Metodologias Multicritérios de Apoio à Decisão

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MULTICRITERIA DECISION ANALYSIS: SOME THOUGHTS BASED ON THE TUTORIAL AND DISCUSSION SESSIONS OF THE ESIGMA MEETINGS

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Abstract. This paper seeks to offer an overview of the streams of thought in the field of Multicriteria Decision Analysis or Aid (MCDA) presented and discussed in the sessions of the annual meeting of the Euro Special Interest Group on Multicriteria Analysis (ESIGMA). Our main purpose is to emphasize some of the most important and original contributions made by the prominent scientists invited to those meetings, and to reflect on the conclusions of the discussions held along the ten years of existence of ESIGMA, without attempting to review the broad multicriteria field in detail.

"In the affair of so much importance to you, wherein you ask my advice, I cannot, for want of sufficient premises, advise you *what* to determine, but if you please I will tell you *how*. {...} My way is to divide half a sheet of paper by a line into two columns; writing over the one *Pro*, and over the other *Con*. Then, during three or four days consideration, I put down under the different heads short hints of the different motives, that at different times occur to me, *for* or *against* the measure. When I have thus got them all together in one view, I endeavor to estimate their respective weights {...} [to] find at length where the balance lies {...}. And, though the weight of the reasons cannot be taken with the precision of algebraic quantities, yet when each is thus considered, separately and comparatively, and the whole matter lies before me, I think I can judge better, and am less liable to make a rash step, and in fact I have found great advantage from this kind of equation, and what might be called *moral* or *prudential* algebra.

Wishing sincerely that you may determine for the best {...}."

In J. Bigelow (ed.), *The Complete Works of Benjamin Franklin, vol. 4*, Putnam, New York, 1887, quoted by Dawes and Corrigan [8]. (See also [31, p. 13].)

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In this letter of Benjamin Franklin to his friend Joseph Priestly, dated 19 September 1772, one can find the two main phases in the methodology of *Multicriteria Decision Analysis or Aid (MCDA)*: structuring and evaluation. Surprisingly or not, many important concepts of MCDA are present in the letter: conflicting criteria, uncertainty, pairwise comparisons, value judgements, compensation, weights, aggregation, etc.

In spite of these early insights, it is only two centuries later that we find the first independent session specifically devoted to multicriteria research in a scientific congress. To our knowledge, this was the session on Multiple Objective Functions organized by Bernard Roy in 1969 during the 7th Mathematical Programming Symposium held in The Hague. But it was the famous First International Conference on Multiple Criteria Decision Making at the University of South Carolina in 1972, organized by James L. Cochrane and Milan Zeleny [7], that started to give form to the previously widely dispersed scientific community interested in the multicriteria domain.

During the seventies, the field experienced a high level of activity. In 1975, Bernard Roy organized the first meeting of the Euro Working Group on Multicriteria Aid for Decisions (which has now had 41 meetings) in Brussels. Also in 1975, Hervé Thiriez and Stanley Zionts [23] organized the first conference of what was later to become the International Society on Multiple Criteria Decision Making (formally established in 1979, with 12 conferences having been held up to 1995). Only ten years later, Milan Zeleny [32, p. X] saw the field as an *independent body of knowledge* (quoting about 3000 multicriteria references), which was rapidly expanding. This expansion has continued up to the present, as the MCDA field stands on the threshold of adulthood.

The eighties confirmed this view, as many more papers, books and special issues of journals (28 up to now, according to [20], starting with the special issue of Computers & Operations Research in 1980 edited by Milan Zeleny [30]) appeared, while many specialized conferences or specialized streams at OR/MS conferences took place. The first International Summer School on MCDA (there have been 5 schools up to the present) was held in 1983 in Acireale, Sicily, organized by Benedetto Matarazzo. At these schools, well-known personalities teach MCDA theory and practice to university researchers, PhD students, and practitioners from all over the world. We must, finally, make mention of the Euro Summer Institute on Multicriteria Analysis, organized by Jean-Pierre Brans in Brussels, during which time ESIGMA, i.e. our EURO Special Interest Group on Multicriteria Analysis, was born. Since then, our working group has met on either the day before, or the day after, the annual EURO Conferences. The following is the full list of the meetings of ESIGMA and the respective organizers:

1st Lisbon, Portugal, September 19-20, 1986 (Carlos A. Bana e Costa).
2nd Brussels, Belgium, March 25-26, 1987 (Philippe Vincke).
3rd Paris, France, July 6-8, 1988 (Denis Bouyssou and Daniel Vanderpooten).
4th Belgrade, Yugoslavia, June 25-26, 1989 (Serafim Opricovic, Djura Kutlace, and Olga Memedovic).
5th Athens, Greece, June 24, 1990 (Denis Yannacopoulos).
6th Aachen, Germany, July 16, 1991 (Brigitte Werners).
7th Helsinki, Finland, June 28, 1992 (Pekka Salminen and Mari Pöyhönen).
8th Lisbon, Portugal, July 11, 1993 (Carlos A. Bana e Costa and José F. Rafael).
9th Glasgow, Scotland, July 23, 1994 (Valerie Belton).
10th Jerusalem, Israel, July 7, 1995 (Zilla Sinuany-Stern and Lea Friedman).

Over the past two decades, MCDA has developed into a discipline in its own right, as is evidenced by the impressive bibliographic survey of Ralph E. Steuer et al. [20], with a specialist journal of its own, the Journal of Multi-Criteria Decision Analysis (JMCDA), starting publication in 1992. In some senses the discipline may still appear to be a *hydra with several heads*, representing diverse streams of thought evolving independently towards maturity, as the editors of JMCDA [11] emphasized in their Welcome: "We recognize that there are differences – significant differences in the underlying principles – between the various methodologies practised around the world". But to this was added: "We hope that part of the service the Journal can perform is to debate these differences so that we can learn from each other's strengths."

This sentiment has always been the main goal of ESIGMA, whose purpose is to offer an informal discussion-oriented forum for the exchange of multicriteria ideas. In ESIGMA meetings, emphasis is given to discussion of subjects of common interest, namely those around which the most significant differences and controversy arise between the various multicriteria schools. In addition to these "Oriented Discussion Sessions" (ODS), there are also Tutorial Sessions, at which prominent scientists are invited to present to the group the principal issues of the methodologies they have been developing or stand for.

One issue which causes considerable misunderstanding and confusion is the absence of a consistent and unified terminology in the field, even as to what is meant by a criterion. The possibility of establishing a consensual definition of this most fundamental concept has been tentatively addressed in an ODS devoted to "what is a criterion?" during the 5th ESIGMA meeting in Athens in 1990. Denis Bouyssou [5] proposed an useful general definition of a criterion as a tool allowing comparison of alternatives according to a particular point of view. This definition incorporates not only a common-language sense of "criterion" as used by many authors (for instance, "criteria are measures, rules, and standards that guide decision making" [31]), but also the more technical notion of a criterion as a model, i.e. a model of preferences between elements of a set A of real or fictitious actions (which includes the mathematical notions of criterion-function proposed by Peter Fishburn [10] and Bernard Roy [16]. Note that these concepts of criterion which are synthesized into Bouyssou's definition include both a proactive user orientation (what do we want to achieve?), and a reactive analytical orientation (what characteristics of the decision alternatives most affect our preferences between them?). This distinction is clearly identified in the work of Ralph L. Keeney [12], to which we shall later refer.

Interest in MCDA increased as the sphere of application of quantitative management science moved from operational decision making situations, for which a more-or-less *well-defined* single objective function could be identified with little controversy (e.g. maximize profit), to more complex levels of managerial planning and decision making, which are naturally multidimensional problems. The key philosophical departure point defining MCDA as a formal approach lies in structuring problems in terms of a number of individual (relatively precise, but generally conflicting) criteria. The one basic conviction underlying every MCDA approach is that the explicit introduction of several criteria, each representing a particular dimension of the problem to be taken into account, is a better path for robust decision-making when facing multidimensional and *ill-defined* problems, than optimizing a single-dimensional objective function (such as in

cost-benefits analysis). In contrast to the more classical OR approaches, the multicriteria decision aid framework facilitates learning about the problem and the alternative courses of action, by enabling people to think about their values and preferences from several points of view.

Some may still argue that a multidimensional problem can be tackled by using a single-criterion approach, provided the one objective incorporates all the various dimensions of interest, generally according to some technical rule. In fact, a superficial view of certain MCDA approaches, especially value function techniques, suggests that precisely this is being done. Such a view misses the point that even value functions, when properly constructed and used, are tools for exploring the interplay between the dimensions or criteria; attempts at simply constructing a single objective function without this intention in mind does not constitute MCDA. Justification of the usefulness of an MCDA approach thus requires more than reference to the multidimensional nature of complex real situations; it is ultimately an *acte de foi* [17] in favour of dealing with decision problems by first constructing a set of multiple criteria. The ideas just expressed are very much influenced by the thoughts of Bernard Roy on the matter, as clearly expressed in his tutorial at the 1st ESIGMA meeting in Lisbon. The title of Roy's book discussed at this meeting, *Multicriteria Methodology for Decision Aiding* [16], very well emphasizes that the key conceptual distinction is between single-criterion and multi-criteria *approaches* rather than single-criterion and multi-criteria *decisions*.

It is perhaps not too surprising that most multicriteria research has been devoted to the development of different techniques for dealing with multiple conflicting criteria. The conclusions of the 8th meeting in Lisbon, dedicated to real world applications, indicated two main justifications for the (enormous) number of multicriteria methods which have been proposed in the literature: (i) the great diversity of scientific origins of the multicriteria pioneers, and (ii) the fact that the context of any particular case needs to be taken into consideration when selecting a particular method for use.

Multicriteria methods may be used in two basic contexts. In the first, the decision-maker (DM) would be either a single actor or an essentially homogenous group, seeking to make a decision which does not seriously impact, or require justification to, other actors. In this case, methods can be relatively informal, and the rationale behind the decision reached does not need substantial documentation. This contrasts with the context in which the DM (individual or group) has to make decisions on behalf of a much larger group or community, or has in fact only to generate a short list of alternatives for consideration elsewhere. This might occur with managers in large corporations, or with public servants. In such cases, the rationale for evaluation of actions and choices must be clearly documented, and justice must be seen to be done, in the sense that criteria might refer to different members of the community being served, and proper consideration of each interest or point of view must be demonstrated. This requirement necessitates the use of rather more formal methods of analysis, even where these may be less efficient, and/or may impose structures (of preferences, for example) which may not strictly be justifiable empirically. [21]

One basic distinction between methods which is particularly relevant in this context is that between *prior and progressive articulation of preferences*, with methods in the latter category sometimes termed *interactive* (although all MCDA is in fact "interactive" in the sense of interacting with the decision maker(s)).

Methods of prior articulation of preferences require, as inputs, value judgements from the DM (or, more generally, from an evaluator) independently for each point of view (in order to construct a partial preference model for each point of view) and some inter-criteria preference information. These inputs are then assembled by using a multi-criteria mathematical aggregation procedure in order to derive, as output, an overall evaluation model. It must be emphasized, however, that this process would include a substantial degree of sensitivity analysis, the results of which would be fed back the DM, in order to provide the required learning of his preference structure, and that this feedback would typically result in some revision of the inputs originally provided.

Methods of progressive articulation of preference, on the other hand, permit the systematic exploration of the decision space without requiring the prior specification of any preferences. The interactive process consists of a sequence of phases of dialogue and of computation, and at each interaction the judgements of the DM concern only a sub-set of Pareto-optimal actions. The method will propose a particular solution (or a small subset of solutions) and if the DM is satisfied with this, the interactive process stops; if not, the reactions of the DM allow the method to direct his attention to another region on the efficient frontier, where the respective actions are analysed in the same way. Thus, the DM contributes to the construction of a solution by intervening directly in an evolutionary approach, within which his judgements need only to be assumed to have local validity. Such interactive methods differ (i) in their basic assumptions regarding the DM's preference structure; (ii) in the manner in which preferences are progressively articulated, i.e. in the kind of information asked from the DM, and in how this information is interpreted in order to move the process forward; and (iii) in the search procedures used to exploit the efficient frontier locally. Many interactive methods are based on linear multiobjective techniques, but non-linear methods do also exist.

A few ESIGMA sessions have been devoted to interactive approaches, addressing questions such as: the classification of the interactive methods in different types, i.e. the distinction between reference point and other procedures (1st meeting); the possibility of its implementation in stochastic cases (2nd meeting); and visual interactive procedures and the possibility of switching during the process from one procedure to another (3rd and 8th meetings). An interesting discussion which has recurred several times in ESIGMA meetings concerns the question as to whether convergence of procedures to a "best solution" is helpful or not. Clearly, to speak about convergence in this framework only makes sense if one assumes a prescriptive perspective in MCDA. From the discussions it has emerged that almost everybody agrees that the interactive process is above all a learning process, where feedback must be allowed, in the sense that the conclusions of a certain iteration should not be taken as definitive but open to revision in the course of the constructive process. In this sense, strict mathematical convergence is seldom a helpful concept. (See [19], [21], [24].)

In comparison to "prior articulation of preferences", the interactive approach allows the difficult problem of expressing "global" inter-criteria preference information to be avoided, but, on the other hand, its applicability is essentially limited to problems requiring choice of a single alternative or course of action (as opposed, for example, to ranking a set of alternatives). Furthermore, methods of progressive articulation of preference seem to be less defensible when solutions need to be justified transparently in a public forum. This is perhaps a reason why relatively few real world applications have

been reported in the literature. Nevertheless, two very interesting real cases were presented by Pekka Korhonen during the 8th meeting at Lisbon, viz. the stockpiling critical materials and multiple objective analysis of input-output models for emergency management, in which the multicriteria decision support system VIG (Visual Interactive Goal Programming), developed by Pekka, was successfully applied.

Up to now, ESIGMA sessions have more commonly been concerned with discussions about MCDA methods with prior articulation of preference. This is because several important and widely applied streams of thought co-exist in this framework, such as *value* or *utility* based approaches and the *outranking* approach, but with significant differences in their conceptual principles.

Two steps can clearly be identified within any decision aiding process which is based upon the concept of prior articulation of preferences. These are:

(1) the construction of a criterion-model for each fundamental point of view, i.e. an evaluation model that formally represents the partial preferences of some evaluator(s) according to a single point of view;

(2) the application and exploration of a multicriteria aggregation procedure that brings together the various criteria into an overall evaluation model, taking into consideration the available information on the nature of preferences between viewpoints.

In spite of this structure which is common to most approaches based on prior articulation of preferences, it is needed to be recognized that the *notion of preference* is made operational by quite dissimilar mathematical representations in each approach. This has emerged from many discussions in ESIGMA. For instance, the partial preference models built into the different approaches are intended to capture rather different properties of alternatives. In a Multiattribute Value Measurement framework [9] one builds value functions based on the concept of relative strengths of preference, in Multiattribute Utility Measurement [13] these strengths of preference are closely linked to the concept of risk preference, in the Analytical Hierarchy Process (AHP), Thomas L. Saaty [18] speaks essentially about priorities, and in the Outranking Approach pseudo-criteria are constructed on the basis of the credibility of statements such as "action a is at least as good as action b" [16]. One should be aware of the fact that measurable value and utility functions are interval scales defined on the set A of actions (or, in fact, on a more general space derived by the convex closure of A), the priority scales of AHP are assumed to be expressed naturally as ratio scales on A, while credibility scales are (or should be) absolute scales on A×A. It is no surprise, therefore, when misunderstanding and controversy appear as proponents of different MCDA schools start discussing the features of their respective approaches, since the criterion-models they use are not only mathematically but also substantively different. A good example of such a situation is the open debate about rank reversals in AHP (see [27] for a survey), which was one of the themes of the 6th meeting of ESIGMA held in Aachen.

In this article we adopt a constructive approach in the sense that, although we believe that the theoretical demonstration of weaknesses in particular MCDA procedures is a necessary part of the development of the field, we also are convinced that recognition of the richest ideas emerging from the coexistent streams of thought will contribute to the progress of MCDA. For example, the path opened by Tom Saaty to

the construction of cardinal criteria-functions from *absolute semantical judgements* concerning well chosen stimuli, is an ingenious and inspiring idea for future research, in spite of certain criticisms of the AHP technique. This idea has borne much fruit, as revealed by the recently developed MACBETH Approach [3].

Turning now to the aggregation phase (step 2 above), an Oriented Discussion Session at the 6th meeting of ESIGMA addressed the fundamental question (perhaps the most fundamental one in MCDA, but one yet open and subject to controversy and misunderstanding) as to how the notion of relative importance of criteria is taken into account, and the way in which inter-criteria preference information needs to be assessed in each approach. The important conclusion can be expressed as follows: there is no sense, and it is theoretically incorrect, to specify measures of importance for the criteria outside of the context of the specific overall evaluation model to be used, that is to say, without having defined the type of mathematical aggregation rule which is to be used in deriving comprehensive preferences. In fact, the notion of relative importance is understood in significantly different fashions by different aggregation procedures. In this context, the distinction between *compensatory* and *non-compensatory* aggregation procedures [4] is particularly relevant.

In compensatory approaches, such as Multiattribute Value and Utility Measurement, trade-offs or substitution rates are assessed in order to derive values for the parameters ("weights") included in the aggregation rule (which is often additive). These parameters are in fact *scaling constants* needed for the cardinal criteria-functions to be commensurate in some way. Thus, in these approaches, weights have no absolute or intrinsic meaning, and there is no sense in attempting to derive them without reference to the criterion-functions. Ralph L. Keeney addressed this problem during his tutorial on Value Focused Thinking at the 7th ESIGMA meeting in Helsinki. We could never explain the issue as clearly as Ralph did, and therefore reproduce here his views, to which we fully subscribe, as they appear in the section entitled *The Most Common Critical Mistake* in his recent book [12, pp. 147–148]. He says:

"There is one mistake that is very commonly made in prioritizing objectives. Unfortunately, this mistake is sometimes the basis for poor decisionmaking. It is always a basis for poor information. As an illustration, consider an air pollution problem where the concerns are air pollution concentrations and the costs of regulating air pollution emissions. Administrators, regulators, and members of the public are asked questions such us 'In this air pollution problem, which is more important, costs or pollutant concentrations?' Almost anyone will answer such a question. They will even answer when asked how much more important the state 'more important' objective is.

For instance, a respondent might state that pollutant concentrations are three times as important as costs. While the sentiment of this statement may make sense, it is completely useless for understanding values or for building a model of values. Does it mean, for example, that lowering pollutant concentrations in a metropolitan area by one part per billion would be worth the cost of $2 billion? The likely answer is 'of course not.' Indeed, this answer would probably come from the respondent who had just stated that pollutant concentrations were three times as important as costs. When asked to clarify the apparent discrepancy, he or she would naturally state that the decrease in air pollution was very small, only one part in a billion, and the cost was a very large $2 billion. The point should now be clear. It is necessary to know how much the change in air pollution concentrations will be and how much the costs of regulation will be in order to logically discuss and quantify the relative importance of the two objectives.

This error is significant for two reasons. First, it doesn't really afford the in-depth appraisal of values that should be done in important decision situations. If we are talking about the effects on the public health of pollutant concentrations and billion-dollar expenditures, I personally don't want some administrator to give two minutes of thought to the matter and state that pollutant concentrations are three times as important as costs. Second, such judgements are often elicited from the public, concerned groups, or legislators. Then decisionmakers use these indications of relative importance in inappropriate ways. {...}

If the value tradeoffs are done properly and address the question of how much of one specific attribute is worth how much of another specific attribute, the insights from the analysis are greatly increased and the likelihood of misuse of those judgments is greatly decreased."

During the 8th ESIGMA meeting, Detlof von Winterfeldt presented joint work by himself and Ralph L. Keeney on cleaning up high level nuclear wastes. This represented a real-world application of multiattribute, multiple stakeholder decision analysis, and clearly demonstrated the relevance of Ralph's work mentioned previously, in a complex public sector decision situation. The empirical research conducted by Martin Weber, F. Eisenführ, and Detlof von Winterfeldt [26] concerning the effects of splitting attributes on weights in multiattribute utility measurement, and discussed by Martin at an ODS held during the 6th meeting in Aachen, also shows how much care is needed when using weighting procedures in practice. Finally, during this same meeting, the discussion which followed Thomas L. Saaty's AHP tutorial revealed that the above also applies in the Analytical Hierarchy Process framework.

In the Outranking framework, that is for aggregation procedures based on concordance and discordance concepts, such as the ELECTRE methods, the notion of importance arises in a very different manner. Two concepts occur here, viz. a *coefficient of importance*, which is analogous to the number of voters defending the particular point of view, and a *veto threshold*, which is analogous to the importance of someone with veto power in a collective decision situation. In our opinion, and as concluded in the discussion held in the 1st meeting, these concepts, together with the idea of incomparability, represent some of the most original contributions of Bernard Roy to MCDA, even though they are often misunderstood by proponents of other approaches. During the 8th ESIGMA meeting, Denis Bouyssou gave a clear introduction to the practical implementation of the outranking approach to decision aid, by means of a very interesting case study, entitled "Analysis of tenders: aiding the selection of a package-sorting machine" [17, chap. 8].

Although, as we have indicated, the core of research in MCDA has traditionally been the development of multicriteria methods, increasing attention in recent years has been devoted to the *structuring* phase of the decision-aiding process. This recent trend has emerged in the ODS on structuring and framing decision situations held during the 7th meeting in Helsinki, and again at the 8th meeting in Lisbon, which was devoted to real-world applications. We shall now attempt to summarize the main conclusions arising from these discussions on structuring.

Apart from defining the set A of actions to be evaluated or compared, itself by no means a trivial task, a key defining feature of the multicriteria model is of course the selection of the set of criteria by which the evaluation will be carried out. This is also a distinctly non-trivial task, and forms part of the structuring process which must precede the evaluation phase, a point which has frequently been under-emphasized.

Structuring is an essential phase of MCDA, as it provides the actors involved in a problematic situation with a common language for debate and learning, and with clear information about the plausible impacts of potential actions on the different points of view, thus serving to make explicit the actors' value systems. Structuring thus offers a sound basis for the identification of decision opportunities, for the construction of new alternatives, as well as for evaluating actions. Because *structuring is a mixture of art and science*, it is easy to understand how significant differences, but also many common ideas, arise in the approaches proposed by prominent "scientific artists" invited to present their conceptions in ESIGMA meetings. This we have seen in the 1st meeting, during the discussion by Bernard Roy of his book [16]; in the 6th meeting, during the discussion by Tom Saaty of his Analytical Hierarchy Process [18]; in the 7th meeting, when Ralph L. Keeney presented the main ideas developed in his book on "Value Focused Thinking: A Path to Creative Decisionmaking" [12].

Inspired by the above discussions, and by Detlof von Winterfeldt [28], we tentatively suggest the following assertion, which we believe might find wide consensus: the structuring and framing of a decision situation is that constructive and learning process which seeks to build a more-or-less formal *representation* integrating the *objective* environmental components of the decision context, with the *subjective* and context-dependent points of view, concerns or objectives, in such a way that the value-systems of actors or stakeholders are made explicit.

Methodologically, Keeney [12] views the subjective idea of value as the starting point to perform that integration, while Roy [16] starts from the more objective notion of consequence of the actions. But both of them want to arrive to what we call a set of *fundamental points of view* (the "set of fundamental objectives", in Keeney's terminology; a "coherent family of criteria", in Roy's terminology) and indicate desirable properties for this set, the most important of which are common to both authors. Moreover, Keeney explicitly associates an attribute with each fundamental objective, where the attributes are what may be called *descriptors*, i.e. impact levels intended to serve as a basis for describing plausible impacts of potential actions in terms of each point of view. In this context, Roy speaks about the "performances" of the actions in terms of each criterion. Other MCDA methods, such as AHP [18] or SMART [29] are more concerned with holistic evaluations of the given set of alternatives from different points of view, which may be derived in some hierarchical fashion, rather than with any explicit linking of these to specific attributes (although the assumption, often unstated, is that the DMs or evaluators have been fully informed of all objective information available on the consequences of each action). Some practical situations in which this approach appears inevitable have been discussed by Stewart and Scott [22].

An important (but as yet little discussed) issue to be addressed by a facilitator while framing a decision situation, is the appropriate *problematic* to be selected for decision aid in that specific context. For many people, decision aid consists purely of aiding a DM to solve a problem of choice. Roy [15] first pointed out that, in reality, there are other possible problematics in decision-aiding, different to that of simple choice, such as ranking and assignment problem situations. During the 3rd meeting, Carlos Bana e Costa, inspired by Roy's thoughts, proposed distinguishing between two main basic problematics: the problematic of comparative evaluation (including choice of a best action, choice of a small number of actions, repeated choice, and ranking problems) and

the problematic of absolute evaluation (including assignment problems and screening). He then further introduced the notion of a rejection problematic [2].

The structuring of complex problem situations has been a matter of concern to other areas of management science outside of the MCDA domain, and this has given rise in particular to those methods which Rosenhead [14] has termed Problem Structuring Methods. Two of these were discussed during the 9th meeting in Glasgow. John Friend introduced his approach termed Strategic Choice, while Colin Eden presented Strategic Options Development and Analysis (SODA). After the initial presentations of these methods, two workshops took place, using the respective software (STRAD and COPE). An important conclusion from this contact with non-multicriteria researchers is that "MCDA has a lot to learn from other disciplines but also has a lot to teach in other fields", as emphasized in "A Manifesto for the New MCDA Era" [6].

This manifesto was intensively discussed during the 9th meeting at Glasgow. The proposal came from five ESIGMA members [6] who claimed that a *shadow line* has been reached in multicriteria decision aid, that should force us to rethink its past and to propose new directions for the future. The question as to what the main lines of future MCDA research should be had been addressed (perhaps not very successfully) five years earlier during an ODS at the 3rd meeting, at which researchers of various streams of thought were present. In Glasgow, the debate was much more fruitful. The session started with the presentation of the Manifesto by its promoters. During the discussion which followed, some participants expressed their disagreement with what appeared from the Manifesto to be an overly pessimistic evaluation of the state of the field. These critics felt that this pessimism was based essentially on a normative perspective in decision aid, while they stood for a constructivist and learning paradigm: to help people in making decisions is, above all, to help them in expressing judgements of value, and in learning about their own preferences. But there was agreement that some popular multicriteria procedures lack a proper scientific basis. This has not yet been clearly shown in the literature, but must be in the future, through "a systematic axiomatic analysis of decision procedures and algorithms", and by reporting empirical evidence. As a conclusion of the debate, the participants agreed in general with the contents of the Manifesto, especially with the stated objectives for the future:

"We believe that two main subjects should be explore: (1) theoretical and axiomatic foundations of MCDA at all levels (approach, methodology, methods); (2) conceptual and operational validation of the use of MCDA in real-world problems. {...} The development of our theories and methods should be guided by the desire to represent a larger number of problem situations. {...} The theory of MCDA is thus an open theoretical field and not a closed mathematical theory solving a specific class of problems. Key theoretical and methodological issues have to be addressed. New potential areas of applications have to be explored. 'True' applications are needed as well as ex-post analysis. Connections between MCDA and other areas of research have to be explored. {...}"

A basic conviction, which has taken form from the debates in ESIGMA, is that the different streams of thought in MCDA must not be seen as conflicting, but rather as complementary approaches and sources of new and rich ideas. Under this constructive perspective, the image of the "hydra with several heads" can thus be replaced by that of a "rocket with several engines", contributing together to the success of its mission: this

is what is needed for MCDA to emerge, somewhere in the future, as a coherent body of tools which are at the same time theoretically well founded and practically operational. Thus, another fundamental objective for the future should be to explore the links between the desires for theoretical foundation and operational validation. Furthermore, we also believe that greater attention needs to be paid to structuring (and framing) as a fundamental phase of decision aid.

The discussions held during the ten years of the existence of our working group have, in our view, contributed very much to the development of the multicriteria field. As indicated in the abstract, we have not attempted to review all the multicriteria methodologies for decision aid in depth. For this purpose, apart from the other references given in this paper, we refer the interested reader to [1], [17], [19], [21], [25], [29], and the full collection of issues of JMCDA!

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