A PROTOTYPE SELECTION COMMITTEE DECISION ANALYSIS AND SUPPORT SYSTEM, SCDAS: THEORETICAL BACKGROUND AND COMPUTER IMPLEMENTATION

A. Lewandowski and S. Johnson
International Institute for Applied Systems Analysis
A-2361 Laxenburg
Austria

A. Wierzbicki
Institute of Automatic Control
Technical University of Warsaw
00665 Warsaw
Poland

1. INTRODUCTION

Many major decisions in public and private arenas are delegated to committees. The institution of a committee, though it has many shortcomings, remains an important aspect of many decision processes; the process of committee decision-making must therefore be improved. As a result of personal experiences with committees, the authors have developed a procedural concept and an automated aid for decision-making by committee, aimed in particular at a committee charged with the task of selecting from a finite set of alternatives.

The theoretical framework for the automated system called "SCDAS" (for Selection Committee Decision Analysis and Support system) follows the concept developed by Johnson (1984). The multi-person decision support system is based on the construction of an order-consistent achievement function (Wierzbicki, 1985) which is used as a multivariable cardinal utility function and depends explicitly on the contextual information supplied by the users. The system described can be applied to a wide spectrum of decision problems and serves as a processor of information about preferences and alternatives that guides the committee. The computer implementation is non-procedural in that a menu format allows entry and re-entry into many stages of the process, thus allowing a great deal of procedural flexibility. Additionally, a rich graphic representation has proven quite user-friendly on the basis of several empirical tests.

2. THEORETICAL BACKGROUND

The problem of selecting one alternative from a finite set of alternatives presented to a committee is one of the most basic and classical decision problems and has received much attention in the decision-theoretical literature. There are many detailed variants of such a problem; here, we consider the following abstract variant:

A *committee* consists of several members (denoted here by $k = 1,\dots,K$); each member can have either equal or different *voting power* (denoted here by a voting power coefficient $v(k)$), specified a priori by the *committee charter*. In addition to the committee structure, the committee charter might specify the purpose of the committee's work, further procedural details, etc.

The problem faced by the committee is to jointly rank or select one or a few from a set of available *decision alternatives* (these might be candidates for a job, proposals for R&D projects, alternative transportation routes, proposed sites of an industrial facility, alternative computer systems, etc.). The list of alternatives need not be complete at the beginning of the committee's work; during the decision-making process, new alternatives may be generated and subsequently evaluated.

Evaluation of alternatives is performed by the committee by first specifying *decision attributes* (such as a candidate's age, experience, professional reputation, etc.) and then assessing each alternative with respect to each of these attributes. The list of decision attributes (denoted by $j = 1,\dots,J$) might be specified in the committee's charter or decided upon by the committee. In any case, decision attributes must be specified before

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alternatives can be evaluated and compared.

Each alternative (denoted by $i = 1,\ldots,I$) must be evaluated by the committee or its individual members. The problem consists of proposing a *decision process* which together with assessment of various attributes of the alternatives and aggregation of evaluations across both attributes and committee members, leads to a final ranking or selection of an alternative(s) in a way that is rational, understandable and acceptable to the committee members.

Several approaches to this problem have been developed; most of them are based on the classical multi-attribute utility theory (see e.g. Keeney and Raiffa, 1976), but there are also alternative approaches, such as the analytical hierarchy of Saaty (1982) or the orderings of Roy (1971). Some of these approaches have been also implemented as microcomputer-based decision support systems: an interesting implementation is that of analytical hierarchy (EXPERT CHOICE, 1983) or the non-procedural package DEMOS (1982) used for probabilistic evaluation of alternatives. Another commercially available implementation (LIGHTYEAR, 1984), based on utility theory and weighting coefficients specified by the user, employs a rather primitive decision process and is restricted to only one user, hence it is not applicable in committee decisions.

Most of these approaches rely on either user-supplied rankings of attributes and alternatives for each attribute, pairwise comparisons of alternatives, or some uncertainty equivalence principle (e.g. comparisons to a lottery). The available assembly of alternatives plays an important role when establishing the principles of the decision. Such decision processes will be called *alternative-led*. An attempt to establish decision principles independently of available alternatives is possible when specifying weighting coefficients by the user; but in addition to the problem of having to specify utility functions or explicit weighting functions for the multiple attributes, weighting coefficients can be reasonably interpreted only locally, when the available alternatives do not differ much in all of the attributes. When the available alternatives differ significantly in some attributes, the approximate linearity of the user's utility function is a questionable assumption.

An easily interpretable outline of decision principles that are independent of available alternatives is possible when requiring each member to specify aspiration and (or) reservation levels for the evaluation of each attribute. Such a process will be called *aspiration-led*. The concept of an aspiration level is essential for the *satisficing framework* of decision-making (Simon, 1958), where it is assumed that as soon as an alternative is discovered that meets aspiration levels for all attributes, the search for alternatives is terminated and the choice is made. However, we do not adhere here to the strictly satisficing framework: aspiration levels are used rather in the construction of an approximate multivariable cardinal utility function that is further averaged and maximized in the system. This approach is called *quasisatisficing* (see Wierzbicki, 1985).

The reservation level represents a minimum acceptable level for each attribute (e.g. minimum 5 years' experience for the position), whereas an aspiration level reflects a higher desired level of expertise. If an alternative is evaluated below the reservation level on even one attribute, it is considered unacceptable, and if it is evaluated at least equal to aspiration levels for all attributes, it is considered highly desirable. Nonlinear approximations of utility functions based on aspiration (reservation) levels supplied by the user are called (order-consistent, or order-preserving and representing) *achievement functions* and have been studied in detail by Wierzbicki (1982, 1985). Johnson (1984) has worked out a concept for a selection committee decision analysis and support system based on committee-supplied aspiration levels and the use of achievement functions for both alternative-led and aspiration-led variants of the decision process; however, only the latter is chosen here for implementation.

2.1. Setting and discussing aspirations

An aspiration-led decision process has several advantages. Most judgmental decision processes require a choice of (and, in a committee, agreement upon) scales of evaluation for each decision attribute . The scales are often qualitative, such as unacceptable, bad, acceptable, good, very good, excellent, though they can be transformed into quantitative scales for computational purposes. When asked to specify *anchor points* (aspiration and reservation levels) on these scales at an early stage of the decision process, the decision-maker is better prepared to make consistent evaluations across alternatives. However, we cannot expect and should not require full consistency in any judgmental decision process, since not all relevant attributes might be evaluated and the relevant information on alternatives is never completely shared by all committee members. If each committee member is asked independently to specify his or her aspiration and (or) reservation levels for each attribute, a comparison of such results across the committee and across attributes serves