Bernard Roy
From Graph Theory to Multiple Criteria

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Biographic sketch

Bernard Roy was born in 1934. After a first career as a consultant, during which he made major breakthroughs in graph theory and project scheduling, he started a second career as an academic interested in multiple criteria decision making. Among his many achievements, he is the father of the "activity on node" project scheduling technique and of the famous ELECTRE methods. Through his research, teaching, consulting, and service to the community, he is one of the major promoters of OR techniques in France.

Childhood

Bernard was born on March 15, 1934 in Moulins-sur-Allier, a medium-sized town in the center of France. He is the only child of René Roy (born 1906) and Jeanne Chérasse (born 1913). Both his parents studied till the *Brevet* and did not pursue any superior education. One of Bernard's grandfathers was a railway station manager. Bernard was the first member of his family to pursue an advanced education. René started his career as a bank employee serving customers over the counter. In 1934 he became an insurance agent at the *Compagnie du Nord*. He was responsible for a portfolio of clients. Jeanne was helping René. René took part in World War II and, after the defeat of France, he was sent to Germany as a war prisoner. He escaped in 1943. During his detention, he met the father of the future wife of Bernard, Françoise.

During World War II, Moulins-sur-Allier was in the occupied part of France but located quite close to the demarcation line. The communication between the two parts of France was then highly problematic. Both Bernard's mother and aunt used to cross the demarcation line to transmit mail between the two zones. His aunt was arrested by the German forces and hopefully soon liberated following a bureaucratic error. These times of war were bleak. Fortunately Jeanne had relatives living in the countryside, so that the family had access to food products that were cruelly missing and Bernard could enjoy peaceful holidays.

Bernard started school, at the age of six, in 1940 at the nearby school. Soon after, he began experiencing vision problems. During these times of war, it was not easy to have access to an ophthalmologist. The first one consulted advised that these problems were somatic. Since things were not getting any better, several other specialists were consulted and the diagnosis was then that Bernard suffered from a compression of the optical nerves. It was only several years later that a solid diagnosis was established. Bernard was suffering from an uncommon retina problem. As a result Bernard gradually lost sight, while keeping a limited peripheral vision. Reading became more and more difficult. Writing became also problematic since after some time nobody could decipher his letters. However, till the end of elementary school (five years in France) Bernard kept writing. Jeanne helped him by reading his notes and books. Bernard started secondary school in 1945 (consisting of four years of *collège* and three years of *lycée*). He soon abandoned writing, taking notes on a mechanical typewriter during classes.

He managed to take exams using the typewriter till the two *baccalauréats* that meant, at that time, the end of secondary school. With time, Bernard had his typewriter customized with some Greek letters added on the keyboard. Bernard's interest in Mathematics was not immediate but grew during this period. Bernard started studying English while his vision was deteriorating. As a result, his mastering of the language was uncertain and during the first part of his career, he mostly published in French. He has always remained attached to publishing results in French.
Bernard ended up passing his second *baccalauréat* (in the *mathématiques élémentaires* section) in 1952 with the highest possible mention. At that time, if Bernard could still see sufficiently to walk by himself thanks to his declining peripheral vision (he rode his bicycle till the age of 22 with severe falls from time to time), it was obvious that his handicap would prevent him from occupying certain professions.

Insert picture 1 about here

Higher studies

Bernard wanted to be an engineer (he spent time building a radio while he was in secondary school). The traditional way to become an engineer in France is not through universities but through the distinct system of *Grandes Écoles*. They select students on the basis of a competitive exam that can only be taken after two years of *Classes Préparatoires*. Bernard went to Paris for his first year of *Classes Préparatoires* at the Lycée Chaptal. His results were so high that he was admitted for the second year to one of France's most prestigious *Classe Préparatoire* at the Lycée Louis-Le-Grand that is usually seen as the first step to the *École Polytechnique* or the *École Normale Supérieure*. Bernard was still using his relatively silent typewriter in class to take notes. His Physics teacher at the Lycée Louis-Le-Grand thought that this noise was intolerable and forbid him to use his typewriter. Bernard, not being able to take notes and rather shaken by this decision, left the Lycée Louis-Le-Grand and the *Classes Préparatoires* system in October 1953. This was the end of his dream to enter the *École Normale Supérieure*. He immediately decided to join the *Université de Paris* to get a degree in Mathematics. In these times the *Licence de Mathématiques* meant obtaining three certificates, which usually took three years. On the first year, Bernard completed two of these certificates (Calculus and Probability). He had there some great mathematicians as teachers that would become famous later: Laurent Schwartz (father of the theory of distributions and member of the Bourbaki group), Jacques-Louis Lions, Gustave Choquet, Robert Fortet. Bernard took his revenge over the *École Normale Supérieure* since he completed his Calculus certificate with the highest possible mention ending up tied with a student from that school.
During the academic year 1953, Bernard met Patrice Bertier. Patrice suffered poliomyelitis during his youth and was using a wheel chair. He became a great friend of Bernard. They spent this year studying together and helping each other. Patrice completed his *Licence* in June 1954 having passed the three certificates. His project was to follow the courses of the *Institut d'Études Politiques* (IEP) in the next academic year. IEP was a relatively special *Grande École* mainly oriented towards Economics and Political Science; it was the usual first step to the highest positions in the French civil service. Needless to say that in these times, the teaching of Economics and Political Science had little to do with Mathematical Economics and that, for someone holding a degree in Mathematics, joining IEP was extremely uncommon. Patrice was attracted to Economics. He persuaded Bernard to join him in this adventure. The only problem was that Bernard had not completed his *Licence* yet since he still had to obtain his third certificate. Bernard then decided to study for his missing certificate

during summer. He finally obtained this certificate (Rational Mechanics) in September 1954, completing his three years of *Licence* in only one year.

Both Bernard and Patrice joined IEP in October 1954. Because this was really uncommon, they also joined the *Institut de Statistique de l'Université de Paris* (ISUP), an interfaculty department granting diplomas in Statistics and Probability. IEP was located rue Saint-Guillaume, West of Latin Quarter. ISUP was located rue Pierre-et-Marie-Curie near the Jardin du Luxembourg, South of Latin Quarter. During the years 1954 and 1955, people walking on the Boulevard Saint-Michel could therefore often attend a strange event: Bernard, half blind, pushing the wheel chair of Patrice on the pavement going from ISUP to IEP back and forth. At ISUP, Bernard had several teachers to be remembered: Georges Darmois, Georges Morlat, Dickran Indjoudjian, Germain Kreweras, René Roy. ISUP was then one of the rare places in France in which Applied Probability and Statistics were taught to highly trained math students. Bernard discovered Mathematical Statistics and Econometrics. Applied Statistics was not forgotten either, although all computations had to be done on electric non-programmable calculators. At IEP he attended the courses of Alfred Sauvy, Jean Fourastié, Paul Delouvrier, André Siegfried. This unique combination of Mathematics and Economics aroused the interest of Bernard for the application of Mathematics to the real world.

This was a really exciting time since during the years 1954-1955, several people, mostly Georges-Théodule Guilbaud, Germain Kreweras, Jean Abadie, Jean Ville, Pierre Bouzitat, Marc Barbut, Michel Rosensthiel, Jean Mothes and Claude Berge began giving lectures and seminars on Operations Research. In these times, OR was not part of any curricula in France. These courses and seminars were delivered unofficially. Bernard especially remembers the lectures of Guilbaud that were followed by a huge crowd in the *Amphithéâtre Hermite* of the prestigious *Institut Henri Poincaré*. Bernard had found his way: he wanted to apply Mathematics in the real world. He wanted to do OR. The emerging French OR community was beginning to organize itself and in 1956 the Société Française de Recherche Opérationnelle (SOFRO) was created (in 1964 it became the AFIRO after a merger with a society regrouping computer scientists, then AFCET in 1968 after a merger with a society regrouping cyberneticians; in 1998, AFCET split and the French OR society became ROADEF). These were years of intense activity for Bernard. Besides the courses at IEP and ISUP, he also obtained additional certificates in Mathematics (Mathematical Methods of Physics and Algebra and Number theory). In 1957 he completed his degree at ISUP with what is probably his first research work in OR: a master's thesis on the newsboy problem (that, at this time, he presented as the baker's problem). He decided to start a Ph.D. on the same subject. He would soon abandon the subject in favor of Graph Theory.

In July 1956, Robert Fortet managed to obtain a position for Bernard and Patrice at the *Centre National de la Recherche Scientifique* (CNRS). The position was little paid but offered an immense freedom. As CNRS did not have any office, Bernard and Patrice were also recruited as interns at *Électricité de France* (EDF, the newly nationalized electricity company) under the supervision of Marcel Boiteux who was at that time in charge of the *Service des Études Économique Générales* (he will later become CEO of EDF). Bernard completed his Master's thesis for ISUP during this period. He also wrote his first research paper and benefited from the advice of Marcel Boiteux on how to write a paper. At that time EDF had no computing facilities and no computer. Small LP models were used to plan production between thermal and hydraulic plants. These LP, although small-sized, were still too large to be efficiently solved by hand. They were sent by ordinary mail to George Dantzig who had access to a computer and sent back the results also by mail. At that time, processing time did not reduce to computation time.

Insert picture 2 about here

Consultant at SEMA

Bernard married Françoise in July 1957. They will have six children: Sylvie (1958†), Laurence (1961), Isabelle (1964), Solange (1966), Patrice (1968) and Philippe (1970†). The meager salary from the CNRS was too little for the young couple. Bernard left CNRS and was recruited by a newly created consulting company SEPRO specialized in OR. Meanwhile, the *Société de Mathématiques Appliquées* (SMA) was created as a joint venture between *Paribas* and an independent consulting company held by Marcel Loichot. The aim of SMA was to be a consulting company that would promote the use of Management Science in French companies. Jacques Lesourne was appointed as CEO. Bernard left SEPRO to join SMA in October 1957, together with Patrice Bertier. SMA quickly became SEMA (*Société d'Économie et de Mathématiques Appliquées*) and, after having created several subsidiaries in Europe, SEMA (Metra International).

SEMA started with few people (around 10) and almost no contracts. Bernard was hired as a consultant. His first task with Patrice was to translate into French the new book of C. W. Churchman, R. L. Ackoff and E. L. Arnoff "Introduction to Operations Research". They also put the final touch to the book by J. Lesourne, *"Techniques économiques et gestion industrielle"*, that is probably one of the first OR book ever published in French.

Contracts began to arrive in 1958 and Bernard started to work on applied OR problems. While working on several scheduling problems, he developed and refined the "activity on node formulation" in project scheduling (see "Early works in Graph Theory"). Bernard also worked on a variety of other problems that led him to get interested in probability and queuing theory (reducing the waiting time at a ferry), data analysis (choosing the name of a new brand of cigarettes), transportation studies (developing a forecasting model for transportation planning), cutting stock (designing cardboard boxes), location (choosing sites for plants), finance (optimizing cash management).

Insert excerpt "Early works in Graph Theory" about here

SEMA was steadily growing at that time. It acquired in 1962 a Control Data computer (CDC 6600) that allowed tackling larger problems and led to the development of several LP and ILP codes. Before that, all computations were performed by a *bureau de calcul* employing many persons working on electric calculators.

In between contracts, Bernard started working on his Ph.D. dissertation devoted to Graph Theory and its application to project scheduling (together with a minor dissertation on Abstract Algebra). He received his Ph.D. in 1961 from the *Université de Paris*, under the supervision of Claude Berge (who published in 1958 one of the first books on Graph Theory, *Théorie des Graphes et ses Applications*). That same year, Bernard was offered a position at the *Université de Paris* in Mathematics. At that time, OR was not part of the math curriculum and the teaching of math was highly slanted toward pure math (this period was highly influenced by the Bourbaki group). Accepting the position would mean returning to pure math. He declined it.

In 1962, Jacques Lesourne decided to create within SEMA a scientific team called "*Direction Scientifique"* with the aim of helping consultants applying new techniques. Bernard joined this team and therefore began to act as a "consultant of consultants". He took the direction of the team in 1964. For years, this multidisciplinary group was the site of intense activities and gathered many people among which Raphaël Benayoun, Patrice Bertier, Éric Jacquet-Lagrèze, Hubert Le Boulanger, Benjamin Matalon, Jean de Montgolfier, Hervé Raynaud, and Gilbert Sussmann. At the same time, SEMA launched a quarterly journal called METRA in

order to popularize the new techniques it promoted (they included OR techniques but also covered every aspects of Management Science). Bernard was appointed editor-in-chief and remained so till the end of the journal in 1977. METRA was publishing papers from consultants of SEMA and its European subsidiaries in four languages (French, Spanish, Italian, and English). It is remarkable that the editorial policy of METRA was to promote the techniques developed at SEMA and that the need to protect commercial secrets did not come into play. Although edited by a commercial company, METRA had a standard academic way to process papers and had a scientific editorial board that included academics (most notably Stafford Beer and Paul Gillis). In those times, few French libraries had subscriptions to Management Science, JORS or Operations Research. Therefore METRA has played, together with RIRO (the newly created journal of AFIRO that will later become RAIRO) an important part in the diffusion of OR techniques in France.
Consulting therefore played a vital part in the shaping of Bernard's view of OR techniques. Most often, the lack of appropriate software, the paucity or poor quality of data, the softness of some constraints, the presence of multiple conflicting objectives made the quest for an "optimal" solution illusory. A good solution that could not be proved optimal was often a major breakthrough in practice. This greatly influenced the thinking of Bernard in his future research (see "An original perspective on OR").

Insert excerpt "An original perspective on OR" about here

The work of Bernard on multiple criteria started in the mid-sixties on the basis of real-world problems submitted by SEMA consultants. This led to the development of the first ELECTRE method (ELECTRE I). A media planning problem led to the development of ELECTRE II (see "ELECTRE methods"). At that time Bernard was unaware of the parallel developments in the USA made by Howard Raiffa, Raph Keeney, and many others. Bernard accepted the invitation of George Dantzig to organize, at the 7th Mathematical Programming Symposium in The Hague, in 1970, two sessions on Multiple Criteria Decision Making (MCDM). These were among the first of this kind to be organized.
In between, Bernard was working, early in the morning, on his book on Graph Theory. The two volumes appeared in 1969 and 1970.
During these consulting years, Bernard became involved into teaching. He taught OR courses at the *Centre Inter-armées de Recherche Opérationnelle* (a permanent education course program in OR for French officers) and headed together with Claude Berge a seminar on Graph Theory and Combinatorial problems. The policy of SEMA at that time was indeed to encourage its consultants to teach.

Insert excerpt "ELECTRE methods" about here

Professor

In the late sixties, following the May 1968 events in France, Bernard started wondering about his future career. Jacques Lesourne soon announced that he would leave SEMA. In between, Bernard was solicited to give a doctoral course on OR at the newly created *Université Paris Dauphine* (this experimental university was created after May 1968 and occupied the former NATO headquarters in Paris). In 1971, he was appointed as an Associate Professor in Mathematics (he will join afterwards the Computer Science department). One year after that he was appointed as a Full Professor. One of his first main academic duties was to reshape the

Management Science curriculum within the Management program. He kept his position at SEMA till 1974, progressively reducing his involvement while SEMA progressively reduced its OR activities (selling more and more computerized management solutions to firms).
In 1974 Bernard creates a research group called LAMSADE that became affiliated to the CNRS in 1976. This was one of the few research groups in France oriented towards OR. Compared to other research groups in France, LAMSADE has the distinctive feature of having always been oriented towards applied OR. Over the years, LAMSADE kept growing. Besides OR, it now includes other active research topics in Computer Science.
Bernard kept contacts with SEMA till 1979. In 1980, he became Scientific Advisor of RATP (the company operating all public transports in the Paris region) following the retirement of Robert Faure, another pioneer in the development and teaching of OR in France.
Bernard developed the OR curriculum at Dauphine with the creation of a doctoral program called *Méthodes Scientifiques de Gestion*. He began supervising doctoral students (both authors of this text are former doctoral students of Bernard). His research at LAMSADE was more and more oriented towards MCDM. Building on this research, he developed an original methodology for decision aiding. More recently he worked on robustness analysis.
Bernard devoted much energy to the development of LAMSADE that he directed till 1999. He also took several important responsibilities within *Université Paris Dauphine*, including the direction of a doctoral school.
Bernard retired in 2001, now being emeritus Professor. A Festschrift honoring him was published at the occasion of his retirement[1]. Today, he is still quite active in his scientific and consulting activities.

Publications

Bernard has published three main books:

- Bernard Roy, Denis Bouyssou, *Aide multicritère à la décision : Méthodes et cas*, Paris, Economica, 1993.
- Bernard Roy, *Méthodologie multicritère d'aide à la décision*, Paris, Economica, 1985 (English translation : *Multicriteria Methodology for Decision Analysis*, Kluwer Academic Publishers, 1996. Polish and Spanish translations are also available)
- Bernard Roy, *Algèbre moderne et théorie des graphes orientées vers les sciences économiques et sociales* : Volume 1: *Notions et résultats fondamentaux*, Paris, Dunod, 1969.Volume 2: *Applications et problèmes spécifiques*, Paris, Dunod, 1970.

He is the author of more than eighty papers in refereed journals and nearly fifty papers in contributed volumes. He has co-edited four books, among which *Combinatorial Programming: Methods and Applications*, Reidel, 1975. He has supervised a large number of doctoral students (more than fifty).
A selected list of Bernard's publications is available from:
http://www.lamsade.dauphine.fr/~roy/roy_publications.htm.

Awards and Honors

Bernard holds six honorary doctoral degrees (Vrije Universiteit Brussels, Belgium, 1978, Université de Liège, Belgium, 1978, Université de Fribourg, Switzerland, 1982, Poznan University of Technology, Poland, 1992, Université Laval, Canada, 1998, Technical University of Crete, Greece, 2002). He received in 1992 the EURO gold medal, the highest

[1] "Aiding decisions with multiple criteria, Essays in honor of Bernard Roy", D. Bouyssou, É. Jacquet-Lagrèze, P. Perny, R. Slowinski, D. Vanderpooten, Ph. Vincke eds, Kluwer, 2002.

distinction granted by EURO. He holds the gold medal from the MCDM International Society as well as the “Hermès de la recherche” from the Université Laval, Québec, Canada.

Offices held

Bernard has served as Vice President (1974-76) and President (1976-78) of AFCET (the French OR society at that time). He has been President of EURO (1985-86) after having served in the executive committee for several years. He founded in 1975, and is responsible of one of the most active and long-lasting working groups in OR (see “The EURO working group MCDA”). He is involved in the editorial committee of many OR journals.

Insert excerpt “The EURO working group MCDA” about here

About the authors.
Denis Bouyssou, after having been Professor of Operations Research at ESSEC (a French business school) is now senior researcher at the *Centre National de la Recherche Scientifique*. Daniel Vanderpooten is full Professor of Computer Science and Operations Research at the *Université Paris Dauphine*. Both have obtained their Ph.D. under the supervision of Bernard Roy with whom they co-authored several papers.

Insert picture 4 about here

Early works in Graph Theory

One of the most famous contributions of Bernard is in the field of project scheduling. In 1958, when working at SEMA, he was faced with the problem of scheduling the construction of new buildings for the headquarters of a large company in Paris. Managing this project, involving several hundreds of tasks and more than one thousand of constraints, required a specific methodology. At this occasion, Bernard developed a method called MPM (*Méthode des Potentiels Metra*). MPM was based on what is now known as the “activity on node” (AON) formulation. While its theoretical foundations were established (in terms of existence and optimality of schedules), this method was applied successfully to several other scheduling problems (production of crankshafts at MAVILOR, design of an appropriate cycle for a new house-building process at TRACOBA,…). These applications required to handle, besides potential constraints, more difficult constraints such as disjunctive or cumulative constraints (this typology of constraints was developed by Bernard). The existence of a large number of difficult constraints, in the context of the scheduling of the equipment of the *France* liner – the largest liner in the world in 1960 – eventually led to the development of another technique (called *description segmentée*) designed to quickly spot incompatible constraints in a system of linear inequalities.

Simultaneously and independently, methods like PERT or CPM, based on an “activity on arc” (AOA) formulation were developed in the United States. It is now widely acknowledged that the AON formulation is superior to the AOA formulation, since it is more systematic, without requiring modelling tricks such as dummy arcs, and handles more easily changes or additions of constraints.

Bernard also obtained results on more theoretical aspects of Graph Theory (related, e.g., to optimal paths, connectivity, transitivity, and chromaticity). As outlined by Pierre Hansen and Dominique de Werra[2], some of these pioneering results, obtained about fifty years ago, are still at the origin of currently published results.

Also well-known is the so-called Roy-Warshall’s algorithm that computes the transitive closure of a digraph. This algorithm was discovered independently by Bernard in 1959 and Stephen Warshall in 1962. In the subfield of network flows, the algorithm to determine a minimum cost flow by successive shortest paths, which is known as Busacker and Gowen’s algorithm in the United States, is known in Europe as Roy’s algorithm.

In cooperation with Patrice Bertier, Bernard was also among the pioneers who developed and formalized “branch and bound” procedures, in the middle of the sixties.

Bernard is the author of a remarkable textbook devoted to Graph Theory: *Algèbre moderne et théorie des graphes orientées vers les sciences économiques et sociales*. This book, published in two volumes in 1969 and 1970, is about 1300 pages long. Even if it is now outdated on some points, it includes an original treatment on many topics that should interest anyone in this field.

[2] P. Hansen, D. de Werra “Connectivity, transitivity and chromaticity: the pioneering work of Bernard Roy in Graph Theory”» in Aiding decisions with multiple criteria, Essays in honor of Bernard Roy, D. Bouyssou, E. Jacquet-Lagrèze, P. Perny, R. Slowinski, D. Vanderpooten, Ph. Vincke eds, Kluwer, 2002, pp. 23-42.

ELECTRE methods

ELECTRE methods were first developed in the mid-sixties to answer a real-world problem brought to Bernard by SEMA consultants. SEMA had developed a technique, called MARSAN, designed to help firms selecting new activities. In order to do so, activities were evaluated on a series of 48 dimensions (the word "criterion" was not used then). They included "quantitative" as well as "qualitative" dimensions. Qualitative dimensions were translated on a numeric scale more or less arbitrarily. A weighted sum of all these numbers was computed to measure the attractiveness of these new activities.

It soon appeared that the use of a weighted sum allowed compensation effects that were not desirable: small advantages on several dimensions could compensate for major weaknesses on some others, which was not felt desirable. Moreover, the numerical recoding of qualitative dimensions was playing an important part in the final result.

Bernard came up with a method that would at the same time deal with qualitative dimensions without the need for recoding them and that would not tolerate compensation effects that were felt undesirable. This was the birth of ELECTRE I. Basically, in ELECTRE I, alternatives are compared by pair using the following reasoning. Alternative *a* will be declared at least as good as alternative *b* if:

- the proposition is supported by a "sufficient majority" of dimensions (concordance condition),
- among the dimensions opposing the proposition, there is none on which the opposition is "too strong" (non-discordance condition).

Such an "at least as good as" relation (quickly called an *outranking* relation) can be built on the basis of purely ordinal considerations. The non-discordance condition prevents undesirable compensation effects from occurring. The application of the concordance condition leads to assigning weights to each dimension. In order to decide if a majority is sufficiently important, the sum of the weights is compared to a threshold called the *concordance threshold* (note that these weights are quite different from the weights used in a weighted sum; they are never multiplied with scores and are therefore independent from the scale used to measure scores). Similarly the strength of the opposition of dimensions is computed using a veto threshold.

A specific feature of this relation is that it does not have to be transitive (even in its asymmetric part, because of Condorcet-like effects) or complete (some alternatives may remain incomparable). Therefore, deriving a prescription on this basis is not an easy task and calls for the application of specific techniques, called exploitation techniques. They differ on the type of recommendation that is looked for. ELECTRE I has been designed in a choice problem formulation, i.e., aims at recommending a subset of alternatives (as small as possible) that is likely to contain the best alternatives. Technically, Bernard suggested using the kernel of the outranking graph, after reduction of eventual circuits.

ELECTRE II is a variant of ELECTRE I that is designed to rank order alternatives. It uses two outranking relations instead of one. The ranking is not necessarily complete: it preserves incomparability between alternatives that appear difficult to compare. ELECTRE III is a far-reaching generalization of ELECTRE II that uses a fuzzy outranking relation instead of two crisp ones. Furthermore, it refines the preference modeling on each dimension with the introduction of thresholds preventing small differences between scores from being interpreted as a definite advantage. Such thresholds were introduced in a new version of ELECTRE I, called ELECTRE IS. ELECTRE IV is a variant of ELECTRE III designed to deal with situations in which weights are difficult to elicit given the diversity of opinions. ELECTE TRI is the most recent method. It is designed to deal with a sorting problem formulation in which each alternative is assigned to a category pre-defined by norms which, e.g., separate “good” and “bad” credit files.

All these methods were developed at the occasion of real-world studies. ELECTRE methods were applied to a large variety of problems in a large number of countries.

Excerpt 3

The EURO working group "Multiple Criteria Decision Aiding"

EURO is the European chapter of IFORS that federates national European OR societies. The first EURO conference was held in Brussels in 1975. One of the major EURO instruments since then was the EURO working groups. Bernard created the EURO working group on Multiple Criteria Decision Aiding (MCDA) in 1975. Since then he is responsible for this group that has invariably met twice a year (in Spring and Autumn) since then. The group aims at promoting original research on MCDA at the European level. The meetings of the group are not conferences. They are designed so as to foster discussions and exchanges. The group has around 350 members, from about 30 countries, and meetings usually gather between 50 and 100 persons. The success of the group is attested by the fact that most texts on MCDM now speak of a "European school of MCDA".

The 50th Anniversary meeting of the group was held in 1999 in the prestigious château de Cerisy-La-Salle and gathered a large number of members. The 66th meeting took place in October 2007. More details on this working group can be found at http://www.inescc.pt/~ewgmcda/index.html

Insert picture 3 about here

An original perspective on OR

The fact that Bernard has started working on OR as a consultant and his work on MCDM have led him to develop a "decision aiding methodology" that is original and rather non-standard in the OR profession. Many works in the area can be characterized by the adherence to three main assumptions:

1. The quest for rationality implies the use of a unique criterion that should be optimized,
2. Qualitative information and ambiguous data should be avoided as much as possible,
3. Science aims at describing a reality that is mainly independent from the observer. Reference to this outside reality is central to the validation of a scientific model.

Bernard soon became rather skeptical about these three assumptions and proposed a decision aiding methodology that would dispense with them.

Indeed, Bernard quickly acknowledged the fact that in many real-world problems, several actors are involved. These several "stakeholders" have different opinions. More than often, their opinion is not always completely structured. It also happens that there is no real "decision-maker". Moreover, what is feasible and what is not feasible is often fuzzy. This undermines the first assumption recalled above and calls for the use of multiple criteria. This does not mean that optimizing is useless but simply that "optimality" within a model does not guarantee an acceptable solution, let alone an optimal one, in the real world.

Real-world situations abound with qualitative information. Contrary to the second assumption, information is often uncertain, imprecise, ill-determined. Trying by all means to convert everything that is qualitative into quantitative information is a difficult task leading to a result that is seldom meaningful. Spending time to obtain information of better quality is often an inappropriate use of resources and may lead to instrumental bias (we may remember the story of the drunkard in the dark only looking for his keys under a street lamp without really knowing where he may have lost them). In all real-world problems an irreducible uncertainty, imprecision, inaccurate determination will remain. Hence, we should accept working with such information, using techniques that allow reaching robust conclusions on this basis.

Decision aiding inevitably means working with preferences. It is exceptional that facing a new complex problem, the preferences of an actor are completely well structured. Hence the analyst by his/her questions will contribute to the shaping of these preferences as much as describing them, which clearly invalidates the third assumption. This learning process, which often is a creation process, is an inevitable part of applying our model in the field.

Over the years, Bernard has proposed a complete decision aiding methodology that does not rely on the above three assumptions.

One of Bernard's most recent research interests deals with robustness in decision aiding. In many decision contexts, parameters involved in a model are often defined approximately due to uncertainty, imprecision or ill-determination. Rather than looking for optimal solutions, it is then more appropriate to look for "robust" solutions that resist to vague approximations and zones of ignorance, i.e., that behave well for all, or at least most, plausible values of the parameters. Such a perspective, often well-received by practitioners, gives rise to many challenging theoretical questions.

Figure 1 : Bernard as a student at the age of 20

Figure 2: Bernard and his wife Françoise in 1988

Figure 3: 50th meeting of the working in MCDA at Cerisy in 1999 (Bernard is in the second rank in the middle)

Figure 4: Daniel Vanderpooten, Bernard Roy, and Denis Bouyssou in 2007

Acronyms used

AFCET: Association Française pour la Cybernétique Économique et Technique
AFIRO: Association Française d'Informatique et de Recherche Opérationnelle
CNRS: Centre National de la Recherche Scientifique
EDF: Électricité de France
EURO: The Federation of European OR Societies
IEP: Institut d'Études Politiques
ISUP: Institut de Statistique de l'Université de Paris
LAMSADE: Laboratoire d'Analyse et Modélisation de Systèmes pour l'Aide à la Décision
MCDA: Multiple Criteria Decision Aiding
MCDM: Multiple Criteria Decision Making
MPM: Méthode des Potentiels Metra
NATO: North Atlantic Treaty Organization
RAIRO: Revue d'Automatique, d'Informatique et de Recherche Opérationnelle
RATP: Régie Autonome des Transports Parisiens
RIRO: Revue d'Informatique et de Recherche Opérationnelle
ROADEF: Recherche Opérationnelle et Aide à la décision (the French OR Society)
SEMA: Société d'Economie et de Mathématiques Appliquées
SOFRO: Société Française de Recherche Opérationnelle