might have hypothesized that perhaps the department had been struck by a tendency towards smaller-group informalities during shorter breaks which would occur at varying moments of the day anyway, and that something unusual would have to be contrived to get staff and graduate students together, if only once every 2 months, for both a professionally and socially rewarding meeting. So, my instruction to the assigned DMs might have been: 'find me some good socialization and communication strategies which do either or not involve whatever kind of refreshment'.

6. GENERAL OBSERVATIONS AND DISCUSSION

6.1. The scenario and the experiment

Perhaps one of the first conclusions is that, despite a folklore among decision analysts that DMs are only motivated to make realistic and useful judgements in the context of a real problem, which *de facto* focuses their attention, there was no doubt that the DMs and the analysts all 'bought in' to the role playing in the exercise. In each of the problem formulation sessions there was an 'emotional' involvement on the part of the DMs with the issues. They were able to—and did—state judgements that 'mattered' to them. There is one qualification to this: at least one analyst admitted to a feeling that 'Simon was Macheavellian enough to have buried rather more nasty issues than there actually were in the mess!'.

The mechanism by which the problem was developed depended upon the modification of an earlier problem 2 years before. Simon had faced this earlier problem when he had been Head of School in his time at Leeds. Two issues which had led to frictions then—the use of the microwave and the source of the coffee supply—did not rise to the surface in any of the sessions, despite having been noted in the briefing of the DMs. Subsequent discussion showed that they have ceased to be important to the members of the School. This suggests that the DMs really did bring the current context to their role playing and thus introduced realism into the exercise. Further evidence of this was provided when one of the DMs provided some background on the social tensions between two research groups in the School.

6.2. Different skills of an analyst

The workshop was constructed to examine three approaches to formulating a 'decision mess' into a soluble problem. Some common skills and techniques were apparent in all the analysts' approaches. Initially, all probed the problem area. They encouraged the DMs to widen their view of the problem, to devise and explore many alternative solutions. In essence, the analysts were trying to bound the problem space. This done, each

analyst was able to determine the perspective which the DM would like to take on the issues. Without this formulation stage being performed successfully, it is unlikely that a satisfactory solution could ever be agreed. Hence, our overall aim in the workshop to demonstrate and explore some possible approaches.

This aim was achieved, in that everyone involved in the workshop witnessed three different approaches from the analysts. Interestingly, the differences which arose were not necessarily due to the alternative requirements of each of the resulting methodologies. It is more likely that they arose out of the differing personalities of the three analysts. Each was working towards a similar structure, and yet each led the DM through a very different experience. The role which the analyst plays in a decision support session clearly influences the event. It is undoubtedly central to the nature of the experience and support offered to the DM.

Some analysts approach their task as 'businessmen': they are efficient, demanding and challenging. Alternatively, some analysts act as 'counsellors': they are calming, sympathetic and coaxing. In essence, this *personality* may be captured by the level of direction used by each of the three analysts. This is not to say that any of the analysts acted more or less professionally than any other, but is more a comment on the pressure which was exerted on each DM. The personality which is employed probably stems from the objectives of the analyst: reflecting, for example, whether placing the DM at ease is more important than completely solving their problem. Such objectives will drive the analyst, and therefore dictate the character of the session. As such, these objectives should be made explicit at the outset in order that the DM has some prior knowledge of the nature of the support process he or she will experience.

An essential skill for an analyst is the ability to withhold personal opinions. The analyst must maintain an objective or detached position. Their role can be jeopardized by intervening inappropriately in a decision analysis session (Phillips and Phillips, 1993). All of our analysts demonstrated this ability, though admitted afterwards that they had practised restraint. Further, the DMs must realize that they have ownership of the problem. They must not look to an analyst *to provide* a solution. Rather, the DMs should be prepared to work with the analyst to find an acceptable answer. It is likely that any solution will perform better if the DMs feel that they own it.

Another observation relates to the pace of the session. Even in a somewhat reduced event, lasting under 2 h, it was apparent that the dynamics of the modelling varied. The analysts were vigilant throughout the session. Sometimes a slowing of pace indicates that the DM is puzzling over an issue, but it could also mean that the DM has nothing more to say on the subject. The analyst needs to be able to tell the difference between these two events. In our workshop, when an analyst felt that an avenue had been exhausted, or noticed that the DM's interest was beginning to wane, they took control and moved the session onto alternative ground. This enabled the DM to re-involve himself with the problem and sustain interest. Further, it promoted confidence in the decision support session, adding value to the DM's experience.

6.3. Transferable procedures?

We have highlighted some of the skills employed by the analysts. While trying to formulate the problem, each explored stakeholders, objectives, and the scale of problem. Furthermore, either explicitly or implicitly, they tried to establish ways forward, criteria and values. Clearly, there are many ways in which this information can be established. In this section, we highlight some of the procedures which, although not used by all of the analysts in the workshop, might well be considered as transferable. That is, the final choice of decision model would not influence whether these approaches could be used. However, it would not be fair to suggest that any analyst could use any approach. There must be a personal attachment; the analyst must feel comfortable with his/her approach to use it confidently and in order that the DM is put at ease.

Freerk's approach, whilst helping the DM to find a simple problem representation, also seemed to be based upon trying to establish the level of commitment to solving the problem. His was a cautious approach, not wishing to give the impression that he would be involved unless there was an equal undertaking from the DM. Such a commitment could be demonstrated by agreeing to pay a fee to an analyst, but this is not sufficient. There must also be a desire to solve the problem, rather than placating others by giving

an impression of addressing it. Through provision of an initial representation of the problem, Freerk was offering the DM a chance to reflect on the problem and ways forward before pursuing a full analysis. The analyst was keen to make use of multiple sessions, and therefore broke off at the point he felt appropriate for reflection.

Raimo was driven by a desire to produce a deliverable for the DM: to provide the DM with a resource to take back to the School for discussion. He was pursuing his own objective in some sense, though this objective was aimed at supporting the DM. As a consequence, Raimo progressed much further into the decision modelling phase than any of the other analysts. His approach to encouraging the DM to appreciate the scope of the problem required the DM to generate numbers. Raimo argued that only through providing weights and preferences could the scope of the problem be understood. He supported the gathering of this data with software, in order to quickly compute the impact of such beliefs.

Valerie's session seemed to be split into two activities—acquiring and structuring knowledge (*cf*. Ackermann and Belton, 1994). Initially, she and the DM discussed issues, ideas, people, problems and solutions. This approach was used to capture all thoughts as they surfaced. As such, the DM was allowed to move from one topic to another, and back again as certain revelations led to other overlooked thoughts. Because of the analyst's approach, there needed to be a flexible form to hold the information. Once this process of acquisition of information was close to complete, Valerie moved on to its organization. Clearly, the DM may still add information to the problem, and therefore knowledge acquisition will progress through the later phases of the analysis. The structuring phase involved clustering ideas, constructing alternative stakeholder's views and building up logical solution strategies. This provided a wide view of the problem, enabling the DM to critically reflect on the various problems which he actually faced. Again, the DM was encouraged to focus on addressing one of these, and the analysis progressed.

Eden *et al*. (1983) suggest three styles of help that might be offered by (decision) analysts: coercive, empathetic and negotiative. Valerie's style was empathetic moving a little in the direction of negotiative. Freerk also operated in the empathetic-negotiative mode, although a little more towards the negotiative. Raimo clearly leant to the coercive style, beginning with some empathetic interactions.

6.4. Discussion about problem formulation

Reflecting on the workshop, all participants agreed that it takes a lot of time and effort to get a problem mess into an agreed matrix of values reflecting criteria, preferences and beliefs. Further, all possible solutions need to be scored against this matrix in order to apply a normative solution procedure. The dynamic nature of problem formulation may lead to divergent working, further complicating the initial problem. However, this will encourage the DM to consider fully the focus which he/she would like to take. Problem formulation is complicated by the fact that people's preferences evolve. There is a danger of an analyst forcing preference values on to the DM in order to perform the analysis. This was not something which was observed in the workshop, but is a temptation which analysts acknowledge in stressful, demanding situations.

In addition to his/her preferences changing, it is likely that many other aspects of the DM's perspective will develop during the analysis. DMs are likely to mention new constraints at each suggested model. As certain issues become more concrete in their minds, it is likely that they will have revelations concerning the problem. Therefore, problem formulation is likely to be cyclic, and each recognizable phase could be revisited at any stage. A good indicator that the model is becoming complete are the feelings of the DM: unease on their part implies that the problem needs further exploration.

A conclusion from the workshop was that it is worth investing a little time at the beginning of the session in social interaction to build a relationship between the DM and the analyst. The early phases of any problem formulation are very much based on good communication between the analyst and DM. Therefore, anything which can facilitate a rapport will be beneficial. Further, a few frivolous comments can give much away about the true nature of the DM's feelings. A request for anecdotes or stories regarding the problem will provide background for the analyst, and may allow the DM to 'let off some steam' with regard to the problem.

Further, it was agreed that analysts should be wary when discussing the problem with the DM. The analyst should not take for granted the stated problem. Indeed, there was a lot of suspicion displayed by the analysts at our workshop as they tried to establish the 'real' issue. The experiences

of those involved showed that there is often more to a problem than is initially made explicit. The DM may be encouraged to reveal this if they feel secure in the session, and if they have confidence in the analyst's ability to help them face the consequences of raising the issue. What is generally agreed is that any solution found to the superficial problem is not likely to survive unless the more fundamental one is addressed.

Some comments arose from the artificial nature of the workshop. Cautionary statements were made about assuming that MCDA would be the right way to solve a problem. Given the brief of the workshop, the analysts involved were safe to assume that the problem would be of an MCDA type. However, this is an aspect which an analyst must normally establish. The DMs involved commented that a 'route map' would have been useful. They felt unsure about where the session was going. The fact that each of the analysts failed to make the session outline clear may have been a factor of performing in front of an expert audience. The analysts were in an unrealistic session, being watched by people who were experienced in decision analysis, and therefore may have felt this unnecessary. A final point emerged due to the hypothetical nature of the scenario. All key players should have been present, including the DM, face-to-face with the analyst for a decision support session. Our analysts and observers noted that their work would have been constrained had they not been able to get all of the problem owners together for the decision formulation.

ACKNOWLEDGEMENTS

We are grateful to Keith Hobley, Tony Jenkins and Matt Morley for acting as DMs, to Mari Pöyhönen for her assistance, to the other participants at the workshop, and to the organizers of SPUDM97 for agreeing to an unconventional format for one of their workshops.

NOTES

1. It is arguable that the term decision maker is incorrect: maybe problem owner would be a better term. But we have chosen to use the former both because we believe that problem formulation is provided with its motivation from its role in the decision making process and we wish to emphasize our concern to compare approaches to the support of decision makers.

REFERENCES

Ackermann, F. and Belton, V., 'Managing corporate knowledge with SODA and V.I.S.A.', *Brit. J. Manage.*, **5**, 163–176 (1994).

Banxia Software, *Decision Explorer*, Glasgow: Banxia Software, University of Strathclyde (Info@banxia.co.uk.), 1996.

Belton, V., Ackermann, F. and Shepherd, I., 'Integrated support for problem structuring through to alternative evaluation using COPE and V.I.S.A.', *J. Multi-Crit. Decis. Anal.*, **6**, 115–130 (1997).

Eden, C., Jones, S. and Sims, D., *Messing about in Problems*, Oxford: Pergamon, 1983.

Hall, P., 'Managing change and gaining corporate commitment', *ICL Tech. J.*, **7**, 213–227 (1986).

Hämäläinen, R.P. and Lauri, H., *HIPRE 3+ Decision Support Software vs. 3.13e*, Helsinki University of Technology, Systems Analysis Laboratory, 1996. (Distributed by EIA Ltd., Tekniikantie 17b, 02150 Espoo, Finland. Tel.: +358 9 70018680; fax: +358 9 7001 8682.)

Hämäläinen, R.P. and Leikola, O., 'Spontaneous decision conferencing in parliamentary negotiations', in *Proceedings of the Twenty-Seventh Annual Hawaii International Conference on System Sciences*, Hawaii: IEEE Computer Society Press, January 4–7, Vol. IV, 1995, pp. 290–299.

Hämäläinen, R.P. and Leikola, O., 'Spontaneous decision conferencing with top-level politicians—discovering the hidden demand for support in political decision making', *OR Insight*, **9**(1), 24–28 (1996).

Larichev, O., Brown, R., Andreeva, E. and Flanders, N., 'Categorical decision analysis for environmental management: a siberian gas distribution case', in Caverni, J., Bar-Hillel, M., Barron, F. and Jungermann, H. (eds), *Contributions to Decision Research*, Amsterdam: North Holland, 1994.

Marttunen, M. and Hämäläinen, R.P., 'Decision analysis interviews in environmental impact assessment', *Eur. J. Oper. Res.*, **87**, 551–563 (1995).

Patel, V.L. and Groen, G.J., 'The general and specific nature of medical expertise: a critical look', in Ericsson, R. and Smith, J. (eds), *Toward a General Theory of Expertise*, Cambridge: Cambridge University Press, 1991.

Phillips, L.D. and Phillips, M.C., 'Facilitated work groups: theory and practice', *J. Oper. Res. Soc.*, **44**, 533–549 (1993).

Szaniawski, K., 'Philosophy of decision making', *Acta Psychologica*, **45**, 327–341 (1980).

Vlek, C., Timmermans, D. and Otten, W., 'The idea of decision support', in Nagel, S.S. (ed.), *Computer-Aided Decision Analysis; Theory and Applications*, Westport (Conn.)/London: Quorum Books, 1993, pp. 33–68.

