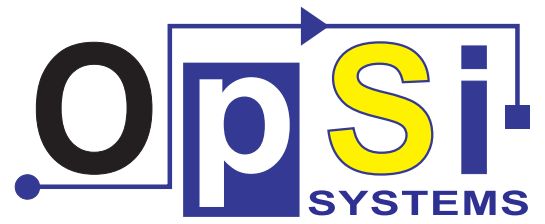Operations Research Society of South Africa

AT THE FOREFRONT OF ANALYTICS IN AFRICA

ORSSA Newsletter March 2017

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From The Editor

By Brian van Vuuren (brianvv@sun.ac.za)

Brian van Vuuren

Dear ORSSA Members

A belated happy new year! I trust 2017 will be a challenging year, but one full of triumphs and success on all fronts!

Much like our government does (or, at least, is supposed to do), I decided to use the first newsletter of the quarter to reflect on 'the State of the Society', and this edition has some great reviews and insights into some of the groups, businesses, divisions and individuals who compose ORSSA as a society. Our goal with ORSSA should really be to come together, benefitting from each other's insights and experiences (both professionally and personally). So what better way to do this than to check in with a couple of our active members.

This kind of check-in isn't new to the newsletter, and the articles in this edition should be read in conjunction with Linke Potgieter's review article of work going on within her research group entitled 'Operations Research for World Peace' (June, 2016), as well as Hans Itmann's fantastic review of African OR societies and their activities (December, 2016). I'd love to do an edition of this kind once every while so, if you or your team would like to be featured, please feel free to drop me a line.

This quarter we get to know Clemens Dempers and his business, BlueStallion Technologies, on page 7. He's been a part of and supported the society for many years. The SUnORE Research Group of Stellenbosch is also profiled on page 9, and the resurgence of the Zimbabwe Chapter of ORSSA discussed on page 17.

We also have a new addition of a logic puzzle, kindly provided by Shane van Heerden. So it's a chance to check in on the old grey matter to make sure all is still operating efficiently.

This marks my first edition as primary editor of the newsletter and I'd like to thank Bernie Lindner for all that he contributed during his term, as well as what he taught me in preparation for taking over. He now moves on to the role of business newsletter manager and, I have no doubt, will be keeping a beady eye to ensure his baby remains well cared for.

Enjoy the newsletter!
Till next quarter,

SOCIAL MEDIA

- **Facebook:** Please visit (and like!) our page at *www.facebook.com/ORSocietySA*
- **Twitter**: @_ORSSA
- **LinkedIn:** Please visit our page at *www.linkedin.com/company/the-operations-research-society-of-south-africa*

The struggles of the dating mathematician...

LUIGI'S — ARE YOU READY TO-A PLACE-A YOUR ORDER?

?? — I'LL HAVE THE VOLUME OF A CYLINDER, WITH RADIUS 'Z', AND HEIGHT 'A', PLEASE

LUIGI'S — UM...WILL THAT BE TO GO, SIR? *THWAP*

V.VUUREN

46th ORSSA Annual Conference
10–13 September 2017

The 46th Annual Conference of the *Operations Research Society of South Africa* (ORSSA) will take place at Champagne Sports Resort, in the Central Drakensberg - KwaZulu Natal, South Africa, from **September 10th to 13th, 2017**.

An optional tutorial hosted by IBM will be held on Sunday afternoon 10 September, followed by a welcome reception that same evening. The main conference will start Monday morning 11 September and will close at lunchtime on Wednesday, September 13th. Participation over the full spectrum of Op¬erations Research is encouraged, including papers of a more fundamental nature, application of Operations Research techniques in business and industry, topical issues in Operations Research, and the philosophy, teaching and marketing of Operations Research.

Registration and submissions of abstracts will open on the **15th of March 2017** and will close on the **14th of July 2017**. Abstracts submitted late will regrettably not be accepted.

Delegates are responsible for their own travel and accom¬modation arrangements. Champagne Sports Resort is recommended, as the Society has arranged competitive rates for delegates at the conference venue. To make an accommodation booking for the conference, please download the accommodation request form on the accommodation page of the website and forward it to Champagne Sports Resort to process your request.

The conference keynote speakers will be **Susara van den Heever** (opening conference keynote) and **Riaan de Jongh** (closing keynote).

Susara van den Heever
(opening keynote)

Riaan de Jongh
(closing keynote)

Champagne Sports Resort

Important Dates

15 March 2017	Early bird registration & abstract/paper submission opens
1 May 2017	Hotel bookings close - after which bookings would be subject to availability
14 July 2017	Abstract submission closes
31 July 2017	Early bird registration closes
18 August 2017	Registration closes
10 September 2017	Optional tutorial
10 September 2017	Conference reception
11 September 2017	Conference opens
13 September 2017	Conference closes

**Please visit the ORSSA website and click on
the link *ORSSA 2017* for more information:**
www.orssa.org.za

From The President's Desk

By Winnie Pelser
(*winnie.pelser@gmail.com*)
ORSSA President

Winnie Pelser

Dear ORSSA members, the year 2017 is already well under way. I would like to wish every member of the Society the very best for the remainder of 2017. The prospects for a year full of interesting activities and opportunities for ORSSA and Operations Research (OR) lies ahead.

On behalf of the Society, I would like to thank every member of ORSSA for their continued support and enthusiasm. Your commitment is crucial to our society. In particular, I want to thank the *Executive Committee* (EC) of 2016 for their time, contribution and dedication in each portfolio. Each member contributed in a most professional manner, despite work and other pressures. This is really important and appreciated.

Some members of the EC had to resign at the end of 2016. They are Hennie Kruger stepping down as Vice-President but remaining as Additional Member, Mark Einhorn (Marketing Manager), Dave Evans stepping down as Database Manager but remaining as Treasurer, Angela Rademeyer and Brian van Vuuren (Additional Members), and Robert Bennetto stepping down as Johannesburg Chapter Chair. I want to thank each of the members for their dedicated service to the Society. New members joining the EC are: Danie Lötter as Vice President, Gemma Dawson as Database Manager, Denzil Kennon as Marketing Manager and Ian Campbell as Additional Member. Berndt Linder is now Newsletter Manager and Brian van Vuuren Newsletter Editor. David Clarke is the new Johannesburg Chapter Chair. I want to thank these new members for their willingness to serve the society. The entire EC of 2017, with their respective portfolios, can be found on the website.

One of the opportunities, and a highlight on the OR calendar, is the annual conference during September. This year it will be organised by the Vaal Triangle chapter. For more detail please have a look at the conference advertisement on the website.

Activities are continuing for the establishment of the *African Federation of Operations Research Societies* (AFROS). The website should be up and running shortly. I want to thank Berndt Linder and Dave Evans for their support with establishing AFROS.

In the trying economic and climatic circumstances we are currently in, operations researchers can contribute tremendously. In addition to the good work done by our Universities in terms of training OR professionals, members should also make use of the Certified Analytics Professional (CAP) international examinations.

I am looking forward to working closely with the EC during 2017, ensuring that ORSSA is and remains the professional and vibrant home of all the operational researchers in Southern Africa. I am also looking forward to join forces with all the ORSSA members to realise our operational research ideals. Please feel free to contact me or any other member of the Executive Committee with suggestions and ideas to improve ORSSA's services and activities.

May 2017 be a memorable year for ORSSA.

With best wishes. Alles van die beste.

Winnie Pelser

Quarterly Puzzle: *Einstein's Riddle*

Provided by Shane van heerden (17683068@sun.ac.za)

Shane van Heerden

Rumour has it that the great Albert Einstein conceived an impossibly difficult riddle when he was just a boy, widely known as "Einstein's Riddle". A number of reports suggest that 98% of the world's population are not able to solve it. Despite what you may think, there are no tricks to this riddle. Like Sherlock Holmes, all you need is sound logic and deduction. Good luck!

There are five houses in five different colours in a row. In each house lives a person of a different nationality. The five owners each drink a certain type of beverage, smoke a certain brand of cigar and keep a certain pet. No owners have the same pet, smoke the same brand of cigar, or drink the same beverage. Other facts:

• The Brit lives in the red house.
• The Swede keeps dogs as pets.
• The Dane drinks tea.
• The green house is on the immediate left of the white house.

- The green house's owner drinks coffee.
- The owner who smokes Pall Mall rears birds.
- The owner of the yellow house smokes Dunhill.
- The owner living in the centre house drinks milk.
- The Norwegian lives in the first house.
- The owner who smokes Blends lives next to the one who keeps cats.
- The owner who keeps the horse lives next to the one who smokes Dunhill.

- The owner who smokes Bluemasters drinks beer.
- The German smokes Prince.
- The Norwegian lives next to the blue house.
- The owner who smokes Blends lives next to the one who drinks water.

The question is: Who owns the fish?
(*The solution is provided on page 20*)

WHAT ARE O(u)R MEMBERS UP TO?

Compiled by Brian van Vuuren (brianvv@sun.ac.za)

Mark Einhorn

Mark Einhorn (*mark.einhorn.1987@ gmail.com*) has been a member of ORSSA for the last 6 years. He recently relocated to Düsseldorf, Germany to take up a position at McKinsey. Here's what he had to say about his new job, the relocation process and what to consider if you hope to do something similar:

How did the opportunity at McKinsey come about?
It was a classic case of "it's more who you know than what you know" to initially get my foot in the door I think. Towards the end of my PhD I needed to start giving some thought to what I was going to be doing with my life when I finally submitted my thesis. A good friend of mine's wife happened to be working in the HR department of the London McKinsey office and we were at a wedding together and started speaking about what it was that I was studying and she suggested that I send my CV to her for consideration at McKinsey.

She got back to me a month or two later saying that people thought it was a good CV and academically strong, but lacked experience, and they would keep it on record nonetheless. I thought that was a fair assessment and thanked her in any case. About a year and half later, I received an email from her that the Düsseldorf office had come across my CV and were interested in me for a position and would be in contact with me about it. They did contact me in time and set up several calls between me and members of the office discussing the work that the office was involved with, to discuss my PhD, and to find out what my views were on the progression of certain industry trends. From there, they advised me that they would put me forward for the formal interview process, at which point it definitely became only about what you know rather than who you know.

How did you find the relocation process?
Certain aspects of it were quite challenging, others were pretty straightforward. I was lucky in the sense that I was

Mark and his girlfriend, Anri, exploring Düsseldorf.

already in possession of a German passport, so I can't say too much around what is required in terms of visa requirements for a South African passport holder. Finding an apartment was pretty tough as demand far exceeds supply in Düsseldorf. Also, a strange quirk about the rental property market here is that in most cases, apartments are not fitted with a kitchen, you either need to buy the kitchen from the previous tenant who had it installed and fitted, or you have to have a kitchen installed yourself. I'm led to believe that this is not the case in all German regions, but it is for some of them, so that's something to be aware of. Also, rental deposits here are the equivalent of 3 months rent. So just entering into the rental market here requires quite a significant capital outlay, and this can be made all the more strenuous if you're converting from rands to euros.

I learnt from fellow employees that Germany is renowned for its bureaucracy. I got a taste of this first hand when I found out that I needed to register myself as a citizen of Germany at the local authorities so that I could get a tax number and health insurance, both necessary if you are to be paid a salary. Of course, you cannot register for either until you have your name on a rental agreement, so that placed considerable pressure on being able to find an apartment. We were rejected on three different occasions when trying to rent an apartment which was pretty disheartening but all is well that ends well and I'm happy to say, that at the time of writing this, we have found a beautiful apartment,

and are both really enjoying the city of Düsseldorf, but it wasn't without a few hardships along the way.

The company was very good to me in that they reimbursed me for both mine and my girlfriends' air tickets and provided us with a lump sum resettlement amount. They have also offered to compensate us for the cost of moving any furniture to Germany, up to a certain amount.

From a work point of view, everybody has been incredibly helpful, supportive and friendly, with the office even covering the costs of my German tutoring lessons.

What team are you joining at McKinsey?

I've joined the Advanced Analytics Team as an Analytic Specialist, with a focus on *travel, transport and logistics* (TTL) related projects.

What projects have you been assigned to and what work are you doing?

In my brief time at McKinsey, I have learned that they place an extremely high premium on maintaining client confidentiality and trust. For this reason, I cannot go into the specifics around the projects that I am involved with or the exact work that we are doing. What I can say is that the work is very exciting, challenging and fulfilling and I am loving every second of it.

What advice would you give to people considering working abroad?

I would advise people to focus their research into the place that they will be relocating to as much as the role that they will be fulfilling at the company they will be joining. I have learnt that relocating can be a very expensive process, so make sure that you have a clear budget drawn up about what costs you can expect to incur, especially when moving somewhere on the back of a weak currency such as the rand.

Most of all, I would advise people to make the most of the opportunity to learn as much as they can, both professionally and personally, and to submerge themselves in the different places and cultures that they will encounter, and to work towards building and expanding their personal and professional networks

---

Christiaan v.d. Walt

The Rhodes Scholarship is considered to be one of the most prestigious graduate scholarships in the World. Not only are all costs related to reading at Oxford covered for a minimum of two years, but scholars gain access to an international network of exceptionally talented and dynamic individuals. Each year, approximately ninety five students from around the globe are selected. Outstanding intellect, character, leadership and commitment to serve are the primary criteria sought by the scholarship selection committees. This year, ORSSA has a Rhodes Scholar-elect to call its own. One of ORSSA's student members, Christiaan van der Walt (*17124891@sun.ac.za*), was selected in November 2016, to go up to Oxford in September 2017.

A maximum of ten scholarships are devoted to Southern Africa each year, and candidates are nominated by either the national selection committee or committees associated with one of four partner schools. Christiaan, as an alumnus of Paul Roos Gymnasium, was nominated by its committee. He first heard of the scholarships during secondary school and was later encouraged to apply by his current research supervisor, and ORSSA fellow, Professor Jan van Vuuren. Himself an Oxford alumnus, Prof. van Vuuren arranged for Christiaan to visit the Mathematical Institute at Oxford in June 2016. This experience reinforced Christiaan's resolve to pursue graduate degrees at Oxford. He was selected upon his second application for the Rhodes scholarship, after reaching the final shortlist the preceding year.

Christiaan is currently completing a master's degree in Engineering at Stellenbosch. His research is focused on demonstrating that certain trends in macroeconomics may be produced using a simple mathematical model within the realm of boundary value problems for parabolic partial differential equations. Last year, he was a finalist in ORSSA's national student competition for honour's projects. In this project, a novel mathematical model for irrigation reservoir control was put forward and implemented in a digital decision support system, and this system has subsequently been adopted at the Keerom Dam in the Western Cape. During his undergraduate studies, Christiaan was actively involved in the leadership of various student committees and societies. At Oxford, he intends to pursue an MSc in Mathematical Modelling and Scientific Computing, followed by an MSc in Statistical Science.

Christiaan visited Oxford last year in June.

The 2017 ORSSA Executive Committee

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Winnie Pelser

Vice-President:
Daniel Lötter

Secretary:
Lieschen Venter

Treasurer:
Dave Evans

Database Manager:
Gemma Dawson

Marketing Manager:
Denzil Kennon

ORiON Editor-in-Chief:
Stephan Visagie

ORiON Journal Manager:
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Newsletter Editor:
Brian van Vuuren

Newsletter Business Manager: Bernie Lindner

Webmaster:
Jacques du Toit

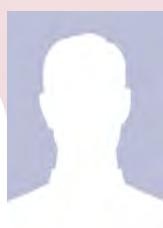## Additional Elected Members

Hennie Kruger

Ian Campbell

Linke Potgieter

Sumarie Koetsier

Chapter Chairs

Johannesburg:
David Clark

Pretoria:
Quintin van Heerden

Vaal Triangle:
Fanie Terblanche

Western Cape:
Shane van Heerden

Kwazulu-Natal:
Vacant

Co-opted External Liaison Representatives

IFORS Representative:
Hans Ittmann

EURO Representative:
Theo Stewart

GETTING TO KNOW BLUE STALLION TECHNOLOGIES

by Clemens Dempers (dempers@bluestallion.co.za) & Brian van Vuuren (brianvv@sun.ac.za)

Clemens Dempers

You've probably seen their adverts in the newsletter and noticed their presence strongly at recent ORSSA conferences – most notably as sponsors of the 2016 annual conference tutorial. But who exactly is Blue Stallion Technologies and what do they do? I asked founder and director Clemens Dempers about the business, the name and the journey of BlueStallion.

How did you get involved in the software business?

It all started at the University of Natal in the late 1980's. During those times there were sanctions against South Africa and it was difficult to get imported scientific software. At the time I was working on a PhD degree in experimental plasma physics. My supervisor was on sabbatical in the USA and, being of entrepreneurial inclination, suggested that he could source software products which I could then distribute locally. From this part time activity, started while I was waiting for repairs to my vacuum chamber, Future Technologies, the predecessor of Blue Stallion was born.

Why the unusual name, Blue Stallion Technologies?

I wanted a non-typical name, something that would stick in someone's mind. Calling it e.g. Scientific Software Solutions, would not really be memorable, and would also very clearly pigeonhole the activity of the company. I was looking for a less prescriptive name so that we could specialize or expand commercial activities without having to look for a new name. At that stage I was involved in equestrian sport, my favorite color is blue, and the logo was selected to resemble a chess piece – hinting at the logical or mathematical nature of the company operations.

Which software products do you distribute?

The first product I started on, was Wolfram Mathematica, and it is really an unusual piece of software. Even though it was originally released in the 1980's, the code and language structure is modern and cutting edge. Infact, many people use it regularly without even knowing that they do – via the iPhone Siri personal assistant, or the WolframAlpha website.

If I am stranded on a desert island and could choose one software product, this would be it (assuming that a sand proof notebook and solar power will be available as well). Mathematica integrates many specialist application areas within one product – GIS, Statistics, Machine Learning, Optimization, Interactive Calculations, Image Processing, Control Systems, Connectivity with external hardware, and much more. So it is one super tool for analytics.

The other key innovative product is Anylogic for Simulation modelling, and they have really grown over the last 10 years, starting off as a small unknown product in the simulation world to one of the top solution providers in this area.

Then we have Origin and SigmaPlot for graphing and data visualization, MathType for equation typesetting, Hugin, and Expert Choice for decision modelling, and quite a few more.

What do you say to people who object to the price of some commercial software products?

I have a woodworking tool analogy to explain my philosophy on selecting software. Many years ago I decided to take up woodworking as a hobby. I visited a local big box store and purchased my first table saw. I settled for one of their budget imports, because I did not really want to break the bank and only had a few home renovation projects.

I rushed home and assembled it, eager to get to work. However, it was not all that easy to assemble and align the table fence. Until I eventually realized that the fence was not cast square and level! This severely impacted the accuracy and speed of my work. I had to keep re-adjusting and fiddling. What was supposed to be a rewarding hobby soon turned into an exercise of frustration.

Since then, I have always tried to rather wait and save up till I could get the very best equipment. It really pays off since it operates well, and instead of getting frustrated, it is a pleasure to use – not mentioning that it lasts for many years.

Which brings me back to software. There are often many different and sometimes free software products available. The price should, however, not be the only deciding factor, but rather how effectively you can use it, and how it will affect your productivity.

It is possible (and cheap from a software purchase point of view) to use Excel as the accounting system of a large company, but it certainly is not practical. Coding your own applications in a low-level language like C, Java, Python or even Fortran is also possible, but is not always the most productive use of your time.

My personal preference is a high-level, rapid modelling environment, like Wolfram Mathematica, or Anylogic. Anylogic is based on Java, and you can indeed program some agent-based applications using free libraries, but you have to be an experienced programmer and industry feedback is that you can build a model about 10 times faster in Anylogic than with low level code.

How did you become involved in ORSSA?

I studied at Stellenbosch University towards a BSc with physics and applied maths as my major subjects. I was fortunate to have Prof. Geldenhuys as one of my lecturers and that really started my interest in operations research. I had a bursary from the Atomic Research Corporation and therefore completed a BSc Hons in Physics. Some years later when I became involved in the software business I renewed ties with ORSSA, exhibiting at the conferences.

Do you only distribute software, or do you also offer other services?

I see Blue Stallion as a solution provider. So the solution may involve just a simple software sale, but it may also involve developing a customized software solution. Sometimes clients may only require a consulting report and no software or simulation model.

What software do you use for your consulting projects?

We practice "Eat our own dogfood", meaning we use the same software tools that we distribute to develop solutions for clients. It is really my opinion that our software tools are very capable modelling tools, and allow us to develop high-end solutions in a fraction of the time it would have taken to do so in a low-level language. The intimate knowledge of the software products also enable us to advise prospective clients of different software solutions, and which may be most appropriate for their needs.

Do you have any interesting new products?

Anylogic, the simulation software company from St Petersburg, has been developing a specialist supply chain simulation and modeling tool called Anylogistix. It is approaching supply chain modelling from a simulation perspective and also has the usual analytic optimization capability built in. This flexibility allows one to model a supply chain from high-level greenfield analysis right down to operations within DC's, warehouses and factories. One can incorporate detailed operational models that you might have done with Anylogic as building blocks within the larger supply chain model.

What kind of projects have you done?

Now that I think about it, it is a rather large range: Sustainable dairy farm modelling, transport optimization for a large cement company, a diamond smuggling detection study, an energy planning tool for a mining consultant, an automated mining ore mineral extraction application, and the development of a tool to visualize and quantify social investment responsibility. There was also a multidimensional company lifecycle visualization tool.

The projects may seem very diverse, but they are all rooted in the application of similar analytical principles.

Is a lot of travel involved?

Our software distribution contracts cover Southern Africa, and for some products even the whole African continent, so I do travel regularly to see clients. Our consulting services are not geographically restricted, so we have done projects in India, Tanzania, Botswana and New Zealand. Then there are also numerous software partner conferences that take place in Europe and the USA that I attend.

Any interesting anecdotes about your travels?

Some years ago, I presented a decision modelling workshop in Dar Es Salaam. The audience of about 30 people consisted of delegates from various countries along the Nile river. I did not realize some of them would be French speaking. The organization did provide translators, and non-English speaking delegates listened with headphones. It was rather difficult to remember that I had to talk very

slowly so that everything could be translated in real time. I still don't know how well the translators managed to convey the information.

While working through the material, I remember cell phones ringtones sounding, and various people got up and all left the room. Sometime later they would re-enter, as if nothing unusual happened, and then asked me to re-cap. Only at the end of the first day did the organizer explain that those delegates were responding to a call to prayer, and their cell phones were set to alert them when they should go to the prayer room.

Do any particular presentations stand out?
Many years ago, I hosted an international visitor, who had a workshop scheduled at the University of Pretoria. I picked him up from his Johannesburg hotel, and we drove to Pretoria, where he had a morning meeting and then the afternoon seminar.

As we arrived he realized that he forgot his special 220V to 115V converter in his Johannesburg hotel room – equipment absolutely essential for the interactive radio keypads to be used in the workshop. After panicked calls to the university audio visual technical services, and even to local companies that may sell this, we realized that we just had to drive back to Johannesburg to collect the transformer. Since we arrived early, we could just make it in time before the workshop was supposed to start. One thing we could, however, not foresee was that there was a freak hailstorm in Johannesburg. It looked like snow at the side of the road. We arrived an hour late and I had to cope with some very irate attendees.

This catastrophe taught me to always have a backup plan B and sometimes a plan C. I now always travel with my own power cords, data projector and a whole range of international plug and projector adapters.

THE STELLENBOSCH UNIT FOR OPERATIONS RESEARCH IN ENGINEERING

by Jan van Vuuren (vuuren@sun.ac.za)

Jan van Vuuren

The *Stellenbosch Unit for Operations Research in Engineering* (SUnORE) was established within the Department of Industrial Engineering at Stellenbosch University in 2014. It is the main *operations research* (OR) grouping within a vibrant department that also engages in a diverse variety of other research areas. SUnORE is responsible for the undergraduate OR course offering of the department, for the supervision of postgraduate OR-related study within the department and for carrying out OR-related research and consulting work.

The purpose of this feature article is to introduce the SUnORE group to readers of the ORSSA newsletter, and to present the members of ORSSA with some idea of the kind of work and activities in which members of the group engage.

The vision of the group is *analysis in support of effective decisions*, while its mission is *to be an inclusive environment for the training, development and inspiration of innovative, yet responsible, scientific young minds.* The values of SUnORE are:

- The continual pursuit of excellence above all else,
- Fostering a serious & professional work ethic,
- Practising defensible, repeatable & responsible science,
- Vigorously & ceaselessly enlarging one's knowledge base,

- Seeking advice as widely and as often as possible,
- Engaging in challenging debate, but respecting the opinions of others,
- Developing a genuine interest in the work of other group members,
- Demonstrating loyalty to one's affiliations & scientific communities, and
- Being tireless ambassadors of the scientific discipline of OR.

At present the academic staff members of SUnORE are Danie Lötter, Brian van Vuuren and Jan van Vuuren. Apart from engaging in their own research, these staff members also supervise final-year and postgraduate students in OR-related research. There are currently 35 SUnORE students — 14 final-year students completing their fourth-year projects in OR, 14 master's students with thesis topics in OR and 7 doctoral OR students. The group is based in two state-of-the-art computer laboratories within the Department of Industrial Engineering (see Figure 1).

Members of SUnORE attend the annual conferences of ORSSA on a regular basis and present their work there. A number of (past) members of the group also currently serve on the ORSSA Executive Committee:

- Danie Lötter — Vice President,
- Brian van Vuuren — Newsletter Editor,
- Bernie Lindner (past SUnORE member) — Newsletter Business Manager,

Figure 1: One of the SUnORE computer laboratories.

- Jacques du Toit (past SUnORE member) — Webmaster,
- Fanie Terblanche — Vaal Triangle Chapter Chair, and
- Shane van Heerden — Western Cape Chapter Chair.

SUnORE is a close-knit research group which subscribes to the philosophy that a fine balance should ideally be maintained between group development and the development of its individual members. The group therefore meets in its entirety once weekly for four hours, during which time a variety of important generic research skills (such as how to plan and conduct research, how to write scientifically, how to compute, and how to present and defend work orally) are developed. During these group meetings there is ample opportunity for members of the group to provide feedback on their work, and to receive constructive criticism, research tips and suggestions from other members of the group. In addition, all SUnORE students also have separate individual weekly meetings with their supervisors to brainstorm and discuss research progress.

SUnORE has a very busy social calendar during which members of the group can discuss work and other matters under relaxed circumstances. The group even has its own soccer team, called the *Profadders*, which competes once weekly in an amateur league. This provides ample opportunity to relieve stress built up in the labs (and to sustain injuries!). The 2016 members of the soccer team are shown in Figure 2.

A Venn-diagram representation of the specific subfields of OR in which members of SUnORE have recently worked and currently work may be found in Figure 3. Using the same subject numbering as in the figure, a variety of research projects by SUnORE members are briefly described in the remainder of this article. Since there are many of these projects, the discussion below is not exhaustive but rather aims to be representative; apologies to all those group members whose work is not covered here. The article closes with an open invitation to readers.

A. Cutting and Packing Problems

Current doctoral student Georgina Rakotonirainy is considering (meta)heuristic solution approaches for the well-known strip packing problem (the problem of, given a number of two-dimensional shapes, packing these shapes into a strip of fixed width with the aim of minimising the packing height). She has tested a large number of algorithms for this problem in respect of benchmark data and she is in the process of designing a new strip packing metaheuristic for this NP-hard problem.

For her 2015 final-year project, Naomi Louw [1] designed a decision support system for a company in Worcester, Western Cape which manufactures long-haul vehicles. The frames of these vehicles are produced from steel plate parts of various shapes that are cut out from large sheets of steel by laser cutting equipment. The company required decision support in respect of which parts to cut themselves, and which parts to outsource to large steel producers.

B. Decision Support in Agriculture

An active application area of research by SUnORE members is the agricultural sector. In collaboration with a large export fruit producer, Anine Burger designed a decision support system for fruit growers in respect of where, when and how much fruit to sample from orchards throughout a season in order to gain a representative understanding of the various fruit growth processes, in her 2014 final-year project [2].

Figure 2: The Profadders. Fltr — BJ van Vuuren (goalie), BG Lindner, T Schmidt-Dumont, JC van der Walt, J Eygelaar, TJ Kellermann, A Smith and A Avertoft.

For his final-year project of 2016, Janco Barnard built a mathematical model for the allocation and scheduling of irrigation water for crops during the various stages of their development [3]. Janco is currently a master's student and for his thesis he plans to build on his previous work by designing a decision support system for farmers in respect of water utilisation planning for the sustenance of both planted crops and livestock.
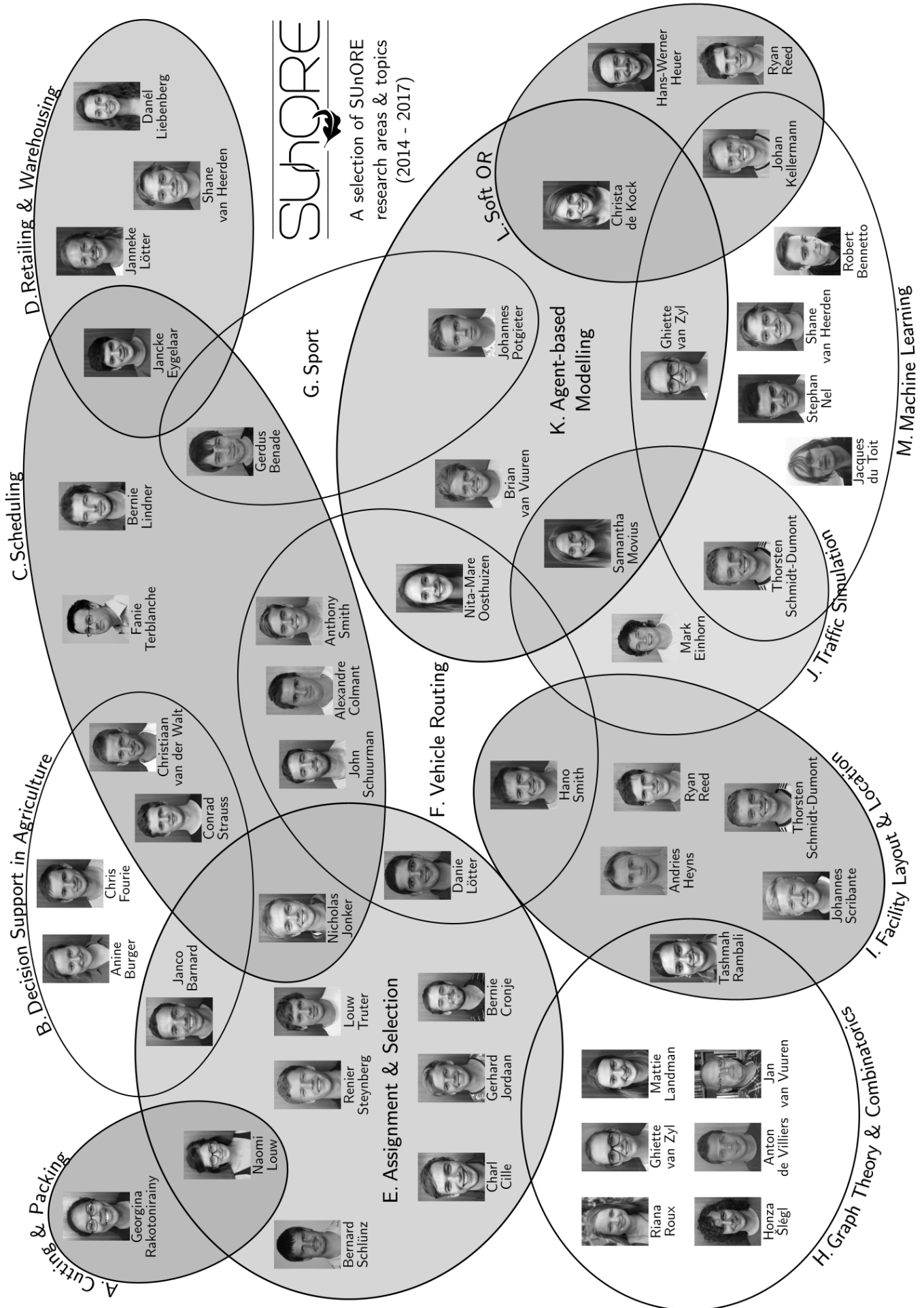
Figure 3: Venn diagram representation of SUnORE research areas (2014–2017).
(Brian van Vuuren is thanked for producing this Venn diagram.)

Former final-year students Conrad Strauss [4] and Christiaan van der Walt [5] designed decision support systems in 2014 and 2015, respectively, for efficient irrigation reservoir sluice control and both students achieved close collaboration with the board of management of Keerom Dam, the second largest privately owned irrigation reservoir in South Africa. Christiaan went on to become a finalist in the 2016 Gerhard Geldenhuys Medal competition organised by ORSSA, eventually winning the runner-up prize for the second best fourth-year OR project on a national level. He also won a Rhodes Scholarship to enable him to go up to Oxford in September 2017 in order to read two further master's degrees after his current one in industrial engineering with the SUnORE group — one in applied mathematics and scientific computing (2017–2018), and another in applied statistics (2018–2019).

Finally, Chris Fourie provided decision support in his 2014 final-year project, also to the board of management of Keerom Dam, with respect to the positioning of a planned pipeline installation aimed at transporting irrigation water from the dam through a 13-kilometre gorge to the Nuy agricultural district just outside Worcester [6].

C. Scheduling

Another active area of research within the group is scheduling. In this area, doctoral students Bernie Lindner [7] and Jancke Eygelaar [8] have focussed on metaheuristic decision support for maintenance scheduling of the power generating units of Eskom according to a variety of scheduling criteria (such as cost minimisation, reliability maximisation, and/or energy production maximisation). Bernie obtained his PhD in March 2017, while Jancke is currently still in the process of completing his dissertation.

Another (part-time) doctoral student, Fanie Terblanche, is currently pursuing decision support (based on exact solution methodologies, including amongst others, graph reduction techniques and Benders decomposition) for underground mine scheduling operations. This is a special case of the more general resource-constrained project scheduling problem [9]. The work forms part of Fanie's second PhD.

For his final-year project of 2014, John Schuurman worked on a sequence-dependent machine scheduling problem that arises in the colour printing industry [10]. Perhaps surprisingly, this problem is a special case of the well-known tool switching problem, and may be modelled as a vehicle routing problem with sequence-dependent travel times.

D. Retailing and Warehousing

While a fourth-year student in 2014, Jancke Eygelaar developed a decision support system for the identification of those outlets of a large local retailer that were using unreasonable amounts of electricity, given their functions, sizes and departments, so that appropriate action could be taken in view of the general unavailability of abundant electricity at the time [11]. This work formed part of his final-year project in industrial engineering.

Danél Liebenberg performed a cost-benefit comparison analysis for adopting two types of pallets for the transportation of goods between warehouses of the aforementioned local retailer [12]. This work formed part of her 2015 final-year project and involved a comparison of standard wooden base pallets and newly available (completely enclosing) plastic containers. She made practical recommendations to the retailer in respect of which type of pallet to use under different circumstances.

In 2016, Shane van Heerden designed and implemented a computerised decision support system for another large local retailer as part of his final-year project. This decision support system was aimed at streamlining stock-keeping unit floor layout designs of the various departments in large retail warehouses [13]. Shane took as placement criterion the pursuit of a trade-off between minimising the expected distances covered by order pickers within the warehouse and minimising warehouse isle congestion.

Janneke Lötter (now Steynberg) completed her master's thesis in 2016 on a topic in retail inventory management [14]. She designed a computerised decision support system for aiding managers in their complicated replenishment order decisions in the fresh fruit and vegetable departments of retail outlets, and she achieved close collaboration with a third large local retailer in the process.

E. Assignment and Selection

In his master's thesis of 2015, Louw Truter designed a computerised testbed for the integration of a large volume of work on weapon assignment and threat evaluation algorithms developed at Stellenbosch University during the period 2004–2013 for use in a ground-based air defence military scenario [15]. Louw went on to receive the 2016 Theodor Stewart Medal from ORSSA for the best master's thesis in OR on a national level for this work.

Bernard Schlünz obtained his PhD in 2016 based on decision support that he provided for the *South African Nuclear Energy Corporation* (Necsa) in respect of loading position assignments for fuel assemblies in the core of their SAFARI-1 nuclear research reactor [16]. Bernard was awarded a Category IV Recognition Award by ORSSA at its annual conference in 2016. This award goes to an upcoming member of ORSSA of age 35 or below for excellence in operations research practice.

In 2015, two final-year students had, in fact, also conducted research related to loading position assignments for fuel assemblies in the core of the SAFARI-1 nuclear research reactor for Necsa. Bernie Cronje adopted a particle swarm optimisation approach toward finding good trade-off fuel assembly loading assignments [17], while Gerhard Jordaan conducted an experimental study to find suitable parameter values for a harmony search algorithmic approach toward solving the same problem [18].

Two final-year students provided decision support to the Faculty of Engineering at Stellenbosch University in 2016 as part of their undergraduate training. Charl Cillie built a mathematical model according to which the 600+ students of the Engineering Faculty can be partitioned into groups of six students for participating in project management group projects [19]. This partitioning was based on a variety of criteria, including diversity in terms of academic performance, gender and home departments. Nicholas Jonker designed a decision support system aimed at supporting the efficient management of the final-year project administration process within the Department of Industrial Engineering [20]. This process involves the fair assignment of project topics to students based on a bidding process, the assignment of examiners to students and the final oral examination timetabling.

For his 2016 master's thesis, Renier Steynberg considered the problem of selecting suitable prospective tertiary students for bursary awards, based on various criteria as possible indicators of potential success. During the course of his research, Renier achieved close collaboration with an NGO responsible for bursary allocations to learners from previously disadvantaged backgrounds [21]. He won the prize for the best master's thesis in the area of computerised decision support from the Department of Industrial Engineering in 2016.

Danie Lötter's current doctoral research is focussed on the development of mathematical models for weapon assignment in a ground-based air-defence environment. He is adopting a multi-objective optimisation approach in which trade-offs are pursued between the minimisation of enemy survival probability, the minimisation of ammunition cost and the maximisation of re-usable ammunition in the least re-engageable weapon after the assignment. This problem has perhaps surprising links with the celebrated vehicle routing problem with time-windows [22]. Danie was appointed as lecturer in the Department of Industrial Engineering at Stellenbosch University on 1 January 2015, and he was also awarded a Category IV Recognition Award by ORSSA at its annual conference in 2016.

F. Vehicle Routing

In the area of vehicle routing, Alexandre Colmant worked on an interesting new type of vehicle routing problem that arises in the safeguarding of the South African coastline against illegal activities (such as drug trafficking, illegal fishing and piracy). Alexandre designed a decision support system capable of suggesting interception routes for vessels suspected of criminal behaviour by maritime law enforcement vessels. This work formed part of Alexandre's doctoral research; he obtained his PhD in 2016 [23].

Current doctoral student Anthony Smith is also working on a new type of vehicle routing problem — one that arises in the healthcare sector during the collection of pathological specimens from clinics and their transportation to suitable laboratories for processing [24]. A distinguishing feature of this new type of vehicle routing problem is that hand-over of commodities between vehicles can occur at virtually any customer (a notion called global cross-docking).

Another current master's student, Hano Smith, is incorporating inventory replenishment and vehicle routing elements into a decision support system he is developing for franchise managers. The working of his system is based on an agent-based simulation model and is aimed at achieving a suitable trade-off between the maximisation of franchise profit and the maximisation of customer service satisfaction.

Finally, current master's student Nita Oosthuizen is developing vehicle routing decision support for armoured vehicles which replenish cash stockpiles at automatic teller machines of banks. For her final-year project in 2016, Nita also considered a vehicle routing and location problem for the placement of a bio-medical waste disposal facility for a group of hospitals [25].

G. Sport

In 2014, Gerdus Benadé obtained a master's degree based on a thesis in which he sought to enumerate Latin squares satisfying certain orthogonality properties [26]. These squares find application in sports tournaments such as round-robin tournaments for card games or spouse-avoiding mixed doubles tennis. Upon graduating, Gerdus took up a full scholarship at Carnegie Mellon University in the United States of America, where he is currently pursuing a PhD in OR in the Tepper School of Business.

For his final-year project of 2015, Johannes Potgieter designed a decision support system for managers of football clubs in respect of field playing formations that their teams should adopt against certain opposing teams for which historical match data are known [27]. The working

of Johannes' decision support system was based on an agent-based simulation modelling approach.

H. Graph Theory and Combinatorics

Within the area of graph theory, Jan van Vuuren has been involved in a number of research projects within the fields of graph colouring, graph domination and graph Ramsey theory. In 2016, he characterised those graphs that are edge-critical with respect to their domination number (*i.e.* those graphs whose domination numbers would increase if any edge were removed from them) [28]. Jan is a mathematician by training and was appointed as professor of OR within the Department of Industrial Engineering on 1 January 2014. He heads the SUnORE group and, together with Mike Henning from the University of Johannesburg, is in the process of completing a textbook on graph theory.

For her PhD dissertation of 2014, Riana Roux considered a natural generalisation of the well-known graph domination problem which has natural applications in supply and demand networks [29]. Instead of requiring that every graph vertex should be adjacent to vertices in or should itself be contained within a dominating set of minimum cardinality, she considered the problem of finding a minimum-cardinality facility location set at the vertices of a graph subject to the constraint that at most r vertices be placed at each vertex and satisfying the requirement that every vertex should have at least s facilities in its (closed) neighbourhood.

Anton de Villiers also obtained his PhD in 2014 based on research related to the problem of graph domination. He carried out a study about the stability and criticality of edge removals of graphs with respect to their secure domination numbers [30]. Essentially, he studied properties of graphs from which certain edges can be removed without increasing their secure domination numbers, characterised which edges may thus be removed from such graphs, and considered how these graphs differed from ones that admit no such edge removals without affecting their secure domination numbers.

In 2016, a Czech master's exchange student, Honza Šlégl, visited the SUnORE group for a period of six months. During this time he worked on a generalised graph colouring problem [31]. The problem involved finding the smallest number of colours with which the vertices of a graph can be coloured so that no vertex in any colour class has a maximum degree more than some pre-specified number. He compared the efficiency of integer programming solution techniques for this problem with that of existing (exact and metaheuristic) algorithms tailor-designed for the problem, and showed that under certain conditions integer programming is the preferred solution approach.

For her 2016 final-year project, Ghiete van Zyl computed so-called *God numbers* for two instances of a combinatorial puzzle designed by Alewyn Burger, called Wrapslide [32]. The puzzle resembles a two-dimensional version of the celebrated Rubic's cube, and was designed for touchscreen applications. (A God number is the smallest number of moves with which any scrambled state of the puzzle can be solved.)

Tashmah Rambali, a current master's student, is considering the problem of the identification of bottlenecks and the recommendation of points of infrastructure expansion in urban storm water drainage networks — Tashmah is modelling the problem as a maximum-flow network problem and has achieved close cooperation with a municipality in the Western Cape.

Mattie Landman, another master's student from 2017 onwards, also plans to embark on a topic in graph theoretic research for her thesis. She plans to provide decision support for *Uber* drivers in terms of best expected locations to assume between trips over a pre-specified decision window.

I. Facility Layout and Location

Group members who have worked in the area of facility location include former doctoral student Andries Heyns who in 2016 derived multi-objective optimisation models and accompanying metaheuristic solution procedures for geographic information system-related facility location problems [33]. In his models Andries considered a variety of placement criteria, such as line of sight visibility, centrality with respect to demand satisfaction, and the dispersion of facilities.

In 2015, Ryan Reed considered a facility location problem related to the placement of firebases in a nature conservation area for his final-year project [34]. Ryan adopted a multi-objective optimisation approach in his project, with firebase placement criteria related to ground slope, historical locations of fires, historical wind speed and direction data, and centrality within the conservation area.

In his 2015 final-year project, Thorsten Schmidt-Dumont developed a computerised decision support system for location of cellular telephone transmission towers aimed at achieving trade-offs between maximising signal coverage and maximising signal strength over a pre-specified portion of terrain [35]. Thorsten went on to receive the 2016 Gerhard Geldenhuys Medal from ORSSA for the best fourth-year OR project on a national level for this work.

Finally, in his final-year project of 2016, Johannes Scribante used metaheuristics to determine good facility layouts in terms of the locations of workstations in the workshops of production facilities [36]. His modelling approach was to pursue a trade-off between the minimisation of materials flow cost between the workstations and minimisation of pairwise undesirable workstation adjacency.

J. Traffic Simulation

Mark Einhorn obtained his PhD in 2015 based on the development of three novel self-organising algorithms for the control of traffic signals at urban street intersections [37]. These algorithms were based on rather unlikely analogies between certain notions in traffic control, on the one hand, and (a) the chemical notion of osmosis and (b) costs in standard inventory models on the other.

For her doctoral degree, Samantha Movius is currently working on the improvement of the aforementioned algorithms of Einhorn as well as on the design of her own, new traffic signal control algorithm, also based on the notion of self-organisation [38].

Whereas the work of Mark and Samantha is rooted in an urban setting, Thorsten Schmidt-Dumont is currently considering the problem of improving highway traffic flow throughput by means of machine learning algorithms in his master's thesis. The controls that Thorsten is considering are variable speed limits and on-ramp flow metering. He has achieved close collaboration with the Smart Mobility Laboratory within the Department of Civil Engineering at Stellenbosch University, as well as with SANRAL.

All three of the above-mentioned students have used agent-based microscopic traffic simulation models as testbeds for their algorithms.

K. Agent-based Modelling

Brian van Vuuren obtained his PhD in 2016 based on a dissertation in which he designed and implemented an agent-based simulation model of the population dynamics evolution of Eldana saccharina Walker, a prevalent sugarcane stalk borer pest in KwaZulu-Natal [39]. Brian was also a finalist for the 2016 Theodor Stewart Medal presented annually by ORSSA, winning the runner-up prize for the second best OR-related master's thesis on a national level for his work. Brian also won the Kynoch Award from the South African Sugarcane Technologists Association in 2016 for his paper *Design of an agent-based model for simulating the population dynamics of Eldana saccharina*. He was appointed as lecturer in the Department of Industrial Engineering at Stellenbosch University on 1 January 2016, while still completing his PhD.

Christa de Kock is working towards her MEng degree for which she is constructing an agent-based simulation model aimed at simulating the displacement and migration of refugees. With particular focus on the large-scale Syrian, Turkish and Greek refugee migrations occurring at present, this model is aimed at assisting in the planning and logistics pertaining to facilities and resources required to accommodate incoming refugees in these different areas, as well as better understand the dynamics of populations of people in affected areas during times of conflict, natural disaster or other refugee-causing events.

L. Soft Operations Research

For his final-year project of 2016, Hans-Werner Heuer designed a human-machine interface for use by military operators in a ground-based air-defence context [40]. The aim of his research was to base his design on factors believed to promote efficient human and machine interaction, by avoiding clutter, superfluous or untimely information and ineffective situation awareness reporting. His work involved interesting experiments to determine the rate of information that can be relayed to a military operator before confusion arises as a result of information or cognitive overload.

Ryan Reed, a current master's student, has embarked on a research project within the realm of behavioural OR. His work is aimed at the facilitation of vague and unstructured group decisions that are subject to a large degree of uncertainty. His work brings together elements of psychology, the study of cognitive biases and heuristic decision making, and the study of individual behaviour under group pressure within a decision facilitation framework capable of guiding facilitators to a point where traditional problem structuring can commence so that there is buy-in from a variety of stakeholders with different value systems and world views, ultimately with a view to reach a consensus problem formulation.

M. Machine Learning

Jacques du Toit obtained his PhD in 2014 based on research toward machine assistance to human operators who are tasked with monitoring vessel tracks at sea for anomalies indicative of illegal behaviour [41]. This behaviour may entail drug trafficking, systematic pollution, illegal fishing or piracy. Since there are so many radar tracks of vessels around the South African coastline, there is an urgent need for automated learning of the tell-tale signs of illegal behaviour and for the capacity to pick out such behaviour from a multitude of tracks corresponding to vessels behaving normally.

For his doctoral dissertation, Robert Bennetto is currently considering the problem of determining effective branch-

ing schemes for constraint programming searches by employing domain-specific information in an abstract way (*i.e.* not on a problem-to-problem instance basis). One of his aims is to employ meta-data from the constraint programming graph itself, as well as associated attributes from elements used to generate nodes in the graph, in a machine learning approach toward determining which branching schemes should be used for the constraint satisfaction problem based on the constraint programming meta-data extracted from benchmark instances.

Johan Kellermann is currently working towards a master's degree on the design of a computerised decision support system in aid of solving subjective selection problems with very large solution spaces. Computer-implemented metaheuristics and machine learning techniques complement pairwise comparisons of selection alternatives by a subjective human decision maker in this design, which aims to learn the decision maker's selection utility function upon making use of a very limited number of pairwise comparisons. Based on knowledge about the decision maker's utility function, the system is able to recommend pleasing solution alternatives to the user.

Ghiete van Zyl, also a current master's student, has just begun her study of machine learning algorithms in aid of destination dispatch, a new elevator control paradigm. Rather than simply pressing "up" or "down," an elevator passenger enters the required destination floor on a touch pad in this new control paradigm, and is informed on a screen which elevator will come to collect him or her. Because the control algorithm knows exactly where each passenger is going, these systems are able to edge closer to perfect efficiency. People headed to the same floor may be bunched together, effectively turning each elevator into an express train. How to do this effectively in real time, however, remains a challenge.

Another first-year master's student, Stephan Nel, is currently working on the development of hyperheuristics for the training and ensembling of artificial neural networks. These networks ensemble together to learn from data and, subsequently, infer non-linear relationships between different characteristics of a problem which can prove useful when solving problems involving function approximation, classification, and data clustering. Stephan is considering ways in which the configuration of the ensemble (*i.e.* number of networks and number of neuron layers in each network) as well as the training algorithm can be enhanced by a hyperheuristic.

Finally, Shane van Heerden embarked this year on a master's study in which he is designing a computerised decision support platform for assisting insurance companies in their determination of the relative shares of insurance pay-outs of the various parties involved in vehicle accident claims. He plans to use a variety of machine learning techniques to discover variables that are important in terms of their ability to assign blame, and to incorporate these variables in predictive models for the percentages of insurance pay-outs apportioned to the various insurers involved in accident claims.

Open Invitation

If any ORSSA member would like to visit the SUnORE group in Stellenbosch (where the ORSSA archives are incidentally also hosted), or if any reader would like to enquire about prerequisites for joining SUnORE on post-graduate level, please contact Jan van Vuuren at the email address provided above.

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OPERATIONS RESEARCH IN ZIMBABWE

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Philimon Nyamugure

Operations Research (OR), was introduced in Zimbabwe in the early 1970s with elective courses offered under engineering and statistics degree programmes at what was then the University of Rhodesia. In fact, Dave Evans, our current treasurer, delivered a numer of these courses. Although not called "operations research" during those years, courses such as systems engineering, optimization, decision theory, and mathematical programming were found in several relevant degree programs (Evans et al., 2011). In 2005, in response to recommendations from industry and commerce, the then Department of Applied Mathematics at the *National University of Science and Technology* (NUST) introduced a four-year Bachelor of Science Honours Degree in OR and Statistics. This increased the use of OR in different industry

sectors in Zimbabwe and hence the demand of graduates with the qualification. With the increased demand of OR graduates in the country, the University introduced the Department of Operations Research and Statistics in 2012 which has grown tremendously and now hosts regional students enrolled for the degree. Going forward, The Department now intends to introduce a degree programme in OR as a stand-alone degree programme (without the Statistics component). Having a stand-alone degree in OR will enable the Department to offer more courses in OR which are currently in demand in industry. The programme will also provide opportunities for students from different academic backgrounds (sciences, commerce and arts) to broaden and apply scientific methods to improve the effectiveness of operations, mathematical skills for quantitative analysis, decision making, and management.

In 2007, the *NUST Operations Research Society* (NORS) was formed with the aim of spreading the gospel of OR across the whole country. NORS also on an annual basis exhibits its programmes and activities on the annual Zimbabwe Trade Fair, an exhibition that attracts foreign and local companies. Plans to form a *Zimbabwe Operations Research Society* (ZORS) have been suggested and are being considered. Since NUST is the epicentre of OR in Zimbabwe, the majority of the members have suggested that we apply to the *Operations Research Society of South Africa* (ORSSA) to become a chapter. A lot of experience can be learnt before the introduction of ZORS.

Through NUST, four local universities are now offering OR programmes. Collaborative work is underway between the universities that are offering OR and industry. Several joint projects are being carried out between the universities and companies so as to increase the awareness of the subject.

In November 2016, Bernie Lindner, an executive committee member of ORSSA, visited NUST and gave a talk on ORSSA and the formation of *Africa Operations Research Societies* (AFROS). He emphasised the need for cooperations between African countries in making sure that OR grows in Africa. He was so keen to see Zimbabwe form or become a chapter of ORSSA – an idea that we are exploring with interest.

It is against this we have also roped in past and current students in the department who have shown a keen interest in the activities of NORS. At university level there are plans to spread OR to other departments in the university like the Computer Science Department and the Industrial and Manufacturing Engineering Department.

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BOOK REVIEW: BEHAVIORAL OPERATIONAL RESEARCH

by Hans Ittmann, University of Johannesburg (hittmann01@gmail.com)

Hans Ittmann

A development within *Operations Research* (OR) that has emerged over the last number of years is a renewed emphasis on the decision maker as a human being. This subfield has become known as *Behavioral Operations Research* (BOR) where the emphasis is on gaining a better understanding of human behavior especially in the process of decision making. How can this then be captured and represented in models together with the appropriate and associated analysis? Although modelling behavior has been applied in such areas as decision analysis and systems dynamics, there has been a growing resurgence and recognition of the need to include behavioral factors such as human judgment and decision-making heuristics and biases, decision-making under uncertainty and bounded rationality into a wider spectrum of quantitative modelling approaches and methods.

Thus, innovative ideas, methods and research frameworks, influenced by recent similar developments in other fields, are now being used by operations researchers to allow for a more rigorous approach to addressing behavioral issues within OR. As more and more research papers on the topic are published, so have special editions of journals devoted to BOR. This has culminated in the publication of the book *Behavioral Operational Research*. This is possibly one of the first books on behavioral OR and covers a wide array of relevant topics.

The book has four main parts, each with a number of chapters written by a host of authors. Part I covers theoretical aspects; Part II focuses on diverse methods used to address behavioral issues in OR; Part III illustrates, with practical OR cases, how behavior plays a key role in model performance and discusses insights thus derived; and Part IV, entitled "The Past, Present and Futures of Behavioral Operational Research", presents a concise wrap up.

Chapter 1 provides an introduction to BOR. It points out that maturity implies recognizing that developing technically correct and valid models is not sufficient anymore – behavioral factors that could enhance or even hinder the

effectiveness of such models need to be considered. This "return" to BOR is achieved through an empirical examination of human behavior in OR-supported processes. An integrative framework based on three concepts, namely: OR methods (techniques or tools), OR actors (those involved) and OR praxis (OR activity) is proposed to drive the development of BOR. Emphasis is placed on conducting empirical studies to examine what people actually do within a system or when engaged in OR-supported processes. The next three chapters in Part I are more theoretically oriented, covering such issues as: "Behavior with Models: The Role of Psychological Heuristics in OR", "Behavior in Models: A Framework for Representing Human Behavior" and "Behavior Beyond the Model". In all three chapters, there is an effort to provide a framework which would allow for embedding behavior with, in and beyond models.

All six chapters in Part II focus on specific OR methods, both "hard" and "soft", to address behavioral issues. Chapter 5 shows how a queuing environment modelled using simulation and laboratory experiments showed that when customers in queues have learned patterns, the assumption that they arrive according to some random process no longer holds. System dynamics is the topic of the next chapter where errors in understanding of feedback structures in the supply chain environment can lead to poor mental models that cause systematic errors. Some mechanisms that involve misperceptions in these situations are discussed. The next two chapters deal with behavioral issues in agent-based modelling and behavioral modelling in decision making. Chapter 9, "Big Data and Behavior in OR: Towards a 'Smart OR' ", address a very current issue of how analytical techniques can be used to extract behavioral insight from Big Data including social media data. Behavioral issues related to two "soft OR" approaches, namely facilitation in scenario planning and group model building, conclude Part II.

In Part III, the focus is on relevant practical examples of OR. Its first chapter provides a literature overview of practical BOR that highlights the breadth and extent of studies that have been undertaken in the area. Each of the next five chapters addresses a different example where behavior is a key component of the model. Healthcare is the first example where a concern on the "lack of reported implementation of model findings and recommendations" is addressed. The issue of whether human behavior should

be incorporated in the conceptual design of simulation models is tackled using two case studies. The availability of "real" human behavior data is shown to be a considerable challenge.

A number of case studies relating to the use of BOR in British Telecommunications is described in Chapter 14. It outlines lessons learnt and presents illustrations of how incorporating behavior in OR models has led to successes. The use of big data and BOR in a "smart" cities context is illustrated through a number of case studies, including energy efficiency planning in different districts and the use of a city dashboard for real-time reporting. A term SMART OR, referring to "the creative use of Big Data with Hard and Soft OR to enhance behavior and positive results for decision makers", is advanced to illustrate what has been done and achieved. Chapters on "Mergers and Acquisitions" as well as "Resource Conceptualization Processes" show how behavior is included in models that deal with both strategic issues and the development of strategies, respectively.

The final chapter is in essence a review of the past, an assessment of the present, and a forecast of possible futures of BOR. Covering a wide range of topics "ranging from the modeling of thought and behavior and the incorporation of behavioral factors in models, to how people understand models and how thought and behavior is influenced by modeling work", the book makes a clear case for incorporating behavior into OR projects. The objective of illustrating "behavior with models", "behavior in models" and "behavior beyond models" has clearly been achieved in this publication. This is a great reference for those who want to emmerse themselves in BOR.

As early as September 1964, during the first international conference held by the Operational Research Society with the theme "Operational Research and the Social Science", Sir Charles Goodeve, stated: "operational research people are very much concerned with change and can deal with the logic, including the economics, of it. But attitudes of people – managers, technicians, workpeople, salesmen, customers etc. – can throw the best of predictions into confusion". These are words that ring true, even today. The book *Behavioral Operational Research* is therefore an important and essential addition to further enhance and broaden the impact of OR as a discipline.
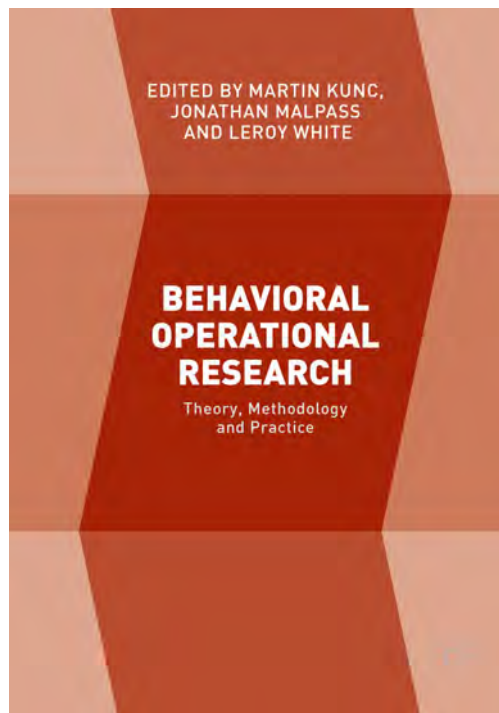
Note from the reviewer: In her opening address at the last ORSSA conference the ORSSA President, Winnie Pelser, made reference to Behavioral Operations Research. This recently published book on the topic proved to be very useful in getting to understand what BOR entails. This review appeared in the December 2016 edition of the IFORS newsletter. Finally, since the word "behavior" is spelt the American way in the title of the book the word, and variances thereof, is used the American English way throughout the review. Why it is spelt this way when all three editors as well as the publishing house are from the UK remains a mystery!

Behavioral Operational Research - Theory, Methodology and Practice by Martin Kunc, Jonathan Malpass and Leroy White Eds., 2016, Palgrave Macmillan UK, Hampshire UK, pp. 395, ISBN 978-1-137-53549-8 (Print) and ISBN 978-1-137-53551-1 (eBook), 149.99 EURO (Hardcover), 118.99 EURO (eBook).

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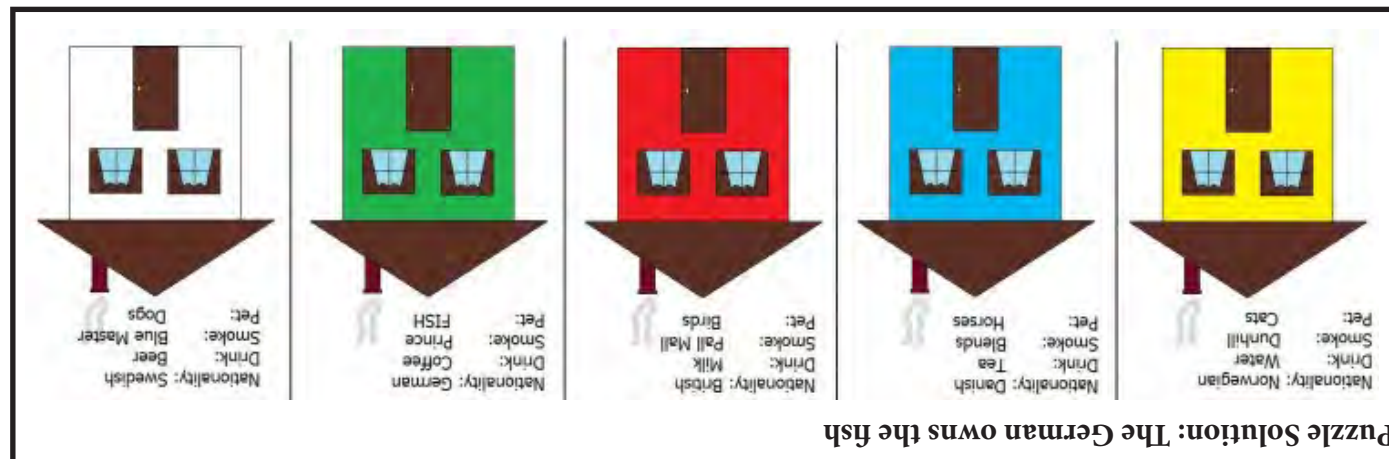
ORSSA INVOICES

A NOTE FROM THE TREASURER

At mid March, 80 members have paid their 2017 membership fees - our thanks to you for your prompt response to the fees invoices.

As many members will know, we have had major problems getting ORiON, Newsletters and membership fee invoices to you by hard copy for several years now. Sadly, the SA Post Office is not improving – I was still receiving Christmas cards at the end of February.

I have therefore sent out the invoices for the 2017 fees by email. This is also flawed, but in a different way – members' email addresses change far more often than their postal addresses. Therefore, if you haven't received an emailed invoice, it may well be because we've got a wrong email address for you on file. Please contact me with your current email address, so that we can update the records and get back in touch with you electronically.

Dave Evans
Treasurer
davevans@gmail.com
082 554 8633

Puzzle Solution: The German owns the fish

Nationality: Swedish	Nationality: German	Nationality: British	Nationality: Danish	Nationality: Norwegian
Drink: Beer	Drink: Coffee	Drink: Milk	Drink: Tea	Drink: Water
Smoke: Blue Master	Smoke: Prince	Smoke: Pall Mall	Smoke: Blends	Smoke: Dunhill
Pet: Dogs	Pet: FISH	Pet: Birds	Pet: Horses	Pet: Cats

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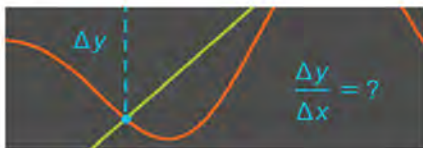
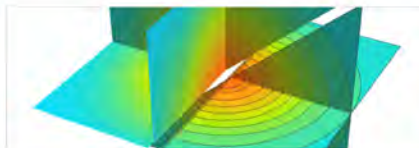## Mathematics
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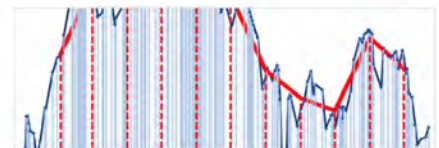**Enhanced Geo Visualization »**
Geo Computation »
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Text and Language Processing »
Multilingual Functionality »

Units & Dates
Time Series Processing »
Quantities in Probability & Statistics »
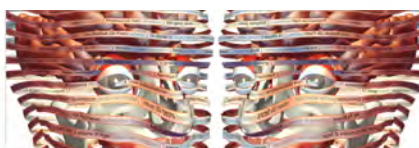**Units & Dates »**

Language & System
Core Language »
Systems-Level Functionality »
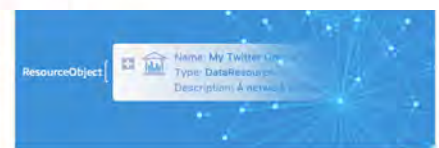**User Interface Enhancements »**
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