Newsletter

Operations Research Society of South Africa
Operasionele Navorsingsvereniging van Suid-Afrika
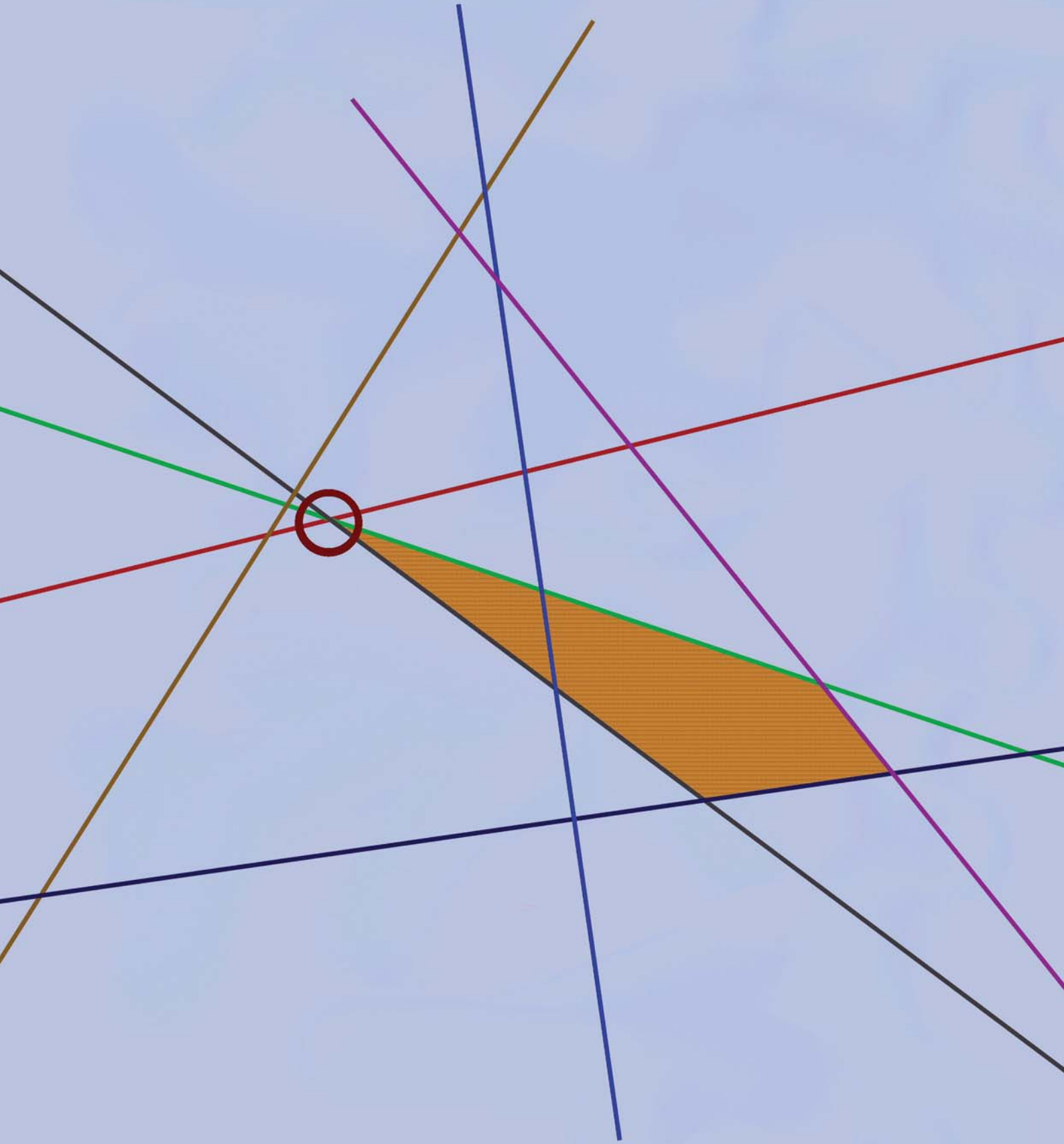
June 2006

FROM THE PRESIDENT'S DESK

By Marthi Harmse (marthi.harmse@sasol.com)
ORSSA President

Marthi Harmse

I am writing (or rather typing) this letter to you while watching golden and ruby leaves sparkling against a pure blue sky. As I watch the seasons passing by, it makes me realise how quickly time passes and all the things already accomplished by ORSSA this year.

Although this is not time for the president's report yet, I would like to thank the executive each for executing his or her duties so well – on a voluntary basis, after hours. A newcomer this year (not to the executive, but in the capacity as secretary) is Isabelle Nieuwoudt. Without making exceptions, but since this letter appears in our newsletter, I would also like to make mention of Cobus Potgieter (editor) and Leo Tomé (business manager). If you have not done so in the recent past, please visit the Executive Page on our website to see who else are serving on the executive. In Afrikaans there is a saying "vele hande maak ligte werk." Therefore, if you are able to offer assistance in any way, please contact the appropriate office bearer – again, especially if you are able to contribute towards our newsletter.

I am also grateful towards Petrovious Horton, Theo Stewart and Hans Ittmann as well as their committees for organising ORSSA 2006, ORPA 2007 and IFORS 2008 respectively. Here too assistance will be greatly appreciated. (Assuming that you all know what ORSSA and the International Federation of Operational Research Societies (IFORS) are about, some of you might be wondering what Operational Research Practice in Africa (ORPA) is all about – please visit http://www.euro-online.org/africanOR/orpaSeriesEn.htm.) This year our annual conference with the theme *Production Scheduling and Logistics* will be hosted in Pietermaritzburg on 3-6 September. Since our last conference in Kwazulu-Natal was nine years ago, in 1997, I would like to call on all our members in the province to assist in making this another memorable event. Also a reminder to everyone to submit abstracts of their presentations – please watch the press for further details.

As Operations Researcher I often reflect on the processes followed in executing the above duties. These processes are all implicit as far as I am aware. I believe it might be valuable to document the ORSSA processes explicitly in order to make improvements where possible, to ensure continuity, etc. Moving beyond ORSSA to OR in general, I wonder how many such processes are mapped, especially in the industries and businesses where they are executed.

Yet, even if these processes are all clearly documented and even optimized, and although we do indeed have the most extraordinary technologies to execute them, I believe it all boils down to the people executing these processes – you. I would therefore like to lift my hat to every Operations Researcher in South Africa and all our valuable members abroad.

May you all shine like precious jewels as ambassadors for OR! ♦

Features

ORMS Today

ORMS Today is the official magazine of INFORMS. Visit the ORMS site at http://ormstoday.pubs.informs.org or go to http://www.informs.org/ for more information on INFORMS.

FROM THE EDITOR

Cobus Potgieter

I must tell you, I am very excited about ORSSA's new website. Not only is it a new face, but it has a very professional look and is a lot more practical. I want to thank Petrus on my behalf for the idea and the implementation and invite anyone who has not visited the new website yet, to do so at www.orssa.org.za.
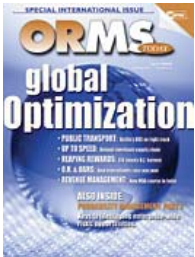
The main article in this issue focuses on the use and application of linear programming under imprecision. Jean-Piere Luhandjula explains in his article how fuzzy sets may be used to manipulate "vague" problems in linear program frameworks.

Hans Ittmann, in his capacity as organiser of the IFORS 2008 tri-annual conference, gives us feedback on the IFORS Executive site visit to South Africa. In this article Hans explains the main objectives of the visit and shares some of stories from their personal experience.

In our book review we see how causal maps can help outline and link our complex everyday thoughts. Hans Ittmann explains how this tool can be used, among other, for improved planning, better understanding of situations and healthier communication, things we usually are not willing to invest time into.

It is almost time for our annual conference and I am looking forward to it. I want to encourage all members to try and attend the 36th ORSSA conference in Pietermaritzburg in September this year and join in the prestige event of the society. More information on the conference can be found on page 12, including the important dates and registration information. See you there!

Until next time,
Cobus

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DEADLINES

The deadline for application at the national OR societies is September 30, 2006.

The deadline for the national OR societies to notify the scientific committee of their selection is October 31, 2006.

ORGANIZING COMMITTEE

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MEMBER PROFILE: MARTIE MULLER

By Cobus Potgieter (pottie@dip.sun.ac.za)

Martie Muller

Martie Muller was born in Springs, on the East Rand, in 1975. She matriculated from Hoërskool Bergsig, Rustenburg (North-West) in 1992 and in 1993 she joined the South African Army Women's College in George. From 1994 to 1997 she completed her BSc and BSc (Hons), both in Mathematical Statistics, at the University of Pretoria. Subsequently she tackled her MSc course work and mini-thesis in Mathematical Statistics at the University of Stellenbosch while working at the Medical Research Council. Her thesis was on random-effects pattern-mixture models for the analysis of binary response data arising from a longitudinal study with clustered data, with special attention to the treatment of missing response data and applied the technique to predict drug use among adolescents in Cape Town.

Martie joined the Medical Research Council (MRC) in Cape Town where she worked in the Biostatistics Division as part of a team studying and modelling adolescent risk behaviour. At the South African Cochrane Centre (based at the MRC) she worked on quality assessment of non-randomised studies and on two systematic reviews and meta-analyses: one on HIV prevention and one on comparison of epilepsy medication. During the 2000-2002 periods of her Cochrane training were based at the Department of Statistics and Operations Research at the University of Liverpool, the Institute for Health Sciences at the University of Oxford and visits to the London School of Tropical Medicine.

In 2001 Martie joined the Institute for Maritime Technology (IMT) in Simon's Town where she now works as a senior scientist in Statistics and Operations Research. She is involved in Combat Management System (CMS) modelling for modern surface warfare vessels and different aspects of underwater security, particularly the application of Bayesian Belief Networks in the field of mine warfare. At the moment she is focussing on the use of spatio-temporal modelling for environmental factors. Her interests also expand to Neural Networks and their application in high frequency radio wave propagation.

Martie joined ORSSA in 2002 and attended her first ORSSA conference at the University of Stellenbosch Business School in Belville in 2004. She presented a talk on *Bayesian Belief Networks* at the 2005 ORSSA conference and is a staunch supporter of ORSSA and ORSSA conferences!

When and how did you first become involved in OR and ORSSA?

When I was 17, career choice was serious business and I perused several career handbooks. I knew I wanted to do research and I liked mathematics and science. Engineering was an option, but mathematics won! I wanted to study OR at undergraduate level, but it was not offered at the University of Pretoria. I included Mathematics, Applied Mathematics, Computer Science and Mathematical Statistics in my degree programme. My honours in mathematical statistics lead to my first job in medical statistics where I analysed lots and lots of data. I still wanted to get more closely involved with problem solving and dealing with solutions on a conceptual level.

I have attended many scientific conferences, but the wide range of topics at ORSSA conferences and especially the application of OR/statistics techniques to *real life problems* impressed me.

What are the main departments at IMT, in which of them are OR used and in what way?

IMT is, in essence, an Operations Research clearing house for the SA Navy. OR is applied in the broader sense of the word: as a fusion of different sciences. The intention is to optimise the systemic potential of the equipment that the Navy deploys for local and regional military requirements. IMT provides the SA defence community with research and development in the area of Defence Science and Technology and employs scientists and engineers from a variety of fields.

IMT has the following programmes:
- Underwater Security
- Submarine Warfare
- Surface Warfare
- Battle Space Characterisation
- Target Characterisation Sub-Surface
- Target Characterisation Above Water
- Decision Support

How often does IMT recruit OR-related personnel?

IMT has a very low personnel turn-over – it must be the view over False Bay that keeps them hooked!

How did you first become interested in tactical Threat Evaluation?

After a year at IMT, I got the job to gather information on the Combat Management System (CMS) of the Navy's new Patrol Corvette. Tactical threat evaluation is an integral part of any warship CMS and IMT is assisting the Navy in developing a Threat Evaluation and Weapon Assignment (TEWA) model that simulates the behaviour of the system with particular reference to identifying the highest priority threat and the optimal fire solution. Discrete event simulation and probability theory are applicable.

What is your message to young aspiring OR practitioners?

Adopt the systems approach to any problem! Ask many questions and make sure you understand the problem (and its associated terminology) in its entirety *before* attempting a solution.

Learn to translate the science into practicable solutions that the client can relate to within their context. Networking is important – talk to your client and colleagues. A lot of work and ideas happen in interaction with other experts. ♦

Linear Programming Under Imprecision
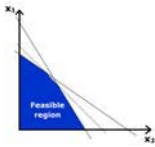
By Jeanne-Pierre Luhandjula (Luhanmk@unisa.ac.za)

Abstract

Linear programming has been successfully used for years in a variety of problems related to hard systems in which the structure, relations and behaviour are well-defined and quantifiable. Unfortunately, attempts to apply similar means to soft systems have not been successful in general. One of the reasons of this mismatching in the key role played by human judgement; preferences which are subjective, imprecise and not easily quantifiable. Although probabilistic theories claim to model decision making under imprecision, there is a qualitatively different kind of indeterminacy which is not covered by these apparatus, that is: inexactness, ill-definedness and vagueness.

This article takes a general look at core ideas aimed at softening linear programming models by making it possible to incorporate the above mentioned non-stochastic kind of imprecision. Flexible linear programming and linear programming with fuzzy coefficients are discussed in turn. Some extensions and applications of fuzzy linear programming are also pointed out. For the paper to be somewhat self-contained we start by briefly presenting basic notions of fuzzy sets theory which are required in subsequent developments.

Keywords: Linear programming, fuzzy sets, fuzzy numbers, flexible programming.

1. Introduction

It is hard to find examples of systems to be controlled or simply analysed that do not include some level of imprecision about the values to assign to some parameters or about the actual design of some of the components of the system. In this connection the noted philosopher Nietzhe was quoted as saying: "No one is gifted with immaculate perception." This was well understood by Physics Nobel Laureate Richard Feynman who once wrote: "When dealing with a mathematical model, special attention should be paid to imprecision in data."

It is of little relevance to inquire about the wrongfulness of a deterministic model. The real questing is whether replacing stubbornly imprecise data by fixed ones in a model does not impige on predictions concerning the phenomenon under investigation. A large amount of evidence [1, 2, 3] exists telling us not to bow to the hammer principle: "When you only have a hammer, you want everything at your hand to be a nail." Indeed, the practice of substituting arbitrarily imprecise data by fixed values in a model would, according to the "Garbage in, garbage out" rule, leave no chance to the model but to churn out meaningless outcomes. False certainty is bad science and it can be dangerous if it stunts articulation of critical choices.

Although probabilistic theories claim to model decision making under imprecision [4, 5, 6], there are qualitatively different facets of indeterminacy which are not covered by probabilistic apparatus. Situations where doubt arises of statements and judgements have little to do with occurrence of events, the back-bone of probability theory. This has led to the development of tools like Fuzzy Sets [7], Possibility Measures [8], Necessity Measures [8], Credibility Measures [9] which do not substitute probabilities but complement them in the modelling of various kinds of imprecision.

In this article, we discribe how Fuzzy Set Theory may be of help in representing and processing non-probabilistic kinds of imprecision called "vagueness" within a linear programming framework. The paper is organised as follows: In the next section, we present basic notions of Fuzzy Sets Theory which are required in the sequel. Section 3 is devoted to flexible linear programming problems with fuzzy coefficients are taken up in section 4. Extensions to situations where fuzziness and randomness are combined in the scope of a linear program as well as to multiple objective programming problems are pointed out in section 5 where some programming are also indicated.

2. Fuzzy Sets

2.1 The concept of fuzzy sets

The main idea behind a fuzzy set is that of gradual membership to a set without sharp boundary – an idea that fits human representations of reality more nuanced than the clear-cut way.

Thus, in a fuzzy set the degree of membership of an element is expressed by any real number from 0 to 1 rather than the limiting extremes. More formally, a fuzzy set μ of a set $A \neq \varnothing$ is a function $\mu : A \mapsto [0,1]$ representing the degree of membership of $x \in A$.

In what follows we restrict ourselves to the class of fuzzy sets of the real line denoted by $B(\mathbb{R})$. The class $B(\mathbb{R})$ and $CH(\mathbb{R}) = \left\{ f \mid f : \mathbb{R} \to \{0,1\} \right\}$ are isomorphic (as sets) with isomorphism

$$\Psi : B(\mathbb{R}) \to CH(\mathbb{R})$$

$$A \to I_A,$$

where I_A denotes the characteristic function of A.

2.2 Main notation and operations with fuzzy sets of $\mathbb{R}$.

The *support* of a fuzzy set μ is the classical set $\sup(\mu) = \left\{ x \in \mathbb{R} \mid \mu(x) > 0 \right\}$. The *kernel* of a fuzzy set μ is the

classical set $\ker(\mu) = \{x \in \mathbb{R} \mid \mu(x) = 1\}$. A fuzzy set μ is said to be *normal* if $\ker(\mu) \neq \varnothing$. The α-cut of a fuzzy set μ is the classical set $\mu^{\alpha} = \{x \in \mathbb{R} \mid \mu(x) \geq \alpha\}$.

Now, if $\mu_1, \mu_2 \in \mathbb{R}$ are fuzzy sets, then the *complement* of μ_i, denoted by $\overline{\mu}_i$, is defined as $\overline{\mu}_i(x) = 1 - \mu_i(x)$. Furthermore the *union* of μ_1 and μ_2 is defined as $(\mu_1 \vee \mu_2)(x) = \max(\mu_1(x), \mu_2(x))$ and the intersection of μ_1 and μ_2 is defined as $(\mu_1 \wedge \mu_2)(x) = \min(\mu_1(x), \mu_2(x))$. A fuzzy set $\mu \in B(\mathbb{R})$ is said to be *convex* if $\mu(x)$ is quasi-concave.

A *fuzzy number* is a normal and convex fuzzy set of $\mathbb{R}$. The set of fuzzy numbers is denoted by $\Im(\mathbb{R})$. A fuzzy number is well suited for representing vague data [2].

Let μ be a normal fuzzy set of $\mathbb{R}$. Now $\{v_{\alpha} \mid \alpha \in (0,1)\}$ is called a set *representation* of μ, if and only if

(i) $\quad 0 < \alpha \leq \beta < 1 \Rightarrow \upsilon_{\beta} \subseteq \upsilon_{\alpha}$

and

(ii) $\quad \forall t \in \mathbb{R} : \mu(t) = \sup\{\alpha I_{\upsilon_{\alpha}}(t) \mid \alpha \in (0,1)\}$.

2.3 Some results on fuzzy sets

Theorem 1: Let μ be a normal fuzzy set of $\mathbb{R}$, then $\{\mu^{\alpha} \mid \alpha \in (0,1)\}$ is a set representation of μ.

Theorem 2: Let μ be a normal fuzzy set of $\mathbb{R}$ and let $\{v_{\alpha} \mid \alpha \in (0,1)\}$ be a set representation of μ. Then

$$\liminf_{\eta \to \infty} \upsilon_{\left(\alpha + \frac{1}{2\eta(1-\alpha)}\right)} = \inf \mu^{\alpha}$$

and

$$\limsup_{\eta \to \infty} \upsilon_{\left(\alpha + \frac{1}{2\eta(1-\alpha)}\right)} = \sup \mu^{\alpha}$$

for $\alpha \in [0,1)$.

The proof of these results may be found elsewhere [9].

2.4 Possibility, Necessity and Credibility measures

Let Θ be a nonempty set representing the sample space and $P(\Theta) = 2^{\Theta}$. A possibility measures is a function $\text{Pos}: P(\Theta) \mapsto [0,1]$ satisfying the following axioms:

(i) $\quad \text{Pos}\{\Theta\} = 1$

(ii) $\quad \text{Pos}\{\phi\} = 0$

(iii) $\quad \text{Pos}\{\bigcup_i A_i\} = \sup_i \text{Pos}\{A_i\}$

(iv) Let Θ_k be nonempty sets on which $\text{Pos}_k\{\bullet\}$ satisfy (i)–(iii) and $\Theta = \Theta_1 \times \Theta_2 \times \ldots \times \Theta_n$, then $\text{Pos}\{A^c\} = \sup_{(\theta_1, \theta_2, \ldots, \theta_n) \in A} \min \text{Pos}_k\{\Theta_k\}$.

Necessity and credibility measures are obtained from Possibility measures as follows:

$$\text{Nec}\{A\} = 1 - \text{Pos}\{A^c\}$$

and

$$\text{Cr}\{A\} = \frac{\text{Pos}\{A^c\} + \text{Nec}\{A\}}{2}.$$

More details on Possibility, Necessity and Credibility measures may be found in [10, 11].

3. Flexible linear programming

A flexible linear program is a problem of the form

$$(P_1) \begin{cases} \widetilde{\min}\ c\,x \\ A_i \lesssim b_i;\ i = 1, \ldots, m \\ x \in X = \{x \in \mathbb{R}^n, x \geq 0\}, \end{cases}$$

where "~" means that some leeway may be accepted in the objective and constraints formulation. Such a flexible version may be required, for instance when specifying strict satisfaction of constraints leads to inconsistencies which result in the vacuosness of the feasible set [12].

The problem (P_1) may be interpreted as follows: Find $x \in X$ such that $c\,x$ is below a reasonable level z_0 and such that the constraints $A_i x \leq b_i;\ i = 1, 2, \ldots, m$ are met as well as possible, *i.e.* Find $x \in X$ such that $c\,x \lesssim z_0$ and $A_i x \lesssim b_i;\ i = 1, 2, \ldots, m$, or merely, find $x \in X$ such that $A_i x \lesssim b_i;\ i = 1, 2, \ldots, m$.

These soft constraints may be represented by means of fuzzy sets $\mu_i;\ i = 1, 2, \ldots, m$ such that

$\mu_i(x) = 0$, if $A_i x > b_i + d_i$

$0 < \mu_i(x) < 1$, if the violation of the constraint $A_i x \leq b_i$ is acceptable *i.e.* if $b_i < A_i x < b_i + d_i$

$\mu_i(x) = 1$, if $A_i x \leq b_i$,

where the d_i are subjectively chosen constants of admissible violation. The following simplest kind of piecewise linear functions may be used to define

$$\mu_i(x) = \begin{cases} 1, & \text{if } A_i x \leq b_i \\ 1 - \dfrac{A_i x - b_i}{d_i}, & \text{if } b_i < A_i x \leq b_i + d_i \\ 0, & \text{if } A_i x > b_i + d_i. \end{cases}$$

By virtue of the Bellman Zadeh confluence principle [14], the solution to (P_1) should be $x^* \in X$ which maximises $\mu_D(x)$, where μ_D is the fuzzy set intersection of μ_i $(i = 0, 1, \ldots, m)$.

The resulting problem is

$$
\begin{cases}
\max \min_{i=0,1,\ldots,m} \mu_i(x), \\[2mm]
x \in X \bigcap_{i=0}^{m} \sup \mu_i .
\end{cases}
$$

This problem is equivalent to the linear program

$$
\begin{cases}
\max \lambda \\[2mm]
\lambda \leq 1 - \dfrac{A_i - b_i}{d_i}; \, i = 0,1,\ldots,m \\[2mm]
x \geq 0
\end{cases}
$$

which may be solved by existing linear programming software like LINDO or LINGO. A reader interested to know more about flexible linear programming may consult references [2,12].

4. Linear programming with fuzzy coefficients

4.1 Problem formulation

Assume that coefficients of a linear program are provided by experts who prefer to view them as fuzzy numbers in the hope of reconciling their vague perceptions with hard statistical data. In this case we have a problem of the form

$$
(P_2) \begin{cases}
\widetilde{\min} \, \tilde{c} \, x \\[2mm]
\tilde{A} \leq \tilde{b} \\[2mm]
x \geq 0 ,
\end{cases}
$$

where $\tilde{A}$ is an $m \times n$ matrix, $\tilde{b} \in \left(\Im(\mathbb{R}) \right)^m$ and $\tilde{c} \in \left(\Im(\mathbb{R}) \right)^m$.

The problem (P_2) is ill-defined and the notion of "optimum optimorum" does not apply. We should then give a meaning to the objective and constraints in a way to single out a satisfying solution in this context. This may be done in three different ways which are discussed in the following sub-sections.

4.2 Solving (P_2) by replacing fuzzy numbers by appropriate values

Here a deterministic version of (P_2) is obtained by replacing involved fuzzy numbers by appropriate values in their respective supports. The most frequently used values are either α-level sets or kernels of involved fuzzy numbers. The resulting program is then a linear program that may be solved by existing linear programming packages.

4.3 Solving (P_2) with the uncertainty-constrained approach

Here the deterministic counterpart of (P_2) is as follows:

$$
(P_2') \begin{cases}
\max_{x} \max \lambda \\[2mm]
F_M \{ \tilde{c} \, x \geq \lambda \} \geq \alpha \\[2mm]
F_M \{ \tilde{A}_i x - b_i \leq 0; i = 1,2,\ldots,m \} \geq \beta ,
\end{cases}
$$

where α, β are fixed levels and F_M is some uncertainty measure, *i.e.* Possibility, Necessity or Credibility.

A hybrid intelligent algorithm has been developed for the case where F_M is the credibility measure [13].

4.4 Solving (P_2) with approaches based on comparison of fuzzy numbers

Suppose the following interpretation between fuzzy numbers is considered: $\tilde{a} \leq \tilde{b} \Leftrightarrow \tilde{a}^\alpha \leq \tilde{b}^\alpha \; \forall \alpha \in (0,1]$ [2]. For a fuzzy number $\tilde{m}$, $\tilde{m}^\alpha = [\underline{m}^\alpha, \overline{m}^\alpha]$ where $\underline{m}^\alpha = \inf m^\alpha$ and $\overline{m}^\alpha = \sup m^\alpha$. A deterministic version of (P_2) based on the above definition of inequality is

$$
(P_2') \begin{cases}
\min \sum_{j=1}^{n} c_j^* x_j \\[2mm]
\sum_{j=1}^{n} \tilde{a}_{ij}^\alpha x_j \leq \tilde{b}_i^\alpha; \; \alpha \in (0,1] \\[2mm]
x_j \geq 0; \; j - 1, 2, \ldots, n
\end{cases} ,
$$

where c_j^* is some appropriate value in $\sup \tilde{c}_j$. (P_2') is now equivalent to

$$
(P_2'') \begin{cases}
\min \sum_{j=1}^{n} c_j^* x_j \\[2mm]
\sum_{j=1}^{n} \overline{a}_{ij}^\alpha x_j \leq b_i^\alpha; \; \alpha \in (0,1] \\[2mm]
x_j \geq 0; \; j - 1, 2, \ldots, n
\end{cases}
$$

The problem (P_2'') is a linear semi-infinite program that can be solved by semi-infinite programming techniques [14].

5. Extensions and applications

Ideas developed in previous sections have also been extended to simultaneously incorporate fuzziness and randomness in a linear programming setting [15, 16], to come to grips with deterministic and fuzzy multi-objective linear programs [17, 18] and to handle linear multistage problems.

Fuzzy linear programming has found successful applications in problems encountered in the following fields: Agricultural economics [19], Assignment [20], Banking and finance [21], Environmental management [22] and Transportation [23].

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IFORS 2008 – Site Visit

*By Hans Ittmann (*hittmann@csir.co.za*)*

It is by now customary for the IFORS Executive to do a site visit of the next IFORS tri-annual conference location. With IFORS 2008 taking place here in South Africa at the Sandton Convention Centre, we knew that such a visit was imminent. What was, however, a real surprise was that the full administrative committee (AC) of IFORS was going to join on this occasion. A day or two was going to be set aside for IFORS specific matters as well as some strategy planning.

The visit was scheduled last year some time for the end of February, beginning of March 2006. With IFORS 2008 only taking place in two years' time, it was and still is a bit unreal. One knows that a lot needs to be done but then it also feels that there is so much time and July 2008 lies way into the future! Nevertheless, the first e-mail around the site visit was from IFORS treasurer, Hugh Bradley, in the second week of December last year. This was just when South Africa was on the point of closing down for its summer vacation! Very diplomatically, Hugh had to be informed that we will only be able to respond in the new year! Quite a way to start the interaction and site visit! The budget is fairly critical and it was going to need a lot of our attention.

As part of the preparation for the site visit, we appointed a Professional Conference Organiser to assist us just for this event. This was of great help and benefit, not only in getting everything arranged but also putting us, ORSSA, in touch with other organisations that provided additional assistance. In this regard, the Johannesburg Tourist Company (JTC) was magnificent through their efforts.

The site visit has a number of objectives, namely:

- To look at the conference venue facilities;
- To investigate possible options for day-long excursions during the conference;
- To familiarise the IFORS committee with hotel and other accommodation facilities;
- To look at possible venues for the social events during the conference;
- To meet with the local organising committee;
- To discuss all the conference programme issues, conference budget, registration rates, etc. with the local committee.

An itinerary was put together for this visit and from 24 February, the IFORS members started arriving. In all cases, we ensured that either an ORSSA member or someone associated with the local committee met the visitors at the airport and took them to their hotel. Most of the visitors had never been in South Africa and, in a few instances, were accompanied by their spouses.

The formal programme for the visit started on Sunday 26 February. JTC arranged a small bus for us all and the whole group then proceeded firstly to the Lion Park, close to Krugersdorp. For our visitors, this was one of the highlights as not only were there many lions, also white lions, but they also had the opportunity to play and cuddle with lion cubs! Some of the male lions misbehaved as we drove past them! A number of the bus occupants that will remain nameless thought this was planned and that it was not a normal act of nature. From there we went to the Cradle of Humankind at Maropeng, a new development recently opened, and had lunch at Maropeng. From there, the group went through the Sterkfontein caves. This required a fair bit of climbing and walking in an environment that is not that conducive for the more elderly ones! Nevertheless, most of our visitors found this very informative. The day ended with sundowners at the Moyo's Restaurant in Melrose Arch. The latter is a possible venue for the IFORS President's Dinner that takes place during the conference.

A picture of lions taken during the visit to the Lion Park close to Krugersdorp.
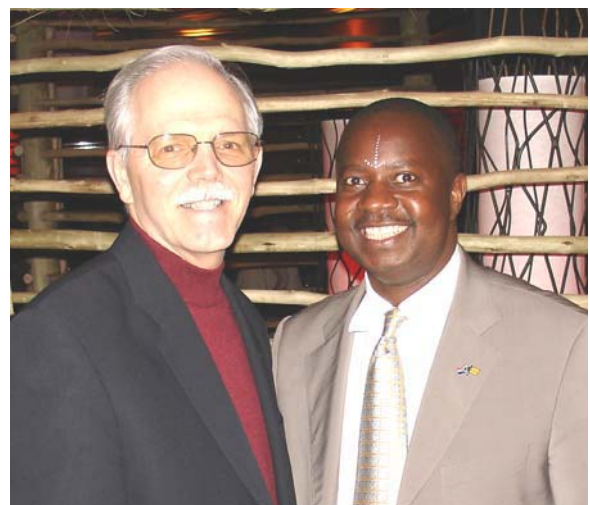
IFORS president, Thomas Magnanti, together with the Host of Moyo's Restaurant in Melrose Arch.

On the Monday, we continued with possible outing options. Our first sight-seeing spot was Constitution Hill and most of us will remember this for the pouring rain we had to endure!! In addition, our guide was determined to show us the "full catastrophy" despite the insistent rain! From there we proceeded to Soweto and specifically the "original" Mandela house. It is a four-room house full of Mandela memorabilia. Most of us were touched by the simplicity of this house of possibly the most famous individual in the world today. The tour came to an end with lunch in Soweto at Robby's Place.

One of the transportation options in Soweto!

The afternoon was devoted to the conference facilities in Sandton. It was very noticeable how a number of the IFORS visitors suddenly became very energetic and talkative. They were now in an environment that was much more familiar to them! We got many useful ideas and suggestions from these experienced people around how to utilise the magnificent facilities to reduce costs but to still have a workable conference venue.

On Tuesday we, the local organising committee, had a day long meeting with the IFORS AC. All aspects related to the conference were covered in comprehensive detail. In the evening, JTC hosted the delegation at the Lekgotla Restaurant in Sandton Square for dinner. This was enjoyed by everyone although we all would possibly have preferred a bit less noise.

IFORS AC met on their own on Wednesday and then they left, some later than others. Those that stayed a day or two longer went on different sight-seeing tours.

All in all, we believe this was a successful site visit. Tom Magnanti sent us an e-mail to thank us for all the arrangements and to quote him, he said the following:

"*We were all very impressed by the convention centre as well as by the many exciting outing options that will be available for participants. IFORS 2008 promises to be a great meeting".* ♦

References

[1] Negoita, C.V. and Ralescu, D.A. (1975) Application of Fuzzy sets to System Analysis. Birkhauser, Stuttgart.

[2] Dubois, D. and Prade, H. (1980) Fuzzy Sets and Systems: Theory and Applications, Academic Press, New York.

[3] Kal, P. (1976), Stochastic Linear Programming, Springer.

[4] Kall, P. and Wallace, S.W. (1994), Stochastic Programming, John Wiley.

[5] Vajda, S. (1972), Probabilistic Programming. Academic Press.

[6] Tapiero, C.S. (1994), Applied Stochastic Control, European Journal of Operations Research 73, pp. 153-164.

[7] Zadeh, L.A. (1965), Fuzzy Sets, Informal Control8, pp. 338-353.

[8] Hisdal E. (1978), Conditional Possibilities, Independence and Noninteraction. Fuzzy Sets and Systems 1, pp. 283-297.

[9] Kruse, R. and Meyer, K.D. (1987), Statistic with vague data. D. Reidel.

[10] Buckley, J.J. (1988), Possibility and Necessity in Optimization. Fuzzy Sets and Systems 25, pp. 1-13.

[11] Liu, B. (2004), Uncertainty Theory: An Introduction to its Axiomatic Foundations, Springer-Verslag.

[12] Luhandjula, M.K. (1989), Fuzzy Optimization: An Appraisal. Fuzzy Sets and Systems 30, pp. 257-282.

[13] Liu, B. (2005), Introduction to Uncertainty Programming. A rough manuscript for distribution in UTLAB only.

[14] Bellman, R. and Zadeh, L.A. (1970), Decision Making in a Fuzzy Environment. Management Science Series B 17, pp. 141-164.

[15] Luhandjula, M.K. (2004), Optimization Under Hybrid Uncertainty. Fuzzy Sets and Systems146, pp. 187-203.

BOOK REVIEW

By Hans Ittmann hittmann@csir.co.za)
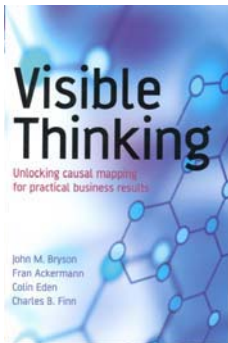
Visible Thinking – Unlocking Causal Mapping For Practical Business Results, John M. Bryson, Fran Ackermann, Colin Eden and Charles B. Finn, 2004. John Wiley & Sons Ltd, Chichester, England. pp. 370. ISBN 0-470-86915-1, 24.99 Pounds.

We all face situations in which thinking really matters – either as an individual or as a group – if we are to create the future we want. For example, have you had trouble figuring out what was bothering you, making you anxious or keeping you awake at night? If some parts of your life have not turned out well, do you wonder why? Have you puzzled about how to make your job more satisfying, get the raise you want or acquire the resources you need? Have you wondered about how to make the most persuasive case to your boss, staff or customers? Have you pondered how you might create more satisfied clients or customers? Or maybe your organisation, church or community group needs to rethink its strategy. Have you wondered about what the content of the strategy should be and how you might go about developing it with the help of others? Would you like more assurance about your decisions, to be more comfortable with your relationships and generally more in control of your life?

The above is the first paragraph of the preface of **Visible Thinking** and it portrays various examples of living in a complex world. Many of us are challenged by issues that are complex and interconnected, and where everything seems to be linked to everything else. To develop effective responses involves careful exploration of elements such as goals, strategies and actions. In many situations the answers are not obvious, while the outcomes could be very surprising. If you want to create the future you want, thinking really matters. In **Visible Thinking,** tools are described to assist in unravelling complexity in decision-making. It introduces the theory and practice of causal mapping, and provides practical guidelines on how to develop these, both as individuals and in groups.

The book is based on three important premises, namely:

- most people do not know for sure what they think about many important matters;

- thinking does matter when it comes to deciding what to do about many important issues; and

- people need tools and techniques to help them think effectively about what to do in areas involving complex issues.

Causal mapping is one of the tools that may be used to clarify a complex problem and to figure out what to do, how to do it and why it should be done. A causal map is a word-and-arrow diagram in which ideas and actions are causally linked with one another through the use of arrows. The arrows indicate how one idea or action leads to another. The process of creating a causal map forces one to think. **Visible Thinking** introduces the theory and practice of causal mapping primarily through the use of examples.
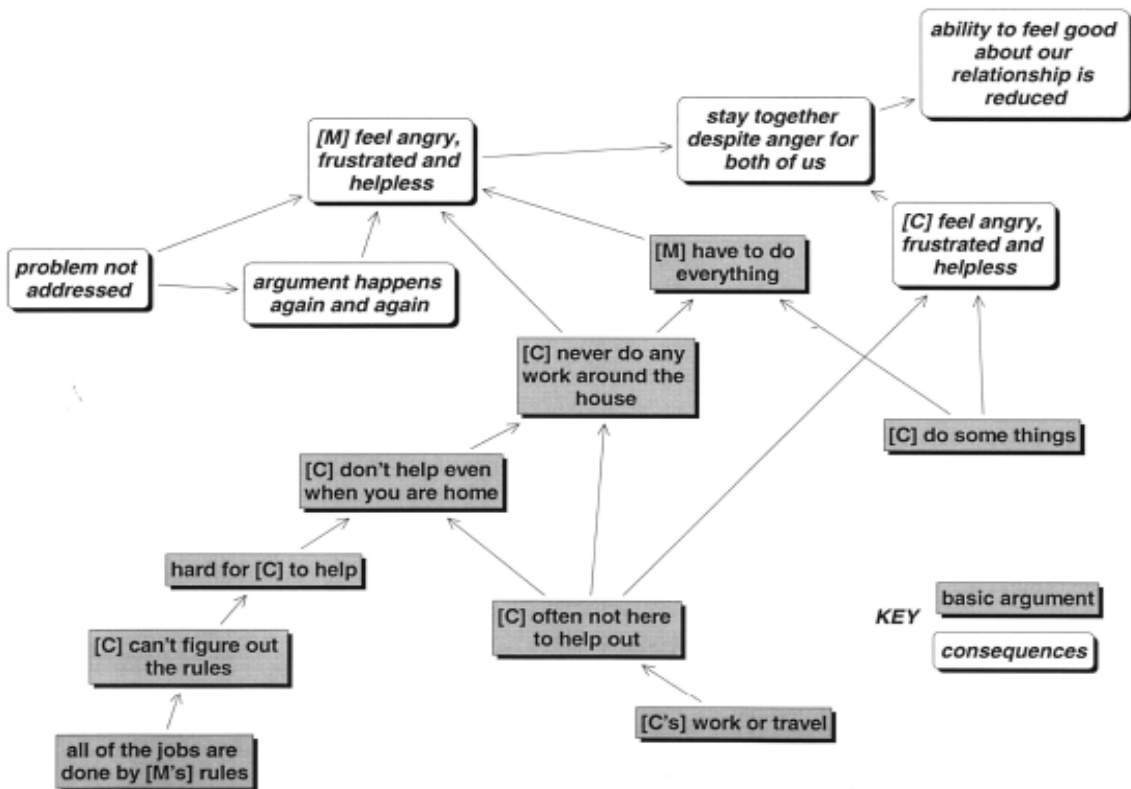

Figure 1: The cosequences of remaining trapped are not good.
(Reproduced from *Visible Thinking – Unlocking Causal Mapping for Practical Business Results*)

There are four main parts in the book. Part 1 addresses the issue of what mapping is and why and how it works. Part 2 focuses on "What do I think? A Guide to Cognitive Mapping".

Part 3 is more about groups and group maps and is titled: "What do we think? A Guide to Oval Mapping". In the final part, everything is summarised in detail and conclusions are drawn.

Throughout the book, the authors make extensive use of examples to illustrate how causal mapping may be applied. The authors' liberal reference to situations from their own personal experience makes the examples more credible. The first example in Part 1 is about a family argument between husband and wife. The wife feels that she has to do everything since her husband is always away and when he is around, he arrives late from work (… this situation could apply to many of our members!). Using mapping, they started addressing the problem. They drew various maps (an example is shown in Figure 1) which assisted them to express their real feelings and experience. The maps became tools to improve, reinforce and build their relationship further while at the same time creating understanding and action. Their maps were a "transitional object", "facilitative device" or "ritual structure" that allowed them to move together to a much better place cognitively, behaviourally and emotionally. Through this process, the couple were also able to develop an "alternative story" that was less problematic, more motivating and generally more satisfying.

There are a number of examples, each one slightly different from the other, to illustrate different aspects of causal mapping. The examples include:

- a personal planning situation – two of the authors planned to sail halfway across America;

- a situation to illustrate bargaining and negotiation between a customer (wanting a boat built in time) and a supplier (the boat builder);

- moving house, but the person (one of the authors) was not quite sure why she wanted to move;

- a difficult and unsatisfactory job situation where the person does not know how to evaluate the various possibilities;

- a range of options around a strategic issue for a college to merge or not to merge;

- what should a small college do not to get smaller; and

- a strategy development example.

With each example, the thinking process is clearly outlined. The process of how this is then converted into mapping objects is described in detail. There is a very detailed outline of what is required in terms of equipment and/or material for each of these examples. Planning is also important, especially when a group is involved. The facilitator needs to plan for all eventualities. At the end of each example, detailed process guidelines are provided, which are very clear and useful.

In Part 4, the learning from all the examples are reviewed and presented, in such a way as to not only deepen understanding, but also to give the reader the ability to use mapping in addressing complex issues. The detail is almost overwhelming and, at the same time, so comprehensive that one gets a full understanding of how everything works. Detailed guidelines are also provided to construct cognitive and oral maps, starting from "recognising when a situation can be mapped and is worth mapping." These guidelines are also very detailed and comprehensive. The final chapter discusses the benefits, limitations and the future of mapping. A number of appendices provide additional material, including a brief history of causal mapping.

Visible Thinking is a very informative and useful book as it focuses on one tool, causal mapping, and takes the reader through the process of drawing such maps in a step-by-step manner. The explanations, the outline of the thinking process and the attention to detail around the environment and all the "equipment" required is such that anyone should be able to use this tool after reading the book. At the same time, one should realise this is only one tool and it does have its limitations. Finally, mapping works because it seeks to replicate the way human beings make sense of their world. Causal mapping is indeed a tool to assist visible thinking and a tool that all OR people should ideally add to their collection of tools and techniques. ♦

(Linear Programming Under Imprecision – Continued from page 9)

[16] Luhandjula, M.K. (2006), Fuzzy Stochastic Linear Programming: Survey and Future Research Directions. To appear in the European Journal of Operations Research (see article in press at www.elsevier.com/locate/ejor)

[17] Zimmermann, H.J. (1987), Fuzzy Sets, Decision Making and Expert Systems. Kluwer Publishers.

[18] Slowinski, R. and Teghem J. (1988), Fuzzy versus Stochastic Approaches to Multi-objective Mathematical Programmming under uncertainty. Naval Research Logistics 35, pp. 673-695.

[19] Lai, Y.J. and Hwang, Ch-L. (1992), Fuzzy Mathematical Programming: Methods and Applications, Springer-Verslag

[20] Darxentas, J. (1987), "On fuzzy location models", in Kacphzyk and Orlovski (eds), Optimization Models using Fuzzy Sets and Possibility Theory, Reidel, pp. 328-341.

[21] Ostermark, R. (1989), Fuzzy Linear Constraints in the Capital Asset Pricing Model. Fuzzy Sets and Systems 30, pp. 93-102.

[22] Sommer, G. and Pollatschek, M.A. (1978), A Fuzzy Programming Approach to an Air Pollution Regulation Problem. Working paper, RWTH Aachen.

[23] Verdegay, J.L. (1984), Application of Fuzzy Optimization in Operational Research. Control and Cybernetics 13, pp. 229-239.♦

36TH ORSSA ANNUAL CONFERENCE 2006

3 – 6 September 2006

DISCOVER THE TRUE ESSENCE OF PIETERMARITZBURG – A CITY WITH A HERITAGE RICH IN CULTURAL SIGNIFICANCE, SPORTING EXCITEMENT AND TRAVELLING OPPORTUNITIES!

PIETERMARITZBURG CITY HALL

Sinodale Centre, corner Boshoff and Burger Street, Pietermaritzburg

THEME

South Africa's two largest harbours are situated in Durban and Richard's Bay. The harbour at Durban is the busiest port in sub-Saharan Africa, while the harbour at Richard's Bay specializes in bulk export. Richard's Bay is also the world's largest titanium slag producer. Kwazulu-Natal is one of Africa's most important producers of pulp and paper, while two of the country's most important jewellery manufacturing nodes are situated in Durban and Pietermaritzburg. These factors, together with a large economy of agriculture, dairy and stock as well as many large manufacturing industries, contribute to the importance of production scheduling and logistics in the province of Kwazulu Natal.

This conference will explore the contribution of Operations Research (OR) to production scheduling and logistics.

GUEST SPEAKER

David M. Ryan (www.esc.auckland.ac.nz/Ryan) is Professor of Operations Research at the University of Auckland. Previously he was Head of the Department of Engineering Science and currently he is Deputy Dean of Engineering. David is responsible for some fundamental and influential ideas in the field of applied combinatorial optimization. His research has significantly influenced OR applications throughout the world, especially with regard to airline crew scheduling problems. His work in this application area resulted in Air New Zealand being selected as a finalist in the 2000 Edelman competition. David has a keen interest in the practical use of OR methods to solve real-world problems and he is an acknowledged master at inspiring students, colleagues and people in industry to practice OR to maximum advantage. At the opening plenary session David will make a presentation on a production scheduling optimisation problem in an aluminium smelter.

VENUE

Pietermaritzburg is the joint capital of Kwazulu-Natal. In 1838 it was established by the Voortrekkers, after which the British took over in 1843. Today the city is regarded as one of the most important high character cities in Africa. It serves as a point of entry into the country for a kaleidoscope of Midland's pleasures (www.midlandsmeander.co.za), the Battlefield Route (www.battlefields.kzn.org.za) and the Drakensberg mountains (www.drakensberg.kzn.org.za), while it is only a 45-minutes drive from Durban. The venue for the conference is the Sinodale Centre, corner Boshoff and Burger Street, Pietermaritzburg. For more information about Pietermaritzburg and the surroundings visit www.pietermaritzburg.co.za or www.pmbtourism.co.za.

IMPORTANT DATES

7 July 2005:   Deadline for submission of abstracts
28 July 2005:   Notification of acceptance of abstracts
4 August 2005:   Deadline for early-bird registration
25 August 2005: Deadline registration and payment

CONFERENCE REGISTRATION

Full conference:		Early bird	Normal fee
Non-Members	Non-speaker	R2 200.00	R2 700.00
	Speaker	R1 700.00	R2 200.00
Members	Non-speaker	R1 700.00	R2 200.00
	Speaker	R1 200.00	R1 700.00
Full-time students (members only)		R 800.00	R1 300.00

Day attendance – per day (excluding functions and visits):

Non-members	R1 600.00
Members	R1 000.00
Full-time student (members only)	R 600.00

Accompanying persons:

Welcoming function	R 180.00
Social event (Day 2)	R 180.00
Gala dinner	R 260.00

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