SOUTHERN AFRICAN INSTITUTE FOR INDUSTRIAL ENGINEERING

OPERATIONS RESEARCH SOCIETY OF SOUTH AFRICA
OPERASIONELE NAVORSINGSVERENIGING VAN SUID-AFRIKA

19th SAIIE & 35th ORSSA
Annual Conference 2005

Building Towards Growth and Sustainability in SA

28 – 31 August 2005
Emerald Casino Resort, Vanderbijlpark

www.saiie.co.za / www.orssa.org.za

28 August 2005

Dear Delegate

The Vaal Triangle Chapter of the Operations Research Society of South Africa (ORSSA) and the Southern African Institute for Industrial Engineering (SAIIE) is honoured to welcome you to the 19th SAIIE & 35th ORSSA Annual Conference 2005. The fields of Industrial Engineering and Operations Research have a lot in common. This, together with the economies of scale benefits utilised, lead the Chapter to host a joint conference.

Modern **Industrial Engineering (IE)** is concerned with the integration of resources and processes into cohesive strategies, structures and systems for the effective and efficient production of quality goods and services. It seeks to find optimal and practical solutions which contribute to the success and prosperity of an industrial undertaking, thereby making a fundamental contribution to the creation of wealth.

The **Southern African Institute for Industrial Engineering (SAIIE)** is a vibrant and learned society representing and promoting Industrial Engineering in Southern Africa. Its mission is to represent, promote and advance the professional interests of its members and of the Industrial Engineering discipline in Southern Africa and in so doing to improve the supply and demand for Industrial Engineering in terms of both quantity and quality.

Operations Research (OR) is also known as Management Science and Quantitative Management. It uses scientific methods to improve the way in which decisions are made in business and industry, in government and society – "the science of better". OR has an interdisciplinary nature and draws upon physical science, logic, applied mathematics, logistics, industrial engineering, social science, economics, statistics and computing, but is none of these on their own. It is concerned with problems that cut across several disciplines and attempts to tackle and solve problems on their merits using relevant tools from any source. OR is about change and therefore also is concerned with people and how they react to change.

The **Operations Research Society of South Africa (ORSSA)** exists primarily to further the interests of those engaged in, or interested in, Operations Research activities. It is involved in matters which concern OR practitioners in general, such as drawing up guidelines for OR education, presenting short courses and marketing OR, and provides information to the public on the nature of and career opportunities in OR.

A vital challenge posed to IE/OR practitioners is to ensure that decisions made and implemented at business, industrial, governmental and societal level are indeed building towards growth and sustainability. This conference explores the contribution of IE/OR to a sustainable, growing Southern Africa in an economic, environmental and social context. Similarly, the long term effective utilisation of IE/OR approaches are considered. The critical call for action is also answered, for example through the *Books for Africa!* project. Each delegate is challenged to donate books on IE/OR or related subjects such as management or science. The literature will be utilised to address the urgent need for IE/OR literature in the rest of Africa and will be distributed to African tertiary institutions.

May you find opportunities to share knowledge, experience and new developments with old and new friends in the IE/OR profession throughout Southern Africa and beyond. May you be inspired by the value that the IE/OR fields could be adding for business and industry, in government and society.

Yours sincerely

Marthi Harmse, Andy Msiza & Lourette Slaghuis
Conference Organising Committee

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ACKNOWLEDGEMENTS

The Conference Organising Committee would like to acknowledge the following sponsors and exhibitors. Their generous support enhances both the Industrial Engineering and Operations Research professions, thereby improving the quality and productivity of business strategies and operations in manufacturing and service industries – and the growth and sustainability in Southern Africa.

Sponsors

Sasol Ltd. (main sponsor)
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Siemens Ltd.

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The IQ Business Group

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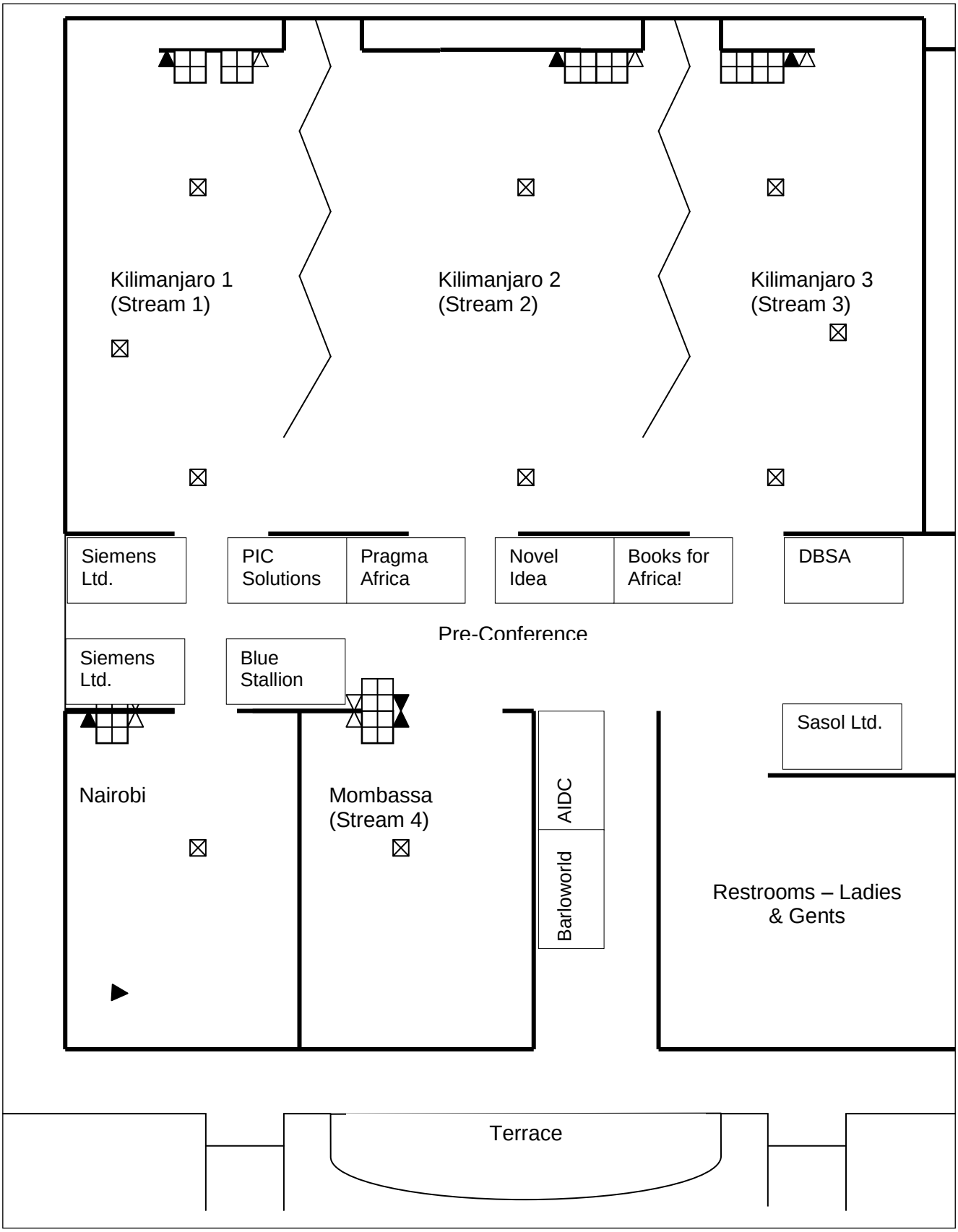
MAP OF VENUE

MAP OF CONFERENCE FACILITIES



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HOUSE RULES

In order to get the most out of the event, please take note of the following:

Special Events

There is no extra charge for delegates registered for the full conference to attend the social functions, but please ensure that you complete the special events register at the Help Desk to assist us in catering to all your needs. You will receive a reservation card that will enable you to participate.

Help Desk

For assistance and/or information contact Petra Lawson at the conference registration desk or on 083-231-6538.

Mobile Phones

Please ensure that your phone is switched off during sessions as not to disturb your colleagues and the presenters.

Smoking

Smoking is only permitted in designated areas.

Evaluation Forms

Please complete the evaluation form in your file and place it in the holder provided.

Name Tags

Name tags should be worn by all participants at all times during the conference.

Session Chairs

All session chairs should ensure that they receive a folder for the relevant session at registration. It is important that all speakers should meet with the session chair during the break prior to their presentation. Please note that no sales related presentations will be allowed.

PROGRAMME

General | Business improvement strategies | Modelling, decision analysis & simulation | Information technology | Project management | Supply chain | Reliability & quality | Labour | Advanced technologies | Keynote speaker & Guest speaker

All plenary sessions are in Kilimanjaro 1,2&3
Stream 1 is in Kilimanjaro 1, Stream 2 is in Kilimanjaro 2, Stream 3 is in Kilimanjaro 3 & Stream 4 is in Mombassa

Sunday 28 August 2005				
16:00-19:00	Registration			
19:00-22:00	Welcoming function sponsored by the Development Bank of Southern Africa			
Monday 29 August 2005				
08:00-09:00	Late registration			
09:00-09:30	Opening address: Ralph Gunn, president of SAIIE			
09:30-10:30	Keynote address: Jannie van der Westhuizen, Sasol Ltd. *Sustaining substantial profit growth through innovative practices: a Sasol case study*			
10:30-11:00	Keynote address: Raj Siriram, Siemens Ltd. *Enterprise Engineering*			
11:00-11:30	Tea			
11:30-12:30	Guest speaker: Alexis Tsoukiàs, president of EURO *A historical perspective on the profession of Operations Researcher and Industrial Engineer and the challenge sustainability represents for our methodology, theory and practice*			
12:30-13:30	Lunch			
	Parallel session 1 stream 1: ***Economic modelling***	**Parallel session 1 stream 2:** ***Perishables***	**Parallel session 1 stream 3:** ***Agriculture***	**Parallel session 1 stream 4:** ***Advanced techniques & approaches I***
13:30-14:00	Gyula Magyarkúti & Petrus Potgieter *The classical and the computable approach to economic models*	Leon Erasmus *The twins of operational success*	Johan Joubert, Ozias Ncube & Jean-Pierre Luhandjula *Management of a South African game ranch through an optimisation model*	PM du Plessis, Giel Hattingh & Hennie Kruger *A mathematical programming approach to simultaneously discard data points, select regressors and make transformation decisions in regression modelling*
14:00-14:30	Jan Kruger *Stock market timing with a Markov model*	Chris Kritzinger & James Bekker *Generic modelling software for fruit packaging*	CJ Lourens & Poobie Govender *Optimising the management of a game farm by utilising techniques of computational intelligence*	Jean-Pierre Luhandjula *Fuzzy stochastic optimisation: Survey and future research directions*
14:30-15:00	Helena Fernandes & Philip Pretorius *A comparison of the effectiveness of different models in forecasting interest rates*	Jeanne le Roux & Jan van Vuuren *Strategic location decisions in a perishable product supply chain*	Esbeth van Dyk *Implementing farm-to-fork traceability in Tanzania*	Martie Muller *A Bayesian belief network for sea mine burial prediction*
15:00-15:30	Tea			
15:30-17:00	AGM			
18:00-21:00	Social event			

Tuesday 30 August 2005				
	Parallel session 2 stream 1: *Knowledge management*	**Parallel session 2 stream 2: *Transportation***	**Parallel session 2 stream 3: *Petrochemical industry***	**Parallel session 2 stream 4: *Education & Consultation***
08:00-08:30	Niek du Preez, Mark Gething & Marize Mostert *The deployment of a sustainable knowledge management architecture for improvement in the competitiveness of research in the South African Manufacturing Industry and advancement in local collaboration for innovation*	Esther Cronje & Johan Joubert *Optimisation of an empty container relocation network: a case study at TrenStar SA (Pty) Ltd*	Martin Albertyn & Paul Kruger *Generic simulation modelling of petrochemical plants*	Philip Pretorius & Anna Pretorius *Identification of engineering students at risk*
08:30-09:00	Larry Jenkins *Knowledge management in manufacturing*	JD Marx, James Bekker & W van Wijck *Development of a scheduling model and solution algorithms for vehicle carriers*	Marthi Harmse & Andrew Wilson *Coal value chain optimisation – planning*	Liezl van Dyk & Pieter Conradie *Intelligent education systems to educate intelligent students*
09:00-09:30	JW Uys, L Louw, Ernst Uys & Niek du Preez *A conceptual framework based approach for the improved viewing and utilisation of organisational databases*	Neil Jacobs *Arrangement of palletised freight to prevent axle mass overloading*	Johan Janse van Rensburg, Melanie Fourie & Marinda Swart *Coal value chain optimisation – simulation*	Paul Fatti *The science of better: How to be a better OR consultant*
09:30-10:00	Sarma Yadavalli & KH Setlhare *Analysis of optimal promotion policy for a manpower system by queueing approach*	Tony Paterson *The relationship between unpredictability and control in the fabrication of welded aluminium structures for the transport sector*	Marinda Swart *Coal value chain optimisation – scheduling*	Johann Basson *Global growth and sustainability: Are we beating about the bush?*
10:00-10:30	Tea			
	Parallel session 3 stream 1: *Portfolio management*	**Parallel session 3 stream 2: *Manufacturing & Maintenance***	**Parallel session 3 stream 3: *Energy management***	**Parallel session 3 stream 4: *Government***
10:30-11:00	Greg Clack & Wim Gevers *A multi-criteria decision framework for capital project selection in a group decision environment*	Poobie Govender *Production optimisation using swarm intelligence*	Leilani Morison & Johan Joubert *Application of ant colony optimisation to the fuel distribution problem*	Stephen Jacobs *South Africa: Sustainable or Time Bomb? The Natural Step to Survival*
11:00-11:30	Madeleine Groenewald & Philip Pretorius *Measuring and managing risk in portfolio selection*	Hagen Nieberding & Niek du Preez *Roadmaps for engineering design*	S Kauchali, AM Moodley, BP Hausberger & D Glasser *Safe packaging and distribution of illuminating paraffin in South Africa: application of a distribution and supply model*	Jan Greben *Several methods of trend analysis applied to the South African elections*
11:30-12:00	Niek du Preez & Bernard Katz *The integration of traditional project management techniques with a methodology to manage innovation*	Dimitri Dimitrov, Konrad Von Leipzig & Daniël Malherbe *Benchmarking in the tooling industry with a special focus on the automotive supply chain*	Danie Payne, Jan Harm & Philip Pretorius *An OR challenge for more accurate electrical load forecasts*	Marita Turpin *The use of morphological analysis to assist local authorities with a crime prevention strategy*

Tuesday 30 August 2005 (cont)				
12:00-13:00	Lunch			
	Parallel session 4 stream 1: *Portfolio management* (cont)	**Parallel session 4 stream 2: Manufacturing & *Maintenance (cont)***	**Parallel session 4 stream 3: *Advanced techniques & approaches II***	**Parallel session 4 stream 4: *Government (cont)***
13:00-13:30	Ozias Ncube, Jean-Pierre Luhandjula & Johan Joubert *A fuzzy stochastic multi-objective linear programme formulation of a portfolio selection problem*	Igor Gorlach *Applications of thermal spaying protective coatings*	Theodor Stewart *Data envelopment analysis for planning and control*	Willie Krause *Better processes to curb unemployment: creating liquid hybrid solutions for process improvement*
13:30-14:00	Tilla van der Walt *What is Six Sigma?*	Frans Erasmus *Quantitative decision making techniques and the maintenance practitioner in non-continuous operational environments*	Sarma Yadavalli, Annemarie Adendorff & Gert Erasmus *Analysis of the dynamic characteristics of a practical system of congestion using chaos generation*	Chris Kumile & TG Nenzhelele *Productivity enhancement within the small and medium enterprises: Garankuwa industrial cluster case study*
14:00-14:30		Andrew Meyer *A pragmatic approach to manage obsolescence risks of complex or long-life systems*	Clemens Dempers & Andrei Borshchev *Pedestrian Models with Anylogic - an agent based approach*	Raj Siriram *Sustainable development through networks and clusters*
14:30-15:00	Tea			
15:00-15:30	Keynote address: Fayaz Sacoor, Automotive Industry Development Centre *Key challenges in the automotive supply chain*			
15:30-16:00	Keynote address: Danie Schoeman, Barloworld *The role of Engineering within a Supply Chain*			
16:00-17:00	Cobus Rossouw (Volition), Johan Louw (Sasol), Johan Strasheim (University of Pretoria), Hans Ittmann (CSIR) & Raj Siriram (Siemens) *Panel discussion on the past and future contribution of Industrial Engineers and Operations Researchers in the evolution of the supply chain profession. Sponsored by Volition Consulting Services*			
19:00-24:00	Gala dinner sponsored by Sasol Ltd.			

Wednesday 31 August 2005			
	Parallel session 5 stream 1: *Logistics*	**Parallel session 5 stream 2: *Metallurgical industry***	**Parallel session 5 stream 3: *Retail***
08:00-08:30	Alwyn Moolman & Sarma Yadavalli *Logistic management with Logicslink, a system built on adaptive object modelling*	LF Scheepers, P Olivier & RA Featherstone *Optimisation of the Mittal Steel SA metallurgical supply chain using linear and mixed integer programming*	Christopher Comodikes *A practical guide to structuring a forecasting process in your organisation while considering the latest trends and dispelling the myths*
08:30-09:00	Hans Ittmann *Humanitarian logistics – a new form of logistics?*	Tony Hearn *Decision support in a pyrometallurgical process using a knowledge-based expert system*	Sharief Allie *The use of data in optimising consumer credit strategies: a case study*
09:00-09:30	Tea		
09:30-10:00	Keynote address: Dave Evans, Development Bank of Southern Africa *The role of Operations Research and Industrial Engineering in development*		
10:00-11:00	Guest speaker: Alexis Tsoukiàs, president of EURO *Constructing meaningful and useful indexes, analysing how indexes from the human development index to the pollution index are constructed and how Multiple Criteria Decision Analysis can help: a practical case concerning quality evaluation*		
11:00-11:15	Closing address: Wim Gevers, president of ORSSA		
11:15-11:30	Speaker prize-giving: Awards will be presented to the best student speaker and the best professional speaker.		
11:30-12:30	Lunch		
12:30-17:00	Industry visits: 12:30-16:30 Eskom (Lethabo power station, capable of producing 3 708 MW electricity from coal) 12:30-16:00 Mittal Steel (Vanderbijlpark Steel Operations, producing 84% of SA's flat steel requirements) 12:30-16:00 Sasol Chemical Industries (Sasolburg plant, producing chemicals from natural gas) 12:30-17:30 Sasol Mining (Sigma underground coal mine, supplying about 2M tons of coal p.a. to Sasol steam stations)		

Sustaining Substantial Profit Growth through Innovative Practices

Jannie van der Westhuizen
Group General Manager, Sasol Limited

The purpose of this presentation will be to suggest a people centred approach towards improving and sustaining business success. Reference will be made to the approaches of great South African leaders, most notably Dr Nelson Mandela, previous president of South Africa.

Reference will also be made to the fact that orchestrated leadership can unlock immense potential in the existing resource base. In this regard, benchmarking to discover appropriate best practices is crucial, as well as the integration of those best practices that can bring about lasting improvement in business results.

A strategic framework for maximizing the people's value proposition will be shared. Such a framework can bring about potential far greater than can be imagined.

However, a vigilant eye has to be kept on poor performance, because it has to be addressed to be able to sustain the improvements that will follow the entrenchment of a renewed world-class work ethic.

Before concluding by means of some advice for the future South Africa, a typical Sasol case study will be shared, covering aspects like:

defining global leadership;
leadership philosophies;
logical sequence of events bringing about dramatic profit growth;
transformation processes and journeys;
continuous improvement;
effective communication; and
learning points, i.e. the secrets, as well as demonstrating a distinct leadership style.

The case study will demonstrate an approach whereby Sasol Mining transformed from a struggling mining company to a leader in its field. In a period of five years the profit improved six fold, productivity more than doubled, the value proposition of the people improved dramatically, the EVA exceeded all expectations and the company won the Platts / BusinessWeek Global Coal Company of the year 2002 award.

Enterprise Engineering

Dr. R Siriram
Siemens Ltd SA

This presentation addresses the need for enterprise engineering encompassing changes towards the 21st Century. The presentation underpins and identifies risks between changes in technology and how these changes have affected people and how organizations have adapted. It reflects some critical elements in enterprise engineering. These elements include the re-invention of enterprise structures and governance structures amongst others. It covers aspects of strategic visioning, change processes, assessment processes and information engineering. Technology is used as a trigger to explain market changes. Market changes are then used to explain enterprise engineering.

Success factors ranging from knowledge management, relationship management and organizational learning are also covered. The paradigm shift from industrial worker to knowledge workers is discussed. The presentation moves towards economic models of the firm and demonstrates how firms may cope with competitive advantages. New visions moving towards customer delight, responsiveness to markets, strategic opportunities from re-engineering the IT function to empowering the workforce is highlighted.

The presentation ends posing a dilemma of results now thinking versus new paradigm thinking. Furthermore key questions around change models, building processes and management processes is also covered.

A historical Perspective on the Profession of Operations Researcher and Industrial Engineer and the Challenge Sustainability Represents for our Methodology, Theory and Practice

Alexis Tsoukiàs
President of EURO

The aim of this presentation is to reflect about the contents of the ``decision aiding'' profession and the methodology and theories to that associated. I first introduce a brief (and personal) reconstruction of the history of Operational Research and Decision Theory. In such a reconstruction I try to focus on the ``extensions'' of this theory during the last 60 years and to justify my claim that there have been several ``decision theories'' developed, all of them with a different legitimisation background.

I then try to identify what ultimately characterises the profession of a ``decision analyst'' or of an “operational researcher” compared with other professions where decision aiding is also practiced such as lawyers and psychotherapists. Two main features are thus identified: - the abstract and formal language used in conducting the decision aiding; - the use of a model of rationality at least as legitimisation for action. Bearing in mind these characteristics we can try to analyse the activities undertaken by an “analyst” when a client contacts him/her for receiving decision support. In order to introduce a formal frame to such activities I introduce the concept of ``decision aiding process'', a particular type of decision process.

The introduction of these concepts allows on the hand to change the perspective as far as the different decision theories are concerned and the other hand to focus our attention on the type of outcomes this process generates. I therefore use this frame for both analysing the different decision aiding approaches discussed in the literature and for characterising the type of activities used in order to provide decision support. This last analysis allows us to get also several operational recommendations which can be sent in order to train young professionals in decision aiding.

The Classical and the Computable Approach to Economic Models

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We shall consider some topics in modern (micro-) economic theory, in particular the modelling of rationality (of producer or consumer preferences) − not only from the classical point of view but also when considering computability as a criterion of rationality and as a condition for obtaining computable (in the broadest sense possible) solutions from model inputs. These are issues occurring in many OR applications, for example decision analysis, and in all applied economic theory. Two separate issues are kept in mind: (1) whether the problem is well posed, i.e. a solution exists, and (2) whether the solution can in principle be found, for example through simulation.

Keywords: rationality, equilibrium theory, computability

Stock Market Timing with a Markov Model

Dr. Jan Kruger
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R. R. Pariseau accepted the hypothesis that a Markov chain model can model Stock exchange prices for the New York Stock exchange and developed an ad-hoc timing model. By following the same procedure, the hypothesis is also accepted on JSE data.

A potential buyer wants to identify the end of a bear market so that he can buy while shares are still freely available, but before the Bull run rush starts and the shares get bid too high. A seller on the other hand wants to sell before the Bear run when buyers still bid up the share price and buyers immediately buy the shares that come onto the market. With a Stochastic model the probability of a change in state can be calculated and a decision to change strategy according to the state expected can be implemented.

Pariseau's timing model to JSE data (assuming a 15% transaction cost) yielded 0.3% p.a., while the market yielded 11% p.a. over this time period. Pariseau showed that his timing model delivered good returns on the New York Stock exchange.

Research problem: Find a reference to (being original at this stage of the research will detract from the main research thrust):
Given an observed process where a variable changes between three discrete states over discrete / continuous time, assume and fit a Markov chain model with ergotic states and find a hypothesis test to test the assumption.

Note: Books only refer to the Kolmogorov Smirnov test, but does it test the assumption or merely the elements in the transition matrix (Confirms that waiting time in a state before transition has an exponential distribution).

A Comparison of the Effectiveness of Different Models in Forecasting Interest Rates

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Dr. PD Pretorius
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Interest rate risk is one of the most important types of risk to which banks are continually exposed. Interest rates determine a bank's profitability and have an effect on a bank's liquidity and investment portfolio and it is, thus, extremely important to manage interest rate risk effectively. In managing interest rate risk, it is important to predict interest rates as accurately as possible. Several models are available for this purpose. The effectiveness of these models for forecasting over different time horizons is compared.

The Twins of Operational Success

Leon Erasmus
Director: Business Development Engineering
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Operational key performance indicators must be given the same importance as information that measures the financial success of business operations. Too often business process decisions are made without understanding fully the impact this has on efficiency, and the knock-on effect this has on costs. But to get there management is overwhelmed with information – much of it inappropriate.

Decisions are often made in ignorance because management has the wrong, or insufficient, data with which to evaluate their impact. Information overload is a common problem and managers are often unable to pick out what is relevant.

Devising and implementing an information gathering and management process is vital if operational and financial key performance indicators are to be given equal weight in the business.

This presentation will focus on:

- Understanding the need to put in place management systems that accurately gather information about the entire business process;
- Understanding the level of detail required to identify inefficiencies before taking corrective action;
- Evaluating the inflows of data that inform KPIs to ensure these measures of business success are not delusional;
- Understanding the cost and efficiency benefits of keeping systems straightforward by identifying what actions are essential and what are merely nice-to-have;
- Using a case study in the Fast Moving Consumer Goods industry where operational efficiencies have resulted in a leaner operation, enabling a logistics company to deliver superior service to a leading supermarket, and
- Understanding the techniques, technology and tools that are required to support the collection and analysis of data so it is an effective aid to management decision making.

Delegates will learn that improving systems and processes is a continual process if cost effectiveness along the supply chain, and return on investment, is to be achieved. They will have the understanding necessary to develop a formal management system on which to base a culture of continual business process improvement.

Generic Modelling Software for Fruit Packaging

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Traceability requirement for export fruit has greatly increased (down to orchard level) in the last few years, with more countries requiring stricter traceability each year. The result is that fruit destined for these markets must now be packaged individually (each orchard). This, in turn, has greatly increased the deviations between consecutive packaging runs (more difficulty in planning and controlling quality), while decreasing the duration of runs (more time spent on setup). By modelling fruit packaging, possible pack line changes can be evaluated, quality control can be improved and more effective planning and scheduling can be achieved. Generic modelling software is now being developed that models all processes found in the South African fruit industry.

The first stage of the project is to test the concept and software using Citrus packaging processes and data. The modelling software will be verified and validated by testing it at more than one Citrus pack house in the Western Cape. It will then be extended to include all fruit types and relevant processes. The project was initiated and is being funded by *Vizier Systems Ltd*.

During the presentation the typical processes for Citrus packaging will be discussed the Generic Modelling concepts used will be discussed and the modelling software will be demonstrated.

Strategic Location Decisions in a Perishable Product Supply Chain

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Logistical decisions about the number, location and capacity of facilities within supply chains are classified as on strategic level. Such decisions have a long-term effect. Decisions on tactical level are updated every week, month or quarter, such as for inventory control purposes and the transportation of goods. The operational level consists of day-to-day decision-making, as in the scheduling and routing of vehicles.

Blood transfusion services perform two main functions: the collection and issuing of blood. The merging of previously independent blood transfusion services in South Africa, to form the South African National Blood Service (SANBS), necessitates new operational, tactical and strategic decisions. Blood is a perishable product that must be kept cold in the transportation chain from supply to processing to demand points.

We will describe a strategic decision-making problem within this perishable product supply chain system. We will also present a literature overview of mathematical programming formulations of network location decision problems.

Keywords: location, supply chain, perishable product, mathematical modelling

Management of a South African Game Ranch through an Optimisation model

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Management of a game ranch is an important issue as many game ranches operate on meagre profits, and some even at a loss, as their part-time owners subsidize the ranches from other sources of income. Often their operations are too small or not attractive enough to focus on eco-tourism. Even larger game ranches battle to earn the equivalent of the risk-free rate in the money market today, because land prices are generally too high and game selling prices too low. Game ranching has many facets, including biological, ecological, eco-tourist and financial elements. All these facets have financial implications. Successful game ranching requires a holistic and diverse approach, encompassing all these facets. In this paper we address this problem in a South African context through an optimisation model. To obtain a faithful picture of reality, the model include several conflicting, yet realistic objective functions, and takes into account the fact that annual rainfall is only known according to some probability. An approach for solving the resulting multi objective integer linear stochastic program is discussed and illustrated with a numerical example from a Northern Cape ranch. The authors solve the numerical example exactly, as well as using multiple metaheuristic algorithms, compare the results from these algorithms, and comment on larger instances of the problem for which exact solution algorithms would be inappropriate, i.e. using more accurate rainfall distributions, and incorporating longer planning horizons.

Keywords: optimization, multi-objective, integer programming, stochastic programming

Optimising the Management of a Game Farm by Utilising Techniques of Computational Intelligence

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Game reserves are a major tourism attraction for South Africa. Like any other business a game reserve has to be efficiently managed to ensure its sustainability. Techniques of industrial engineering can be applied to optimize the management and the sustainability of a game park.

One factor affecting the sustainability of a game park lies in the efficient management of its vegetation. Grazers such as elephants consume huge quantities of vegetation on a daily basis. The challenge facing the park's management is to determine the migration and feeding patterns of these animals. This information can be used to develop a strategy that would ensure the sustainability of the ecosystem in terms of how well the available resources of the park can support it population.

Determining the migratory patterns of different herds would require a system of identification for these animals. Techniques such as animal tagging and satellite tracking collars have been developed to identify animals such as farm livestock and wild animals on a game reserve. Some identification systems utilize a scanner to scan the animal and pick up a signal from a microchip that is embedded somewhere within the animal's anatomy. This technique is suitable for identifying domesticated animals such as livestock; in the case of wild animals such as elephants, being in the close proximity of the animal would be dangerous. Tracking systems utilizing satellite tracking collars are often used to track wild animals in order to observe their behaviour patterns as they forage for food, but these techniques are expensive and the data recovered from them would have to be analysed by a skilled statistician.

Given the above-mentioned scenarios, a techniques utilizing computational intelligence will be proposed to overcome the shortcomings of the above-mentioned approaches. The proposed method will use an image identification system that makes use of neuro-computing techniques to identify different animals within a herd. When implemented in real time, images from strategically located cameras could be used to process the data to identify the animals and hence determine their pattern of migration throughout the park. This information can be used by management to plan the efficient utilization of the park's resources in order to guarantee the sustainability of the ecosystems that exist within it.

Implementing Farm-to-Fork Traceability in Tanzania

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Food safety is a major concern for consumers and retailers in Europe. In the last decade there has been a series of food scares such as mad cow disease, foot and mouth disease and salmonella poisoning. Due to these events the EU has decided to reform its food policy, resulting in a range of new legislation. The overarching regulation is the “General Food Law”, Regulation (EC) No. 178/2002. In the USA food safety is also a major concern due to possible terrorist activities. This has led to the US Bioterrorism Act.

The new legislation implies that no food or feed products may be exported to the EU and the USA unless the exporter and importer can provide evidence that a detailed record keeping system is in place throughout the whole supply chain to provide traceability back to the source and to support product recalls in case of any problems. The traceability requirements are quite demanding to comply with, even more so for developing countries such as Tanzania, where small quantities of produce from numerous smallholders are combined into a single batch.

This paper will give a brief overview of the traceability requirements of the EU and USA legislation and of the Tanzanian project in which the author is involved. The coffee supply chain in Tanzania and its challenges in meeting the traceability requirements will be described. This will be followed by a discussion of the recordkeeping system, which is under development.

Keywords: traceability, food safety, coffee supply chain

A Mathematical Programming Approach to Simultaneously Discard Data Points, Select Regressors and made Transformation Decisions in Regression Modelling

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The paper aims to make a contribution to regression modelling where suspicious data, regressor selection and transformation selection are factors to be considered. Models based on mathematical programming techniques are discussed that consider data elimination, regressor selection and transformation selection simultaneously. Empirical results will be presented.

Keywords: forecasting mathematical programming, computer science/applications to OR

Fuzzy Stochastic Optimization: Survey and Future Research Directions

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In many concrete situations, one has to combine evidence from disparate sources and, as a result, to grapple with both probabilistic and possibilistic information.

Such a hybrid intellectual context has opened new vistas for finer webs of ideas from probability and fuzzy sets theories that has been spinned even culminating in such notions as probability of a fuzzy event, probabilistic set, fuzzy random variable, random fuzzy variable. These notions have been explored with good reasons to permit incorporation of both fuzziness and randomness in an optimization framework-giving rise to the field of Fuzzy Stochastic Optimization.

In this paper we survey this emerging field with an eye to some important themes and questions that deserve further consideration. We also indicate some promising research directions.

Keywords: fuzziness, randomness, fuzzy random variable, optimization

A Bayesian Belief Network for Sea Mine Burial Prediction

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One of the Mine Warfare objectives of the SA Navy is to counter a sea mine attack on South African Sea Lines of Communication by detecting and neutralising such minefields. The collection and interpretation of sea bottom and other environmental data are essential in order to achieve this objective. Oceanographic sampling is time and cost intensive and therefore it is important to model existing expert knowledge regarding environmental influences on mine warfare, before proposing an environmental sampling plan or monitoring program.

A Bayesian Belief Network (BBN) is a data-mining tool that organises information on causal independence concerning a collection of interrelated events into a graph theoretical network. With this as structure, the principles of conditional probability are applied to evaluate the likelihood of certain events, depending on the information available at evaluation time.

Firstly, a Bayesian Belief Network (BBN) was used to model expert knowledge regarding environmental factors that may influence mine burial on the sea floor. Secondly, available environmental data was used to investigate the utility of data (vs. expert knowledge) in the same Bayesian Network. The results from the BBN based on expert knowledge were compared to the results from the BBN based on measured data. The implications for research and the interpretation of results will be discussed.

Keywords: Bayesian Belief Network, Mine Warfare, Mine burial, Sea Mine, Modelling, Expert knowledge

The Deployment of a Sustainable Knowledge Management Architecture for Improvement in the Competitiveness of Research in the South African Manufacturing Industry and Advancement in Local Collaboration for Innovation

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The South African Manufacturing Industry is perfectly poised to take advantage of the growing awareness of its participants for the need to collaborate and grow together as an industry.

Globally, competitive manufacturing is driven by exponential increases in development speed and the ability to rapidly produce a variety of products. Market penetration and the success of manufacturing initiatives are determined by the ability to compete on cost, quality and lead times as base standards. The ability of a manufacturing initiative to become industry champions however, relies on innovation and flexibility.

With a few exceptions the development of propriety technology has not been a feature of the South African Manufacturing Industry and local firms are generally characterized as being low spenders when it comes to innovation.

The ideal situation is to provide the local manufacturing industry with a medium through which it can grow, combining efforts and resources for the benefit of the group. This medium must be adapted to the uniqueness of the South African Environment, which can use local and international expertise to compete in selected niche markets.

The GCC of the University of Stellenbosch has designed a Web Portal – The Knowledge Dome – to apply Enterprise Engineering concepts such as Knowledge Management, Change Management and Innovation Management to the Manufacturing Value Chain in order to improve the collaborative efforts of the industry and help it become globally competitive.

The Portal is designed to give users access to the type of information they require for their particular needs. To do this, the information is captured and organized into one of four layers - ranging from broad-scope to highly-specific information. Structuring information in this manner is where the true value adding potential of this project lies.

Keywords: Knowledge Management, Innovation, Competitiveness, Collaboration, Manufacturing, Web Portal

Knowledge Management in Manufacturing

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The presentation surveys how knowledge management (KM) is, and can be, used to advantage in the manufacturing sector. Ongoing manufacturing operations, maintenance, supply chain management, design and development of new products all have the potential to benefit from KM. However, KM as something of a buzz word, covers the gamut from simply having company standard operating procedure published on an intranet to the type of cultural change necessary for sharing of informal ideas on a daily basis.

The paper categorizes the range of approaches covered under the general rubric of KM, and discusses the practicalities and limitations of implementing and benefiting from KM in manufacturing organizations. Some South African examples are used to illustrate different approaches and different levels of success.

Keywords: Knowledge management, Manufacturing, Maintenance, Supply Chain

A Conceptual Framework (CF) Based Approach for the Improved Viewing and Utilisation of Organisational Databases

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For a business to remain competitive in the global marketplace, agile decision-making capability is of the essence. A thorough understanding of the organisation's high-level entities and their relationships, modelled in a Conceptual Framework (CF), facilitates fast, well-informed business decisions.

There are three important informational resources which may serve as inputs to the CF: (a) electronic organisational documents, (b) organisational databases, and (c) organisational experts. Although electronic documents contain information about virtually all aspects of the organisation, it is difficult to automatically extract concepts from these documents due to the difficulty of interpreting natural language and unstructured information in general.

Organisational databases, on the other hand is used for, and populated by the execution of everyday organisational activities. Data/information in databases is more structured and therefore easier to exploit for the automatic population of the CF. In order to extract useful information from databases, SQL queries need to be compiled and executed. This requires specialised skills that decision makers usually do not have. Furthermore, the information returned by queries usually does not lend itself to easy interpretation because (a) the names of database entities are usually hard to interpret due to the cryptic field and table names used in database design, (b) query results are usually non-graphical. A CF facilitates easier exploitation of organisational information by means of visual querying. This is done by clicking on self-explanatory entity and relationship names.

The CF is created with the aid of the organisational experts, having knowledge of all the important concepts/entities in the organisation as well as the relationships/allowed interactions between these. In order to populate the CF with actual information, it is linked to key informational entities residing in one or more organisational databases. A Mapping Layer is used to realise and maintain the interface between the relevant databases and the CF.

Keywords: database, ERD, ontology, concepts, relationships, data, information, knowledge

Analysis of Optimal Promotion Policy for a Manpower System by Queuing Approach

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In this competitive world with large number of qualified persons, manpower planning draws a serious attention of the researchers engaged in this field, as any organization requires employees with specialized sill in various fields. Through man power planning the management of any organization not only optimises the expertise and skills of its human resources but also can choose the optimal number and right kind of persons of the right pace and the right time. This paper introduces a queuing approach to determine optimal promotion policy and total optimal cost of the promotion for the manpower planning system. Variation-effect of various parameters on the total optimal cost of the system for the promotion has also been assessed by the use of numerical illustration of the model.

Optimisation of an Empty Container Relocation Network: A Case Study at TrenStar SA (Pty) Ltd

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In this presentation the problem of distributing empty containers is addressed. The problem originates from a South African company, *TrenStar*.

TrenStar hires different types of containers to its customers, mainly in the automotive industry. These inland customers use the containers to pack and ship their parts or products to the assemblers, situated at the coast. The main reason for *TrenStar*'s unbalanced network is the fact that there are not a significant number of customers making use of the return leg. In order to be able to satisfy future demand, *TrenStar* has to relocate the empty containers between their depots around South Africa. This is a costly activity, and the number of relocations should be minimised, without undermining the ability to fulfil demand. This trade-off is addressed through an Operations Research network relocation optimisation model.

The *TrenStar* problem forms part of the group of Empty Container Allocation Problems (ECAP). The specific instance of the ECAP is formulated as a static, deterministic, multi commodity problem, where the stochastic demand is addressed by forecasting the demand and incorporating these deterministic values into the model. To solve the ECAP, the Simulated Annealing meta-heuristic is applied. In addition to computing the relocations, the ECAP algorithm is also employed to conduct a what-if analysis to determine the optimal fleet size for the following planning period.

The model results are compared with actual relocation data obtained from *TrenStar*. A research agenda is also proposed for empty container allocation and relocation problems.

Keywords: Empty Container Relocation, Network Optimisation, Fleet sizing

Development of a Scheduling Model and Solution Algorithms for Vehicle Carriers

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Automotive manufacturers frequently outsource the transportation of manufactured vehicles to companies that have specialised vehicle carriers. Consequently, companies that specialise in vehicle transportation are faced with complex vehicle routing problems (VRPs).

These vehicle routing problems are complex for a number of reasons: Firstly, vehicle transportation companies typically own a heterogeneous fleet of carriers. The carriers differ in the speed at which they travel and the number of vehicles they can carry. Secondly, the manufactured vehicles cannot be modelled as a single commodity (which is an underlying assumption in most VRPs), since the vehicles differ in size. As a consequence, not every vehicle can be loaded onto any slot of a carrier, and unique loading rules are required to describe the allowable relationships between carriers and vehicles. Thirdly, unlike most VRPs, there is no clear distinction between customers and depots, as any customer can receive or despatch vehicles. Fourthly, a vehicle can be routed on various carriers to its destination.

Vehicle transport companies require the ability to address this vehicle routing problem as well as the ability to examine the effects of various changes to their fleet and customers to ensure long and short-term profitability.

This paper discusses the development of a scheduling model and solution algorithms that were used to solve a vehicle routing problem for a vehicle transport company, as well as its implementation in a software tool that can be used to simulate various changes to a scheduling model.

Keywords: Vehicle routing problems, Scheduling Algorithms.

Arrangement of Palletised Freight to Prevent Axle Mass Overloading

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Public roads are designed to carry vehicle traffic of a specific axle mass profile during its design life. Government establish axle mass limits to protect the infrastructure. These axle mass limits are clearly described in legislation and the laws are enforced by traffic authorities through the use of weighbridges that measures the downward forces that a vehicle and its load exerts on the road in the different axle positions.

A vehicle is normally specified to distribute its maximum load across all its axles. If the load on board a vehicle is within the carrying capacity of a vehicle and homogeneous, then an even distribution of the load across the load bed will normally ensure compliance. If the freight units are of varying mass, then each specific arrangement creates a specific set of forces in the different axle positions. A subset of arrangements exists for some of these loads that may not comply with legislation and methods need to be developed to find legal arrangements, if it exists.

A particularly challenging problem is created when the arrangement of freight units is such that any variation of an arrangement can only be accomplished by changing the position of at least two freight units. This problem was studied for the case where the freight units have identical footprints on the load bed, such as encountered in the loading of palletised consumer goods. A solution is presented for this problem. The legal prescriptions and vehicle characteristics are coded as constraints in a mixed integer linear program that arranges pallets such that the overloading on any axle is eliminated or minimised while the left and right sides are also balanced. Variations of the problem and the challenges each variation poses are also discussed.

Keywords: measures to curb axle mass overloading, load arrangement, palletized freight

The Relationship between Unpredictability and Control in the Fabrication of Welded Aluminium Structures for the Transport Sector

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Transport applications are normally dynamically loaded. The extent of dynamic load depends on the specific routes chosen. Much of the service condition data is not available to fabricators at the time of tender. Because static loading is more dependent on material properties and dynamic is more dependent on joint detail or joint geometry information transfer is needed. Often this is not made available. In addition, people who, often, do not understand or have been involved in the design parameters judge the tender process. Even if they were, the fabricator is not asked to develop a method statement. Consequently the choice of a value package, a trade off between cost and value is difficult to achieve, difficult to judge. The paper will consider the aspect of welded construction for the transport industry, highlighting the issues that need be considered by both client and fabricator before fabrication is let and those that need be managed during fabrication to ensure that appropriate quality is built into the work; that clients return, not products.

Generic Simulation Modelling of Petrochemical Plants

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The key objective of this paper is to present a generic simulation modelling methodology that can be used to model a petrochemical plant (or any other stochastic continuous system) effectively. The generic methodology renders simulation models that exhibit the following characteristics: short development and maintenance times, user-friendliness, short simulation runtimes, compact size, robustness, accuracy and a single software application.

An example of a petrochemical plant (referred to as the Synthetic Fuel plant) is introduced and the characteristics of the plant are identified. A generic simulation modelling methodology that accommodates these characteristics is presented. It consists of the following eight methods and techniques: the variables technique, the iteration time interval evaluation method, the event-driven evaluation method, the Entity-represent-module method, the Fraction-comparison method, the iterative-loop technique, the time “bottleneck” identification technique and the production lost “bottleneck” identification technique.

One of the methods and techniques is used to determine the governing parameters of the system that is under scrutiny and the other seven are encapsulated in five high-level simulation model building blocks. The five high-level building blocks were used to construct identical simulation models of the Synthetic Fuel plant in two different simulation software packages, namely: Arena and Simul8. An iteration time interval and minimum sufficient sample sizes were determined and the simulation models were verified, validated and then used to evaluate two alternative scenarios. A comparison of the simulation models is provided and an example of the results is discussed.

Possible future developments are proposed and it is indicated that the range of application in the petrochemical industry includes the following processes: oil-from-coal, classic crude oil refinement and gas-to-liquids. To conclude, the most salient points of the paper are highlighted.

Keywords: Generic methodology, Simulation model, Petrochemical plant, Stochastic system, Continuous system, High-level building block, Arena, Simul8

Coal Value Chain Optimisation - Planning

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The coal supply from Sasol Mining to Sasol Synfuels in Secunda has a high variation of coal properties, especially the particle size distribution. As a result of this variation in the properties of the coal supplied to the Sasol Synfuels gasifiers, the pure gas production is not sustainable over the long term. An integrated set of tools was developed to facilitate optimisation of the Coal Value Chain. The focus was on ensuring sustainability of the pure gas volume produced by the gasifiers through optimising the supply of available coal qualities. The tool set consists of a planning model, a stochastic model and a scheduling model.

In this paper, the planning model is discussed. The Process Industry Modelling System (PIMS) by Aspen Technology, Inc. was used to develop the non-linear programme with an eight-week planning horizon. The objective of the planning model is reviewed, as well as the approach, including the scope of the project, assumptions made and data received. The structure of the model is furthermore explained with special reference to the integration of the model with the complete tool set. The paper is concluded by discussing the results obtained, conclusions, recommendations made and the implementation of the tool set. The stochastic model and scheduling model are discussed in separate papers.

Keywords: Supply Chain, Integration, Planning model, Non-linear Programming, Mining Industry

Coal Value Chain Optimisation – Simulation

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The coal supply from Sasol Mining to Sasol Synfuels in Secunda has a high variation of coal properties, especially the particle size distribution. As a result of this variation in the properties of the coal supplied to the Sasol Synfuels gasifiers, the pure gas production is not sustainable over the long term. An integrated set of tools was developed to facilitate optimisation of the Coal Value Chain. The focus was on ensuring sustainability of the pure gas volume produced by the gasifiers through optimising the supply of available coal qualities. The tool set consists of a planning model, a stochastic model and a scheduling model.

In this paper, the simulation model is discussed. ARENA was used to develop the simulation model for the coal supply operation, and its interaction with the Sasol Synfuels coal processing operation to determine the response of the gasifiers to the feedstock, as well as the infrastructure constraints on the physical system. The objective of the simulation model is reviewed, as well as the scope of the model, assumptions made and data received. The purpose of the model is discussed with reference of how it fits into the complete tool set. Discussing the results obtained, and the implementations of the model within the tool set conclude the paper. The planning model and scheduling model are discussed in separate papers.

Keywords: Supply Chain, Integration, Simulation model, Mining Industry, Petrochemical industry

Coal Value Chain Optimisation - Scheduling

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The coal supply from Sasol Mining to Sasol Synfuels in Secunda has a high variation of coal properties, especially the particle size distribution. As a result of this variation in the properties of the coal supplied to the Sasol Synfuels gasifiers, the pure gas production is not sustainable over the long term. An integrated set of tools was developed to facilitate optimisation of the Coal Value Chain. The focus was on ensuring sustainability of the pure gas volume produced by the gasifiers through optimising the supply of available coal qualities. The tool set consists of a planning model, a stochastic model and a scheduling model.

In a previous paper the basic development principles for the scheduling model were discussed. This paper focuses on the improvements to the original scheduling model to facilitate operational use. Improvements such as the use of Special Ordered Set variables, the structure of time variables, the total model structure and the role of the objective function will be discussed. Operational results will be presented. Special attention will be given to the integration of this model with the rest of the tool set as well as the integration with the operational environment. The planning model and stochastic model are discussed in separate papers.

Keywords: Supply Chain, Integration, Scheduling model, Mixed Integer Non-linear Programming, Mining Industry

Identification of Engineering Students at Risk

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The aim of this article is to describe an alternative mechanism for predicting success among engineering students at tertiary institutions. In search of such a model, the following inventories were used: a) The Study Orientation Questionnaire in Mathematics (SOM) and b) The Senior Aptitude Test Advanced (SAT L). For three consecutive years, first-year engineering students completed both questionnaires (SAT L and SOM) at the beginning of the year, before beginning to attend lectures. Based on first semester marks as well as senior year marks in the follow-up study, students were divided into two groups: successful students and those whose achievements were below par. This article further explores the differences between the successful and unsuccessful groups in engineering. It also investigates the predictive value of the Senior Aptitude Test Advanced (SAT L) and the Study Orientation Questionnaire in Mathematics (SOM) for first-year and senior students. The results of this study conclude that the SOM, certain sub-fields of the SAT L and final school results in mathematics and science can be used for the identification of engineering students at risk.

Keywords: Study attitude, engineering, predicting failure, study orientation in mathematics

Intelligent Education Systems to Educate Intelligent Students

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The streamlining of business practices and the more efficient use of information technology are necessary for higher education institutions (HEIs) to cope with pressures to improve productivity. Information technology is an enabler as well as driving force of changes concerning teaching and management practices at Higher Education Institutions (HEIs). The use of learning management systems (LMSs) in HEIs is growing exponentially. The purpose an LMS is to facilitate learning through the optimal use if information technology. Many research projects are confirming the advantages of LMSs from a pedagogical point of view. A spin-off advantage is the potential value of data that is captured by LMSs and related transactional systems. For example, demographic information or student performance can be linked to the login patterns of students. Conclusions drawn from this can aid in decision making concerning admission, training and assessment practices through LMSs.

The purpose of this paper is to investigate the potential of LMS data to support admission, training and assessment decisions. As case study the LMS (WebCT) login data of all first year students for the first quarter of 2005 within the School of Engineering (University of Pretoria) are combined with demographic and student performance data from other systems. For each student registered for each first semester course, the date, time and type of page is available for each visit to WebCT. A business intelligence approach is followed to create a warehouse of this data and to mine accordingly for meaningful patterns and correlations.

Keywords: Learning management systems, WebCT, Business intelligence

The Science of Better: How to be a Better OR Consultant

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In 2003 the USA Institute for Operations Research and the Management Sciences (INFORMS) launched its ambitious marketing campaign under the banner: “Operations Research: The Science of Better”. Central to improving the image of OR as the science of doing things better, is the need for practicing OR Scientists to improve their consulting skills. Based on experience gained from many years as an OR and Statistics consultant, the author presents a number of “tips, tricks and techniques” towards enabling the OR practitioner to become more effective consultant.

Keywords: Client, formulation, presentation, implementation

Global Growth and Sustainability: Are we beating About the Bush?

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Planning for growth and sustainability in South Africa needs to be conceptualised within the context of global growth and sustainability.

The Division for Sustainable Development of the United Nations Department of Economic and Social Affairs defines sustainable development as:

> *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

The author poses the question: "What is meant with 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'?"

The author endeavours to paint a holistic picture of the key issues that need to be addressed for sustainable development without compromising the ability of future generations to meet their own needs.

The question arises: "Are we as members of the scientific and engineering fraternity addressing the real issues for global growth and sustainability or merely beating about the bush?"

Keywords: Sustainability, World population growth, Global value system, Good governance, Excellence Models

A Multi-criteria Decision Framework for Capital Project Selection in a Group Decision Environment

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Everyone, generally, would like to make good decisions, or receive the greatest benefit from a decision made. Companies are no different in this respect and the process of selecting an investment project portfolio has become an important activity. This is, further, complicated by the fact that companies have multiple, and often, conflicting objectives in a situation of capital rationing.

This paper proposes a conceptual framework for project portfolio establishment, for application in an industrial manufacturing type environment, by integrating project evaluation and selection, a multi-criteria decision analysis technique and group decision-making. The project issues, the selection of a multi-criteria decision analysis technique and group decision-making are dealt with sequentially and then integrated to develop this conceptual framework.

In dealing with the project evaluation and selection issues, the triple bottom line is proposed to capture the multiple objectives of the company's decision context. The Analytic Hierarchy Process is proposed as the underlying multi-criteria decision analysis technique to support this conceptual framework. Group decision-making is investigated, and an aggregation procedure is suggested. Finally, the framework is applied to a case and the results presented.

Keywords: Project selection; multi-criteria decision analysis; group decision making

Measuring and Managing Risk in Portfolio Selection

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In order to properly evaluate the performance of investments and determine the best efficient choice for an investor with particular preferences for profitability and safety, one must quantify the risk taken to achieve a particular return. It is therefore important to perform accurate forecasting, linear programming formulation, risk/reward analysis, investment strategy formulation and monitoring to obtain an optimised portfolio. Thus, the construction of a portfolio of stocks in such a way, that risk is minimised for some given return target.

Keywords: Risk/reward analysis, portfolio selection, forecasting, volatility

The Integration of Traditional Project Management Techniques with a Methodology to Manage Innovation

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This paper presents the integration of traditional project management techniques with a methodology to manage an innovation project. Traditional project management techniques often fail to manage the complex and uncertain environment of most innovation projects. Further more the use of traditional project management techniques may restrict the creativity and flexibility required for a successful innovation as well as stifle an innovative culture. However innovation projects also require a level of structure and control in order meet the objectives of the project without exposing an organisation to unnecessary risks.

The paper first identifies the criteria for measuring a successful innovation and then presents an innovation management methodology, which encompasses these criteria. The methodology has four key components and these components are unified at the end of the methodology description.

The integration of the innovation management methodology and the traditional project management techniques is achieved by categorising a set of generic projects and indicating which project management techniques and methodology components are required at specific stages of the different generic project types. The aim of this exercise is to develop a technique, which a project manager can use to determine the level of innovation management and project management required at different stages of their projects.

Finally the paper presents a case study of a project in the financial services industry. The case study highlights the use of traditional project management techniques integrated with the innovation management methodology. It also identifies the successes and failures of the project and makes recommendations as to how the project balance between project management and innovation management could have been improved.

Keywords: Innovation, Project Management, Financial Services

Production Optimisation Using Swarm Intelligence

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Paradigms of computational intelligence, such as 'swarm intelligence' can be applied within a factory environment to improve the production process. 'Swarm intelligence is defined as being the collective cohesive behaviour that emerges from a group of social insects such schools of fish, a swarm of bees or a colony of ants. These so-called 'swarms' are constituted of 'simple individual agents' that exhibit an intelligent behaviour when they operate within a group in order to achieve a common objective.

Swarm intelligence has enormous potential for applications to various branches of engineering. Areas where swarm intelligence can be efficiently utilized include telecommunications routing, production scheduling and transport logistics. Our paper provides an overview of swarm intelligence and will focus on how it can be effectively utilized to optimize production within an industrial environment.

Keywords: computational intelligence, swarm intelligence, collective behaviour, intelligent agents, production

Roadmaps for Engineering Design

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The capability to perform engineering design and development is directly related to the health of the economy and therefore its sustainability. Projects such as the Gau-train, the pebble-bed nuclear reactor and the revitalisation of the South African railway transportation are not the only ways to stimulate the economy. They also have a long-term effect by establishing know-how, facilities and resources which can be utilised long after the project has been completed.

Given this background the department of industrial engineering has last year initiated a project, under the supervision of Professor Du Preez, to provide the engineer responsible for the execution of a design project with a tool to configure his own specific design methodology for his specific circumstances. This presentation and paper discusses the findings of the literature survey regarding product life cycles, models of the development process, the commonly available design methods and ways to select them, as well as the gap between the theory of design science and the practice in industry. The presentation concludes with a summary of the next phases of the project.

Keywords: product development, engineering design, design methodologies, design methods, design science

Benchmarking in the Tooling Industry with a Special Focus on the Automotive Supply Chain

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The Automotive Industry (AI) is the 3rd largest contributor to the SA GDP. It has been identified as one of the growth points specifically targeted by government, which introduced the Motor Industry Development Program (MIDP) in 1995. Over the last five years, the AI experienced an annual average growth rate of 37%.

Within the AI, tooling is a huge contributor not only to the financial success of the industry, but also to further development and refinements within specific models and ranges. The total tooling requirements of the AI is approximately R2bn annually. At present, 90% of this is imported, while the remainder accounts for 60% of the total tooling requirements in SA. There could thus be an annual trade advantage of R1.5bn if local tooling provides globally competitive services to the AI, and this would also facilitate the agreement with Original Equipment Manufacturer's (OEM) targets of reaching 75% local content.

The Department of Industrial Engineering (IE), University of Stellenbosch (US) developed a benchmarking tool to analyse the capacities of SA tool rooms. It is based on a similar model developed by WZL (The Laboratory for Machine Tools and Production Engineering, University of Aachen, Germany). The model focuses on 5 specific areas of competency, namely the manufacturing process chain, machine capabilities and utilization, costs, time utilization, personnel and order management. As a starting point, 3 SA Tool Rooms identified by the AIDC are to be benchmarked against available information from global competitors (WZL) and against each other.

Indicators are developed to compare focus areas and to determine the current situation of a tool room with regards to competitors. From these, improvement plans and procedures on an individual organization level and on a national level are developed in order for the entire industry to become more competitive.

This paper will present the detailed methods and preliminary findings of this study.

Keywords: benchmarking, tooling, automotive

Application of Ant Colony Optimisation to the Fuel Distribution Problem

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The distribution of commodities from one or more supply points to interim storage facilities in anticipation of forecasted customer demand is receiving a large amount of research attention. The improvement of fuel distribution from refineries to depots and finally to end customers is an interesting, yet complex instance of this type of problem. Although a large amount of literature concerning the basic distribution problem exists, the motivation for further study in this specific instance lies not only in the industry relevance, but also in the fact that the application provided in this paper has an array of factors that as of yet have not been addressed in one comprehensive model.

A generic mathematical model of the distribution problem is formulated, with specific emphasis on a fixed infrastructure, mixed-multi-echelon distribution network with multiple-commodities and a multi-modal transportation system. Other factors taken into account are capacity limitations on the transportation system and depots, as well as government regulated petrol zoning. Uncertain demand is represented by random variables with known probability distributions. A two stage fixed recourse approach is employed to address the randomness in the model formulation.

The generic model is solved optimally using a small test case. As the actual industry problem contains a much greater number of variables, a meta-heuristics method, namely *Ant Colony Optimisation* (ACO) is proposed as a solution method.

Observing real ant colony foraging behaviour inspires ACO. This behaviour allows ants to find the shortest paths between nests and food sources. In ACO algorithms a finite-size colony of artificial ants collectively searches for good-quality solutions to an optimisation problem. The ACO algorithm performance is compared to the optimal solution found for the small test case instance and the authors comment on computational time, and solution quality for larger problems.

Keywords: fuel distribution, network flow model, stochastic modelling, fixed resource, meta-heuristic, Ant Colony Optimisation, multi-commodity, multi-modal transportation system

Safe Packaging and Distribution of Illuminating Paraffin in South Africa: Application of a Distribution and Supply Model

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It is envisioned that 100% of South Africa's illuminating paraffin (IP) will be safely packaged and distributed to all household-based paraffin consumers. The requirements for interventions to provide access to pre-packaged IP are to be established.

A proposed intervention strategy was to determine the optimal distribution pathways between IP suppliers, IP packaging agents and the various consumers in South Africa. A distribution network model based on a demand-supply strategy is presented and a distribution network for packaged paraffin is suggested in a South African context. The analysis determines the location and number of packaging sites that are required to achieve the desired objective. A minimum packaging volume is assumed for the packaging facility, which in turn sets the maximum number of packaging sites. The method of solving incorporates the use of logical assumptions, the travelling salesman model as well as the demand-supply model. There are approximately 100 demand nodes, 6 supply nodes and 10 packaging sites. The assumptions made are as follows: the ten packaging sites may be selected from the 100 demand nodes as these are points of established road, community and communication infrastructure (a smaller set may be chosen on the basis of average quantities consumed); major towns and cities will be obvious candidates to start from. The method now defines regions (10 in total) that comprise of supply node(s), a packaging facility and the satellite demand points that can sustain a packaging site. The demand-supply and travelling salesman models are then applied to these regions in order to determine upper and lower bounds on the total cost of the packaging and transportation.

The precise location of the packaging site within a given region was determined by minimising the cost for transportation of bulk paraffin from depot to packaging site as well as the cost for transportation of packaged paraffin from packaging site to areas of final demand. The analysis

also investigated the possibility of different packaging options and its subsequent impact on distribution and location of the packaging sites.

The method currently used to determine the regions are based on observations and topological features of the country. However, these methods will be refined into rigorous based methods where the regions will be determined for an optimal solution.

Keywords: paraffin, distribution, packaging

An OR Challenge for More Accurate Electrical Load Forecasts

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Load forecasting used to be a simple procedure and for most utilities the customer consumption remained fairly constant from one year to the next. It appears that the confident load prediction has become more difficult over the past decade. Even with more sophisticated techniques, utilities have been wrong much more than they have been correct.

OR can play an important role to ensure the electrical load predictions are more accurate and information. The answer is explained in terms of a triangle, the three angles are:

1) Load Analysing
2) Load Modelling
3) Load Forecasting

To ensure consensus exists between different electrical forecasts an electrical load has been developed to structure the different forecasts and solved as a “non-linear programming problem”. Research is still ongoing to develop proper methods for one of the electrical forecasts, the geographical area forecast.

South Africa: Sustainable or Time Bomb? The Natural Step to Survival

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Sustainable development is one of those ideas that everybody supports; yet no one really knows what it means in practice. Yet everyone is aware of major challenges facing our planet. The Natural Step (TNS) process slices through that confusion, providing organisations and individuals with a scientifically rigorous, easy to understand set of rules, to use as a compass to navigate our way towards sustainability.

There is no “recipe” for sustainable development - only progressively informed dialogue leading to action across a widening front. Once the members of a community share a reliable framework and a sense of common direction they tend to find and implement their own “win-win” solutions. The Natural Step framework is a methodology for successful personal, organisational and community planning.

Planning with the help of the TNS Framework focuses on the initial causes of problems rather than reacting to their environmental effects. Investments and measures are thus selected which develop the organisation in a sustainable direction with maximum long-term flexibility and short-term profitability.

A growing number of corporations around the world use the TNS framework, including Nike, Electrolux, IKEA, Home Depot, Scandic Hotels, McDonalds and Air BP. More than 60 municipalities in Sweden, Australia and New Zealand also use it. Companies using the TNS framework as a strategic planning tool have increased their profits and market share by reducing their use of natural resources and developing new technologies and processes that work with the cycles of nature, not against them. They are leaders in the societal transition towards sustainability.

Come and find out how you too can become more active in sustainable practices and do your bit to make our planet more sustainable.

Several Methods of Trend Analysis Applied to the South African Elections

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Trends in the in South African elections are determined by optimizing a correlation matrix which relates the results of the last election to those of the previous one. If such a matrix is based exclusively on the overall results, it is highly ambiguous. Including the results of each of the individual 17000 voting districts can reduce this non-uniqueness. The resulting matrix cannot directly be interpreted in terms of election trends, as about 35% of it elements are negative. In order to transform this matrix in a trend matrix that does not contain negative elements, we apply various methodologies. First we use the Kuhn-Tucker approach, which ensures optimality under the given constraints. Second, we introduce a new method, which is less data intensive and can be applied directly to the original trend matrix. The merits of both methods are analysed. We also discuss the usefulness of such trend matrices in the current and other contexts.

Keywords: trend analysis, elections, optimisation

The Use of Morphological Analysis to Assist Local Authorities with a Crime Prevention Strategy

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Morphological Analysis (MA) is a methodology for structuring ill-defined problems; where role players come from different backgrounds, disagree about the problem to be solved, and where there is often a lack of or contradictory data/evidence. MA is typically used to define scenarios about the problem situation (dealing with variables that cannot be controlled) and subsequently to develop strategies (using variables that can be controlled, to respond to the scenarios).

CSIR's Crime Prevention Centre, in cooperation with UN Habitat, has developed a Crime Prevention Toolkit to assist local authorities in Africa with developing and implementing a crime prevention strategy. This talk reports on a component of the Toolkit project, where MA was used to define and explore crime prevention strategies for a local authority in response to the drivers of crime in that community. The process of developing the MA fields together with stakeholders will be discussed, and the resulting fields will be shown.

Keywords: morphological analysis, crime prevention strategy

A Fuzzy Stochastic Multi-objective Linear Program Formulation of a Portfolio Selection Problem

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The paper presents an LP formulation of a portfolio selection. The focus will be on a portfolio consisting of Government Bonds. Based on the conflicting objectives of maximising return, while minimising risk, a multi-objective program is proposed. The uncertainty and non-exactness of some parameters in the model lends itself to both stochastic and fuzzy programming. In this model, both approaches have been combined to give a hybrid linear program. A case study based South African Government bond information is presented.

Keywords: fuzzy, stochastic, hybrid, multi-objective, return, risk, yield

What is Six Sigma?

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Novel Idea is the leading provider of Six Sigma DMAIC methodology, Design for Six Sigma (DFSS), Lean Sigma and Change Management training, consulting and project management, specialising in deployment, and training of Master Black Belts, Champions, Black Belts, Green Belts, and team members in Leading Organisations.

Novel Idea's comprehensive portfolio of products, services and software have been designed to enable rapid deployment of organisation-wide improvement efforts. Novel Idea has partnered with Sigma Breakthrough Technologies (SBTI) in the US for the launch of Design for Six Sigma (DFSS), Technology Design for Six Sigma (TDFSS) and Marketing for Six Sigma (MFSS) in South Africa.

The opportunity to you today is to learn about - "What is Six Sigma? "

After this session you will have a better view of:

- Six Sigma – overview of what it is.
- Six Sigma and the organisation Strategy
- Six Sigma and Projects
- Return on Investment through Six Sigma (USA Companies)

Applications of Thermal Spraying Protective Coatings

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With rapid growth of modern industry, the requirement of higher performance and efficiency of machines has led to a development of new coating processes and materials in order to protect base components from excessive heat, corrosion, wear and the combination of those. Thermal spraying is a surface coating technology, which combines a variety of positive characteristics. In recent years, thermal spraying has become increasingly important both in the manufacturing of new components and in the repair of existing parts. The thermal spraying protective coatings are applied in many sectors of automotive, aerospace, construction, mining, biomedical and other industries. In this paper, thermal spraying techniques as well as the development trends are presented and discussed.

Quantitative Decision Making Techniques and the Maintenance Practitioner in Non-continuous Operational Environments

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The demise of Operations Research (OR) in industry as a decision support function is paradoxical.

A closer scrutiny of application environments reveals some logical explanations. In the maintenance and support environments two opposing situations exist. On the one hand a broad base of successful applications exists in high-volume operational environments. This is however not necessarily the case with smaller batch oriented operations.

With the development of systems engineering, the design and development of maintenance and support systems have evolved into to a fine art. In these development processes OR techniques are well entrenched and play a major and vital role. These methodologies migrated very successfully to the development of support systems for high-volume operational systems. The same however does not hold true for low-volume environments. With large product ranges and changing mixes, the benefits of a systems approach are more illusive.

In addition to the lack of OR based methodologies, Business Processes Reengineering (BPR) also had a detrimental impact on OR applications in these environments. BPR generally brought about a reduction in specialist support functions. Many operational line functions thus lack the necessary specialist support and/or knowledge to resolve typical OR problems.

The paper explores the contextual background to the problem of diminishing application of OR techniques in the maintenance environment. It explores some of the typical problem areas in this environment where OR can play a significant role. It argues that a sensible solution to the problem is to equip future incumbents with some foundation in OR techniques. The paper finally conveys what is being done at the Tshwane University of Technology in this regard.

Keywords: Operations Research in maintenance and support environments; demise of Operations Research; Systems Engineering approach; small batch and jobbing environments; equipping maintenance technicians and technologists with theoretical OR foundation; Tshwane University of Technology

A Pragmatic Approach to Manage Obsolescence Risks of Complex or Long-Life Systems

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The paper will discuss prime obsolescence drivers and propose a methodology for optimising management activities in order to reduce obsolescence risks of complex electronic systems or for systems that have a long operational life cycle. Feedback and lessons learned from relevant projects in the South African context and applicable literature on the subject of obsolescence management are combined to propose a model where obsolescence mitigation timeline(s) can be applied during all life-cycle phases of systems.

Component obsolescence has been a problem for almost as long as the electronics industry exists and it has become increasingly serious over the last decade. Component obsolescence is not limited to specific types of hardware or electronic equipment. It affects test equipment, software tools, manufacturing processes, logistic products, standards and specifications in military, industrial as well as commercial systems and products. It is not industry specific, although products of the automotive, aerospace, defence, medical equipment, telecommunication and nuclear industries are particularly vulnerable. Due to the expensive, time-consuming consequences of component obsolescence, obsolescence management cannot be ignored during the development and design, or during Through Life Support (TLS) life-cycle phases of products and systems.

Commercial products, including commercial of the shelf (COTS) equipment, are also increasingly encountering the obsolescence phenomenon and even systems with relatively short life cycles, are also being affected. This is especially true in the computer, telecommunications, military- and related electronic technology industries. Apart from contributing to increasing life-cycle costs, component obsolescence is fast becoming the single biggest technical risk factor impacting the operational availability and maintainability of complex products and systems. Proactive management actions to address the problem are essential to prevent systems to be phased out prematurely, because their operational readiness and availability requirements cannot be sustained or be achieved as required.

Keywords: Component obsolescence management, influences and drivers, mitigation options, mitigation timeline

Data Envelopment Analysis for Planning and Control

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Data Envelopment Analysis (DEA) is a method for comparing the productive efficiencies of different “decision making units (DMUs)”, when each DMU has a different profile of inputs and outputs. DEA uses linear programming to identify the best practice frontier, and to establish benchmark performance standards for inefficient DMUs.

The DEA approach has much in common with multicriteria decision analysis (MCDA). Cooper (a pioneer in both fields) has stressed that DEA is a tool for management control (how well do existing DMUs utilize the inputs provided?). MCDA, on the other hand, is a tool for management planning (what new strategies or “DMUs” will best satisfy organizational goals?). The distinction between planning and control is, however, blurred, as identification of unsatisfactory performance will lead to seeking new strategies. There is merit, therefore, in exploring the synergies between DEA and MCDA.

The original DEA formulation placed great store on “objectivity”: Are there any sets of weights on inputs and outputs, which would make the DMU under consideration efficient? While apparently fair for purposes of monitoring, this virtual freedom in weight selection can lead to bizarre results, where a DMU may be designated as efficient on the basis of a single input and single output. Thus even in using DEA for management control, some form of judgemental weight restrictions are needed, and these become even more crucial when extending DEA to broader management planning, when management goals must be brought into play.

The above considerations have led to a search for greater integration of the value measurement aspects of MCDA with the technical production frontier analysis of DEA. We review a number of approaches to including weight restrictions in DEA, and report on computational experiments aimed at identifying the insights provided by each.

Keywords: Data envelopment analysis; multi criteria decision analysis

Analysis of the Dynamic Characteristics of a Practical System of Congestion using Chaos Generation

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The provision of a time-varying solution for a System of Congestion is examined for a practical system of a complex nature. It attempts to depict the transient operation of the system via chaos based system orbit generation and in so doing endeavours to furnish a modelling technique for use in achieving optimum dynamic operation. The system to be considered from the point of view of dynamic operation is one in which two single channel queues alternatively make use of a single server and are combined to form a single System of Congestion.

Pedestrian Models with Anylogic - an Agent Based Approach

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Anylogic is a new generation simulation tool that is based on the advances in modelling science and IT made over the last 10 years. It supports multiple modelling approaches. This talk will focus on pedestrian movement models, combining discrete event and agent based modelling. Real time simulation examples will also be presented.

Better Processes to curb Unemployment: Creating Liquid Hybrid Solutions for Process Improvement

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Process methodologies are used worldwide to increase competitiveness and profitability within organisations. This paper is concerned with the application of process methodologies in the South African environment and the far-reaching effects this could have on employment sustainability.

With an unemployment rate of 28%, South Africa is in desperate need to create new employment opportunities, as well as to retain current employment opportunities. While many components contribute towards the unemployment rate, including the regular need for retrenchment of workers, a powerful factor that deserves mention is competitiveness.

One way to become a more competitive country is to encourage and motivate more competitive businesses and Government institutions. Process improvement has emerged as a key focus area to improve the ability of South African organisations to compete with developed countries in the global market.

Multiple tools, methodologies and frameworks created over the years aim at improving processes within organisations. Applying a pre-built solution may not be the most optimal approach in addressing process improvement. This paper explores the advantages of implementing a liquid hybrid solution, ultimately contributing towards employment sustainability.

Included in this paper are the following:

- Current unemployment situation in South Africa.
- The shortcomings of single process methodology implementation.
- Advantages of creating liquid hybrid solutions
- Framework for hybrid solution development.
- Possible advantages for employment sustainability.

Productivity Enhancement within the Small and Medium Enterprises: Garankuwa Industrial Cluster Case Study

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Small and medium enterprises (SMEs) play an important role in modern economies because of their flexibility and ability to innovate. In nearly every country, SMEs play a significant role in providing employment opportunities and supporting large scale manufacturing firms.

However, there are not many studies reported in the literature that deal with productivity problems within SMEs. Considering the importance of SMEs, the experiences of small companies engaged in continuous improvement and a related conceptual model are discussed here to highlight how productivity can be improved with limited resources. The case study presented in this paper was conducted at Garankuwa Industrial Cluster in which various manufacturing companies were grouped by National Productivity Institute under their workplace challenge programme. The findings of this research will be used for the evaluation and assessment of the productivity levels of the SMEs concerned by using of the Key Performance Indicators (KPI).

The research was through site visits to selected SMEs around the Garankuwa cluster in order to gather data on the present situation of the SMEs concerned. This was done by means of questionnaires, interviewing of staff members, observation of processes and the reading of process related documents. The data was analysed and the necessary interventions implemented in the said SMEs. The monitoring of interventions and the results followed with the aim of identifying potential areas for cost savings resulting from productivity gains. Finally, implementation issues associated with productivity improvement strategies in a small to medium companies are discussed.

Keywords: Productivity enhancement, Small-to-medium-sized enterprises, Case studies

Sustainable Development through Networks and Clusters

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Moving towards the world cup 2010, South Africa will be spending large sums of money in terms of infrastructure development. Infrastructure development will require competencies in technological skills ranging from design, project management and after sales services. Many engineering skills have been lost through the brain drain in the 1980's through to the early 2000's. The infrastructure development projects could be utilised as foundation to developing additional technological skills that could be utilised for further development of the local economy. This paper looks at the possible different infrastructure projects that could be developed. In addition the development of networks and clusters through small medium and micro enterprises (SMME's) is also explored.

Key Challenges in the Automotive Supply Chain

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Being exposed to the global automotive supply chain, the South African automotive industry has had to deal with many internal and external factors that contribute to our competitiveness as a global player. The impact of operating in the global 'playing fields' has been felt to a large extent, by the component manufacturers in the South African industry, forcing them to address these challenges head-on or face redundancy.

The role of Engineering within a Supply Chain

Danie Schoeman
Barloworld

Logistic Management with Logicslink, a System Built on Adaptive Object Modelling

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Logistics is the combination of transport, storage and control of material all the way from the supplier, through the various facilities, to the customer. Logistics cost is one of the largest cost components in the supply of physical goods. Companies that improve their processes and systems for planning and measurement of logistics activities improve service and reduce cost.

Logicslink is an enterprise wide logistics management system. Logicslink started as a THRIP project in collaboration with the University of Pretoria, identifying the need in the South African market for an easy customizable system, that caters for our unique environment. Logicslink has been developed based on the e-Logics ESI (expandable software infrastructure) technology. This technology empowers domain experts to take control over application implementations, and allow them to change an application's business model as business evolves. Business models and rules have migrated from compiled source code to external metadata. The system is database independent with implementations on Oracle and Microsoft SQL Server databases.

Logicslink integrates with measurement devices such as tracking units on vehicles to enable proactive management. The key performance indicators for logistics activities are measured by comparing planned versus actual. These performance measurements should be the primary driver for the improvement of execution.

This paper discusses the implementation of Logicslink on the ESI, and the concept of meta data driven implementations.

Keywords: logicslink, logistics, adaptive object modelling, meta data, ESI, route optimization

Humanitarian Logistics – A New Form of Logistics?

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Throughout the world many “disasters” occur per annum. Some are events that happen very suddenly, like the devastating tsunamis late last year, while others happen over extended periods of time. In the latter case the humanitarian aid required for HIV/AIDS orphans are a typical example. With all of these disasters one of the first priorities is to provide aid in some form or another. This could be in the form of medical aid, medical supplies or food stuff. The immediate question is how would this happen, who takes ownership of such a situation and who will fund such operations.

The supply of aid as described here has logistics written all over it. Many different “things” have to be moved or transported to the affected areas, there are many things that need to be organised and as such this must be seen as some form of logistics or supply chain management. The question is how does it compare to what has become known as logistics or supply chain management? Is what is required in this context different from is being practiced all over the world? This paper will endeavour to provide an overview of what logistics entails in the context of humanitarian aid and how it compares to traditional logistics and supply chain management. It will convey some initial exposure to this potentially new emerging field. In addition we will also report on examples of such projects in the South African context.

Keywords: logistics, supply chain management, humanitarian aid

Optimisation of the Mittal Steel SA Metallurgical Supply Chain using Linear and Mixed Integer Programming

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Analysis, during 1998, of the available models serving Top Management in the sphere of optimised strategic planning and decision support, revealed a total lack of support for the Decision Makers of the then Iscor (now Mittal Steel SA). This led to the development of an optimisation model of the integrated mining and iron-and-steelmaking complexes with the objective of maximisation of NPV of cash flow before tax. Although the Sishen and Thabazimbi iron ore mines as well as the Grootegeluk, Tshikondeni and Leeupan coal mines are included in the model other mining complexes can be included generically by the user in the input data. The model includes both the Newcastle and Vanderbijlpark Iron and Steel Works and interactions between them. Model techno-economics consists of the steel markets (prices and volumes per generic steel product within region within continent) and the various production units: - sinter, DRI, coke batteries, blast furnaces, EAF, BOF, casting and the mills. The system is driven by the coke CSR and the sinter percentage in the blast furnace feed, subject to detailed and calibrated metallurgical, thermodynamic, slag chemistry and stoichiometric balances. Fixed, capex and opex costs are included. The matrix dimension of a single period model is 2553 variables (300 binaries) in 2761 constraints. The data entry vehicle is user-friendly Excel spreadsheets defining various classes and tables. A matrix generation, optimisation and report generation is conducted in less than 2 minutes. The model was used to demonstrate to Management the considerable costs locked up in sub-optimised planning and to optimise the Group's long-term iron ore procurement strategy.

Decision Support in a Pyrometallurgical Process using a Knowledge-Based Expert System

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Pyrometallurgical processes for the production of ferroalloys using submerged arc furnaces are characterized by two overriding issues that render the control of such processes challenging. The first is the highly aggressive nature of the reaction regime necessitating the inferring of process conditions. The second is the interaction of sub-processes having differing residence times and reaction rates. The effects of the above two issues are that there is a considerable reliance on the human experiential input in the control activity. The interpretation of the activities of certain reaction species and requirements in the process is then subjective. This paper will address the following issues considered to be pervasive in the development of a decision support system enabling optimal operation of the pyrometallurgical process.

There is, in respect of many conditions in the submerged arc furnace process, a relatively large range of process variable values allowable. The decision making criterion that is then important is the rate of change of the variable under consideration. The decision result is further complicated by the allowable rate of change being a function of the absolute value of the variable. The historical database values for the variable are then used to combine the rate-of-change value with the absolute value to derive a range of decision points used in the knowledge-based expert system.
Real-time process conditions can then be inferred and reacted to by using the derived values.

The control of the interaction of sub processes having differing residence times and reaction rates is enhanced by the use of a knowledge-based expert system as there are too many permutations for the human operator to consider before reacting optimally. The development of the decision support system has been facilitated by the use of the result of radioactive tracer tests of the submerged arc furnace process. The outcome is the ability to delineate the control issues that are important in each sub process.

The two developments mentioned above result in the decision support system for the pyrometallurgical process.

A Practical Guide to Structuring a Forecasting Process in your Organisation while Considering the Latest Trends and Dispelling the Myths

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The intention of the paper is to provide a practical guide to designing a forecasting process. It tables the principles of forecasting on which more detailed discussions can be built. It also challenges the thinking behind some of the more recent trends.

The Use of Data in Optimising Consumer Credit Strategies: A Case Study

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This paper portrays how a leading edge South African retailer effectively used behavioural customer data to design credit strategies in order to improve profitability and customer satisfaction. This case study is specific to the management of credit limits on a retail cards portfolio.

Traditionally, credit limit testing was based on running different strategies against similar groups over a defined performance period. At the end of the test period, basic measures such as spend and delinquency were used to define the wining strategy. For this particular lending institution, the analysis highlighted specific areas within each strategy where performance has been quantified as being better. By combining the best component parts of each strategy, an optimised hybrid strategy was devised, which delivered significant business after implementation.

The methodology used includes using mathematical techniques to define significant differences between strategies in order to identify the better performing parts of each strategy. In addition, a notional profitability metric was developed with subsequent analysis of credit limit strategies within a controlled testing environment.

The Role of Operations Research and Industrial Engineering in Development

Dave Evans
Development Bank of Southern Africa

“Development” is a term which is now a commonplace in the global vocabulary, but it is easy to overlook the fact that with its current meaning, it has only been around for about 40 years. In one slightly longer term sense, it could be argued that the idea dates from the Marshall Plan to rebuild Europe’s economic infrastructure after World War Two, and return large parts of it to being normally functioning members of the international economic community.

Constructing Meaningful and Useful Indexes, Analysing how Indexes for the Human Development Index to the Pollution Index Area are Constructed and how Multiple Criteria Decision Analysis can help: A Practical Case Concerning Quality Evaluation

Alexis Tsoukiàs
President of EURO

Indexes are present in our everyday life. Routine as well as strategic decisions are taken because a certain "index" reached a certain "degree". What these indexes really say about the world around us? What do they represent? Do they effectively induce the results for which they have been conceived and designed?

The talk examines in details two indexes: the Human Development Index, implemented by the United Nations (HDI) and the French Air Pollution Index (ATMO). Different realities appear to be representable depending on what the actors involved in using the indexes are looking for. Further on, it is shown that the use of the index can give rise to unexpected behaviours as far as the observed entities are concerned (nations for the HDI or towns for the ATMO).

These findings are used in order to support two principal claims: - indexes are not a faithful representation of the reality, but, at best, a purposeful representation of a certain reality; - in designing indexes we both need to take care of the formal properties (from a measurement theory point of view) they satisfy and the operational purpose for which they are designed. Under such a perspective, decision theory results a useful tool in designing implementing indexes. Besides showing some general principles, the talk also introduces an example concerning quality evaluation.

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