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## Opinion Makers Section

**Text of the speech given the 30th of January 2009, by Bernard Roy, Emeritus Professor, *Université Paris-Dauphine* on receiving an honorary doctoral degree from the *Università degli Studi di Catania*, Italy**

### TWO CONCEPTIONS OF DECISION AIDING [1]

I ask you to consider the following situation. In a company or a public institution, a manager and/or a group of people are confronted with a problem that requires that they make a decision. They call on an in-house operational research service or an outside consultant or even a university research team to get help in making "the best possible" decision. I will designate as **analysts** those who are appointed to give this decision aiding and as **decision makers** those in whose name or for whom this decision aiding must be given.

In the operational research and decision aiding community to which I belong, the **decision-aiding activity** (which is meant to be scientific) is founded on three pillars:

1º- A relatively formal definition of the possible decisions, which are usually called **actions** (or alternatives).
2º- A relatively formal definition of the **consequences** that these actions could have, which allows them to be compared.
3º - One or more **preference system** models.

This last pillar needs further explanation. Based on the consequences and the individual's value system, each individual, whoever he/she may be, can state when given two possible actions "I prefer the first to the second" or vice versa, "I am indifferent between the two" or "I am unable to compare these two actions". "Preference system" refers to the result of an **implicit or explicit process** that, for each pair of actions envisioned, assigns one and only one of these three possibilities: **preference**, **indifference**, **incomparability**. Modeling a preference system means specifying a process that will provide this type of results based on a pre-established model of the action consequences. These consequences are most often complex and inadequately known. They can be modeled in quantitative or qualitative terms, in a certain or stochastic manner, with a part of arbitrariness or ill determination. I will designate as $C(a)$ the model of the consequences of action $a$.

Based on the pillars described above, decision aiding can be carried out according to two clearly different conceptions. One, primarily positivist, is supported by Anglo-Saxon research; the other, primarily constructivist, was born and developed mainly in Europe. In what follows, I will refer to the first as **the "Anglo-Saxon" conception** and the second as **the "European" conception**. Obviously, these designations are oversimplified. By using them, I would not like anyone to believe that every Anglo-Saxon systematically adopts the first nor that every European systematically adopts the second. I will rapidly present these two conceptions and illustrate their differences with regard to a specific point. Before doing so, I think it is important to point out that the two conceptions described hereafter do not exhaustively cover all of the conceptions that have been conceived and that are used by decision aiding professionals for scientific meaning. Still, it is often one or the other that implicitly underpins the decision aiding activity if this activity is based on the three pillars described above.

#### 1. THE "ANGLO-SAXON" CONCEPTION

According to the "Anglo-Saxon" conception, the analyst must endeavor to reach objective truths in decision making. To do so, he/she must use an approach that aims to produce knowledge, exact or at least approximate, about the "best possible decision in the decisional context studied". This approach must be based on models designed to represent simplified versions of reality. In essence, this reality is considered to be **pre-existing data**, independent of the decision aiding process used. The process that makes up the decision maker's preference system is part of this pre-existing reality. This process, which can remain very mysterious, is assumed to be **stable**. It is supposed to lead decision makers, given two actions $a$ and $a'$ (whatever they may be), to state without ambiguity either their preference for one action over the other or their lack of preference or indifference, based on models $C(a)$ and $C(a')$ of the actions' consequences. In

[1] I use "decision aiding" rather than "decision support", "decision making" or "decision analysis" to escapesimplistic assimilations.

this conception, incomparability is not envisioned; it is possibly assimilated to indifference.

In the "Anglo-Saxon" conception, to discover the correct responses to the decision maker's questions, the analyst must endeavor to model the decision maker's preference system as closely as possible. In order to hope to find coherent responses, he/she must also verify that the decision maker is **rational** in a certain sense that would be too long to explain here. In fact, the decision maker's preference system must conform to this rationality requirement in order to give meaning to the notion of "best decision". To verify decision maker rationality and elaborate a model that is likely to describe the decision maker's preference system, the analyst must ask this decision maker a certain number of questions. (I cannot describe them here). The analyst must obviously assume that the decision maker correctly understands the questions and that the responses given are in fact produced by the process that makes up the decision maker's preference system.

In order to objectively produce exact or at least approximate knowledge about the best possible decision in the decisional context studied, it seems to me that the analyst following the "Anglo-Saxon" conception of decision aiding must accept the following two postulates:

Postulate of the decision maker's optimum. *In the decisional context studied, there exists at least one optimal decision, or in other words, there exists one decision for which it is possible (if sufficient time and means are available) to establish objectively that there are no strictly better decisions with respect to the decision maker's preference system.*

*Postulate of the decisional context reality.* The principal aspects of the reality on which the decision aiding is based (particularly the decision maker's preferences) are related to knowledge objects that can be seen as data (i.e., existing outside of the way they are modeled); these objects can also be seen as sufficiently stable over time and for the questions asked such that it is possible to refer to the exact state or the exact value (certain or stochastic) of given characteristics judged to accurately portray an aspect of that reality.

## 2. THE "EUROPEAN" CONCEPTION

According to the "European" conception, the analyst must seek for obtaining a coherent structured set of results. These results must be sought in order to guide the decision making process and facilitate communication about the decisions. To do so, the analyst must use an approach that aims to produce knowledge from working hypotheses that take into account the objectives and the value systems of the decisional context involved. This approach must be based on models that are, at least partially, **co-constructed through interaction with the decision maker**. This co-construction first concerns the way the actions studied are taken into account, as well as the consequences on which these actions will be judged. (Of course, this can also occur in the "Anglo-Saxon" conception.) Second, the co-construction process concerns the way that were designed certain characteristics (notably the values attributed to the different parameters) of the preference model that was judged the most appropriate given the specificities of the decisional context and the working hypotheses retained. In this conception, it is no longer necessary to assume that there exists, in the mind of the decision maker, a stable procedure capable of defining the decision maker's preference system completely, before even beginning the decision aiding process.

To elaborate results likely to make things clearer for the decision maker (e.g., if…, then… results), in the "European" conception, the analyst must propose working hypotheses which allow the co-construction of preference model to play an appropriate role in the decision aiding process. The co-constructed model must be a tool for looking deeper into the subject, exploring, interpreting, debating and even arguing. To guide this process of co-construction, the analyst must also interact with the decision maker, assuming that he/she understands the questions that are asked. Nevertheless, in the "European" conception, it is not necessary to assume the responses given are produced through a stable pre-existing process, but only that these responses are made up through interaction with the decision maker's value system, which is rarely free of **ambiguity or even contradiction**. In particular, the analyst must make sure that the person who responds to the questions is able to place these questions in the concrete context studied. This analyst must admit that the novelty of these questions can bring the person thus questioned to **revise** certain pre-existing preferences momentarily and locally.

According to the "European" conception, the knowledge produced does not aim to help the decision maker discover a good approximate decision that would objectively be one of the best given his/her value system, but rather more humbly to provide the decision maker with a set of results derived from the reasoning modes and working hypotheses. The decision maker will better understand the results produced and will better appropriate them (and potentially share them) if the analyst has made sure that understanding of the underlying reasoning modes and working hypotheses is integrated into the model co-construction process.

In this "European" conception, the analyst does not need to accept either one of the two postulates presented above. He/she may see these postulates as totally unrealistic. He/she may even have good reasons for accepting the existence of incomparabilities in the preference models used.

## 3. ILLUSTRATION

Before concluding, I want to illustrate the difference between these two conceptions in relation to a specific aspect of the preference system modeling process. To do this, I consider the case of a family of criteria designed to evaluate and compare the actions to be studied. In the

decision maker's mind, the process that is supposed to define the preference system makes these criteria play roles that are generally not interchangeable. Some of these criteria can play "very important" roles; others play a "totally secondary" role. Whatever way the analyst models the preference system, he/she must include in the model adopted a set of parameters that characterize the specific role appropriate for each criterion. This set most often associates to each criterion a single parameter, usually called the criterion weight. This is the term I will use in this section, although the metaphor of weight (the greater the weight, the greater the importance of the criterion) can be misleading. I will look at the way the analyst has to define the parameter set to attribute a value to each parameter in the set.

According to the "Anglo-Saxon" conception, the analyst must retain a model type that is likely to reproduce, as exactly as possible, the reality of the process used to define the decision maker's preference system. The parameter set that differentiates the role of the various criteria is assumed to really exist, and consequently, each parameter must have a true value. The analyst must thus design his/her questioning protocol to find the best possible approximation of this true value. In particular, if the parameter set represents weights in the model adopted, the analyst must try to come as close as possible to the "true weight" of each criterion.

According to the "European" conception, the analyst must retain a preference model type that is appropriate to the role that the model must play in the decision aiding process. The set of parameters that differentiate the various roles attributed to various criteria is not assumed to really exist. Thus, there is no true value that must be approximated as best possible. For this reason, the analyst must design his/her questioning protocol in such a way as to attribute to these parameters the most appropriate value so that the resulting preference model constitutes a basis from which it is possible to elaborate interesting results. The analyst may decide that one type of model, whose parameters represent weights, is particularly appropriate because it can be easily understood and accepted by the decision maker. The way that the analyst interacts with the decision maker (notably during the questioning phase of the process) when attributing a weight value to each criterion is intended to make a value emerge so that the criterion will play a role that is coherent with the one that the decision maker wants it to play (notably to obtain "if…, then…" results). This role can be greatly affected by uncertainty since the decision maker's preference system was not necessarily completely defined *a priori*. It is not uncommon that the decision aiding process can contribute to make this preference system evolve. In fact, in the "European" conception, the preference model that is adopted for reasons of convenience and clarity does not pretend to reproduce the implicit process that is assumed to make up the preferences in the decision maker's mind. It follows that the way that the analyst interacts with the decision maker is also intended to help him/her to better understand the links that may exist between the weight value attributed to a criterion and the role that this criterion plays in the type of model adopted. In these conditions, the questioning protocol can lead to retaining not a single set of weights but rather several, in order to evaluate the impact that each of the weight sets can have on the results produced.

## 4. CONCLUSION

Continuing the oversimplified designations of the two conceptions (which do not seem to me to be fundamentally incompatible, I will conclude by schematizing the differences between them on three levels as follows:

*Source of legitimization*: The "Anglo-Saxon" conception situates the source of legitimization in realism and objectivity, while the "European" conception situates it in procedural rationality and communication.

*Status of the preference model*: In the "Anglo-Saxon" conception, it is a matter of reproducing as faithfully as possible the decision maker's preference system as it truly exists in order to get as close as possible to the best decision, while in the "European" conception, it is a matter of working with the decision maker to co-construct one or more preference models in order to study the results to which they lead.

*Place of the analyst*: In the "Anglo-Saxon" conception, the analyst is assumed to be neutral, or in other words, to be outside of the decision aiding process, while in the "European" conception, the analyst must admit that, as soon as he/she interacts with the decision maker to obtain information, this interaction makes him/her a co-constructor of the knowledge produced; thus, he/she cannot be seen as being outside of the decision aiding process.

Catania, the 30 January 2009

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**Texte de l'allocution présentée le 30 janvier 2009 par : Bernard Roy, Professeur émérite, Université Paris-Dauphine à l'occasion de la réception en tant que Docteur Honoris Causa de l'Université de Catania, *Italie***

## DEUX CONCEPTIONS DE L'AIDE À LA DÉCISION

Je vous invite à vous intéresser à la situation suivante. Au sein d'une entreprise, d'une institution, un responsable et/ou un groupe de personnes se trouvent confrontés à un problème qui les place dans l'obligation d'arrêter une décision. Ils font appel au service de recherche opérationnelle interne à leur entreprise ou à un consultant extérieur ou bien encore à une équipe universitaire pour obtenir de l'aide afin de décider « le mieux possible ». Je désignerai par **analystes** celles et ceux qui vont être mandatées(és) pour apporter cette aide et par **décideurs** celles et ceux au nom de qui ou pour le compte de qui l'aide à la décision doit s'exercer.

Dans la communauté de la recherche opérationnelle et de l'aide à la décision dont je fais partie, cette **activité d'aide à la décision** (qui se veut scientifique) repose sur trois piliers :

1° - Une définition plus ou moins formalisée des possibilités de décision que l'on appelle habituellement **actions** (ou alternatives).
2° - Une définition, ici encore plus ou moins formalisée, des **conséquences** que peuvent avoir ces actions afin de pouvoir les comparer.
3° - Une, éventuellement plusieurs, modélisation d'un **système de préférences**. Ce dernier point nécessite un minimum d'explications.

C'est à partir de ces conséquences et du système de valeur qui lui est propre qu'un individu, quel qu'il soit, auquel on soumet deux actions peut déclarer « je préfère la première à la seconde (ou l'inverse) », « je suis indifférent entre les deux » ou « je ne peux pas comparer ces deux actions ». Sous le nom de système de préférences, on désigne le résultat d'un **procédé implicite ou explicite** qui, à chaque paire d'actions envisagées, associe une et une seule des trois possibilités **préférence, indifférence, incomparabilité**. Modéliser un système de préférences, c'est précisément expliciter un tel procédé fournissant ce type de résultat sur la base d'une modélisation préalable des conséquences des actions. Ces conséquences sont le plus souvent complexes et mal connues. Leur modélisation peut être effectuée en termes quantitatifs ou seulement qualitatifs, de manière certaine ou avec une part d'aléa, d'ambiguïté, de mauvaise détermination. Je désignerai par $C(a)$ la façon dont les conséquences de l'action $a$ sont ainsi modélisées.

Je vais maintenant vous montrer que, sur ces bases, l'aide à la décision peut être conduite selon deux conceptions bien distinctes. L'une, d'essence positiviste, prend principalement appui sur des travaux du monde anglo-saxon ; l'autre, d'essence constructiviste, a pris naissance et s'est développée surtout en Europe. De façon certes caricaturale, je me référerai à la première sous le nom **conception « anglo-saxonne »** et à la seconde sous le nom **conception « européenne »**. Bien évidemment, cela ne signifie nullement que tous les Anglo-Saxons adoptent systématiquement la première et tous les Européens systématiquement la seconde. Je vais rapidement les présenter puis illustrer leurs différences sur un point précis. Auparavant, je crois important de préciser que les deux conceptions ci-après n'épuisent pas l'ensemble de celles qui ont été conçues et qui sont utilisées par les professionnels d'une aide à la décision qui se veut scientifique. Toutefois, c'est bien souvent soit l'une, soit l'autre qui, implicitement, sous-tend l'activité d'aide à la décision dès l'instant où elle prend appui sur les trois piliers ci-dessus.

### 1. LA CONCEPTION « ANGLO-SAXONNE »

Selon cette conception, l'analyste doit s'efforcer d'atteindre des vérités objectives en matière décisionnelle. Il doit pour cela recourir à une démarche qui vise à produire des connaissances, sinon exactes du moins approximatives, relatives à une « meilleure décision possible dans le contexte décisionnel étudié ». Cette démarche doit prendre appui sur des modèles conçus pour être des représentations simplifiées de la réalité ; cette réalité est, pour l'essentiel, considérée comme une **donnée qui préexiste** indépendamment du processus d'aide à la décision mis en œuvre. Le procédé qui fabrique le système de préférences du décideur appartient à cette réalité préexistante. Ce procédé, qui peut rester très mystérieux, est supposé être **stable**. C'est lui qui, sans ambiguïté, doit conduire le décideur à dire que, entre deux actions $a$ et $a'$ (quelles qu'elles soient), soit il préfère l'une à l'autre, soit il est indifférent entre elles deux, cela à partir des modèles $C(a)$ et $C(a')$ de leurs conséquences. Dans cette conception, l'incomparabilité est une possibilité qui n'est pas envisagée ; elle est éventuellement assimilée à l'indifférence.

Pour découvrir les bonnes réponses aux questions que se pose le décideur, l'analyste doit, dans cette conception, s'efforcer de modéliser le plus fidèlement possible le système de préférences du décideur. Pour espérer pouvoir trouver des réponses cohérentes, il doit aussi vérifier que le décideur est **rationnel** dans un certain sens qu'il serait trop long de préciser ici. Il est en effet nécessaire que le système de préférences du décideur soit conforme à cette exigence de rationalité pour pouvoir donner sens à la notion de « meilleure décision ». Pour vérifier cette rationalité du décideur et élaborer un modèle susceptible de décrire son système de préférences, l'analyste doit lui poser un certain nombre de questions (dans le détail desquelles je ne peux pas entrer ici).

L'analyste doit bien évidemment supposer que le décideur comprend correctement ses questions et que les réponses fournies sont effectivement produites par le procédé qui fabrique le système de préférences du décideur.

Pour pouvoir produire de façon objective des connaissances, sinon exactes du moins approximatives, relatives à une meilleure décision possible dans le contexte décisionnel étudié, l'analyste doit, il me semble, accepter les deux postulats suivants :

*Postulat de l'optimum du décideur*. Dans le contexte décisionnel étudié, il existe au moins une décision optimale, c'est-à-dire pour laquelle il est possible (sous réserve de disposer de suffisamment de temps et de moyens) d'établir objectivement qu'il n'en existe pas de strictement meilleures au sens du système de préférences du décideur.

*Postulat de la réalité du contexte décisionnel*. Les principaux aspects de la réalité, en particulier les préférences du décideur, sur lesquels l'aide à la décision prend appui se rapportent à des objets de connaissance qui peuvent être regardés comme donnés, c'est-à-dire existant en dehors de la modélisation qui en est faite et comme suffisamment stables face à la durée et aux questions posées pour que référence puisse être faite à l'état exact ou à la valeur exacte (qui peut être de nature certaine ou stochastique) de telles ou telles de leurs caractéristiques jugées significatives d'un aspect de la réalité.

## 2. LA CONCEPTION « EUROPÉENNE »

Selon cette conception, l'analyste doit chercher à obtenir un ensemble structuré et cohérent de résultats. Ces résultats doivent être recherchés en vue de guider la prise de décision et de communiquer à son sujet. L'analyste doit pour cela recourir à une démarche qui vise à produire des connaissances à partir d'hypothèses de travail qui prennent en compte les objectifs et les systèmes de valeur propres au contexte décisionnel dans lequel il est impliqué. Cette démarche doit prendre appui sur des modèles qui, pour une part au moins, sont **co-construits en interaction avec le décideur** ; cette co-construction porte en premier lieu (ce qui peut aussi avoir lieu dans la conception « anglo-saxonne ») sur la façon de prendre en compte les actions qu'il convient d'étudier ainsi que sur les conséquences sur lesquelles ces actions doivent être jugées. Elle porte en second lieu sur la façon de concevoir certaines des caractéristiques (notamment valeurs à attribuer à différents paramètres) du modèle de préférence qui a été jugé le mieux approprié compte tenu des spécificités du contexte décisionnel et des hypothèses de travail retenues. Dans cette conception, il n'est plus nécessaire de supposer qu'avant même la mise en œuvre du processus d'aide à la décision il existe, dans l'esprit du décideur, un procédé stable, capable de définir complètement son système de préférences.

Pour élaborer des résultats (par exemple de type si … alors) susceptibles d'éclairer le décideur, l'analyste doit, dans cette conception, proposer des hypothèses de travail sur la base desquelles la co-construction du modèle de préférence pourra jouer le rôle qui lui est dévolu dans le processus d'aide à la décision : être un outil pour approfondir, explorer, interpréter, débattre et même argumenter. Pour conduire ce travail de co-construction, l'analyste doit ici encore interagir avec le décideur et supposer que celui-ci comprend les questions qui lui sont posées. En revanche, il n'a plus à supposer que les réponses fournies sont produites par un procédé stable, préexistant mais seulement qu'elles sont façonnées au cours de l'interaction par le système de valeur du décideur qui peut ne pas être exempt **d'ambiguïté ni même de contradiction**. L'analyste doit ici tout particulièrement veiller à ce que la personne interrogée soit apte à replacer les questions qui lui sont posées dans le contexte concret étudié. Il doit admettre que la nouveauté de ces questions puisse amener l'interrogé à **réviser** momentanément et localement certaines des préférences qui pouvaient préexister.

Selon cette conception, les connaissances produites n'ont pas pour objet d'aider le décideur à découvrir une bonne approximation d'une décision qui serait objectivement l'une des meilleures compte tenu de son propre système de préférences mais, plus modestement, de lui apporter un ensemble de résultats auxquels conduisent certaines modes de raisonnement et hypothèses de travail. Il comprendra d'autant mieux les résultats produits et pourra d'autant mieux se les approprier (éventuellement les faire partager) que l'analyste l'aura mieux associé à la construction des modèles et à la compréhension des modes de raisonnement et des hypothèses qui les sous-tendent.

Dans cette conception, l'analyste n'a nul besoin d'accepter l'un ou l'autre des deux postulats précédents. Il peut même avoir de bonnes raisons de les regarder comme tout à fait irréalistes. Il peut aussi avoir de bonnes raisons d'accepter la présence d'incomparabilités dans les modèles de préférences qu'il utilise.

## 3. ILLUSTRATION

Pour terminer, je vais illustrer ce qui différentie ces deux conceptions à propos d'un aspect particulier de la modélisation du système de préférences. Je considère pour cela le cas où une famille de critères a été conçue pour évaluer et comparer les actions à étudier. Le procédé qui, dans l'esprit du décideur, est supposé définir le système de préférences fait jouer à ces critères des rôles qui, en général, ne sont pas interchangeables. Certains de ces critères peuvent jouer un rôle « très important », d'autres un rôle « tout à fait secondaire ». Quelle que soit la façon dont l'analyste procède pour modéliser le système de préférences il est amené à faire intervenir, dans le type de modèle qu'il adopte, une famille de paramètres qui servent à caractériser le rôle spécifique dévolu à chaque critère. Cette famille associe le plus souvent, à chaque critère, un paramètre et un seul. Ce paramètre est alors couramment appelé poids du critère. C'est ce terme que je vais utiliser par la suite bien que la métaphore du poids (plus grand est le poids et plus grande est l'importance du critère) puisse être trompeuse. Je vais m'intéresser à la façon dont

l'analyste doit s'y prendre pour définir cette famille de paramètres et attribuer une valeur à chacun.

Selon la conception que j'ai appelée « anglo-saxonne », l'analyste doit retenir un type de modèle susceptible de reproduire, de façon aussi exacte que possible, la réalité du procédé qui définit le système de préférences du décideur. La famille de paramètres qui sert à différentier le rôle que jouent les critères est supposée avoir une existence réelle et, par conséquent, chaque paramètre doit avoir une vraie valeur. L'analyste doit donc concevoir son mode de questionnement de façon à trouver la meilleure approximation possible de cette vraie valeur. En particulier, si, dans le modèle qu'il a cru justifié d'adopter, la famille de paramètres représente des poids, il doit chercher à approcher au mieux le « vrai poids » de chaque critère.

Selon la conception « européenne », l'analyste doit retenir un type de modèle de préférence adapté au rôle qui lui est dévolu dans le processus d'aide à la décision. La famille des paramètres qui servent à différentier le rôle dévolu à chaque critère n'est pas supposée avoir une existence réelle. Il n'existe donc pas de vraie valeur qu'il s'agit d'approcher au mieux. L'analyse doit de ce fait concevoir son mode de questionnement de façon à attribuer à ces paramètres la valeur qui convient le mieux pour que le modèle de préférence qui en découle constitue une base de travail à partir de laquelle il paraît possible d'élaborer des résultats intéressants. L'analyste peut juger qu'un type de modèle dont les paramètres représentent des poids est particulièrement approprié parce qu'il peut être aisément compris et accepté par le décideur. La façon d'interagir avec lui (notamment mode de questionnement) afin d'attribuer une valeur au poids de chaque critère a ici pour objet de faire émerger une valeur telle que le critère joue, dans le modèle, un rôle cohérent avec celui que le décideur souhaite lui voir jouer (notamment pour obtenir des résultats de type si … alors). Ce rôle peut fort bien être entaché d'une part d'incertitude dans la mesure où le système de préférences du décideur n'est pas nécessairement complètement défini *a priori*. Il n'est pas exclu que l'aide à la décision puisse contribuer à le faire évoluer. En effet, dans cette conception, le modèle de préférences qui a été adopté par souci de commodité et de clarté ne prétend pas reproduire le procédé implicite qui est supposé fabriquer les préférences dans l'esprit du décideur. Il s'ensuit que la façon d'interargir avec le décideur a aussi pour objet de l'aider à mieux comprendre le lien qui peut exister entre la valeur attribuée au poids d'un critère et le rôle que joue ce critère dans le type de modèle adopté. Le questionnement peut, dans ces conditions, conduire à retenir non pas un seul jeu de poids mais plusieurs afin d'apprécier l'impact que peut avoir chacun d'eux sur les résultats produits.

## 4. CONCLUSION

De façon toujours un peu caricaturale, je conclurai en schématisant comme suit sur trois plans les différences entre ces deux conceptions qui ne me paraissent pas pour autant être fondamentalement incompatibles.

*Source de légitimation* : La conception « anglo-saxonne » la situe dans le réalisme et l'objectivité alors que la conception « européenne » la situe dans la rationalité procédurale et la communication.

*Statut du modèle de préférence* : Dans la conception « anglo-saxonne », il s'agit d'appréhender le plus fidèlement possible le système de préférences du décideur tel qu'il existe afin d'approcher au mieux sa meilleure décision alors que, dans la conception « européenne », il s'agit de co-construire, avec le décideur, un ou plusieurs modèles de préférence afin d'étudier les résultats auxquels il conduit ou conduisent.

*Position de l'analyste* : Dans la conception « anglo-saxonne », l'analyste est supposé être neutre, autrement dit être extérieur au processus d'aide à la décision alors que, dans la conception « européenne », il doit admettre que, dès l'instant où il interagit avec le décideur pour obtenir de l'information, cette interaction le rend co-constructeur des connaissances produites ; il ne peut donc pas être regardé comme extérieur au processus d'aide à la décision.

Catane, le 30 janvier 2009
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# MCDA Research Groups

## INESC Coimbra – An interdisciplinary R&D Unit with multi-criteria as the "original fabric"

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### Presentation and Organization

The Institute for Systems Engineering and Computers of Coimbra (INESC Coimbra) is a non-profit R&D institute affiliated with the University of Coimbra, which is regularly evaluated by international panels in the framework of the pluri-annual financing by the Portuguese Foundation for Science and Technology. INESC Coimbra was created in 1986 as a branch of INESC, an institute at the national level with branches in the main Portuguese universities. This model evolved in the beginning of this century for the autonomy of those branches and INESC Coimbra became an autonomous institute in January 2002, having as "shareholders" the University of Coimbra (UC) and the INESC holding.

INESC Coimbra integrates presently about 75 researchers, 40 of whom holding PhD degrees in diverse science, technology and management domains, from the Faculty of Sciences and Technology (Departments of Electrical Engineering and Computers, Mathematics and Civil Engineering) of UC, the Faculty of Economics of UC, the University of Beira Interior, and the Polytechnic Institutes of Leiria (where a delegation is located), Coimbra, Setúbal, Viseu and Bragança.

According to its statutory mission, INESC Coimbra aims at contributing to the progress of scientific and technical knowledge, integrating competences in Engineering Sciences and Management Science/Operations Research within a systems engineering approach.

Since becoming an autonomous institute, INESC Coimbra has adopted a form of internal organization structured along three main axes: researchers, competences and projects. R&D clusters are dynamically formed for each project, providing a high flexibility and efficiency in assembling and managing research teams. This form of organization has revealed to be successful, given the interdisciplinary nature of the research team, leading to a high level of scientific publication, participation in projects, as well as a sustained growth of the unit (from 13 PhDs in 2003 to 40 in early 2009) achieved both by the completion of the PhD of junior researchers and the attraction of new researchers with competences in other areas (such as geographical information systems, remote sensing and computational mechanics) thus enlarging the intervention potential into new fields.

The most distinctive feature of INESC Coimbra is the interdisciplinary nature of its activities within a systems engineering framework. The background fabric is given by the competences in operational research models and methods, namely concerning multi-objective optimization (MOO) and multi-criteria analysis (MCA), coupled with software engineering expertise to develop decision support systems that exploit those competences. Besides originating innovative theoretical and methodological work, these competences provide the ground for interdisciplinary research stemming either from specific problems in application domains (namely in energy and telecommunications) or integrative use of different methodologies.

**Areas of intervention**

The main intervention areas of INESC Coimbra have been:

- Decision support systems and methodologies - emphasizing multi-criteria and multi-objective models as well as dealing with imprecision/uncertainty; support for collaborative work (groupware) and negotiation processes; evaluation of efficiency in industries and services; analysis and evaluation of investment projects; optimization problems (routing, location, etc.).

- Teletraffic engineering and telecommunication networks planning - dynamic routing methods; reliability of telecom networks; traffic modeling and simulation.

- Regional and urban planning - decision aiding based on Geographical Information Systems; vehicle routing and other network optimization problems; location of infrastructures and facilities.

- Rational use of energy and energy planning - management of demand for energy; electricity consumption models; urban energy planning; energy efficiency in buildings; E3 (energy-environment-economy) studies; electricity markets; quality of service analysis in electrical networks.

In the area of telecommunications, INESC Coimbra has generated innovative work in the application of MOO programming models and methods, as well as heuristics and meta-heuristics, to dynamic routing in multimedia networks, also involving performance analysis issues. The joint work of researchers with expertise in operations research and teletraffic theory led to new MOO dynamic routing methods for multi-service networks and multi-exchange networks, hierarchical MO routing models for MPLS networks, methods for routing computation in multimedia networks, and application of a k-quickest path algorithm to Internet packet routing. On the other hand, this application domain led to the development of algorithmic advances for MOO shortest path problems using labeling schemes and automated reference point-like approaches, for calculating the most reliable pair of disjoint paths in a network, and for the computation of the k-quickest paths.

In the energy domain a strong emphasis has been placed on issues dealing with energy efficiency and rational use of energy. MCA models and methods for the evaluation of energy efficiency actions have been proposed. Novel MOO optimization models based on genetic algorithms / evolutionary programming have been developed for the design and choice of remote load control actions and power factor compensation in distribution networks. This R&D effort fostered by applications led to the development of innovative methodological work in evolutionary programming, namely related with adaptive parameters and robustness analysis. Also, a stream of research has been pursuit dealing with MOO models for the study of energy-environment-economy interactions based on input-output analysis by combining expertise of economics and energy systems. This cross-fertilization is also displayed in the methodological work on electricity markets and market integration.

Application problems in regional and urban planning fostered the development of methodological work coupling MCA with Geographic Information Systems (GIS) for decision support. On the other hand, GIS tools

are used to facilitate the practical understanding of vehicle routing, infrastructures and facility location problems, and the implementation of network optimization methods.

Regarding MOO/MCA software packages have been developed for MOLP (such as the interactive environments TRIMAP, TOMMIX and SOMMIX), for MO mixed integer LP, for performance aggregation using additive value function (VIP - Variable Interdependent Parameters for multi-criteria choice problems) and interactive robustness analysis and parameters' inference for multi-criteria sorting problems (IRIS). Some downloadable demo versions are available at http://www.inescc.pt/ingles/produtos.php.

**International cooperation**

Besides other less formalized R&D cooperation projects in several topics with colleagues in European and (North and South) American universities, INESC Coimbra is involved in the COST Action "Algorithmic decision theory" (www.algodec.org) as well as in the Decision Deck project (www.decision-deck.org/). INESC Coimbra 's researchers have also a very active role in the initiative Energy for Sustainibility of the University of Coimbra, which is integrated in the MIT – Portugal Program (www.mitportugal.org).

The organization of international scientific events has been a relevant vector of the activity of INESC Coimbra, including the 11th International Conference on MCDM (August 1994) and the 52th Meeting of the EURO Working Group on MCDA (October 2002). In the last years, the other focused events have been organized: Mini-EURO Conferences on "Managing Uncertainty in Decision Support Models" (2004) and "Operational Research Models and Methods in the Energy Sector" (2006), Group Decision and Negotiation Conference (2008), International Conference on Decision Support for Telecommunications and Information Society (DSTIS, in cooperation with the Lacnosci Institut – Poland, to be held in September 2009). Extended papers of the communications presented at these events have been included in special issues of journals, such as the European Journal of Operational Research (2), Decision Support Systems, Energy Policy, International Journal of Energy Sector Management, Group Decision and Negotiation, and the Journal of Telecommunications and Information Technology.

**Some ongoing streams of research involving MOO/MCA**

Multi-criteria group decision and negotiation: development of approaches enabling the actors to progress in group decision and negotiation processes without demanding complete information about the way how they evaluate the alternatives, by emphasizing methodologies based on preference exploration and learning.

Multi-criteria classification: development of approaches combining statistical techniques, such as clustering, with MCA preference models, such as outranking relations, for classifying objects in classes, which my be ordered, partially ordered or having no underlying order.

Multi-objective programming based on solution populations: development of approaches based on populations of solutions, such as genetic/evolutionary algorithms and particle swarm) for MOO problems, enabling a detailed characterization of Pareto fronts, techniques of preserving solution diversity and including guiding mechanisms to guide the search according to preferences; robustness evaluation embedded in the evolutionary process; development of adaptive operators.

Development of new MOO/MCA approaches for location and routing problems, interactive decision support systems to respond to the challenges of equipment location in technological and social support networks, involving fast computational procedures and adequate Human-computer interfaces.

Multi-criteria analysis of multi-service telecommunications networks for different planning, project and management problems, taking into account the growing relevance of multidimensional, heterogeneous and service-dependent quality of service (QoS). This involves routing models for Wavelength Division Multiplex (WDM) networks, multidimensional and multi-objective routing for Multi-Protocol Label Switching (MPLS) in Internet networks, multi-attribute models for resilient (fault-tolerant) routing in MPL networks.

Exploiting the links and complementary features of Data Envelopment Analysis (DEA) with both MOO and MCA.

**A sample of recent publications (2008 and 2009)**

INESC Coimbra's researchers published about forty papers in international scientific journals in 2006-2008, in several domains ranging from theory and methodology to application-oriented works namely in the energy, telecommunication and urban and regional planning domains. A representative sample of the more recent papers follows:

1. Almeida, L. A., J. Coutinho-Rodrigues, J. Current, "A Multiobjective Modeling Approach to Locating Incinerators", Socio-Economic Planning Sciences, 2009.
2. Almeida, L. A.; L. Tralhão, L. Santos, J. Coutinho-Rodrigues, "A Multiobjective Approach to Locate Emergencying Shelters and Identify Evacuation Routes for Emergencies in Urban Area", Geographical Analysis, special issue in memory of C. ReVelle, 2009.
3. Alves, M .J., J. Clímaco, C. H. Antunes, H. Jorge, A. G. Martins, "Stability analysis of efficient solutions in multiobjective integer

programming: a case study in load management", Computers and Operations Research, vol. 35, 186 – 197, 2008.

4. Alves, M. J., J. P. Costa. "An Exact Method for Computing the Nadir Values in Multiple Objective Linear Programming". European Journal of Operational Research, 2009.
5. Antunes, C. H., C. Barrico, A. Gomes, D. F. Pires, A. G. Martins, "An evolutionary algorithm for reactive power compensation in radial distribution networks". Applied Energy, 2009.
6. Captivo M.E., J. Clímaco, M.Pascoal. "A mixed integer linear formulation for the minimum label spanning tree problem", Computers and Operations Research, 2009.
7. Clímaco, J., M. Pascoal. "Finding Non-Dominated Bicriteria Shortest Pairs of Disjoint Simple Paths", Computers & Operations Research, 2009.
8. Costa, J. P., M. J. Alves. "A reference point technique to compute non-dominated solutions in MOLFP". Journal of Mathematical Sciences, 2009.
9. Costa, M. G.; M. E. Captivo, J. Clímaco. "Capacitated Single Allocation Hub Location Problems: A Bicriteria Approach". Computers and Operations Research, Vol. 35, Issue 11, 3671-3695, 2008.
10. Craveirinha, J., R. Girão-Silva, J. Clímaco, "A Meta-Model for Multiobjective Routing in MPLS Networks", Central European Journal of Operations Research, vol. 16, no. 1, 79-105, 2008.
11. Dias, J., M. E. Captivo, J. Clímaco. "A Memetic Algorithm for Multi-objective Dynamic Location Problems. Journal of Global Optimization, Vol. 42, No. 2, 221-253, 2008.
12. Girão-Silva, R., J. Craveirinha, J. Clímaco, "Hierarchical Multiobjective Routing in MPLS Networks with Two Service Classes – A Heuristic Solution", International Transactions in Operational Research, 2009.
13. Gomes da Silva, C., J. Clímaco, J. Figueira, "Core Problems in Bi-Criteria 0-1 knapsack Problems". Computers and Operations Research, vol. 35, Issue 7, 2292-2306, 2008.
14. Gomes, A., C. H. Antunes, A. Martins. "Design of an Adaptive Mutation Operator in an Electrical Load Management Case Study". Computers and Operations Research, vol. 35, 2925 – 2936, 2008.
15. Gomes, T., J. Craveirinha, J. Clímaco, C. Simões. "A bicriteria routing model for multi-fibre WDM networks". Photonic Network Communications, 2009.
16. Gouveia, M. C., L. C. Dias, C. Henggeler Antunes. "Additive DEA based on MCDA with imprecise information ". Journal of the Operational Research Society, vol. 59 54-63, 2008.
17. Madlener, C. H. Antunes, L. Dias. "Assessing the performance of biogas plants with multi-criteria and data envelopment analysis". European Journal of Operational Research, 2009.
18. Neves, L., A. G. Martins, C. H. Antunes, L. Dias. "A multi-criteria decision approach to sorting actions for promoting energy efficiency". Energy Policy, vol. 36, issue 7, 2351-2363, 2008.
19. Neves, L., L. Dias, A. G. Martins, C. H. Antunes "Building a decision model to appraise energy efficiency initiatives". European Journal of Operational Research, 2009.
20. Oliveira, C., C. H. Antunes. "An interactive method to tackle uncertainty in interval multiple objective linear programming". Journal of Mathematical Sciences, 2009.
21. Rocha, C., L. C. Dias. "An algorithm for ordinal sorting based on ELECTRE with categories defined by examples". Journal of Global Optimization, Vol. 42, No. 2, 255-277, 2008.
22. Santos, L., J. Coutinho-Rodrigues, J. Current. "Implementing a multi-vehicle multi-route spatial decision support system for efficient trash collection in Portugal", Transportation Research Part A: Policy and Practice, Vol. 42, Issue 6, 922-934, 2008.
23. Sarabando, P., L. C. Dias, "Multi-attribute choice with ordinal information: a comparison of different decision rules", IEEE Transactions on Systems, Man, and Cybernetics, Part A, 2009.

INESC Coimbra publishes since 2002 a series of Research Reports and Documents (see www.inescc.pt/ingles/pubinter.php). The number of research reports downloads amounted to about 7000 in 2008.

**Ongoing PhD Theses in which MOO and MCA play a key role**

There are currently underway about 30 PhD thesis supervised by INESC Coimbra' researchers, about half of them explicitly involving MCDA models and methods, including the following topics:

- A multi-criteria approach to the routing problem in WDM networks
- Planning and operation problems in electrical distribution networks using multi-objective meta-heuristics

- Decision support in integrated urban energy planning
- Decision support in urban rehabilitation planning
- Adaptive operators and hybridization in population-based meta-heuristics in MOO
- Group decision support
- Integrated use of MCDA and DEA models
- Multi-criteria sorting based on examples
- Multi-criteria design and project of networks
- Methods and software with ordinal information for problems of performance evaluation, selection and ranking of alternatives.
- Multi-criteria routing models for IP/MPLS networks
- Multi-criteria location
- Multi-objective models for electricity dispersed generation expansion planning

# Forum

## (Robustness Analysis)

### Robustness in OR-DA: a generic framework and its application to the configuration of power distribution networks

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#### 1. Introduction

Usually works made in optimisation field assumed that the problem is entirely exactly known. Then a solution $S$ for one given forecast instance $I^{ref}$ is computed with regard to a criterion $z$ that will be considered as a maximisation criterion without loss of generality. An optimal solution for an instance $I$ is denoted $S_I^*$ and its associated performance is denoted $z_I^*$. The performance of a solution $S$ applied to an instance $I$ relatively to an optimisation criterion $z$ is denoted $z_I(S)$. The classic way to solve an optimisation problem without uncertainty is the predictive approach. An off-line algorithm builds an optimal solution $S_{I^{ref}}^*$ for the forecast instance $I^{ref}$, and guarantees an optimal performance for this instance only, valued by $z_{I^{ref}}^*$. In practice, the real system is subject to perturbations such that the solution $S_{I^{ref}}^*$ is applied to the actual instance $I$ that may be different from the forecast instance $I^{ref}$, and $S_{I^{ref}}^*$ may not be optimal and even admissible for $I$. In the most optimistic case (when $S$ remains admissible for $I$), the actual performance $z_I\left(S_{I^{ref}}^*\right)$ can be "far" from the forecast performance $z_{I^{ref}}^*$, leading a costly resolution step to return a poor performance solution. Developing robustness features has appeared to be an efficient way to cope with uncertainties and inaccuracy even though researchers do not use the same definition depending on the application. Roughly speaking, robustness measures the solution ability to remain "good" despite variability of the data. What is exactly a so called good solution and the considered class of uncertainties is strongly application-dependent, and has led researchers to develop a large variety of approaches (See [2] for a commented survey of some approaches).

The goal of this paper is to present a generic robustness framework to deal with uncertainty in optimisation. In the next section, the framework is proposed. A robustness definition is given and five robustness issues, which are highlighted by the robustness definition, are detailed, discussed and compared to existing literature. Finally this framework is illustrated through an example in section 3.

#### 1. A generic robustness framework for Operational Research and Decision-Aid

Many robustness definitions can be found in the literature as shown in [1]. The robustness definition given in [7] is used in this paper: the robustness is defined as the solution ability to guarantee a performance level $L_\lambda$, according to a robustness criterion $\lambda$, on a risk to be covered $P$ (a set of instances or versions in this paper). The usual robustness criteria have been defined in [5] as follows:

1. Absolute robustness:
$$\lambda_1(S,z,P) = \min_{I \in P} z_I(S)$$
2. Robust deviation:
$$\lambda_2(S,z,P) = \max_{I \in P} \left\{ z_I^* - z_I(S) \right\}$$
3. Relative robustness:
$$\lambda_3(S,z,P) = \max_{I \in P} \frac{z_I^* - z_I(S)}{z_I^*}$$

*Definition 1.* In [7], a solution $S$ is said to be $L_\lambda$-robust on the set of instances $P$ relatively to the robustness criterion $\lambda$ if it satisfies the following inequality:

$$\lambda(S,z,P) \geq L_\lambda \quad (1)$$

Note that this definition generalises the $p$-robustness [8] and the $\beta$-robustness [4]. The $L_\lambda$-robustness highlights five robustness issues. These issues

are identified by their input data or decisions variables in the definition of $L_\lambda$-robustness. In the following of the paper, $\lambda$ and $z$ are assumed to be given.

2.a. *First robustness issue: stability analysis*

It is assumed that only a forecast instance $I^{ref}$, a performance level $L_\lambda$ and a solution $S_{I^{ref}}$ are given. Then, the first robustness issue can be stated as follows: "knowing a solution $S_{I^{ref}}$ and given an expected performance level $L_\lambda$, what is the neighbourhood $P$ of $I^{ref}$ such that $\lambda(S_{I^{ref}}, z, P) \geq L_\lambda$ ?". This question can be seen as a *stability analysis problem*. Addressing this problem means finding the neighbourhood $P$ in which the solution $S_{I^{ref}}$ remains stable in the sense of $L_\lambda$. This problem includes the first and second questions of *sensitivity analysis* defined in [6]:

1) In what neighbourhood $P$ of $I^{ref}$ does $S^*_{I^{ref}}$ remain optimal?

Using the $L_\lambda$-robustness formalism, $S = S^*_{I^{ref}}$, $\lambda = \lambda_3$ and $L_\lambda = 0\%$.

2) In what neighbourhood $P$ of $I^{ref}$ does $S_{I^{ref}}$ remains feasible, with acceptable performance?

Now $S$ is supposed to be given, $\lambda = \lambda_3$ and the value of $L_\lambda$ defines what is a so-called acceptable performance.

2.b. *Second robustness issue: sensitivity analysis*

It is assumed that only a forecast instance $I^{ref}$, a neighbourhood $P$ of $I^{ref}$ and a solution $S_{I^{ref}}$ are given. Then, the second robustness issue can be stated as follows: "knowing a solution $S_{I^{ref}}$ and assuming a neighbourhood $P$ of $I^{ref}$, what is the performance level $L_\lambda$ that is guaranteed by $S_{I^{ref}}$ such that $\lambda(S_{I^{ref}}, z, P) \geq L_\lambda$ ?" This question can be seen as a *sensitivity analysis problem* where the sensitivity is measured by $L_\lambda$ on the set of instances $P$. This problem generalises the third question of *sensitivity analysis* defined in [5]:

3) Considering $I$ a neighbour of $I^{ref}$, is the solution $S^*_{I^{ref}}$ feasible for $I$ and then, what is its performance degradation?

Using the $L_\lambda$-robustness formalism, $S = S^*_{I^{ref}}$, $\lambda = \lambda_3$ and $P = \{I\}$.

In our framework, the instance $I$ is generalised by the neighbourhood $P$, and the performance deviation is assessed in the worst case on the neighbourhood.

2.c. *Third robustness issue: finding a robust solution*

It is assumed that only a forecast instance $I^{ref}$, a neighbourhood $P$ of $I^{ref}$ and a performance level $L_\lambda$ are given. Then, the third robustness issue can be stated as follows: "knowing a performance level $L_\lambda$ that must be guaranteed on a given neighbourhood $P$ of $I^{ref}$, what is a robust solution $S$ such that $\lambda(S, z, P) \geq L_\lambda$ ?".

2.d. *Fourth robustness issue: maximising stability*

It is assumed that only a forecast instance $I^{ref}$ and a performance level $L_\lambda$ are given. Then, the fourth robustness issue can be stated as follows: "knowing a performance level $L_\lambda$ that must be guaranteed, find a solution $S$ that maximises the neighbourhood $P$ of $I^{ref}$ such that $\lambda(S, z, P) \geq L_\lambda$". To answer this question, the neighbourhood $P$ covered by the solution $S$ must be measurable. That means that the first issue must be addressed beforehand.

2.e. *Fifth robustness issue: minimising sensitivity*

It is assumed that only a forecast instance $I^{ref}$ and a neighbourhood $P$ of $I^{ref}$ are given. Then, the fifth robustness issue can be stated as follows: "assuming a neighbourhood $P$ of $I^{ref}$ that must be covered, find a solution $S$ that maximises the performance level $L_\lambda$ such that $\lambda(S, z, P) \geq L_\lambda$". To answer this question, the performance level $L_\lambda$ must be measurable. That means that the second robustness issue must be addressed beforehand.

## 2. Configuration under uncertainty of a power distribution network

The aim of this section is to illustrate the previously presented robustness framework towards a power distribution network.

In the context of electrical energy, the market deregulation is deeply modifying the conditions of control of the operational safety of the networks. This trend results in exploiting the networks closer to their physical limits. If the present operating system remains flexible insofar as the sources capacities are much higher than the customers load, this situation cannot last in a context of quick increase of the loads and of stabilisation of production capacities. The challenge of the next years will be to exploit the networks with an available power which tends to balance with the loads. In this context, taking into account uncertainties on the sources capacity and on the loads will induce challenging problems. These uncertainties are mainly due to new technologies such as renewable energies whose production remains very fluctuating. The aerogenerators can be disconnected from the network for safety reasons and can induce voltage drops. Moreover their production is very related to weather conditions. In the same way, the production of

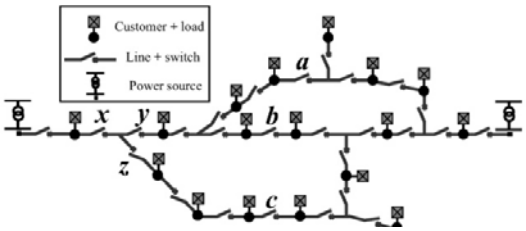


**Fig. 1 A power distribution network**

photovoltaic cells is dependant on the sunning. When voltage drop occurs, the only present solution to face these problems is to resort to load-shedding.

A power distribution network is composed of several power sources, electrical lines with their switch and customers with their load (see figure 1). The set of power sources must serve the set of customers with feeding their load and satisfying some electrotechnical constraints (like no connection between two sources). Configuring the network is choosing which power source serves which customer by setting the appropriate switches. Thus, the switches positions are the network configuration.

3.a. *Problem modelling*

The power distribution network is composed of *m* power sources that have to feed *n* loads (residential, commercial or industrial customers).

The power distribution network is modelled as a directed graph like in figure 1. However, the nodes have not all the same role in the network, and the set of nodes $N$ is decomposed into three subsets: the customer nodes $N_c$, the junction nodes $N_t$ and the source nodes $N_s$ such that $N = N_c \cup N_t \cup N_s$. Each node $i$ of $N_c$ represents a customer with its load whereas $N_s$ represents the set of sources with their capacity. $N_t$ represents the set of junction nodes. The network of the figure 1 is modelled as the graph of the figure 2. This network is composed of $n = 17$ customers $(1,\ldots,17)$, of $t = 6$ junction nodes $(18,\ldots,23)$ and of $m = 2$ sources (24 and 25). The junction node 18 represents the junction point between switches which are denoted $x, y,$ and $z$ on the network of figure 1. The junction nodes behave as customers without load, which are not to be necessarily served. The load of the customers and the junction points is represented by an integer $(n+t)$-sized vector $L$ such that $\forall k \in N_t, L_k = 0$. Each source *j* from $N_s$ is power-limited by a capacity $C_j$. $C$ is an integer *m*-sized vector. The network structure is represented by arcs between nodes of *N*. Each arc represents an electrical line with a switch. As flow direction is not pre-defined, each electrical line is represented by two arcs modelling the two possible orientations. However, a power flow cannot arrive to a source, thus there is no incoming arc for source nodes.

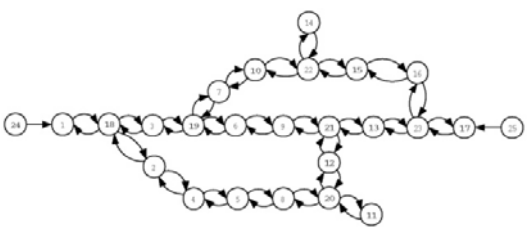

**Fig. 2 Model of the network of the figure 1**

The distribution network configuration is modelled by a $(n+t+m)^2$-binary matrix denoted S. $S_{i,j} = 1$ if the switch represented by the arc $(i, j)$ is closed: the electrical current flows from $i$ to $j$. $S_{i,j} = 0$ if the same switch is opened or if it does not exist: the electrical current does not flow from *i* to *j*.

We consider the power distribution network as a service production system. The most important constraint to be satisfied by the configuration is thus a service constraint: *each customer must be served and the service must cover the total load*.

The other constraints to be satisfied are electrotechnical ones which express the operation and safety conditions of the network. They can be defined as follows:

1. *Network radiality*: there cannot be cycle in the configuration and each node must have at most one predecessor.
2. *Disconnected sources*: an admissible configuration cannot contain any path connecting two sources.
3. *Power limitation of sources*: each source can provide only a limited quantity of power characterised by the capacity *C*.
4. *Power limitation of electrical lines*: each arc (*i*,*j*) is constrained by a capacity of maximum flow denoted $f_{i,j}^{\max}$.
5. *Constraints on voltage drops*: the depth of the solution forest is limited by an integer $D_{max}$.

An admissible solution is a directed forest whose roots are the source nodes. Moreover, this forest must span all the customers nodes and satisfy the previous constraints. We can illustrate these requirements on the example of the figure 1 completed by the following data:

$$\begin{cases} \forall i \in N_c, L_i = 1 \\ \forall k \in N_t, L_k = 0 \\ \forall j \in N_s, C_j = 10 \\ D_{\max} = 10 \\ \forall (i,j) \in N^2, f_{i,j}^{\max} = 10 \end{cases} \quad (2)$$

An admissible configuration for this example is the forest of the figure 3. This solution consists in opening the switches represented by the arcs $\{(5,8);(8,5)\}$, $\{(6,9);(9,6)\}$, and $\{(10,22);(22,10)\}$ (resp. the switches *a*, *b*, and *c* of figure 1) while keeping closed the other switches: i.e., on the two arcs representing each other switch, one arc is used following the sense of the current.

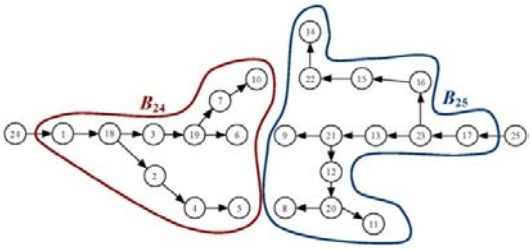


**Fig. 3 An admissible configuration**

3.b. *Perturbations: highlighting and robustness definition*

Naturally a lot of perturbations can occur in power distribution networks:

- risks: loss of an electrical line, loss of the functioning of a switch …

Buried lines may be inopportunely cut by mechanical diggers on a construction site. For the case of overhead lines, an ordinary road crash can cause the fall of an electrical pylon and so the cable disconnection.

- uncertainties: load variations, source actual capacities …

Actually loads vary during the days (cooking, television, washing machines), the weeks (evenings, week-ends) and the seasons (heaters, lights). Moreover, the profile of the load varies with the type of customer (residential, commercial, and industrial). Concerning the uncertainties on source capacities, they are mainly due to the introduction of the new technologies of energy production like renewable energies that remains very fluctuating as their efficiency strongly depends on weather conditions.

The challenge of the next years will be to exploit the networks with an available power which tends to balance with the loads. That is the reason why, to our point of view, taking into account uncertainties on the sources capacity (vector $C$) and on the loads (vector $L$) induce challenging problems. Thus in this paper, the network is regarded as being free from failures: i.e. lines and switches are always well functioning.

So, in the following of the paper, we will take into accounts the uncertainties on loads and on source capacities to propose robust configurations.

Uncertainties on load and on source capacities can lead to load-shedding. Meeting energy demand was a constraint in certain context; it becomes a performance to guarantee by taking into account the uncertainties on load and source capacities. Let an instance $\mathrm{I}$ be defined as follows:

$$\mathrm{I} = \begin{cases} L_i & \forall i \in N_c \cup N_t \\ C_i & \forall i \in N_s \end{cases}$$

For an admissible configuration $\mathrm{S}$, a service level can now be defined by:

$$z^{SL}(\mathrm{S},\mathrm{I}) = \frac{\sum_{i\in N_c}\sum_{j\in N} \mathrm{S}_{j,i}}{n} \quad (3)$$

where $\sum_{i\in N_c}\sum_{j\in N} \mathrm{S}_{j,i}$ is the number of served customers.

To measure the global performance of a configuration, the service level in the worst case appears to be a relevant criterion. Thus, we can use the absolute robustness as a robustness measure. That means that:

$$\lambda_1(\mathrm{S}, z^{SL}(\mathrm{S},\mathrm{I}),\mathrm{P}) = \min_{\mathrm{I}\in\mathrm{P}}\{z^{SL}(\mathrm{S},\mathrm{I})\}.$$

It measures the minimal rate of served customers when the source capacities $C$ and the customer loads $L$ vary in $\mathrm{P}$. A configuration $\mathrm{S}$ is then said to be robust (in reference to the definition 1) if the value $\lambda_1(\mathrm{S}, z^{SL}(\mathrm{S},\mathrm{I}),\mathrm{P})$ is higher than a performance level $\mathrm{L}_\lambda$ (a minimal waited rate of served customers).

Now the five robustness problems defined in section 2 can be instantiated to our problem.

3.c. *Stability analysis*

In the addressed problem, stability analysis consists in finding the set $\mathrm{P}$ of instances $\mathrm{I}$ that can be covered by the configuration $\mathrm{S}$ without load-shedding ($\mathrm{L}_\lambda = 100\%$). A configuration $\mathrm{S}$ defines $m$ sets $B_j$ that partition $N_c \cup N_t$ where $B_j$ is the set of loads served by the source $j$ in the configuration $\mathrm{S}$. In the example of figure 3, we have $B_{24} = \{1;2;3;4;5;6;7;10;18;19\}$ and $B_{25} = \{8;9;11;12;13;14;15;16;17;20;21;22;23\}$.

It has been shown in [2] that $\mathrm{P}$ can be evaluated as follows:

$$\mathrm{P} \equiv \left\{ \mathrm{I} \;\middle|\; \mathrm{I}_j - \sum_{i\in B_j} \mathrm{I}_i \geq 0, \forall j \in N_s \right\} \quad (4)$$

This result is trivial and can be evaluated in polynomial time. This result only gives an implicit measure of $\mathrm{P}$. If two configurations have to be compared by the stability analysis, an explicit value has to be proposed. If a forecast load $L^{ref}$ and a nominal capacity $C^{nom}$ can be given, then a forecast instance denoted $\mathrm{I}^{ref}$ can be defined as:

$$\mathrm{I}^{ref} = \begin{cases} L_i^{ref} & \forall i \in N_c \\ 0 & \forall i \in N_t \\ C_i^{nom} & \forall i \in N_s \end{cases}$$

Now a load-shedding margin for each source $j$ can be deduced from formula (4) and valued by:

$$M_j\left(\mathrm{S}, \mathrm{I}^{ref}\right) = \frac{C_j^{nom} - \sum_{i\in B_j} L_i^{ref}}{C_j^{nom}} \quad (5)$$

And finally $\mathrm{P}$ can be measured by the minimal load-shedding margin valued by:

$$M = \min_{j\in N_c} M_j\left(\mathrm{S}, \mathrm{I}^{ref}\right) \quad (6)$$

This value is proposed as an explicit measure of $\mathrm{P}$.

In the example of figure 3, with the same values as in equation (2), $M_{24} = 20\%$ and $M_{25} = 10\%$.

3.d. *Sensitivity analysis*

For the considered example, sensitivity analysis means finding the rate of served customers $L_\lambda$ by the configuration $S$ in the worst case on a given set $P$ of instances $I$.

It is assumed that the set $P$ is defined as:

$$P = \left\{ I \mid I_i \in [\alpha_i \quad \beta_i] \right\} \quad (7)$$

where $\alpha_i$ and $\beta_i$ are exactly known.

Considering the fact that:

1) the worst case is defined by $I^{wc}$:

$$I^{wc} = \begin{cases} \beta_i & i \in N_c \\ 0 & i \in N_t \\ \alpha_i & i \in N_s \end{cases}$$

2) the configuration $S$ defines $m$ sets $B_j$ that partition $N_c \cup N_t$,

it has been shown in [2] that solving this problem is equivalent as solving $m$ knapsack-problems with precedence constraints (one knapsack for each source). As the precedence constraints are defined by a tree, this problem is only weakly NP-hard [3] and a lot of efficient approaches exist.

3.e. *Finding a robust configuration*

In the addressed problem, finding a robust configuration means finding a configuration that guarantees the service to customers ($L_\lambda = 100\%$) on a set $P$ of instances $I$. This problem remains open.

3.f. *Maximising stability*

In the context of power distribution networks, maximising stability consists in finding the configuration $S$ that maximises the set $P$ of instances $I$ without resorting to load-shedding ($L_\lambda = 100\%$).

Using the minimal load-shedding margin proposed at section 3.c. to measure the stability of a given configuration, the problem consists in finding the configuration that maximises the minimal load-shedding margin.

After having proved that this problem is strongly NP-hard, we have proposed in [2] a MILP formulation and a tabu search to solve this problem.

3.g. Minimising sensitivity

In the addressed problem, minimising sensitivity means finding the configuration that maximises the rate of served customers $L_\lambda$ in the worst case on a given set $P$ of instances $I$. This problem remains open.

## 3. Conclusion

In this paper, a generic robust framework has been proposed and illustrated through an example in which uncertainty is a major issue. This example shows that the five robustness problems that are highlighted by our framework are relevant for real-life applications. This framework appears to be an interesting decision-aid scheme for managers having to take decisions under uncertainties.

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# Consultancy Companies

### Banxia Software Ltd

www.banxia.com

Banxia Software Ltd is a small software company, based in Kendal, in the UK. Matthew Jones, who founded Banxia Software Ltd in 1994, was part of an academic team, initially based in the School of Management at the University of Bath and then based in the Department of Management Science, at the University of Strathclyde. Matthew left the University of Strathclyde, set up Banxia Software and became a full-time software developer, working on a variety of decision support and operational research tools, including Decision Explorer® and Frontier Analyst®. In 1995 the University of Strathclyde licensed Decision Explorer® to Banxia, to continue its development

and make it available to a wider audience. For the first seven years of its existence, Banxia was based in the Lord Hope Building, on the University of Strathclyde campus, where the university runs an "incubator" facility (serviced offices) for start-up companies. The core staff at Banxia all worked in the Department of Management Science at the University of Strathclyde and so have a good understanding of the theoretical as well as practical uses of Decision Explorer and Frontier Analyst. From its founding 15 years ago, Banxia has extended both its range of products and its international reach, with Banxia products now in use in over 60 countries worldwide.

Banxia's focus has always been on decision support and operational research tools, with the foundation of the business being built around Frontier Analyst® (a data envelopment analysis tool) and Decision Explorer® (an ideas mapping package). Banxia offers support, training and, through a network of consultants, consultancy using Frontier Analyst® and Decision Explorer®.

**Frontier Analyst®, Decision Explorer® and MCDA.** Frontier Analyst® and Decision Explorer® complement those tools already in the Multiple Criteria Decision Aiding (MCDA) practitioner's toolbox. In particular, Banxia's tools can assist with two of the most challenging aspects of MCDA – the selection of weights and the construction of criteria hierarchies and determining alternatives.

Banxia's products draw on a range of decision support research, and as such are designed to "play nicely" in multi-methodology engagements – which are becoming more prevalent with today's complex problems. Data can be imported to, or exported from, Banxia's tools using a variety of standard formats. The extensive use of visualization tools assists users in interpreting results in a (relatively) methodologically neutral manner.

**Frontier Analyst®.**
Frontier Analyst® is based on an operations research technique known as Data Envelopment Analysis (DEA). DEA is, at heart, an option comparison tool. Indeed, DEA and MCDA can be seen, in one way, as limiting cases of each other. DEA is suitable for situations where you have many more options than criteria, while MCDA approaches tend to focus on a small number of options that need to be compared across numerous criteria. Of course, both DEA and MCDA tools exist that can be used more widely, but this basic focus remains.

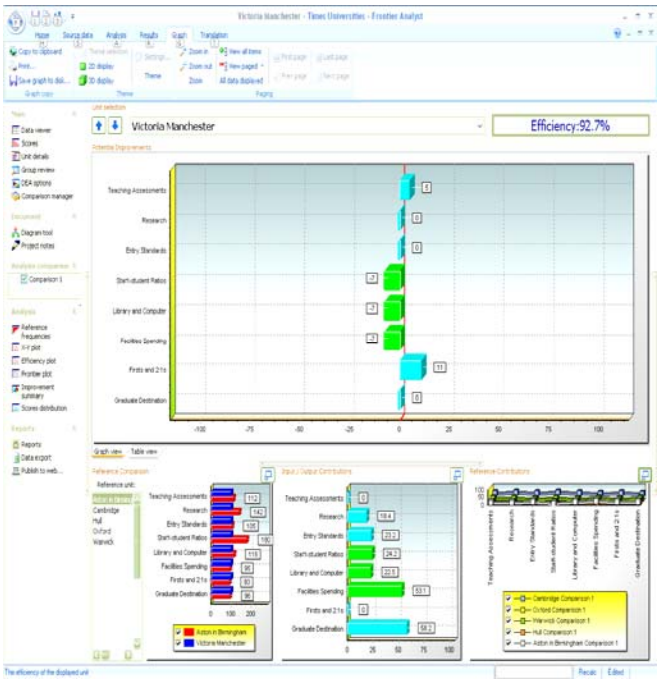


*Figure 1: general screen shot showing some of the Frontier Analyst results charts. Gives an overview of an inefficient unit. Each results chart can be maximized in turn, while the others can be visible (or not) as desired.*

In a Frontier Analyst® model, the weights are endogenous – i.e. they are derived from within the model, as opposed to being defined externally (e.g. by decision makers)[2]. Weights are chosen to optimize the score assigned to an option – with the score being conceived of as an efficiency rating – i.e. how effectively the option (or unit, in DEA terminology) translates its inputs into outputs.

There is a crucial constraint placed on these scores – no option can have a score in excess of 100. As the same weights must be applied to *all* the options, this means that some options will score less than 100 – e.g. if they are dominated by other options.

Frontier Analyst® has been used by many different types of organization, to analyse many different processes, across all of which is the common feature that a process is performed by a number of discrete, autonomous business units, all of which are using a common set of resources to produce a common set of products.

An example of the application of Frontier Analyst® is its use by the Arizona and New York State Education Departments to study school performance. Andrew Tait (formerly at the University of Strathclyde and now with Banxia and Idea Sciences in the USA: Andrew.tait@ideasciences.com) was one of the consultants involved in this project. A web-based benchmarking service, schoolbenchmarking.com, was built on top of a Frontier Analyst® model to allow

[2] As is the case with most decision support approaches, Frontier Analyst® supports externally derived weights, but we'll focus on the "classic DEA" approach in this article.

comparisons between "underperforming" schools and their higher performing peers. Schools were evaluated on how effectively they produced results (e.g. graduation rates) given their resource utilization (e.g. expenditure per pupil) and constraints (e.g. local poverty). This particular application is mentioned because in this instance further analysis was carried out on the weights applied to the inputs and outputs. The weights assigned to the evaluation criteria were studied to identify areas of generally high/low performance within the systems, with an eye to aiding strategic planning.

**Decision Explorer®**

Decision Explorer® is an ideas mapping package, designed to support the cognitive mapping approach as developed by Colin Eden, Fran Ackermann and colleagues. Matthew Jones, Banxia's founder, worked on the original MS-DOS version of Decision Explorer®, which was, at the time, known as "COPE". With the advent of MS Windows® COPE was developed further and became "Graphics COPE". When it was licensed to Banxia, further development took place and the product was renamed "Decision Explorer", to reflect the role that the tool plays in supporting decision making. The link between Decision Explorer® and MCDA comes in the way that Decision Explorer® can be used for problem structuring, as a means of eliciting and structuring the criteria which will then be modeled in the value tree to determine alternatives.

Decision Explorer® is essentially a "neutral" tool, in that it is the text in the ideas and the links that are made between them, which "bend" the tool to a particular purpose. Although designed to support cognitive mapping (which is a causal mapping method), Decision Explorer can be used to support other mapping methods (such as "concept mapping" – based on Joseph Novak's work, and "mind mapping" – based on Tony Buzan's work).

Prof Fran Ackermann (fran@mansci.strath.ac.uk) has been involved in a number of interventions where the use of Decision Explorer® has been linked with MCDA. One of these interventions is reported in: Belton, V., Ackermann, F., Shepherd, I (1997), "Integrated Support from Problem Structuring through to Alternative Evaluation using COPE and VISA". *Journal of Multi-Criteria Decision Analysis, Vol. 6, pp115-130* (Which won the Wiley Prize for Best Application Paper). This paper acknowledges the fact that many real-world problems are often ill-defined and a "front-end" process is needed to help manage the problem and ensure that the inputs for the MCDA model tie up with the "actual" rather than the "perceived" problem. The mapping process facilitates group negotiation and recognizes that it is a cyclical process between opening up the decision space before applying more precision through weights and scores which in turn generate more qualitative issues and insights.

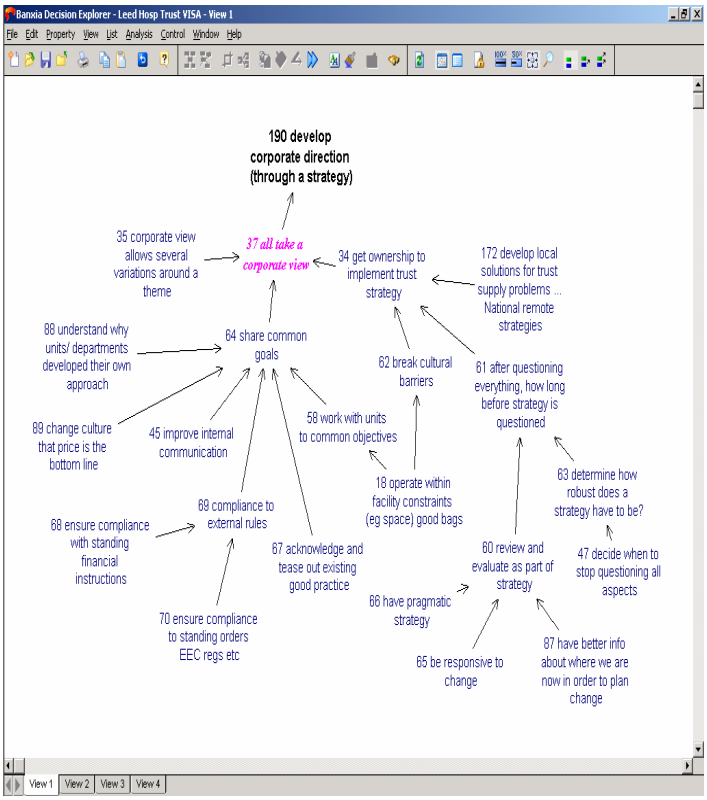


*Figure 2: concepts taken from the "front end" of the Decision Explorer® (COPE)/MCDA intervention.*

For those who want to read more about Frontier Analyst® and Decision Explorer® and the methods that they support, bibliographies can be found on the web site at www.banxia.com, along with working demonstrations. You can email enquiries to Banxia at info@banxia.com, and Prof. Fran Ackermann (fran@mansci.strath.ac.uk) and Andrew Tait (Andrew.tait@ideasciences.com) are happy to talk to anyone about their work and their use of Banxia's tools.

# Software

## A Multicriteria Bank Rating System

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*Financial Engineering Laboratory*
*University Campus, 73100 Chania, Greece*
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### 1. Introduction

Banks have a prominent role in the financial and business environment. The increasing risks that banks face, have led to the introduction of the new regulatory framework of Basel II, which defines the core principles for financial risk management in banking institutions. One of the pillars of this framework involves the banking supervision process. The central banks that are responsible for supervising the banks in each country use rating systems to assess the soundness of the banks. According to Sahajwala and Van den Bergh (2000), the emphasis is put on the development of formal, structured and quantified assessments taking into account the financial performance of banks as well as their underlying risk profile and risk management capabilities. Such assessments support the supervisors and examiners in identifying changes in banks' condition as early as possible.

Due to lack of sufficient historical data about bank defaults, bank rating systems usually implement empirical assessment techniques, which are based on a broad set of criteria selected from the CAMELS categories (Capital, Assets, Management, Earnings, Liquidity, and Sensitivity to market risk).

Several multicriteria techniques have also been used (mainly at the academic/research level; cf., Mareschal and Brans, 1991; Raveh, 2000; Zopounidis et al., 1995). This short paper presents the DSS implementation of a multicriteria bank rating approach. The proposed methodology is based on the PROMETHEE II method (Brans and Vincke, 1985). The bank evaluation criteria are selected in cooperation with expert analysts from the Bank of Greece. The selected criteria comply with the CAMELS framework and include both qualitative and quantitative measures. Special emphasis is put on the sensitivity of the results with regard to the relative importance of the evaluation criteria and the parameters of the PROMETHEE method. Analytic sensitivity analysis techniques are used for this purpose, together with Monte Carlo simulation.

### 2. Problem context and methodology

The main output of bank rating models is the classification of the banks into ordinal risk grades (groups). The number of risk groups is usually defined to be equal to 5, with group 1 indicating low risk/high performance banks and group 5 indicating high risk/low performance banks. The overall performance is decomposed into partial scores (for each individual evaluation criterion).

In accordance, with the CAMELS model which used by the Bank of Greece, a multicriteria methodology has been implemented that enables not the only definition of the required risk grades, but also the development of an overall performance index that enables comparisons on the relative performance of the banks. The methodology is based on PROMETHEE II. The workflow of the methodology is given in Figure 1.

The PROMETHEE II method is widely used to rank a set of alternatives on the basis of pairwise comparisons. In the proposed methodology, PROMETHEE II is also used to perform an absolute evaluation of the banks in comparison to a pre-specified reference point, which is selected by the bank analyst either as the ideal or the anti-ideal bank. The system incorporates several tools for supporting user in the specification of the evaluation parameters (weights, type of preference functions and the associated parameters) and provides detailed results on the overall score of the banks (net flows), its decomposition into partial scores (unicriterion net flows), and the implied risk ratings.

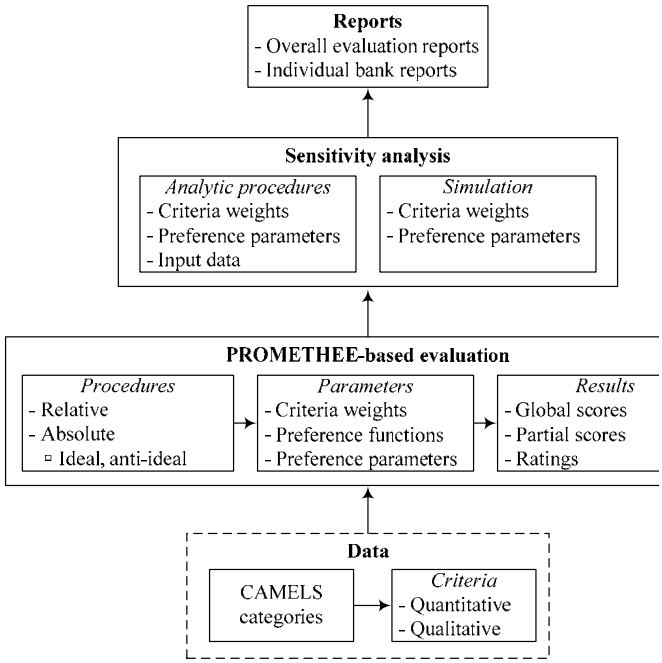


Figure 1: Modeling methodology

Special emphasis is also put on the sensitivity and robustness of the results. To this end, analytic procedures and Monte Carlo simulation are used. Analytic procedures are employed to define intervals for the criteria's weights, the parameters of the preference functions and the banks' data, within which the ratings of the banks remain unchanged. On the other hand, Monte Carlo simulation is

used to explore how different scenarios for the weights of the criteria and the preference functions affect the rating of the banks.

### 3. An illustration of the DSS

The DSS has been installed at the Bank of Greece, where it is currently in use. Multiple individual analysts can use the DSS simultaneously, in their local PCs, all having access to a shared database, which has the information on the criteria and the banks. Senior analysts have full access to the database and they are able to make permanent changes, by modifying the set of evaluation criteria, their weights and the corresponding type/parameter of the preference functions. Lower-level users have full access to all the capabilities of the system, but they are only allowed to make temporary modifications to the database, which are discarded upon exit from the system.

In its initial form 31 criteria (financial ratios and qualitative criteria) have been included in the system, covering all aspects of the CAMELS framework. The system, however, allows the user (senior analyst) to modify the set of criteria. The weights of the criteria have been defined by the senior analysts of the Bank of Greece. The weights are defined for each main category of criteria, as well as for the criteria in each category. Estimates of the criteria importance are also given using the rank-order centroid (ROC) and rank-sum (RS) approaches (Jia et al., 1998) as shown in Figure 2.

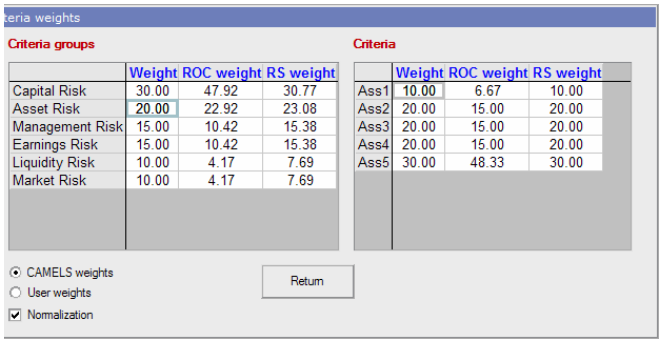


Figure 2: Definition of the criteria’s weights and their ROC and RS approximations

For the specification of the preference functions of the criteria (i.e., the generalized criteria in PROMETHEE) and the corresponding parameters, the system provides a visual representation that supports the user. Through the screen of Figure 3, the analyst can specify the form of the preference function (Gaussian or linear), the corresponding parameter and the resulting unicriterion net flows for the banks in the database are illustrated in a graph. All net flows are rescaled in a [0.5, 5.5] interval in accordance with the overall 5-point rating scale. With this rescaling, lower net flows indicate better performance and lower risk. The rescaling is based on the ideal and anti-ideal values of the criteria, which are defined by the analyst. This visual representation helps the user to understand the effect of the individual preference parameters on the partial scores (unicriterion flows) of the banks.

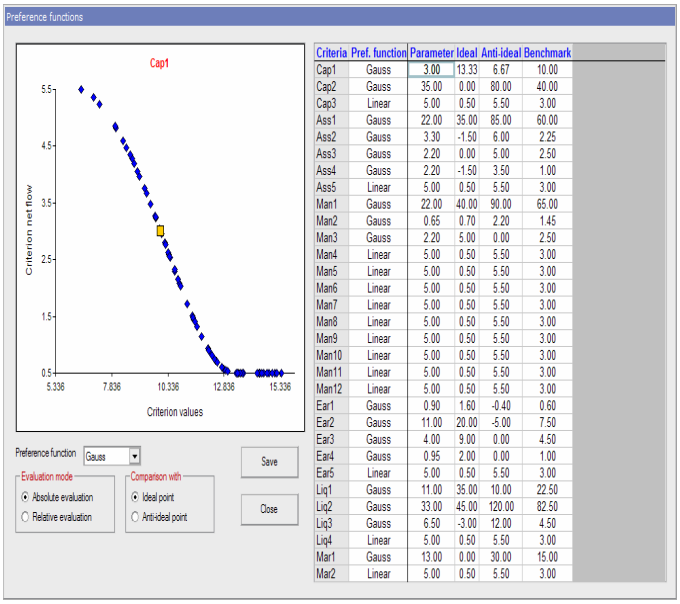


Figure 3: User-inputs for the partial preference functions (generalized criteria)

The results from the application of the PROMETHEE II method are presented through the screen of Figure 4. The overall net flows (rescaled in the aforementioned [0.5, 5.5] scale) are shown for each year and each bank. Interactive sensitivity analysis is available. The user can modify the weight and/or the parameter of the preference function for a selected criterion and the net flows are updated automatically. Analytic sensitivity results are also available in separate sheets, with regard to the weights of the criteria and the parameters of the corresponding preference function (e.g., Figure 5). Individual detailed reports on evaluation of a specific bank and the sensitivity of its ratings with respect to the parameters of the evaluation are also available.

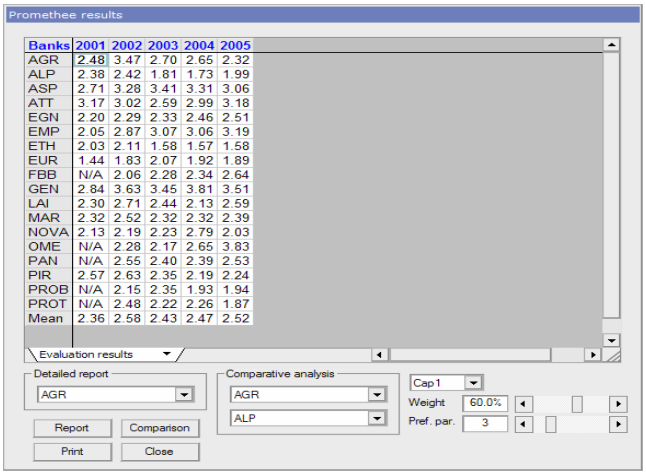


Figure 4: Presentation of the overall evaluation results

The user also has the capability to perform a Monte Carlo simulation involving the parameters of the evaluation process (weights, preference parameters). The scenarios for the simulated parameters are either completely random but additional information from the analysts can also be taken into consideration (e.g., the ranking of the criteria in terms of their relative importance). This kind of scenario analysis provides useful statistics on the performance (net flows) of the banks (e.g., means, medians, standard deviations, 95% confidence intervals). Detailed results are also given for each bank as shown in Figure 6. This kind of report provides information on the distribution of the ratings for the selected bank (across all scenarios), the variability of its net flow (Box plot). Information is also provided on the relation of the simulated parameter (weights) with the evaluation results, which supports the identification of the strengths and weaknesses of the selected bank.

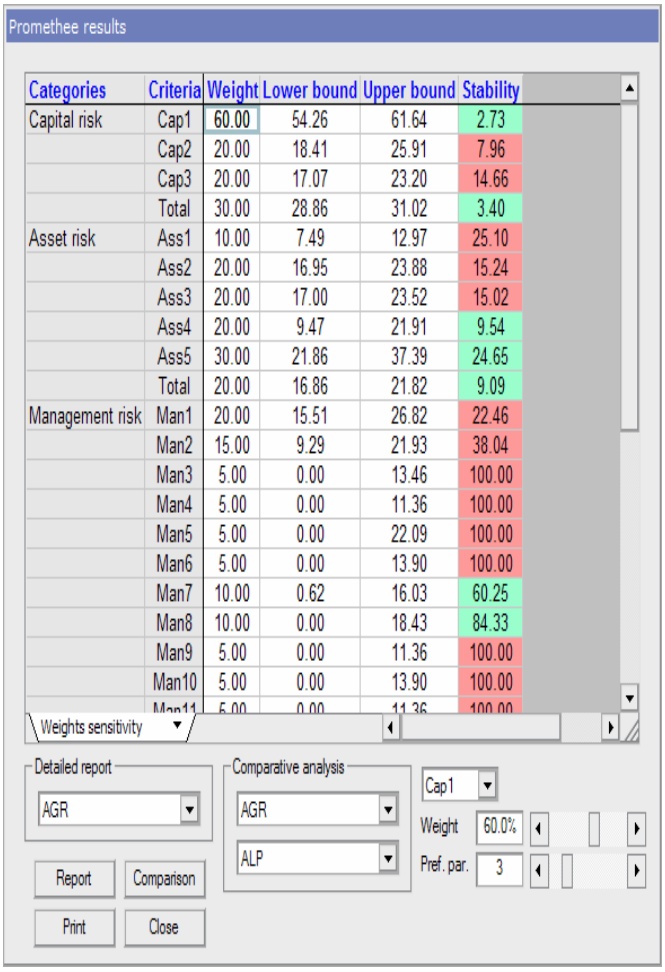


Figure 5: Sensitivity analysis results for the weights of the criteria

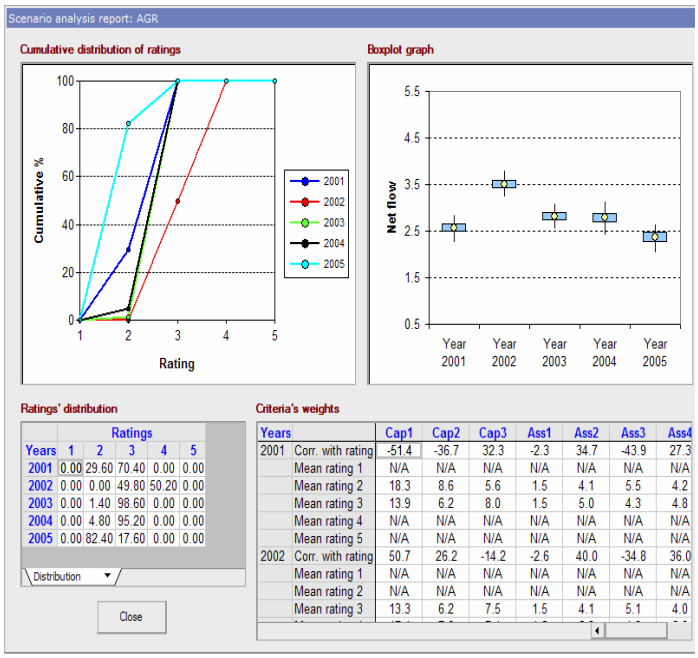


Figure 6: Scenario analysis report for a specific bank

## 4. Conclusions

The bank rating system presented in this short paper, has been developed to act as a supporting tool for the analysts at the Bank of Greece. It provides a rich set of evaluation options, visualization, and reports that enable the analysts to identify the strengths and weaknesses of the banks. Further enhancements are explored towards building early warning models, the extension to cooperative banks, as well as the specification of appropriate criteria regarding the investments made by Greek banks abroad.

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## Persons and Facts

Dear Colleagues,

It is my great pleasure to inform you that the Senate of the Università degli Studi di Canania, Facoltá di Economia, has unanimously decided to award an honorary doctorate degree to Professor Bernard Roy (Emeritus Professor at Université Paris-Dauphine, France).

Professor Roy has been awarded this honorary doctorate degree for his outstanding scientific contribution to a decision aiding science.

The award ceremony occurred on January 30, 2009, at the Aula Magna Palazzo Centrale, Catania, Italy.

*** ***

It is also my great pleasure to inform you that the Senate of the University Paris-Dauphine has unanimously decided to award a honorary doctorate degree to Professor Philippe Vincke (recteur de l’Université Libre de Bruxelles, Belgique).

Professor Vincke has been awarded this honorary doctorate degree for his outstanding contribution to multiple criteria decision aiding, and more especially, to preference modelling

The award ceremony occurred on May 12, 2008, at the University Paris-Dauphine, France.

*** ***

Le Conseil d'Administration de HELORS base sur la proposition d'un Comite d' Experts dans le domaine de Recherche Operationnelle, a decide d’attribuer le Gold Medal de HELORS au Prof. Constantin Zopounidis, pendant son Congrès annuel qui a eu lieu le 28 Mai à Athenes. Jusqu' a aujourd'hui le Gold Medal à été attribué à des Personalités grecs de très haut niveau scientifique venant de l'étranger. Félicitations Kostas !
José

*** ***

In December 2008 Matthias Ehrgott was appointed as the new area editor for "Decision Analysis and Decision Making Techniques" of the Asia-Pacific Journal of Operational Reserch.

(http://www.worldscinet.com/apjor/apjor.shtml).
Below is the editorial statement. High quality papers on MCDA are very welcome and can be submitted online via the journal homepage.

Operations Research offers a variety of quantitative techniques to support decision making processes with single or multiple decision makers and involving single or multiple criteria. This area of APJOR covers all aspects of Operations Research relating to decision analysis at all stages of decision making processes, from the problem formulation stage through modelling aspects and solution methods to implementation.

We invite high quality papers on all aspects of decision analysis and decision making techniques. Topics may range from fundamental theoretical aspects of decision science to methods for decision analysis and decision support and real world applications of decision making techniques.

Submitted papers should either focus on theoretical and methodological aspects or describe novel applications. All submissions will be judged on originality, technical quality, and presentation and papers published in APJOR should be of interest to a wide audience within the OR community. Theoretical and methodological papers will present new ideas, important new results, new methods and algorithms, or unification of existing knowledge. Application oriented papers may report on the use of new methods in practice or the application of existing techniques in new areas. It is expected that a publication in APJOR extends current knowledge and helps solve decision problems in new ways.

Congratulations! José

## About the 69th Meeting

**69th MEETING OF THE EURO WORKING GROUP**
***MULTIPLE CRITERIA DECISION AIDING***
**Brussels, Belgium, April 2-4, 2009.**

The 69th meeting of the European Working Group "Multiple Criteria Decision Aiding" was co-organized by Yves De Smet (Université Libre de Bruxelles) and Marc Pirlot (Faculté Polytechnique de Mons) on April 2 and 3, 2009.

The meeting took place at the Université Libre de Bruxelles. Among the 88 registered participants, 73 of them, coming from 21 different countries, actively took part to the meeting. The main theme of the conference was "Multicriteria classification" but all contributions dealing with multiple criteria decision aiding were welcome. Out of the 32 submitted papers, 22 were scheduled for presentation in 6 sessions during the two days.

A distinctive feature of this meeting was the organization by Philippe Nemery de Bellevaux (Université Libre de Bruxelles) of a poster session for PhD students during the registration time. 17 master and Phd students had the opportunity to present their current research projects.

It is worth noting that a special issue of the new "International Journal of Multicriteria Decision Making" will be dedicated to this meeting. The deadline for submitting the text of the communications is May 15, 2009.

The social program included a banquet dinner on Thursday evening at "Le Crabe Fantôme". On Saturday morning, 15 participants joined a walking excursion in the streets of Brussels to discover the treasures of "Art Nouveau" architecture. This was followed by a memorable lunch at "La Quincaillerie".
More information about the meeting can be found at www.mcda69.org.

Yves De Smet (yves.de.smet@ulb.ac.be)
Marc Pirlot (marc.pirlot@fpms.ac.be)

**FINAL PROGRAMME**

**Thursday, April 2**

11:00 – 13:00 **Young MCDA Meeting: posters**

*Chairman:Philippe Nemery de Bellevaux*

**Almeida Dias Juscelino** (Portugal)
The ordinal sorting problematic with characteristic reference actions: The case of the ELECTRE TRI-C method

**Barbara Latifa** (France)
L'apport de l'aide multicritère à la décision au diagnostic et à l'évaluation économique des organisations

**Cailloux Olivier** (Belgium)
Predicting cardiac frequency variations using mcda techniques to adapt to inter-patient variability

**Dagmara Swistek** (Belgium)
Data Envelopment Analysis (DEA) and Analytic Hierarchy Process (AHP): a combined approach

**Deparis Stéphane** (France)
"Does incomparability exist ?" An empirical approach

**Douale Fetgo Isidore Robert** (France)
Efficience dynamique des Institutions de Microfinance en réseau au Cameroun: Une analyse par la méthode PROMETHEE-GAIA

**Eppe Stefan** (Belgium)
Decision Ants - Applying Ant Colony Optimization to Multicriteria Decision Aid

**Gnatenko Nadiia** (Ukraine)
PRIOL: Decision Support Based on Preference Function Learning

**Huaulme Maud** (France)
Création d'une procédure d'introduction de la méthodologie multicritère dans le suivi et l'évaluation de politiques publiques et de programmes

**Hyunh Minh Tuan** (Belgium)
L'Approximation Circulaire pour la représentation graphique de matrices de préférence valuées

**Lidouh Karim** (Belgium)
GAIA Map: Visual MCDA Analysis in Geographical Information Systems

**Liguigli Ersilia** (Italy)
MCDA to support conceptual design: the case of a land monitoring system

**Ouerdane Wassila** (France)
Reaching a decision is great, but it's even better if it is justified

**Rocha Clara** and **Dias Luis** (Portugal)
On Hierarchical Cluster Analysis for relational multicriteria clustering

**Rocha Clara** and **Dias Luis** (Portugal)
On Multicriteria Sorting and Clustering methods with ordinal and nominal categories

**Roland Julien** (Belgium)
Clustering Multicritère Relationnel

**Selvaraj Ramkumar** (Belgium)
Clustering Multicritère Ordonné

**Verly Céline** (Belgium)

Choix de portefeuilles en se basant sur trois critères

11:00 – 13:00 **Registration**

13:00 – 14:00 **Lunch**

**Session 1 – Classification / Sorting**

*Chairman: Jose Rui Figueira*

14:00 – 14:30 **Opening session: Yves De Smet, Marc Pirlot**

14:30 – 15:00 **R. Lahdelma, P. Salminen**: Simple method for ordinal classification in multicriteria decision making

15:00 – 15:30 **J. Navarro, E. Fernandez**: Multicriteria classification by minimizing inconsistencies with a fuzzy outranking relation: the TESEO method

15:30 – 16:00 **N. Belacel**: A comparative study of well-known classifiers and PROAFTN method

*Papers submitted for discussion*

**R. Slowinski, S. Greco et M. Kadzinski**: The most representative value function in robust multiple criteria sorting

**J. Almeida Dias**: Some improvements of the ELECTRE TRI-C method

**M. Doumpos, C. Zopounidis**: A comparative evaluation of multicriteria classification methods

16:00 – 16:30 **Coffie Break**

**Session 2 – Applications 1**

*Chairman: Bertrand Mareschal*

16:30 – 17:00 **A.Valls, M. Schuhmacher, J. Pijuan, A. Passuello, M. Nadal**: Some approaches to the use of MCDA tools for the management of sewage sludge application on agricultural soils

17:00 – 17:30 **F. Macary, D. Ombredane, D. Uny**: Application de la méthode ELECTRE, aide multicritère à la décision, en agroenvironnement: risques d'érosion dans le blocage du sud-Manche, en France

17:30 – 18:00 **M.F. Norese**: A classification procedure to identify and validate a decision reference system

18:00 – 18:30 **P. Wouters**: Classer des phénomènes de sécurité à l'aide des méthodes multicritères : problèmes pratiques

*Papers submitted for discussion*

**N. Schurwirth, J. Lienert**: How to deal with pharmaceuticals in hospital wastewater ? Decision support with the help of MCDA

**Friday, April 3**

**Session 3 – Méthodologie / Methodology**

*Chairman : Maria Franca Norese*

09:00 – 09:30 **P.L. Kunsch**: Les méthodes d'aide multicritère à la décision permettent-elles de simuler valablement les comportements multicritères observés ?

09:30 – 10:00 **S. Matias, J. Rui Figueira, M. José Carvalho, C. E. Plancha**: A Multiple Criteria Decision Aiding Assignment Methodology for Assisted Reproductive Technology

10:00 – 10:30 **J. Renaud, J. Lieber, C. Fonteix, A. Chirvase, M. Caramihai**: Analyse multicritère et raisonnement à partir de cas. Proposition d'une démarche intégrée appliquée à la santé

*Papers submitted for discussion*

**L. Caklovic**: A graph approach to MCDM
**H. Yamnahakki, M. Maslouhi**: Aide multicritère à la décision et analyse coût-bénéfice

10:30 – 11:00 **Coffee Break**

**Session 4 – Applications 2**

*Chairman : Pierre L. Kunsch*

11:00 – 11:30 **S. Leger, N. Belacel, H. Fournier, D. Cormier, S. Robichaud**: Web Integration of Clinical Decision Support System for Screening and Assessment of Suicide Risk
11:30 – 12:00 **S. Shmelev** : Measuring Progress: New MCDA Approaches for the Dynamic Assessment of Sustainability at the Macro Scale
12:00 – 12:30 **J. Lienert, S. Langhans, P. Reichert**: A Decision theoretic approach to river assessment
12:30 – 13:00 **K. Vaillancourt, J.-Ph. Waaub**: Proposition d'élaboration d'échelles de mesure des critères d'évaluation des dossiers de demande de subvention

*Papers submitted for discussion*

**M. Le Louarn**: L'évaluation transverse des politiques et programmes de l'Union Européenne: enjeux et défis méthodologiques

**P. Xidonas, G. Mavrotas, J. Psarras**: IPSSIS: An integrated multicriteria decision support system for stock portfolio construction and selection

13:00 – 14:00 **Lunch**

**Session 5 – AHP & Choquet**

*Chairman: Roman Slowinski*

14:00 – 14:30 **B. Roy**: prochaine réunion et organisation/Next Meeting and organization issues
14:30 – 15:00 **A. Ishizaka**: Selection of new production facilities with incorporation of stakeholder preferences in the Analytic Hierarchy Process
15:00 – 15:30 **S. Angilella, S. Greco, B. Matarazzo**: Non-additive robust ordinal regression with Choquet integral
15:30 – 16:00 **B. Mayag, M. Grabisch, Ch. Labreuche**: A characterization of the 2-additive Choquet integral through a preferential information on binary actions

*Papers submitted for discussion*

**C.Escribano Rodenas, G. Fernandez Barberis, C. Garcia Centeno**: Evaluating the volatility in the financial market by using multiple criteria decision aid methods

16:00 – 16:30 **Coffee Break**

**Session 6 – Nouveaux développements/ New developments**

*Chairman: Luis Dias*

16:30 – 17:00: **T. Tervonen, D. Postmus, H.L. Hillege**: Multi-criteria decision analysis in drug benefit-risk assessment
17:00 – 17:30: **M.J. Geiger**: Multi-Objective vehicle

routing: Presentation of a solution framework, its computer implementation, and experimental verification
17:30 – 18:00: **P. Meyer, R. Bisdorff, V. Mousseau, M. Pirlot**: Latest news on the Decision Deck Project

*Papers submitted for discussion*

**A. Mendas**: SIG et analyse multicritère pour choisir le meilleur site d'implantation d'une retenue collinaire
**G. Mavrotas, J. Rui Figueira, A. Antoniadis**: Exact solution of Bi-Objective Multi-dimensional Knapsack Problems using the concept of core: Experience with large problems

## Forthcoming Meetings

(This section is prepared by Carlos Henggeler Antunes)

### Forthcoming EWG Meettings/ Prochaines réunions du Groupe

**Note:**

- It should be remarked again that this is a bilingual group; all the papers should be presented in both official languages of the group (i.e. French with English slides, and *vice-versa*).
- Ceci en un groupe bilingue ; tous les papiers doivent être présentés dans les deux langues officielles du groupe (i.e. en français avec les transparents en anglais et *vice-versa*).

**The 70th meeting of the European Working Group "Multiple Criteria Decision Aiding" will be held in Moncton, New Brunswick, Canada at The Delta Moncton Hotel. Date: Sepetember, 24-26, 2009. Organizers: Nabil Belacel (Nabil.Belacel@nrc-cnrc.gc.ca) and Georges Corriveau (Georges.Corriveau@nrc-cnrc.gc.ca). Web site: www.mcda70.org. Topic: "MCDA in Health, Environment, and Energy". Se also the following slides:** : http://www.mcda70.org/mcda70.pdf

**The 71h meeting of the European Working Group "Multiple Criteria Decision Aiding" will be held in Torino, Italy. Date: 25-27 March 2010.**

### Other Meetings

8th World Congress on Structural and Multidisciplinary Optimization, Lisbon, Portugal, June 1-5, 2009, http://www.wcsmo8.org/

13th IFAC Symposium on Information Control Problems in Manufacturing, Moscow, Russia, June 3-5, 2009, http://incom09.org/

Conference of the European Chapter on Combinatorial - ECCO XIV, Bonn, Germany, June 5-8, 2009, http://www.euro-2009.de

CORS/INFORMS International Toronto 2009, Westin Harbour Castle, Toronto, Ontario, Canada, June 14-17, 2009, http://meetings.informs.org/Toronto09

20th International Conference on Multiple Criteria Decision Making, Chengdu, China, June 21-26, 2009, http://www.mcdm2009.cn

23rd European Conference on Operational Research, Bonn, Germany, July 5-8, 2009, http://www.euro-2009.de

International Conference on Computers & Industrial Engineering (CIE39), Troyes, France, July 6-8, 2009, http://www.utt.fr/cie39/index.htm

7th International Conference on Information Science Technology and Management (CISTM 2009), New Delhi, India, July 13-15, 2009, http://www.cistm.org/

VIII Metaheuristic International Conference (MIC 2009), Hamburg, Germany, July 13-16, 2009, http://www.smartframe.de/mic09/Home.html

VIII Brazilian Workshop on Continuous Optimization, Rio de Janeiro, Brazil, July 13-17, 2009, http://www.impa.br/opencms/pt/eventos/store/evento_0902

EURO Summer Institute 2009, Lleida, Spain, July 25-August 8, 2009, http://www.esi2009.udl.cat

24th IFIP TC7 Conference on System Modelling and Optimization, Buenos Aires, Argentina, July 27-31, 2009, http://www.ifip2009.org/

Multidisciplinary International Scheduling Conference: Theory and Applications - MISTA 2009, Dublin, Ireland,

August 10-12, 2009, http://www.mistaconference.org/2009/index.html

MOPTA 2009: Modeling and Optimization: Theory and Applications, Bethlehem, PA, USA, August 19-21, 2009, http://coral.ie.lehigh.edu/~mopta/

20th International Symposium on Mathematical Programming, Chicago, Illinois, USA, August 23-29, 2009, http://ismp2009.eecs.northwestern.edu/

10th European Conference on Knowledge Management, Vicenza, Italy, September 3-4, 2009, http://academic-conferences.org/eckm/eckm2009/eckm09-home.htm

8th International Conference on Decision Support for Telecommunications and Information Society, Coimbra, Portugal, September 4-7, 2009, http://www.itl.waw.pl/konf/dstis/2009/

OR51, Warwick University, UK, September 8-10, 2009, http://www.theorsociety.com/

Hamburg International Conference of Logistics 2009 (HICL2009), Hamburg, Germany, September 10-11, 2009, http://www.hicl.org/

14th Belgian-French-German Conference on Optimization, Leuven, Belgium, September 14-18, 2009, http://www.kuleuven.be/bfg09/

70th Meeting of the EWG on MCDA, Moncton, New Brunswick, Canada, September 24-25, 2009, http://www.mcda70.org/. Organizers: Nabil Belacel (Nabil.Belacel@nrc-cnrc.gc.ca) and Georges Corriveau (Georges.Corriveau@nrc-cnrc.gc.ca). Topic: "MCDA in Health, Environment, and Energy".

14th International Congress on Computational and Applied Mathematics, Antalya, Turkey, September 29 – October 2, 2009, http://www.iccam2009.net

5th International Vilnius Conference and EURO-Mini Conference Knowledge-Based Technologies and OR Methodologies for Strategic Decisions of Sustainable Development (KORSD-2009), Vilnius, Lithuania, September 30 – October 3, 2009, http://www.mii.lt/KORSD-2009

International Joint Conference on Computational Intelligence (IJCCI), Madeira, Portugal, October 5-7, 2009, http://www.ijcci.org/

INFORMS Annual Meeting 2009, San Diego, California, USA, October 11-14, 2009, http://meetings.informs.org/sandiego09/

Algorithmic Decision Theory, Venice, Italy, October 21-23, 2009, http://www.adt2009.org

V Latin-American Algorithms, Graphs and Optimization Symposium (LAGOS'09), Gramado (Rio Grande do Sul), Brazil, November 3-7, 2009, http://www.inf.ufrgs.br/lagos09/

IV Encuentro de la Red Iberoamericana de Evaluación y Decisión Multicriterio, Zapopan, México, November 10-13, 2009, http://redmulticriterio09.cucea.udg.mx/

2009 IEEE International Conference on Industrial Engineering and Engineering Management, Hong Kong, China, December 8-11, 2009, http://www.ieem2009.org

3rd International Conference on Operations and Supply Chain Management, Malaysia, December 9-11, 2009, http://www.oscm-forum.org/oscm2009

INFORMS 2010 Practice Conference: Applying Science to the Art of Business, Orlando, Florida, USA, April 18-20, 2010, http://meetings.informs.org/

ALIO/INFORMS International 2010, Buenos Aires, Argentina, June 6-9, 2010, http://meetings.informs.org/

Seventh Triennial Symposium on Transportation Analysis - TRISTAN VII, Tromsø, Norway, June 20-25, 2010, http://www.tristan7.org

12th International Conference on Stochastic Programming Halifax, Nova Scotia, Canada, August 16-20, 2010, http://ispc12.dal.ca

MCPL 2010 – Management and Control of Production Logistics, Coimbra, Portugal, September 8-10, 2010, http://mcpl2010.uc.pt/

INFORMS Annual Meeting 2010, Austin, Texas, USA, November 7-10, 2010, http://meetings.informs.org

## Announcements

**The 10th MCDA Summer School, Ecole Centrale Paris, June 27th - July 9th, 2010.**

**http://www.gi.ecp.fr/mcda-ss**

**(seef flyer in the end)**

# Call for Papers

**Web site for Call for Papers:**
www.inescc.fe.uc.pt/~ewgmcda/CallforPapers.html

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## Next Meeting of the EWG on MCDA

Dear friend,

We are pleased to cordially invite you to the 70th meeting of the European Working Group "Multiple Criteria Decision Aiding" that will be held on September 24-25, 2009 in Moncton, New Brunswick, Canada at the Delta Hotel. This meeting is organized by Nabil Belacel and Georges Corriveau of the Canadian National Research Council (Institute for Information Technology).

The main theme of this meeting is "MCDA in Health, Energy and Environment". All contributions dealing with multiple criteria decision aiding, and in particular those relating to the theme of the meeting, are welcome. Communications can be made in both official languages of the Group: English and French.

Please find additional information on the website www.mcda70.org. The organizers can also be contacted at their e-mails: admin@mcda70.org

Nabil Belacel and Georges Corriveau

Chère amie, Cher ami,

Nous avons le plaisir de vous inviter aux 70ième journées du groupe de travail européen «Aide multicritère à la décision» qui se tiendront les 24 et 25 septembre 2009 à Moncton, Nouveau-Brunswick, Canada à l'hôtel Delta. Les journées sont conjointement organisées par Nabil Belacel et Georges Corriveau du Conseil National de Recherches Canada.

Le thème majeur de ces journées sera : L´Aide Multicritères à la décision pour la santé, l´énergie et l´environnent. Toutes contributions concernant l´aide multicritères à la décision et, plus particulièrement, celles concernant le thème de la réunion seront les bienvenues. Les communications pourront être présentées dans les deux langues officielles du groupe : le français et l´anglais.

Vous trouverez des renseignements complémentaires sur le site www.mcda70.org

Vous pouvez également contacter les organisateurs : admin@mcda70.org.

Nabil Belacel & Georges Corriveau

(Registrations Forms will be attached to this Issue)

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# Books

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**Multiobjective Programming and Goal Programming Theoretical Results and Practical Applications**

Series: Lecture Notes in Economics and Mathematical Systems , Vol. 618. Barichard, V.; Ehrgott, M.; Gandibleux, X.; T'Kindt, V. (Eds.), 2009, XV, 298 p. 98 illus., Softcover. ISBN: 978-3-540-85645-0.

This book gives the reader an insight into the state of the art in the field of multiobjective (linear, nonlinear and combinatorial) programming, goal programming and multiobjective metaheuristics. The 26 papers describe all relevant trends in this fields of research . They cover a wide range of topics ranging from theoretical investigations to algorithms, dealing with uncertainty, and applications to real world problems such as engineering design, water distribution systems and portfolio selection. The book is based on the papers of the seventh international conference on multiple objective programming and goal programming (MOPGP06).

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## Metaheuristics: from design to implementation

**Prof. El-Ghazali Talbi**
(University of Lille, CNRS, INRIA)

Wiley 2009 (624pp),
http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470278587.html
ISBN: 978-0-470-27858-

**A unified view of metaheuristics**

Abstract: This book provides a complete background on metaheuristics and shows readers how to design and implement powerful search algorithms to solve complex optimization problems across a diverse range of optimization problems in science and industry. It presents the main design questions for all families of metaheuristics (e.g. representations, neighborhoods, parameter tuning, constraint handling, performance evaluation).

The key search components of metaheuristics are considered as a toolbox for:

• Designing efficient single-solution based metaheuristics (e.g. local search, tabu search simulated annealing, GRASP, variable neighborhood search, iterative local search, guided local search).
• Designing efficient population based metaheuristics (e.g. evolutionary algorithms, scatter search, particle swarm, ant colonies, bee colonies, artificial immune systems, EDA, differential evolution).
• Designing efficient metaheuristics for multi-objective optimization.
• Designing hybrid, parallel and distributed metaheuristics.
• Implementing metaheuristics on sequential and parallel machines. It clearly illustrates how to implement algorithms to reuse both the design and code.

With more than 200 illustrative examples using various case studies and treating design and implementation independently, this book gives readers the skills necessary to solve large-scale problems quickly and efficiently.

It is a valuable reference for practicing engineers from diverse areas dealing with optimization; researchers and developers designing metaheuristics; and graduate or undergraduate students in business, management, computer science, operations research, engineering, and applied mathematics. More than 200 exercises are also provided.

(see the flyer of the book at the end)

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**Advances in Computer and Information Sciences and Engineering**

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|---|---|
| Publisher | Springer Netherlands |
| DOI | 10.1007/978-1-4020-8741-7 |
| Copyright | 2008 |
| ISBN | 978-1-4020-8740-0 (Print) 978-1-4020-8741-7 (Online) |
| Subject Group | Computer Science |
| Subject | Computer Science, Software Engineering/Programming and Operating Systems, Electronics and Microelectronics, Instrumentation and Computer Systems Organization and Communication Networks |

**Preface**
This book includes Volume I of the proceedings of the 2007 International Conference on Systems, Computing Sciences and Software Engineering (SCSS). SCSS is part of the International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering (CISSE 07). The proceedings are a set of rigorously reviewed world-class manuscripts presenting the state of international practice in Innovations and Advanced Techniques in Computer and Information Sciences and Engineering. SCSS 07 was a high-caliber research conference that was conducted online. CISSE 07 received 750 paper submissions and the final program included 406 accepted papers from more than 80 countries, representing the six continents. Each paper received at least two reviews, and authors were required to address review comments prior to presentation and publication. Conducting SCSS 07 online presented a number of unique advantages, as follows:
• All communications between the authors, reviewers, and conference organizing committee were done on line, which permitted a short six week period from the paper submission deadline to the beginning of the conference.
• PowerPoint presentations, final paper manuscripts were available to registrants for three weeks prior to the start of the conference.
• The conference platform allowed live presentations by several presenters from different locations, with the audio and PowerPoint transmitted to attendees throughout the internet, even on dial up connections. Attendees were able to ask both audio and written questions in a chat room format, and presenters could mark up their slides as they deem fit.
• The live audio presentations were also recorded and distributed to participants along with the power points presentations and paper manuscripts within the conference DVD.

The conference organizers and I are confident that you will find the papers included in this volume interesting and useful. We believe that technology will continue to infuse education thus enriching the educational experience of both students and teachers.

Tarek M. Sobh, Ph.D., PE
Bridgeport, Connecticut
June 2008

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**Evolutionary Multi-Criterion Optimization: 4th International Conference, EMO 2007 Matsushima, Japan, March 5-8, 2007 Proceedings**

**by**
Obayashi, Shigeru (Editor), Deb, Kalyanmoy (Editor), Poloni, Carlo (Editor)

This book constitutes the refereed proceedings of the 4th International Conference on Evolutionary Multi-CriterionOptimization, EMO 2007, held in Matsushima, Japan in March 2007.

The 65 revised full papers presented together with 4 invited papers were carefully reviewed and selected from 124 submissions. The papers are organized in topical sections on algorithm design, algorithm improvements, alternative methods, applications, engineering design, many objectives, objective handling, and performance assessments.

**Publisher:** Springer
**ISBN:** 3540709274
**EAN:** 9783540709275
**No. of Pages:** 954

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**Adaptive Scalarization Methods in Multiobjective Optimization**

**Eichfelder**, Gabriele

**Publisher:** Springer
2008, XIV, 242 p. 69 illus., Hardcover
ISBN: 978-3-540-79157-7
Series: Vector Optimization

This book presents new adaptive solution methods for multiobjective optimization problems based on parameter dependent scalarizations. With the help of sensitivity results an adaptive parameter control is developed so that high-quality approximations of the efficient set are generated. These examinations are based on a general scalarization approach for arbitrary partial orderings defined by a closed pointed convex cone in the objective space. The application of the results too many other well-known scalarization methods is also presented. Background material of multiobjective optimization and scalarization approaches is concisely summarized at the beginning. The effectiveness of these new methods is demonstrated by test problems and a recent problem in intensity-modulated radiotherapy. The book concludes with a further application: a procedure for solving multiobjective bilevel optimization problems.

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**Sequential Approximate Multiobjective Optimization Using Computational Intelligence**

**Nakayama**, Hirotaka, **Yun**, Yeboon, **Yoon**, Min

2009, XVI, 200 p. 111 illus., Hardcover
ISBN: 978-3-540-88909-0
Series: Vector Optimization

This book highlights a new direction of multiobjective optimzation, which has never been treated in previous publications. When the function form of objective functions is not known explicitly as encountered in many practical problems, sequential approximate optimization based on metamodels is an effective tool from a practical viewpoint. Several sophisticated methods for sequential approximate multiobjective optimization using computational intelligence are introduced along with real applications, mainly engineering problems, in this book.

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**Optimization and Multiobjective Control of Time-Discrete Systems: Dynamic Networks and Multilayered Structures**

**Lozovanu**, Dmitrii, **Pickl**, Stefan

**Publisher:** Springer
2009, XVI, 285 p. 53 illus., Hardcover
ISBN: 978-3-540-85024-3

The study of discrete structures and networks becomes more and more important in decision theory. A relevant topic in modern control theory reflecting this fact is concerned with multiobjective control problems and dynamical games. The monograph presents recent developments and applications in the field of multiobjective control of time-discrete systems with a finite set of states. The dynamics of such systems is described by a directed graph in which each vertex corresponds to a dynamic state and the edges correspond to transitions of the system moving from one state to another. This characterization allows us to formulate the considered control models on special dynamic networks. Suitable algorithms are derived exploiting multilayered structures. Game theoretical properties are characterized. A multilayered game on a network can be used to model a certain trading procedure of emission certificates within Kyoto process. Optimal economic behavior and equilibria can be determined.

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## Articles Harvest

(This section is prepared by Juscelino ALMEIDA DIAS)

Abdi M. R. (2009). Fuzzy multi-criteria decision model for evaluating reconfigurable machines. *International Journal of Production Economics* 117(1), 1-15.

Aghezzaf B. and M. Naimi (2009). The two-stage recombination operator and its application to the multiobjective 0/1 knapsack problem: A comparative study. *Computers & Operations Research* 36(12), 3247-3262.

Aissi H., C. Bazgan, and D. Vanderpooten (2009). Min–max and min–max regret versions of combinatorial optimization problems: A survey. *European Journal of Operational Research* 197(2), 427-438.

Alves M. J. and J. P. Costa (2009). An exact method for computing the nadir values in multiple objective linear programming. *European Journal of Operational Research* 198(2), 637-646.

André F. J. (2009). Indirect elicitation of non-linear multi-attribute utility functions. A dual procedure combined with DEA. *Omega* 37(4), 883-895.

Ang A. T. H., A. I. Sivakumar, and C. Qi (2009). Criteria selection and analysis for single machine dynamic on-line scheduling with multiple objectives and sequence-dependent setups. *Computers & Industrial Engineering* 56(4), 1223-1231.

Arana-Jiménez M., A. Rufián-Lizana, R. Osuna-Gómez, and G. Ruiz-Garzón (2008). A characterization of pseudoinvexity in multiobjective programming. *Mathematical and Computer Modelling* 48(11-12), 1719-1723.

Arbel A. and L. Vargas (2007). Interval judgments and Euclidean centers. *Mathematical and Computer Modelling* 46(7-8), 976-984.

Asan U. and A. Soyer (2009). Identifying strategic management concepts: An analytic network process approach. *Computers & Industrial Engineering* 56(2), 600-615.

Azaron A., C. Perkgoz, H. Katagiri, K. Kato, and M. Sakawa (2009). Multi-objective reliability optimization for dissimilar-unit cold-standby systems using a genetic algorithm. *Computers & Operations Research* 36(5), 1562-1571.

Basnet C. and A. Weintraub (2009). A genetic algorithm for a bicriteria supplier selection problem. *International Transactions in Operational Research* 16(2), 173-187.

Bazgan C., H. Hugot, and D. Vanderpooten (2009). Implementing an efficient fptas for the 0–1 multi-objective knapsack problem. *European Journal of Operational Research* 198(1), 47-56.

Belgasmi N., L. Ben Saïd, and K. Ghédira (2008). Evolutionary multiobjective optimization of the multi-location transshipment problem. *Operational Research - An International Journal (ORIJ)* 8(2), 167-183.

Berghammer R. , A. Rusinowska, and H. de Swart (2009). An interdisciplinary approach to coalition formation. *European Journal of Operational Research* 195(2), 487-496.

Bies W. and L. Zacharia (2007). Medical tourism: Outsourcing surgery. *Mathematical and Computer Modelling* 46(7-8), 1144-1159.

Blecic I., A. Cecchini, and C. Pusceddu (2008). Constructing strategies in strategic planning: a decision support evaluation model. *Operational Research - An International Journal (ORIJ)* 8(2), 153-166.

Bojovic N. and M. Milenkovic (2008). The best rail fleet mix problem. *Operational Research - An International Journal (ORIJ)* 8(1), 77-87.

Bouyssou D. and M. Pirlot (2009). An axiomatic analysis of concordance–discordance relations. *European Journal of Operational Research* 199(2), 468-477.

Boyer V., M. Elkihel, and D. El Baz (2009). Heuristics for the 0–1 multidimensional knapsack problem. *European Journal of Operational Research* 199(3), 658-664.

Branke J., B. Scheckenbach, M. Stein, K. Deb, and H. Schmeck (2009). Portfolio optimization with an envelope-based multi-objective evolutionary algorithm. *European Journal of Operational Research* 199(3), 684-693.

Brauers W. K. M. (2008). Multi-objective decision making by reference point theory for a wellbeing economy. *Operational Research - An International Journal (ORIJ)* 8(1), 89-104.

Campello R. J. G. B., E. R. Hruschka, and V. S. Alves (2009). On the efficiency of evolutionary fuzzy clustering. *Journal of Heuristics* 15(1), 43-75.

Cardoen B., E. Demeulemeester, and J. Beliën (2009). Optimizing a multiple objective surgical case sequencing problem. *International Journal of Production Economics* 119(2), 354-366.

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## Seminars

SÉMINAIRE «MODÉLISATION DES PRÉFÉRENCES
*ET AIDE MULTICRITÈRE À LA DÉCISION*»

**Responsables : Bernard ROY,**

**Daniel VANDERPOOTEN**

(le mardi, à 14.00, en salle P 510)

Prochaines réunions

31 mars 2009 Discussion des travaux de **Wassila Ouerdane** (LAMSADE) :

*Une hiérarchie de schémas d’arguments pour un modèle d’évaluation multicritère*. (salle B104 bis)

EXCEPTIONNELLEMENT MERCREDI 13 MAI 2009 À 15:00

Conférence de **Javier Pereira** (Ecole de Génie Informatique, Université Diego Portales, Santiago du Chili) :

*Identification d’ensembles de composants logiciels « intéressants » à partir d’information imparfaite*. (salle à préciser)

26 mai 2009 Conférence de **Stanislav Shmelev** (Environmental Change Institute, University of Oxford, Grande-Bretagne) :

*Measuring progress: New MCDA approaches for the dynamic assessment of sustainability at the macro scale*. (salle à préciser)

16 juin 2009 Conférence de **Margaret M. Wiecek** (Department of Mathematical Scienes, Clemson Unviersity, USA) :

*Efficients sets of multiobjective complex systems* (résumé joint). (salle à préciser).

## Dissertations

**ANDRE**, Stéphane. Titre : « Evaluation de la performance non financière des entreprises : Apport des méthodes multicritère d’aide à la decision ». Thèse de Doctorat : Université Paris-Dauphine. Jury : Directeur (Bernard ROY), Rapporteurs (Alberto COLORNI, José Rui FIGUEIRA, Pascal OBERTI), Suffrageants (Vincent MOUSSEAU, Alexis TSOUKIAS, Florence RODET). Le 3 juin 2009.

RESUME **:** Avec l’intégration du développement durable dans la stratégie des entreprises, l’évaluation de la performance connait une profonde évolution. L'objet de cette thèse est de valider l'intérêt des méthodes d'aide multicritère à la décision (AMCD) pour l'évaluation des performances non financières. Dans ce contexte, nous avons conçu la démarche EPISSURE qui permet une évaluation de performances non financières grâce à des indicateurs de synthèse hiérarchiques élaborés selon un processus de concertation cadrée. Les indicateurs de synthèse sont organisés selon quatre niveaux hiérarchiques imbriqués et sont calculés grâce à des outils AMCD. Comme tout processus de concertation, celui que nous avons choisi a pour objectif d’aboutir à l’élaboration d’une vision commune aux différents acteurs parties prenantes de l'évaluation. Notre parti pris est de considérer que le contour de cette vision commune doit être défini par l'entreprise. Pour valider cette démarche, nous l’avons expérimentée en entreprises, entre mai 2005 et juin 2008, sur huit terrains traitant de l’évaluation de la performance environnementale de sites de raffinage et de l’évaluation de la performance d’actions de mécénat. Sur ces huit terrains, l’utilisation de la démarche EPISSURE continue sur la moitié d’entre eux. Bien qu’un certain nombre de limites ait pu être mis en évidence, les retours terrain nous amènent à penser que l’intérêt de la démarche EPISSURE pour l’évaluation de la performance non financière en entreprise semble validé. MOTS CLE : Evaluation, Performance non financière, Electre TRI, Concertation, Indicateur de synthèse.

**AUBRY**, Alexis. "Optimisation pour la configuration robuste de systèmes de production de biens ou de services". Thèse de doctorat : Institut Polytechnique de Grenoble. Jury : Directrices (Pr. Mireille Jacomino, Dr. Marie-Laure Espinouse), Rapporteurs (Dr. Philippe Baptiste, Pr. Alexandre Dolgui, Pr. Damien Trentesaux), Suffrageants (Dr. Mohamed Ali Aloulou, Pr. Yannick Frein). Le 16 octobre 2007.

RESUME : Les travaux de cette thèse de doctorat apportent une contribution à la configuration des systèmes de production en contexte incertain. Les différents outils permettant d'appréhender l'incertain en optimisation sont d'abord présentés. Nous insistons plus particulièrement sur la notion de robustesse à travers l'approche utilisée dans le cadre de nos travaux. Nous présentons ensuite deux applications : la configuration d'un atelier de machines parallèles partiellement multifonctions soumis à des incertitudes sur la demande et la configuration d'un réseau de distribution d'électricité soumis à des incertitudes sur les caractéristiques de puissance. Pour chaque application, nous identifions les incertitudes prises en compte ainsi que les performances attendues. Nous proposons ensuite un critère de robustesse en adéquation avec cette problématique. Enfin des méthodes de résolution sont proposées pour appréhender les différents problèmes mis en évidence par ce critère.

ABSTRACT: The configuration of production systems under uncertainties is considered in this thesis. First, the main tools used to handle uncertainty in optimisation are presented. The robustness notion is emphasized through our approach. Then, two applications are presented: the

robust configuration of a parallel multi-purpose machines workshop under demand uncertainties and the robust configuration of a power distribution network under uncertainties on customers load and power sources capacities. For each application, the disturbances that are taken into account are identified as well as the performances to maintain despite these perturbations. Then a robustness criterion is defined to fit these applications. Finally resolution methods are designed to address the different robustness problems raised by this criterion.

**FIGUEIRA**, José Rui. Titre : « Critères Multiples en Recherche Opérationnelle et Aide à la Décision». HDR : Université Paris-Dauphine. Jury : Coordinateur (Bernard ROY), Rapporteurs (Margarida VAZ PATO, Raymond BISDORFF, Daniel VANDERPOOTEN), Examminateurs (Denis BOUYSSOU, Roman SLOWINSKI). Le 26 février 2009.

RESUME **:** Ce mémoire d’HDR est structuré autour de deux parties. Une première partie fondamentale est entièrement consacrée à la présentation de la recherche développée dans les six thèmes de recherche suivants : (1) conception de nouvelles méthodes pour les problèmes d'optimisation combinatoire, en nombre entiers et mixtes multi-objectifs ; (2) conception de nouvelles méthodes et procédures dans le cadre des méthodes de surclassement, notamment pour les méthodes du type ELECTRE ; (3) conception de nouvelles méthodologies et introduction de nouveaux concepts pour les méthodes issues de la théorie de l'utilité ou de la valeur multi-attribut, notamment des méthodes du type UTA (UTilités Additives) ; (4) conception d'une approche intégrée qui permet de résoudre des problèmes multi-objectifs à l'aide des méthodes du type UTA ; (5) construction d'indices pour les problèmes de partition d'un territoire en zones « homogènes » ; (6) développement de travaux théoriques en théorie du choix social lorsque les préférences des individus sont modélisées à l'aide d'une relation binaire floue sur l'ensemble des candidats. Même si la nature de nos travaux de recherche est fort diverse, nous nous sommes efforcés principalement de développer des concepts ou, plus généralement, des outils pour des problèmes à critères multiples. Le titre de ce mémoire « La prise en compte de Critères Multiples en Recherche Opérationnelle et Aide à la Décision (RO-AD) » donne une indication précise sur la façon dont nous avons travaillé dans plusieurs méthodologies multicritère en RO-AD. Notre projet de recherche a toujours eu un élément ou une ligne commune pour attaquer les problèmes d'aide à la décision, c'est-à-dire, une vision de la nature multidimensionnelle des problèmes de RO-AD. Ensuite, dans une deuxième partie nous ferons une présentation de nos activités d'animation de recherche, enseignment et d'autres activités scientifiques collectives. Ce mémoire est encore composé par deux annexes : la première annexe contient la liste de nos travaux personnels : et, la deuxième annexe est consacrée à la présentation de notre *Curriculum Vitae*.

**Announcement:**

The "Useful links" section of the group's homepage

(http://www.inescc.pt/~ewgmcda)

is being enlarged. Contributions of URL links to societies, research groups and other links of interest are welcome.

A membership directory of the European Working Group on "Multiple Criteria Decision Aiding" is available at the same site. If you would like to be listed in this directory please send us your data (see examples already in the directory).

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## Web site for the EURO Working Group "Multicriteria Aid for Decisions"

A World Wide Web site for the EURO Working Group on "Multicriteria Aid for Decisions" is already available at the URL:

http://www.inescc.pt/~ewgmcda

This WWW site is aimed not just at making available the most relevant information contained in the Newsletter sections, but it also intends to become an online discussion forum, where other information and opinion articles could appear in order to create a more lively atmosphere within the group.

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**European Working Group "Multiple Criteria Decision Aiding"**

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