Highlights from the 17th International Conference on Multi-Criteria Decision Making

Whistler, BC, August 6-11, 2004.

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1. Introduction

The 17th annual conference on Multi-Criteria Decision Making was held at the Whistler Conference Centre from August 6 to 11, 2004. There were around 150 participants and as many presentations, spread across 4 parallel sessions. Participants came from many different fields, most notably from economics, management science, business administration, operations research, mathematics, software engineering and industrial engineering. This made for very different presentations, some concerning new research ideas, others applications and case studies, theoretical foundations, tutorials or software surveys.

2. Overview of the Areas of Research and Application

Although there were many different topics, most presentations were related to one of the following areas:

1. Group Decision Support Methods;
2. Decision Support Methods;
3. AHP applications;
4. Multi-Objective Linear Programming (MOLP) algorithms;
5. Industrial engineering applications;
6. Behavioural considerations, and
7. Fuzzy MCDM.

3. Topics for Further Research

Of the many subjects presented, the following appeared to be of potential interest to ORD. Further research into some of those areas could provide insight in the way we deal with multi-criteria decision problems. Further details concerning these areas and their application to specific ORD projects will be discussed in phase 2 of the Maritime OR Toolset Review.

1. Dempster-Shafer theory

The theory developed by Dempster and later by Shafer is an extension of Bayesian theory. It defines a set of rules and operators for combining evidence under uncertainty. Dempster-Shafer theory was also a recurring theme at the INFORMS/CORS conference, especially from professors at the US Military Academy in West Point, NY. Among other things, they use this logical paradigm to model sensor information flow, in particular in a network centric context. For MCDM, it is at the core of the Evidential Reasoning approach and the focus of some research on multi-criteria group decision making to combine evidence from decision makers and evidence from criteria.

2. Behavioural Considerations and Impact of Cognitive Biases on MCDM

Results presented by several speakers indicated that behavioural considerations play an important role in decision making. This is especially important when using software like AHP or when constructing questionnaires for SME's (see [10] for many examples).

One particular study [1] showed that the number of mechanical errors produced by decision makers increased greatly with the size of the problem when using AHP, sometimes enough to counter the positive effect of using a Decision Support System. Mechanical errors are typos and other errors that result from lapses in the user's attention.

Another study [2] suggested that of all types of cognitive biases, anchoring is one that can severely skew the results of the decision analysis. For example, the two questions "How many CP-140 patrol area A weekly?" and "How many CP-140 do you think are needed weekly to patrol area A?" should not be asked in this sequence in a questionnaire or interview. The answer to the second question could be dependent of, i.e. anchored to, the answer to the first question. Research shows that the anchoring happens frequently and has a strong impact on decision making.

Another particularly interesting presentation [3] insisted that good decisions are made with intuition and emotion. The author referred to neuro-biological studies to enforce this point. The main criticism was aimed at methods like AHP that use pairwise comparisons to "simplify the cognitive burden" on the user. The speaker argues that this creates artificial scenarios that prevent the user from making intuitive decisions. The conclusion of the speaker, expressed in his own terms, is the following: " The challenge, therefore, is to develop processes that are able to still present such trade-off problems in a way that is vivid enough to elicit emotions when the decision-maker ponders the alternatives."

3. **Integration of Discrete Event Simulation, Evolutionary Multi-Objective Optimisation and Multi-Criteria Decision Making**

   Currently still at the early stages of development, this project seeks to use MCDM to facilitate the exploration of the parameter space in Discrete Event Simulations (DES). Typically, DES (like MARVIN or any ARENA model) is used in a trial and error fashion to explore the space of possible outcomes. This works well when the system under study is fairly small and if there is only one criterion to measure performance, the problem becomes much more complex when performance is measured by conflicting criteria. Research in this area is looking at combining DES with multi-objective evolutionary optimization (like Genetic Algorithms) to reduce the space of parameters to explore. A MCDM system could provide the choice for the preferred solution from this reduced set of outcomes and provide a strategy for improvement (a new search direction). This decision support system would be interactive.

   Some of these ideas have been applied to chemical process design using a commercial numerical simulator and an interactive multi-objective optimization method called NIMBUS (see [4]).

4. **Cooperative Games for Auto-Scheduling**

   Although this area is in no way a trend (there was only one presentation on this subject ([5])), it is a different and unusual application of decision support. The problem presented consisted in finding the optimal schedule for a set of machines in a shop with resource and time constraints. The solution proposed was inspired from game theory and modeled each machine as a player cooperating with the other players (machines) to achieve its own goal, i.e. minimize the penalties associated with the infringement of the constraints. Each player-machine was associated to a software agent and a super-agent was tasked with the negotiation process between the players, in other words the group decision support. This procedure is fully automated and implemented in Java, it produces schedules in a few seconds for relatively small problems.

4. Software and Methods

A number of software tools and methods were mentioned during the conference. They seem to correspond to different ‘schools of thought’ rather than to apply to specific problems. This is a short list of the most frequently mentioned. It is of interest to note that a survey of commercial tools for MCDM appears annually in the publication “OR/MS Today”.

1. Interactive Decision Support (IDS)

Uses the Evidential Reasoning approach, based on Dempster-Shafer theory. Intervals and uncertainty are handled in the decision matrix. [13];

2. Multi-Attribute Value Theory (MAVT): HiView, VISA
   Very interactive tools that allow the user to visualize the input data and manipulate it with the mouse, also provides some sensitivity analysis;

3. Analytical Hierarchy Process (AHP): ExpertChoice
   Based on Saaty's method of pairwise comparisons to elicit weights for criteria and performance scores of options on the different criteria;

4. Hybrid MAVT & AHP: WebHipre, Logical Decisions
   Those methods are similar in format to the methods of the second category but they also use pairwise comparisons. WebHipre is meant to be used over the internet, and is based on the Hipre3+ method;

5. knowCube
   Different type of software that uses a 'spider' graph to explore the space of options and attributes. Highly interactive. [14]; and ,

6. Outranking methods: PROMETHEE and ELECTRE
   From the 'French' school of MCDM. Those methods essentially consist in asking the decision maker to rank the options relative to each criterion, the method then tries to outrank the options to find a dominating one. These are the methods that resemble the most the tau-x based method used at ORD [I.15].

5. Overall Impression

Overall, this conference was a great opportunity to get an overview of the field and the applications of MCDM.

As mentioned previously, participants came from very different backgrounds. This led to interesting discussions as case studies were presented to 'theoreticians'. In a few instances, claims made during the presentations were refuted by one or more members of the audience, leading to instructive discussions for both the presenter and the audience.

An important element that comes out of this conference is the practical impossibility to measure the quality of a decision. This, to a certain extent, limits the convergence of methods because results cannot be compared. It also means that mistakes or wrong assumptions can easily go unnoticed, enforcing the idea that the best decision support systems must be sound and simple.

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List of symbols/abbreviations/acronyms/initialisms

AHP	Analytical Hierarchy Process
CORT	Central Operational Research Team
DES	Discrete Event Simulation
DRDC	Defence Research and Development Canada
IDS	Intelligent Decision System
MARVIN	Maritime Vignettes (Discrete Event Maritime Simulation)
MAVT	Multi- Attribute Value Theory
MCDM	Multi-Criteria Decision Making
MOLP	Multi-Objective Linear Programming
ORD	Operational Research Division

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