

OR61 Tuesday 3 September 2019

Time	Sibson LT3	Sibson LT1	Sibson LT2	Sibson PC1	Sibson SR1	Sibson MBA	Sibson SR2	Sibson SR3	Sibson SR4	Sibson SR5	Sibson SR6	Kennedy SR10	Kennedy SR2	Kennedy SR3	Kennedy SR4	Kennedy SR5	Kennedy SR6	Kennedy KENPC3
	Registration – Sibson Building Atrium																	
09:00	Opening Ceremony– Sibson Building Lecture Theatre 3 Plenary: Erhan Erkut – Sibson Building Lecture Theatre 3 Optimising the Teaching of OR – Yesterday and Tomorrow																	
10:30	Refreshments – Sibson Building Atrium																	
11:00			Meet the Editors Panel Session		OR Applications in Public & Government Services OR61A200 OR61A221 OR61A47	Data Science: Techniques & Industrial Applications OR61A44 OR61A147 OR61A55 OR61A156	Making an Impact - Workshops OR61A237	Soft OR & Problem Structuring OR61A304 OR61A290 OR61A75 OR61A30	Sustainable Development Goals OR61A298 OR61A292 OR61A218 OR61A277	MCDM OR61A133 OR61A82 OR61A291	Systems Thinking OR61A354	DEA and its Applications OR61A249 OR61A178 OR61A16 OR61A17	Combinatorial & Global Optimisation OR61A130 OR61A93 OR61A152 OR61A220	Control Theory OR61A118 OR61A160 OR61A59	Simulation OR61A175 OR61A170 OR61A106	OR & Strategy OR61A121 OR61A24	Healthcare Applications OR61A275 OR61A78 OR61A245 OR61A215	
12:30	Lunch – Sibson Building Atrium																	
13:30					OR Applications in Public & Government Services OR61A262 OR61A318 OR61A350	AGM Community OR Invited guests only	Behavioural OR OR61A305 OR61A184 OR61A224	Soft OR & Problem Structuring OR61A69 OR61A244 OR61A46 OR61A236	Sustainable Development Goals OR61A43 OR61A52 OR61A263	MCDM OR61A163 OR61A190	Systems Thinking OR61A355	DEA and its Applications OR61A212 OR61A49 OR61A235	Combinatorial & Global Optimisation OR61A126 OR61A29 OR61A333	Locational Analysis: Theory & Application OR61A112 OR61A32 OR61A328 OR61A334	Simulation KEYNOTE OR61A356 OR61A280	OR & Strategy KEYNOTE OR61A174 OR61A128	Healthcare Applications OR61A101 OR61A284 OR61A31	
15:00	Refreshments – Sibson Building Atrium																	
15:30	Plenary: Panos Pardalos – Sibson Building Lecture Theatre 3 Sustainable Interdependent Networks																	

OR61 Tuesday 3 September 2019

Time	Sibson LT3	Sibson LT1	Sibson LT2	Sibson PC1	Sibson SR1	Sibson MBA	Sibson SR2	Sibson SR3	Sibson SR4	Sibson SR5	Sibson SR6	Kennedy SR10	Kennedy SR2	Kennedy SR3	Kennedy SR4	Kennedy SR5	Kennedy SR6	Kennedy KENPC3
16:30			Women in OR 16:45 OR61A122		OR Applications in Public & Government Services OR61A204 OR61A265 OR61A70	OR for Sustainable Approaches OR61A270 OR61A283 OR61A313	Behavioural OR OR61A297 OR61A107 OR61A197	Soft OR & Problem Structuring KEYNOTE OR61A226 OR61A127 OR61A169		Data Science: Techniques & Industrial Applications OR61A143 OR61A119 OR61A322	Systems Thinking KEYNOTE OR61A338	DEA and its Applications OR61A233 OR61A324 OR61A81 OR61A303	Combinatorial & Global Optimisation OR61A146 OR61A161 OR61A347 OR61A91	Locational Analysis: Theory & Application OR61A281 OR61A135 OR61A228 OR61A68	Simulation OR61A285 OR61A241 OR61A256		Healthcare Applications OR61A198 OR61A23	
18:15	MAI: Women in OR & Analytics Network Drink Reception – Sibson Building Lecture Theatre 2																	
19:30	Dinner – Eliot College Dining Hall																	
21:00	Pub Quiz – Eliot College Dining Hall																	

OR61 Wednesday 4 September 2019

Time	Sibson LT3	Sibson LT1	Sibson LT2	Sibson PC1	Sibson SR1	Sibson MBA	Sibson SR2	Sibson SR3	Sibson SR4	Sibson SR5	Sibson SR6	Kennedy SR10	Kennedy SR2	Kennedy SR3	Kennedy SR4	Kennedy SR5	Kennedy SR6	Kennedy KENPC3	
08:30	Welcome and intro to MAI																		
09:00	Chipperfield SR5 Speed Networking		Making an Impact - Workshops OR61A247	Making an Impact - Workshops OR61A209 Repeated at 15:30	Systems Thinking OR61A48 OR61A294 OR61A149	Systems Thinking OR61A314 OR61A301 OR61A293 OR61A167	Systems Thinking OR61A89 OR61A358 OR61A67 OR61A257	Sustainable Development Goals KEYNOTE OR61A99 OR61A302 OR61A199	Systems Thinking OR61A296 OR61A125 OR61A154 OR61A151	Systems Thinking OR61A53 OR61A74 OR61A65 OR61A103	DEA & its Applications OR61A341 OR61A351	Combinatorial & Global Optimisation OR61A97 OR61A34 OR61A66	Logistics & Transportation KEYNOTE OR61A269 OR61A124 OR61A202 OR61A344		Forecasting OR61A153 OR61A192 OR61A90	Healthcare Applications OR61A274 OR61A306 OR61A276			
10:30	Refreshments – Sibson Building Atrium																		
11:00			Making an Impact - Workshops OR61A335	Making an Impact - Workshops OR61A315	Making an Impact - Workshops OR61A321	Making an Impact - Workshops OR61A327	Pro Bono Invited guests only 10:30 to 12:30 OR61A273 OR61A193 OR61A144 OR61A45	Sustainable Development Goals OR61A173	Making an Impact - Workshops OR61A352	Making an Impact - Workshops	DEA & its Applications OR61A208 OR61A251 OR61A211	Combinatorial & Global Optimisation OR61A176 OR61A195 OR61A255 OR61A342	Logistics & Transportation OR61A289 OR61A267 OR61A258 OR61A261		Forecasting KEYNOTE OR61A332 OR61A286 OR61A317 OR61A359				
12:30	Lunch – Sibson Building Atrium																		
13:30	<p>Presidents Medal – Sibson Building Lecture Theatre 3</p> <p>Richard Wood, Ben Murch, Phil Clatworthy & Justin Pearson (NHS Bristol) Optimising Capacity Requirements for a Centralised Stroke Service</p> <p>Philip Macdent & Martine Wauben (Ministry of Justice) The Safety Diagnostic Tool: Harnessing Operational Data to Make Prisons Safer</p> <p>Andreas Schaefer, Jen Houle & Daniel Clegg (RBS) Fishing for Mules with Nets</p>																		
15:00	Refreshments – Sibson Building Atrium																		

OR61 Wednesday 4 September 2019

Time	Sibson LT3	Sibson LT1	Sibson LT2	Sibson PC1	Sibson SR1	Sibson MBA	Sibson SR2	Sibson SR3	Sibson SR4	Sibson SR5	Sibson SR6	Kennedy SR10	Kennedy SR2	Kennedy SR3	Kennedy SR4	Kennedy SR5	Kennedy SR6	Kennedy KENPC3
15:30 - 17:00				Making an Impact - Workshops OR61A336 OR61A337	Making an Impact - Workshops OR61A209 Repeat of earlier workshop	Systems Thinking OR61A79 OR61A299 OR61A72	Making an Impact - Workshops OR61A311 15:30 to 18:30	Systems Thinking OR61A64 OR61A129 OR61A108 OR61A109	Sustainable Development Goals OR61A278 OR61A206 OR61A203 OR61A191	Making an Impact - Workshops OR61A196 15:30 to 18:30	Making an Impact - Workshops OR61A339 15:30 to 18:30					Forecasting OR61A259 OR61A295 OR61A54		Making an Impact - Workshops OR61A361
19:30 - 23:30	Gala Dinner & Band - Kings Hall Herne Bay																	

OR61 Thursday 5 September 2019

Time	Sibson LT3	Sibson LT1	Sibson LT2	Sibson PC1	Sibson SR1	Sibson MBA	Sibson SR2	Sibson SR3	Sibson SR4	Sibson SR5	Sibson SR6	Kennedy SR10	Kennedy SR2	Kennedy SR3	Kennedy SR4	Kennedy SR5	Kennedy SR6	Kennedy KENPC3	
09:30	Plenary: Grazia Speranza – Sibson Building Lecture Theatre 3 Kernel Search: A General Heuristic Approach to MILP Problems																		
10:30	Refreshments – Sibson Building Atrium																		
11:00					Simulation OR61A50 OR61A266	SIG Problem Structuring Methods Open to all	Behavioural OR OR61A114 OR61A172	Sustainable Supply Chain Management OR61A98 OR61A268 OR61A182		Data Science OR61A71 OR61A150 OR61A57	Making an Impact - Workshops OR61A216	DEA & its Applications OR61A116 OR61A187 OR61A104 OR61A323		Logistics & Transportation OR61A264 OR61A105 OR61A343	Reliability & Applied Stochastic Processes KEYNOTE OR61A329 OR61A80 OR61A326				
12:30	Lunch – Sibson Building Atrium																		
13:30					Simulation OR61A58 OR61A210	Systems Thinking OR61A271 OR61A243 OR61A166 OR61A316	Systems Thinking OR61A28 OR61A222 OR61A164 OR61A51	Sustainable Supply Chain Management OR61A231 OR61A131	Systems Thinking OR61A320 OR61A115 OR61A357 OR61A227	Data Science OR61A171 OR61A87 OR61A230	Soft OR & Problem Structuring OR61A205 OR61A137 OR61A85 OR61A83	DEA & its Applications OR61A279 OR61A239 OR61A346		Logistics & Transportation OR61A96 OR61A185 OR61A33 OR61A260	Reliability & Applied Stochastic Processes OR61A113 OR61A134 OR61A56 OR61A288				
15:00	Refreshments – Sibson Building Atrium																		
15:30	Short Plenary: Gerald Midgley – Sibson Building Lecture Theatre 3 A Systems Theory of Marginalization and its Implications for Operational Research Closing Session: John Hopes – Sibson Building Lecture Theatre 3 Cheese & Wine – Sibson Building Atrium																		

ABSTRACTS

The following pages list all the abstracts for presentations to be given at the conference. They are grouped by stream and are listed in the date/time order in which they appear in the full timetable. Please remember that some streams are split over more than one day.

Please note that this order may be subject to change.

To help delegates select relevant and accessible papers, each submitting author was asked three questions. The questions and their range of answers were:

What is the nature of your talk?

- Very practical
- Practical
- A mix of practical and theoretical
- Theoretical
- Very theoretical

Does your talk require prior knowledge of the subject area?

- None
- A little
- Some
- Quite a lot
- Subject experts only

Is your talk accessible and relevant to practitioners?

- Not at all
- Somewhat
- Relevant
- Very
- Highly

The three answers to these questions are listed after the abstract.

Behavioural OR



Organisers: Ilkka Leppanen and Konstantinos Katsikopoulos

03/05/2019, 13:30 – 15:00, Sibson SR2

OR61A305

Understanding Riskless Multi-Attribute Decisions Through Process-Tracing

Götz H. Giering, Gilberto Montibeller & L. Alberto Franco (*Loughborough University*)

Empirical findings from behavioural research suggest that individuals employ a range of strategies to construct their preferences when faced with multi-attribute (MA) choice problems. However, it is not well understood what information decision makers use when making a MA choice, and if training decision makers can improve MA choice quality. In this presentation, we report on an ongoing behavioural study that adopts a process-tracing approach to evaluate preference construction processes in terms of quality. The study involves a set of hypothetical choice problems, and utilises normative standards as a benchmark to compare against observed decision processes. By doing so, this study goes beyond consistency checks and thus has the potential to identify underlying causes for deviations from the value model. The study findings will enable the development of recommendations to improve decision-making processes in MA choice problems.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A184

Need for Cognition and IT Evaluation

Tuan Yu (*Kent Business School*)

IT evaluation is a form of decision making process. As such it is influenced by both external and internal factors. A major internal factor is the predisposition of the IT user which may affect the carrying out of tasks involved in the process of IT evaluation. One such predisposition is a personality trait known as the "Need for Cognition" (NFC). While individual differences have been acknowledged in IT evaluation research, these individual differences are usually ignored and, specifically, the relationship between NFC and IT evaluation has not been explored enough in these studies. This talk explores the NFC construct and its relevance and importance to IT evaluation including the construct's links to other personality traits such as "Core Self Evaluation". An empirical investigation carried out to test the relationship between NFC and IT evaluation outcome using a validated NFC scale will be also reported. Strengths and weaknesses of the conceptualisation and measurement will be discussed and future research strategies will be highlighted. The usefulness of this approach is explained and justified within the context of the most common forms of IT evaluation practice.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Highly

OR61A224

Modelling and Simulation for Behavioural Analysis in Healthcare

Athary Alwasel, Masoud Fakhimi & Lampros Stergioulas (*University of Surrey*)

Modelling & Simulation (M&S) studies have been broadly used to gain insights necessary for coping with complex systems. Healthcare systems are an example of such complex systems, and therefore it comes as no surprise that an increasing number of healthcare-focussed M&S studies have been reported in literature over the years. According to our literature review, some of the existing sophisticated M&S studies evaluate new medical treatments or interventions in terms of economic and clinical efficiencies and lack to incorporate human factors in their underlying systems. In reality, the outcomes from those simulation models may not be fully reliable for decision makers because they are unable to reflect the whole real system. Although the application of OR techniques for behavioural analysis is gaining increased attention among researchers and practitioners, there is still a lack of research in this area, particularly in healthcare M&S. M&S for behavioural analysis seeks to understand and explore the behaviour of individuals and how they react to certain interventions within underlying systems. This research argues that due to the high level of uncertainty and complexity dealing with human behaviour, modellers must incorporate the behavioural aspects of patients and staff to reflect on the quality of services provided and improve healthcare outcomes. In order to ensure that the results of simulation are applicable to the real world, modellers must understand the assumptions, conceptualizations, and implementation constraints of this human behaviour. In this research, we will report on the key findings from a comprehensive literature review on using M&S for behavioural analysis in the healthcare context. We will discuss the current developments and challenges application of simulation techniques for behavioural analysis. This study also explores the specific characteristics of patients' behaviour in order to investigate the issues that are usually being neglected by modellers in this area.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? Some
Is your talk accessible and relevant to practitioners? Relevant

03/09/2019, 16:30 – 18:00, Sibson SR2

OR61A297

The Role of Openness to Experience and Agreeableness on Investment Decision. A Mediation and Moderation Analysis of Financial Self-Efficacy and Individual Mood

Shakhnoza Samadkhodjjeva (*Southwest Jiaotong University*)

Using theories from personality psychology and the theory of planned behavior, this study investigated those personality variables and psychological mechanisms through which individual investor intends to make investment decisions. The main purpose of this study was to examine the relationship between Openness to Experience, Agreeableness, and Short term Investment decisions. This study also examined the moderating effects of individual mood and mediating effects of financial self-efficacy between the study variables. Data was collected from 506 individual investors by using a questionnaire. Investors were selected from Pakistan Stock Exchange. Mediation analysis was performed using Hayes (2013) PROCESS macro in SPSS. Results of the study supported a positive relationship between openness to experience

and short term investment decision. The results from bootstrapping supported the mediation hypothesis and financial self-efficacy mediated the relationship between agreeableness, openness to experience and short term investment decision. To test the moderation hypotheses step-wise regression analysis techniques were used. The results confirmed the moderating effect of mood on short term investment decisions. In conclusion, this study has made an integrated attempt to examine the combined effect of personality, cognition and mood on an individual's short term investment decisions. Drawing on the findings, we discussed some implications for the policymakers including investment marketers, investment advisors and offered advice to investors in addition to discussing some limitations and future directions.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A107

Behavioural OR: A 30-Year Review of Interventions Studies

Luis Alberto Franco (*Loughborough University*), **Raimo Hamalainen** (*Aalto University*), **Etienne Rouwette** (*Radboud University*) & **Ilkka Leppanen** (*Loughborough University*)

In this talk I will present an overview of the rapidly growing body of empirical research that examines the impact of behaviour within the context of OR-supported interventions. A survey of the relevant literature spanning 30 years identified four types of empirical studies. Each study type varies in how it characterises behaviour (determinist or voluntarist), and the research methods it employs (variance or process) to examine behavioural phenomena within the intervention. During the talk, I will argue that each type can only offer a partial understanding of the role and impact of behaviour in OR-supported interventions, and that taking the insights produced by all four study types together offers a richer understanding of the behavioural dimension than any one type can offer by itself. I will end the talk with some suggestions for the further development of the behavioural agenda in research that examines OR-supported interventions.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A197

Antibiotics Prescribing Decision-Making Process in Secondary Care: A System Dynamics Approach

Nina Zhu, **Raheelah Ahmad**, **Alison Holmes** (*Imperial College London*), **Julie Robotham** (*Public Health England*), **Reda Lebcir** (*University of Hertfordshire*), **Rifat Atun** (*Harvard School of Public Health*)

To tackle antimicrobial resistance, strategies to reduce inappropriate consumption of antibiotics have been implemented in healthcare systems in the UK. In secondary care, behavioural antimicrobial stewardship (AMS) interventions have had limited effect in optimising doctors' antibiotic prescribing practices as reflected in the observed deviation from guidelines. A powerful analytical tool is required to capture the determinants of antibiotic prescribing decision-making within the complexity of the health system to inform intervention design and allow subsequent evaluation of impact. A System Dynamics (SD) model was

constructed including structural and behavioural factors of influence, to enable the simulation of antibiotic prescribing decision-making processes in English hospitals. Literature review, analysis of patient records, healthcare professional interviews and survey responses provided the influencing factors and casual relationships impacting on doctors' decision-making. A qualitative SD model was constructed, parameterised, and validated through a series of tests to ensure the credibility of the model to simulate doctors' behaviours under different resource and behavioural scenarios. Computer-based simulations were performed to predict doctors' prescribing outcomes measured by the level of guideline compliance. Maximal improvement in doctors' guideline compliance at empiric stage could be achieved if senior doctors' guideline compliance was increased, combined with the microbiology laboratory turnaround time of blood cultures within 24 hours, for all patients. At review stage, doctors' decision-making could be enhanced if more opportunities for specialist microbiology input were provided. SD modelling enables capture of causal mechanisms and prediction of prescribing outcomes by transparent qualitative mapping and quantitative simulation of complex, dynamic prescribing decision-making processes. This approach acknowledges that doctors' sub-optimal antibiotic prescribing is a feature of bounded rationality compounded by multiple contextual interacting influences. AMS interventions can be re-designed for maximum effect with minimal additional resources, if the most influential healthcare professionals and the most critical events in the prescribing decision-making processes are targeted.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

05/09/2019, 11:00 – 12:30, Sibson SR2

OR61A114

The Practice of Mixing OR Methods: Interviews with Experienced Modellers

Susan Howick (*University of Strathclyde*) & **Fran Ackermann** (*Curtin University*)

The complexities of real-world problems mean that combining OR methods (in part or whole) is often required. However, to date, when combining OR methods, researchers have predominantly focused on how methods can be effectively mixed with a number of researchers discussing theoretical considerations whereas, the implications for practice have been given relatively limited attention. To gain further insight into the practice of mixing OR methods, this presentation will reflect on the findings of a series of in-depth interviews that were carried out with 14 practitioners (both academic and non-academic) who have an average of 25 years of OR modelling experience. To explore not only the content but also the structure of the interviews, i.e. how particular insights impacted other insights, a novel approach was taken to the analysis of the material. After coding the material and highlighting initial themes, causal mapping was used to reflect the linkages between themes and emergent characteristics of the material allowing for an analysis to be undertaken of the systemicity of the material. This led to a number of insights about mixing methods, in particular with respect to the approach taken to mixing methods, the modelling team and the value and learning gained from the experiences. The insights from both the content and structural analysis have implications for both the practice and teaching of OR.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A172

Agent-Based Classroom Lesson Simulation

Fred Ingram (*Lancaster University*)

The goal of the research was to develop an agent-based model and simulation that adequately represented some of the dynamic and spatial complexities of secondary school classroom lessons, with interactions between autonomous students, their teacher and an optional teaching assistant. By implementing the conceptual model as a simulation, the aim was to study quantitatively the consequences of common classroom scenarios, to gain behavioural insights into what happens and how this affects overall class productivity, disruption, etc. Such a simulation model could be a valuable lesson analytics tool, enabling teachers and educators to explore the consequences of interventions prior to implementing the changes in lessons. Potential scenarios might include providing or withdrawing a teaching assistant, changing seating arrangements, or trying alternative lesson plans. During a 5-month case study, a lesson event recording tool was developed and used to record many types of student and teacher activities in 42 hours of lessons. These data have been used to calibrate and validate the model, lesson by lesson. Various metrics have been identified or constructed to characterise lessons, classes, students and teachers in order that empirical results and the results of simulations may be compared and evaluated. The simulation software, coded in NetLogo (a popular open-source tool), is fully operational, providing animated lesson play/replay with rich statistical outputs for lesson analytics. The software will be demonstrated.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

Combinatorial and Global Optimisation: Exact and Heuristic Approaches



Organisers: Adam Letchford, Andrew Parkes and Ender Ozcan

03/09/2019, 11:00 – 12:30, Kennedy SR2

OR61A130

Cross-Domain Parameter Tuning of a Memetic Algorithm

Duriye Betul Gumus, Ender Özcan & Jason Atkin (*University of Nottingham*)

Cross-domain search is an emerging research area, where a single search method is used to solve a broad range of optimisation problems rather than just a single problem. Metaheuristics can be used as a high-level cross-domain search method utilising the available low level heuristics/operators for each of the problem domains to modify a solution. Memetic algorithms, which hybridise genetic algorithms with local search, are well-known metaheuristics that have parameters which can influence the search behaviour of the algorithm. Tuning these parameters is a time-consuming task; however, it is crucial for a better algorithm performance. There are different parameter tuning methods available for metaheuristics applied to a single optimisation problem. In this study, a racing procedure is utilised as a cross-domain parameter tuning method to find a good configuration using a subset of training instances from a limited number of problem domains, which is then evaluated across different problems in nine problem domains. Three strategies are presented to illustrate the capability of the racing method for cross-domain search. The experiments were performed using two different run time budgets. The empirical results show that two out of three of the strategies identified different configurations as the best one, depending on the training run time budget and in what order instances are introduced during the tuning process. However, all of the strategies managed to find good parameter configurations which outperformed the untuned version of the algorithm.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A93

HRMA: Hyper-Heuristic Based on the Random Choice of Move Acceptance Methods

Valdivino Santiago Júnior (*Instituto Nacional de Pesquisas Espaciais (INPE)*) & **Ender Özcan** (*University of Nottingham*)

Selection hyper-heuristics are high-level search techniques controlling a set of low level (meta)heuristics, and they are designed with generality in mind being applicable to classes of problems rather than a specific one. The move acceptance and (meta)heuristic selection methods are identified as the crucial components of a selection hyper-heuristic. In this study, we present a novel multi-objective selection approach, referred to as Hyper-Heuristic based on

the Random Choice of Move Acceptance Methods (HRMA), which considers three move acceptance methods rather than relying on a single one. The main reasoning behind the approach is that having a set of move acceptance methods at our disposal, even if a random choice among them is made, can enable the overall algorithm to perform better. HRMA manages a set of low-level Multi-Objective Evolutionary Algorithms (MOEAs). The results on DTLZ and WFG benchmark functions and a real-world problem, namely Vehicle Crashworthiness, indicate that HRMA is superior than two other well known selection hyper-heuristics and all individual MOEAs run in isolation.

This work was supported by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP)/Brazil [process number: 2018/08372-8], and The University of Nottingham/United Kingdom.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A152

Preprocessing Stable Matching Problems

William Pettersson, David Manlove (*University of Glasgow*), **Maxence Delorme, Sergio García-Quiles, Joerg Kalcsics & Jacek Gondzio** (*University of Edinburgh*)

Bipartite stable matching problems consist of two distinct sets of agents, L and R , where each agent in L expresses preferences (allowing ties) over some or all of the agents in R , and vice-versa. A solution is a matching of agents such that no pair (l,r) that are not matched together would prefer to be matched with each other over their current partners. Such matchings are called stable, and maximum size or maximum weight can be found using integer programming (IP) techniques. If the total number of preferences expressed by agents is large, then solving the problem using an IP model is intractable. Preprocessing such problems can remove preferences that are not part of any stable matching. This can significantly reduce the size of the IP model without affecting any solution. We present new heuristics, exact algorithms, and an IP model to perform this preprocessing. Computational experiments show that our new exact method can halve IP solve times compared to known preprocessing methods.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Somewhat

OR61A220

Using T-Joins to Approximate Solutions for Min Graphical K-Path TSP

Kheffache Rezika (*University of Mouloud Mammeri*) & **Ouafi Rachid** (*University of Sciences Technology, Algeria*)

We consider a generalized Path Traveling Salesman Problem where the distances are defined by a 2-edge-connected graph metric and a constant number of salesmen have to cover all the destinations by traveling along paths of minimum total length. We show that for this problem there is a polynomial algorithm with asymptotic approximation ratio of $3/2$.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

03/09/2019, 13:30 – 15:00, Kennedy SR2

OR61A126

Convex Hulls for Mixed-Integer Quadratic Programs with Bounded Variables

Adam Letchford (*Lancaster University*)

A wide range of problems, in Operational Research, Statistics, Finance and Engineering, can be formulated as "mixed-integer quadratic programs" (MIQPs); that is, optimisation problems with a mixture of continuous and integer-constrained variables, linear constraints, and a quadratic objective function. Although some sophisticated algorithms have been developed to solve MIQPs, they can still present a formidable challenge, especially if the objective function is non-convex. We consider non-convex MIQPs in which all variables are explicitly bounded. Many exact methods for these specific MIQPs use additional variables, representing products of pairs of original variables. We study the convex hull of feasible solutions in this extended space. Some other approaches use bit representation to convert bounded integer variables into binary variables. We study the convex hulls associated with these formulations as well. The ultimate goal is to use these theoretical results to develop improved algorithms and software. This talk is based on joint work with Dr Laura Galli, University of Pisa.

What is the nature of your talk? Very theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Not at all

OR61A29

Uncertainty Quantification for Converging Beam Triple LIDAR Wind Velocity Measurements

Anthony Brooms (*Birkbeck, University of London*) & **Theodore Holtom** (*Wind Farm Analytics Ltd*)

We consider the problem of uncertainty quantification for the converging beam triple LIDAR technology, used for measuring wind velocity passing through a fixed point in space and which is of relevance for the appropriate operation of wind turbines. Converging beam triple LIDAR employs the use of three non-parallel, non-coplanar, laser beams which are directed from a fixed platform, typically at ground level, that extend to meet at the point at which measurement of velocity is sought. Coordinate values of the velocity are ascertained with respect to unit vectors along the laser beam lines of sight (Doppler vectors), which are then resolved in order to recover an estimate of velocity in Cartesian coordinates. Any statistical imprecision associated with the measured Doppler velocity coordinates and/or the perceived orientations of the lasers, however small, will lead to statistical imprecision in the reconstructed velocity. We will show that bounds on the (estimated) variance of any particular reconstructed velocity component are inversely proportional to the volume of a parallelepiped of unit edge length, delineated by the configuration of the Doppler unit vectors: thus best/worst case configurations for the bounds are straightforward to characterize in the unconstrained case (even though the problem is seemingly non-convex w.r.t. the Doppler vector orientations). We will also briefly remark on a numerical heuristic approach to the optimization when there are constraints on the possible configurations.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A333

Current Development in Gurobi: Quadratic Terms in Mixed-Integer-Programming

Michael Winkler (*Gurobi Optimization*)

Products of problem variables appear naturally in quadratic programs (QPs). Special preprocessing, linearization and cutting plane techniques are available to deal with such products. If at least one of the two variables in a product is binary, then the product can be modeled using a set of linear constraints. As a consequence, there are many mixed integer linear programs (MILPs) that actually contain products of variables hidden in their constraint structure. Rediscovering these product relationships between the variables enables us to exploit the solving techniques for product terms. We demonstrate ideas on how these product terms can be exploited to improve the performance of an MILP solver. Additionally, we give an overview on how we solve non-convex mixed integer quadratic constraint programs (non-convex MIQCP) with a linear or quadratic objective to global optimality by splitting quadratic constraints into linear and bilinear parts while introducing the McCormick reformulation for the non-convex bilinear parts.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

03/09/2019, 16:30 – 18:00, Kennedy SR2

OR61A146

Yard Crane Scheduling in Container Ports Using Mathematical Modelling and an Optimisation Approach

Abdel Salhi, Hammed Bisira (*University of Essex*), Tom Corkhill (*Port of Felixstowe*)

In container terminals, Yard Cranes (YC), are deployed in the interface between the storage yard and internal and external trucks. A delay in the operations of YC's affects the overall performance of the container port. There is, therefore, need for good and reliable planning and scheduling of this resource for an effective day-to-day running of the port. A lot of work has gone into the modelling and solving the YC Scheduling Problem (YCSP). The problem, however, is captured differently depending on the assumptions made, the nature of the constraints considered and the objective to be achieved. Yard cranes are of two types: (a) Rail bound ones, and (b) Rubber Tyred Gantry (RTG) cranes. We are concerned with the scheduling of RTG's. Explicitly, we wish to determine the number of RTG's to allocate to a given block in the yard, and the time a RTG moves from one block to another. This paper reviews the most important contributions to the modelling and solving of YCSP of the last few decades, dwells on probably the most prominent of them, namely that of Linn and Zhang [1], and then suggests improvements to it. Moreover, it does that within a real world context since this work is joint with the Port of Felixstowe, a major container port in the UK and Europe and also part of the Hutchison Ports conglomerate. Beside an improved model of YCSP, experimental results will also be presented.

References [1] R.J.Linn and C.-Q.Zhang, "A heuristic for dynamic yard crane deployment in a container terminal," IIE Transactions, Vol. 35, No. 2, pp. 161-174, 2003.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Quite a lot

Is your talk accessible and relevant to practitioners? Relevant

OR61A161

Optimising the Design of Medical Screening Methods

Andrew J Parkes, Graziela Figueredo & Peng Shi (*University of Nottingham*)

A common problem within healthcare is to design screening methods for potential disease conditions. Naturally, these methods need to be good at catching potential cases; however, they also need to avoid generating too many false positives, as this leads to further tests, raising patient anxiety and costs. Often the design of the test includes selection of relevant quantities, choice of thresholds on these, and a decision procedure for how these are combined. Altogether, these requirements generate a multi-objective optimisation problem; and that is furthermore closely linked with decision trees in machine learning. However, has differences in that the designed decision procedures need to be simple and understandable to clinical staff and patients. We discuss a particular problem in cancer screening, and describe recently-developed methods based on a hybrid of genetic algorithms and harmony search.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Somewhat

OR61A347

Constructive and Metaheuristic Search Approaches for the Packing of Rectangles into a Fixed Size Circular Container

Mouaouia Cherif Bouzid (*Ecole Nationale Supérieure de Technologie*) & **Said Salhi** (*CLHO, KBS, University of Kent*)

In this talk, we present a new constructive heuristic called 'pack' for the orthogonal packing of rectangular objects into a circular container of fixed radius. This polynomial decoding procedure, which is based on simple combinatorial moves combined with powerful geometrical analytical forms, permits to reduce drastically the number of possibilities when solving the problem while proving very efficient. It is embedded into two metaheuristics, namely, variable neighbourhood search (VNS) and simulated annealing (SA). The proposed methodology produces 32 new best solutions out of the 54 benchmark instances while requiring less computational effort than the state-of-the-art method. Additional experiments are conducted on newly generated larger instances which we have made publicly available alongside with their respective results obtained from VNS and SA.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A91

Capacitated Lot Sizing with Sequence-Dependent and Independent Setups

Satyaveer S Chauhan (*Concordia University*)

Production planning in food processing industry requires simultaneously lot sizing and scheduling of multiple products. In this talk, we present one such problem involving multiple setups including sequence-dependent setups. A problem specific mathematical programming heuristic is developed to improve the lower bound and reduce the MIP solve time. Numerically study based on realistic data sets will be presented to demonstrate the efficiency of the approach.

What is the nature of your talk? Practical
Does your talk require prior knowledge of the subject area? Some
Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 09:00 – 10:30, Kennedy SR2

OR61A97

Fair-Fixture: Minimizing Carry-Over Effects in Football Leagues

Dilek Gunnec (*Ozyegin University*) & **Ezgi Demir** (*Bosch (BSH) Corporation*)

We study a sports scheduling problem with the objective of minimizing carry-over effects in round robin tournaments. In the first part, focusing on tournaments that allow minimum number of breaks (at most one) for each team, we formulate an integer programming model and provide an efficient heuristic algorithm to solve this computationally expensive problem. We apply the algorithm to the current Turkish Professional Football League and present an alternative scheduling template. In the second part, we discuss how the carry-over effects can be further decreased if the number of breaks is allowed to be of slightly larger value and numerically represent this trade-off.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Very

OR61A34

Heuristics for the Score Constrained Strip Packing Problem

Jonathan Thompson, Asyl Hawa & Rhyd Lewis (*Cardiff University*)

In this research we consider a problem that arises in the production of boxes, where flat cardboard items must be scored to aid the folding process. Consider a set of rectangular items of fixed height and varying widths, where each item possesses two vertical score lines marked in predetermined places. The score widths of an item are the distances between each score line and the nearest edge of the item. A pair of knives mounted onto a bar cut along the score lines of two adjacent items simultaneously, allowing the items to be folded with ease. By design, the distance between the knives must exceed a fixed minimum, and as such have a "minimum scoring distance". The aim is to find an alignment of the items on a strip such that the sum of adjacent score widths exceeds the minimum scoring distance, in order for the knives to score the items correctly. In practice, strips of material are provided in fixed widths, thus given large problem instances multiple strips may be required. The Score-Constrained Strip-Packing Problem (SCSPP) involves finding the minimum number of strips required to pack all items such that the scoring distance constraint is fulfilled. In the special case where the minimum scoring distance is zero the SCSPP is equivalent to the NP-hard one-dimensional bin packing problem, hence the SCSPP is also NP-hard. We will present an exact polynomial-time algorithm for finding a feasible alignment of items on a strip, which models the problem graphically and attempts to construct a specific type of Hamiltonian path. Then, we will explain how this algorithm can be integrated with a heuristic to find solutions for the SCSPP, and compare this with two simpler heuristics. Finally, we will show how the combined heuristic is more effective at finding solutions for harder instances.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Relevant

OR61A66

Constructing Class-Based Portfolios on Gulf Markets with Metaheuristics

Tahani Alotaibi, Panagiotis Tziogkidis & Matthew Craven (*University of Plymouth*)

Parallel metaheuristic optimisation methods are used to find optimal portfolio allocation strategies for Gulf Cooperation Council (GCC) investors wishing to hedge the risk of holding either oil or stocks. This is important since the GCC economies are heavily dependent on oil. Oil, and precious metals, are traded in US\$. The GCC economies are Saudi Arabia, Qatar, the United Arab Emirates, Oman, Bahrain and Kuwait. Data of daily return observations obtained from "Datastream" are used, encompassing 495 Gulf companies, oil prices and prices of three precious metals (gold, silver and copper) during the period January 2008-January 2019. Resulting optimal portfolios, being designed for GCC investors, are partitioned by class and/or cardinality constraints (the latter constraint rendering the problem NP-hard). Class constraints are where investors may separate assets into disjoint sets sharing certain characteristics. Cardinality constraints are where a limited number of assets from the total number available are chosen; as this constraint becomes more stringent it becomes harder to achieve prescribed returns. The risk accrued thus often reflects this change in difficulty. Benefits around hedging or diversification in investor portfolios are examined. Measures of risk involving copulae are also introduced, in an attempt to model joint distributions of assets more accurately. The end result developed may be incorporated into a product developed for GCC investors. Experiments are coded in R and run on a SLURM cluster via MPI at the home institution. This work is a mixture of practical and theoretical topics, and is based on the ongoing PhD thesis of the first author. The first author is also with Dept. of Mathematics, Shaqra University, Saudi Arabia.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 11:00 – 12:30, Kennedy SR2

OR61A176

Branch-and-Price Algorithms for the Minimum Sum Coloring Problem

Diego Delle Donne (*Université Paris 13 – LIPN*), **Fabio Furini** (*PSL, Université Paris Dauphine*),

Enrico Malaguti (*DEI, University of Bologna*), **Roberto Wolfler Calvo** (*LIPN, Université Paris 13*)

The Minimum Sum Coloring Problem (MSCP) is an extension of the classical Vertex Coloring Problem (VCP) in which each color is represented by a positive natural number and the goal is to find a proper coloring of a given graph minimizing the sum of the colors (with multiplicity) assigned to the vertices. In this work, we propose five Integer Linear Programming (ILP) formulations for MSCP. The first three are compact formulations adapted from known formulations for VCP in a straightforward way. The last two formulations has exponentially-many variables, and for them we develop two branch-and-price algorithms. Computational experiments are then conducted, both in random and benchmark instances, showing that the branch-and-price schemes provide better results concerning: number of solved instances, running times and dual gaps obtained (when optimality is not achieved).

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A195

Decomposition and Heuristics Approaches for Fixed Jobs Scheduling Problem on Parallel Machines with Renewable Resources

Boukhalfa Zahout, Ameer Soukhal & Patrick Martineau (*LIFAT, Tours-France*)

We consider a scheduling problem where n independent jobs have to be carried out without preemption on m identical parallel machines. Each machine has limited renewable resource units necessary to perform each job and it is continuously available. A machine can then process more than one job at a time with respect to its capacity. The start time and finish time of each job are given. Each job is also defined by a weight and needs certain quantities of different renewable resources to be executed. All data are assumed positive integers. The objective is to determine a feasible schedule that minimizes the total rejected costs. For this strongly NP-hard problem, we propose a column generation technique based on a natural Dantzig-Wolfe decomposition of a compact integer programming formulation and some greedy heuristics. Experimental results are conducted to analyze the performances of the proposed methods, which have proven to be effective in solving instances of this problem.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Quite a lot

Is your talk accessible and relevant to practitioners? Somewhat

OR61A255

A Strong Lagrangean Relaxation Bound for Cross-Dock Door Assignment Problem

Placide Nduwayo, Saïd Hanafi & Christophe Wilbaut (*LAMIH-UMR CNRS 8201*)

The Cross-Docking Assignment Problem (CDAP) arises in the operational level of the supply chain management where the loaded incoming trucks enter the cross-dock and unload goods at inbound dock doors. Goods are immediately sorted and organized according to their destinations and transferred to outbound dock-doors to be loaded into outgoing trucks. The goal of CDAP is to find an optimal assignment of trucks to dock doors so that the total transportation cost within cross-dock is minimized. The cost is measured as total weighted traveled distance by forklifts between inbound and outbound dock doors. The constraints to be satisfied are capacity and assignment constraints. The CDAP considered includes the Generalized Assignment Problem (GAP) as a subproblem. As the GAP is an NP-hard problem, the considered problem is also NP-hard. Several mixed linear integer programs (MIPs) have been proposed in the literature based on different linearization of the quadratic objective function by exploiting the multiple-choice constraints. The quadratic terms are derived from the product of two binary variables: one to indicate whether an origin is assigned to an inbound dock door or not; and another to indicate whether a destination is assigned to an outbound dock door or not. In this talk, first we present those MIPs models able to solve medium size instances optimally and we compare their performance. We compare the upper bound provided by the LP relaxation of those MIPs on large size instances. In order to improve the LP-relaxation bound for large instances, we present a Lagrangean relaxation of the best-known MIP formulation for the CDAP. The proposed Lagrangean relaxation relaxes the knapsack constraints added to strengthen the MIP model. The computational results on all tested instances show that the Lagrangean dual solved by a subgradient algorithm improves significantly the LP relaxation value while consuming more CPU time.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A342

Dantzig-Wolfe Reformulations with Zero Integrality Gap

Stefan Ropke, Jens Vinther Clausen & Richard Lusby (*Technical University of Denmark*)

In this talk, we consider bounded integer programming (IP) problems and apply Dantzig-Wolfe reformulation in order to get tighter linear programming (LP) relaxations. We are especially interested in Dantzig-Wolfe reformulations where variables are shared between sub-problems, this technique is known as "variable-splitting" or "Lagrangian decomposition". We propose a new family of valid inequalities for such reformulations. The cuts are of the non-robust type where each added cut complicates the sub-problems. We can show that if the decomposition satisfies certain properties then the LP relaxation of the reformulation has zero integrality gap after adding all violated valid inequalities from the new family of cuts (by zero integrality gap we understand that the objective of the LP relaxation matches the optimal IP solution). For any bounded IP, there are many decompositions that satisfy the necessary properties, but in practice, it may be too difficult to solve the resulting sub-problems, especially after adding cuts. However, for some problem classes, the method provides very promising results. We present computational results for the temporal knapsack problem and test on 200 instances proposed in the literature. None of the methods proposed in the literature, so far, have been able to solve all 200 instances. Using the proposed methodology all of the instances are solved to optimality in the root node in less than one hour on a standard PC.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

Control Theory and its Applications to OR-related Fields



Organisers: Virginia Spiegler, Mohamed Naim and Christos Papanagnou

03/09/2019, 11:00 – 12:30, Kennedy SR3

OR61A118

The Impact of Internet of Things on Bullwhip Effect: A Control Theoretic Approach

Christos Papanagnou (*University of Salford*)

Internet of Things (IoT) provides better connectivity among supply chain participants by providing additional information and making, which may be used for better replenishment policies and inventory control. As information transmission lag still exists in supply chains, even when state-of-the-art RFID and IoT technologies exist, organisations seek solutions to leverage the existing technology and improve the overall supply chain performance. In this research work, a novel 3-node supply chain model is presented (Supplier-Manufacturer-Retailer), where base-stock replenishment policies are modelled by means of a proportional controller and IoT is utilised among supply chain nodes. A stochastic state-space model is derived to capture the inventory and product quantity changes as a function of (i) information derived from IoT and (ii) proportional controller. Customer demand is represented by a stochastic sequence while the model is analysed under stationarity conditions with the aid of a covariance matrix. The model provides useful insights on how IoT is linked with replenishment policies while an optimisation method is introduced to study the impact of IoT on inventory management. This allows measuring and alleviating the bullwhip effect subject to fluctuations in inventory. The model proposed can solve the information asymmetry problem in supply chain effectively and can help organisations to develop a global supply chain management strategy based on IoT technology.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A160

On the Impact of Core Quality Grading on the Bullwhip Performance of Hybrid Manufacturing-Remanufacturing Systems

Borja Ponte (*The Open University*), **Salvatore Cannella** (*University of Catania*), **Roberto Dominguez** (*University of Seville*), **Mohamed M. Naim & Aris A Syntetos** (*Cardiff University*)

We consider a hybrid manufacturing/remanufacturing system where the returned products (cores) are classified into two quality grades. This results in a parallel structure in the reverse flow of materials, with different remanufacturing lead times depending on the condition of the input material. We examine the implications of this grading system on the dynamics of closed-

loop supply chains, by benchmarking this against the baseline system where all the returns are pushed through the same remanufacturing process. Through control engineering techniques, we evaluate the Bullwhip performance of the supply chain by observing the step response of the orders and inventories (the shock lens), analysing the frequency behaviour of these signals (the filter lens), and measuring their long-term variability (the variance lens). We discuss the operational benefits and costs derived from quality grading in terms of smoothing the supply chain operation. We observe that the documented 'lead-time paradox' of the remanufacturing process results in a 'quality paradox' in this new closed-loop context. This is especially relevant for low-frequency demand signals. Interestingly, we analytically derive the optimal setting of the pipeline estimation for avoiding long-term inventory drifts. Through a sensitivity analysis, we highlight the potential benefits of information transparency for improving supply chain performance. Both under and overestimating the pipeline lead time may have dramatic consequences. Finally, we extensively reflect on the managerial implications of our work.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A59

The Dual Effects of Demand and Lead-Time Disturbances in an Adaptive Production and Inventory Control Model

Virginia Spiegler (*University of Kent*), **Mohamed Naim** (*Cardiff University*) **Li Zhou** (*University of Greenwich*) & **Aris Syntetos** (*Cardiff University*)

The design of efficient and resilient production and inventory control systems is of great importance for supply chain managers, whose goal is to match customer demand with supply while minimising operational costs that are normally driven by order and inventory variance. Disturbances and uncertainties from both demand and supply sides makes the design of such control systems very challenging. In addressing gaps in the literature, our previous work modified existing production and inventory control models to investigate the impact of lead-time disturbances on the system's responses and designed an adaptive model that deals with lead-time changes. However, the assumption has been that the demand remained constant. In this work we analyse whether the previously developed adaptive model is robust to simultaneous demand and lead-time disturbances. The resulting model is nonlinear with a multi-input multi-output (MIMO) configuration. Hence, nonlinear control theory for MIMO systems is applied in combination with system dynamics simulation to analyse the impact of both demand and lead-time changes on the order rate and inventory responses. We use linearisation via Taylor series expansion to derive the system characteristic equation and simulation to capture the nonlinear effects of the adaptive model. Preliminary results suggest that the adaptive model can be used and designed to cope with both demand and lead-time disturbances. As expected, when both demand and lead-time increase both resilience and cost performances are deteriorated. However, the effects of lead-time changes seem to be more manageable than for demand changes. The supply chain designer can opt to choose a design that prioritises customer service levels and attain resilience or opt for a cost reduction design and decrease the bullwhip effect.

What is the nature of your talk? Very theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

Data Science: Techniques and Industrial Applications



Organisers: Jeremy Bradley and Betty Schirrmeister

03/09/2019, 11:00 – 12:30, Sibson MBA

OR61A44

A Vision for the Successful Application of Data Science at British Airways

Stefan Jackson (*British Airways*)

We're British Airways. Britain's national flag carrier. 2019 is our centenary year. We fly millions of people to hundreds of destinations each year. Our Central Analytics Team is right at the heart of our global business. Developing insights from a vast range of data. Shaping the customer journey. Underpinning our future strategy - and ensuring we continue to improve operational efficiency and drive revenue growth. The Data Science team in Central Analytics champion the use of pioneering data science and machine learning to take our business forward. We influence senior business leaders in the strategic application of data science and we assess the performance of third party machine learning suppliers. We've set ourselves a challenging change agenda, and we'd like to share this with you.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A147

Working with Business to Deliver Data Science Products, with an Emphasis on OR

George Dikas (*Tesco plc*)

The journey to deliver large scale data science product to deliver business benefits in most cases is long and difficult. In this session I will share some of the common issues someone needs to overcome throughout the different life-cycle stages of the project, how applying the fundamental concepts of OR can help business counterparts understand which areas of data science are relevant, and why the concept of "one table" is key for successful delivery.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A55

From Electricity Generation to Retail: Implementation of Data Oriented Software Within EDF Energy

Nick Dillon & Jean-Francois Hullo (*EDF Energy*)

From power generation to energy retail, EDF Energy faces challenges where data understanding and processing delivers great value. Over the recent years, EDF Energy R&D has successfully implemented and deployed a variety of bespoke machine and deep learning based pipelines across different business units. From large data and deep learning to expert support and interpretability, we will share the lessons learnt of our key successes in the field.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A156

Intelligent Decision Making Support for Water Quality Monitoring

Agnieszka Jozwik, Amanda Clare, Wayne Aubrey (*Aberystwyth University*), **Willow Smallbone & Katherine Martin** (*Dwr Cymru Welsh Water*)

Dŵr Cymru Welsh Water is a not-for-profit company providing drinking water services to most of Wales. Process Scientists and Production Technicians make daily decisions regarding water treatment and would benefit from the support of statistical models to improve efficiency and sustainability and to reduce cost. All processes for water treatment are continually monitored by numerous inline sensors. Warnings are triggered and events are initiated based on threshold values or scheduled standard operating procedures. We are modelling the expected and anomalous behaviour based on multivariate time series data analysis from the water treatment plant sensors, to assist the plant operators with intelligent decision support. Determining the optimum strategy is challenging because the data is noisy and includes sensor readings from parallel flow through many system components, lag in the correlation of values, spikes that are intended vs those that are anomalies, and changeable weather. We present the initial findings of our models when applied to these complex systems.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

03/09/2019, 16:30 – 18:00, Sibson SR5

OR61A143

Crafting an Industrial Vehicle Routing Optimisation Solution for Parcel Delivery

Fabrice Durier & Jeremy Bradley (*Royal Mail*)

We focus on an industrial application of the vehicle routing problem, giving the context of the problem for timed parcel deliveries from multiple delivery hubs. We will be discussing the industrial setting and company-specific constraints and the challenges that has given us. Along the way we will highlight some of the operational issues that face a company that is new to deployment of optimisation approaches and discuss some of the compromises and nudges that can be put in place to secure a successful uptake of a mathematical approach in a data-oriented setting.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A119

Price Optimisation for B2B Projects with Negotiations Using Machine Learning

Darian Raad (*Peak*)

We consider the problem of optimising selling price targets for a non-commoditized, materials business, responding to requests for quotes on projects with multiple competing contractors, price negotiations, price leakage between customers, and high price variability across projects. We apply artificial neural networks to build probabilistic price-based classifiers of sale / no-sale outcomes for quote product lines. A multi-input neural network is used to enhance the importance of the price signal. When combined with a per-product gross margin regression model, this can be used to find the vector of selling price targets for a given quote that maximises expected gross sales margin. This model includes both numeric and categorical variables, and takes into account cross-product prices, alternative product prices, specification strength and customer cohorts. An approximate gradient-descent method is used to rapidly find good target price solutions for a live system. Quote opening prices are left to the discretion of the salesperson. Given the natural downward pressure in the direction of the lowest price allowed (the target price acts as a strong attractor in this setting, with sales managers tasked with meeting targets), it is hypothesised that using this optimisation model will improve profitability. This industry has an extended sales cycle, and the method is currently being A/B tested in practise.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A322

Data Mining with modeFRONTIER: Quick and Effective Techniques to Deepen the Understanding of your Data

Novella Saccenti (*Enginsoft S.p.A.*)

Data Mining is the process of analyzing data from different perspectives: design, statistical and distribution analysis charts, response surface algorithms and more allow engineers to extract the benefit from often complex and hard to understand data. Information from complex numerical data, generated by experimental or optimization studies, can be projected easily onto sophisticated charts through process automation and optimization platforms such as modeFRONTIER. Where data mining can be repetitive and time consuming, such as the training and validation of RSM algorithms, automated methods can be used to find the best predictive metamodel. This simplifies the steps required to run a virtual optimization and allows a 'one click' approach to a traditionally manual task. This presentation will explain the latest powerful data visualization techniques and demonstrate them through real industrial case studies.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 11:00 – 12:30, Sibson SR5

OR61A71

Why we Need Product Managers in Data Science

Tereza Iofciu (*Free Now*)

After over a decade since its official invention the data science role is still a broadly defined position. Depending on the data domain and the type of projects the data scientists are working on, teams might need a wide variety of skills, such as data analytics, software engineering, machine learning and dev ops. Many successful data science teams end up being cross disciplinary teams developing end-to-end solutions. Most traditional software engineer teams have product owners or product managers to help interact both with stakeholders but also to prioritise and understand the tasks at hand. Besides that, the role of product manager in a data science team requires also good understanding of working with data. This talk is about the lessons learned while discovering the role of data science product manager, what are some of the skills needed and what this role can look like.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A150

Royal Mail's Estimated Delivery Window – A Data Science Success Story

Betty Schirrmeister (*Royal Mail*)

One of Royal Mail's latest initiatives to improve customer experience and convenience was launched in April this year. Customers are now receiving information about their parcel deliveries a day in advance and also get shorter estimated delivery windows, down to a time frame of two hours. I will present some of the data science behind the project, as well as how we managed to make this project another data science success story for Royal Mail.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A57

Bounded Job Start Scheduling Under Uncertainty: Application to Royal Mail Delivery Scheduling

Ruth Misener, Dimitrios Letsios, Natasha Page (*Imperial College London*), & **Jeremy Bradley** (*Royal Mail*)

Royal Mail provides mail collection and delivery services throughout the United Kingdom. In the final delivery step, vans leave a delivery office and drive to the final destination. Each postal worker's itinerary has been optimized and fixed, but we seek to improve the allocation of itineraries to vans, i.e. reduce the number of delivery vans on the road. Allocating itineraries to vans generalizes the fundamental makespan scheduling problem: there are a set of jobs, each one associated with a processing time, on a set of identical machines so that the makespan is minimized. The delivery scheduling problem additionally has a parameter g upper bounding the number of jobs beginning simultaneously, i.e. the number of vans leaving the delivery office depot in a given time window. When g is equal to the number of machines, i.e. all vans can leave the depot simultaneously, the delivery scheduling problem is equivalent to the well-known fundamental makespan scheduling problem. We show that the delivery scheduling problem is

strongly NP-hard even in the case $g = 1$ by presenting a reduction from 3-partition. We develop an integer programming formulation and several heuristics with constant-factor guarantees to solve the Royal Mail delivery scheduling problem for any g . The presentation subsequently considers a two-stage setting for solving the mail delivery scheduling problem under uncertainty. The first stage computes a feasible, efficient solution for an initial nominal problem instance. After the first stage, a different, perturbed problem instance becomes known, e.g. when a delivery van breaks down or an itinerary takes significantly longer than expected. The second stage transforms the first stage solution into an efficient, feasible solution for the perturbed problem. Lexicographic optimization is our key tool for the two-stage setting: we show why a lexicographic solution in the first stage enables effective second stage recovery.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 13:30 – 15:00, Sibson SR5

OR61A171

Contemporary Analytical, Big Data-Driven and IT-Based Industrial Skills: Redesigning Multidisciplinary Curriculums for Business Schools Facing Industry 4.0

Pervaiz Akhtar (*Kent Business School*)

Contemporary analytical, big data-driven and IT-based skills are becoming vital for modern business operations. Business schools consequently operating in the era of industry 4.0 need to integrate such skills in their curriculums. However, the optimal integration and relative utilization of increased digitisation and automation are limited due to certain challenges like the shortage of multi-skilled academics who possess business domain knowledge as well as equipped with technical skills from computing, statistics and mathematics. Additionally, students in business schools are not fully prepared to take multi-disciplinary-designed curriculums that challenge them, creating student dissatisfaction and affecting university rankings ultimately. These challenges links back to the courses that students study in their secondary schools and colleges, which need to update and absorb new developments in their curriculums. Thus, when students come to universities (or business schools), they can cope with contemporary analytical, big data-driven and IT-based courses that are required by industry 4.0. It can be co-designed by developing the collaboration between business schools and industry, resulting in higher employability for business schools' students. Based on the literature and in-depth interviews from leading academics and industry experts, the study provides a framework that offers an equilibrium of qualitative and quantitative skills. Interesting implications for the above-referenced highlights that challenge academia and industry to redesign balanced curriculums for students studying specialized business programmes such as in productions, operations, manufacturing, logistics and supply chains are discussed.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A87

Quantifying Human Performance Through Data Driven Policy Learning: Parallel Case Studies from Autonomous Driving and Athlete Training in Football

Varuna De Silva (*Loughborough University*)

Learning the best course of action to succeed or survive in an uncertain environment is key to the development of autonomous systems. Data-driven policy learning is a branch of artificial intelligence, which utilizes data to learn optimal policies (best set of actions in a given situation) to accomplish a goal. Reinforcement learning is the most well known type of algorithm for this purpose. Data driven reinforcement learning, also known as deep reinforcement learning, has made significant progress during the last two decades, as demonstrated by systems such as Alpha-Go which beat the Go Champion (Go- is considered to be the most difficult board game on earth). However, it is difficult to frame most real-world problems as a reinforcement learning, because of the requirement to define a reward function. Imitation learning is a different paradigm for policy learning, which is motivated by the fact, we as humans learn by observing experts. We demonstrate our how imitation learning can be used to learn data-driven policies in two environments, i.e. driving and team sports. The use of these policies goes beyond just training autonomous robots, and has potential in many other domains. We will discuss how the learnt policies can be utilized to measure the performance of individual agents in a competitive environment. Specifically, the imitation learning models are utilized to quantify the decision making ability of footballers during a competitive game.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A230

Analysis and Visualisation of Network Data Using Pajek

Philip Sinclair (*Manchester Metropolitan University*)

This talk introduces some methodologies that have been developed for the analysis and visualisation of large networks. The methods are implemented in a flexible program for network analysis called, Pajek (<http://mrvar.fdv.uni-lj.si/pajek/>). Pajek allows for different objects, such as partitions and vectors, to be calculated and combined with networks. These then enable the analyst to obtain interesting visualisations and to make a variety of decompositions. The techniques will be illustrated using data sets developed for students' projects at Manchester Metropolitan University, on international trade and directorate interlocks.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Somewhat

DEA and its Applications



Organiser: Ali Emrouznejad

03/09/2019, 11:00 – 12:30, Kennedy SR10

OR61A249

Determinants of the Performance of Insurance Companies: A Review of Theory and Survey of Evidence

Tafadzwanashe Zinyoro & Meshach Aziakpono (*University of Stellenbosch*)

The performance of insurance companies has been a subject of intense empirical enquiry for more than three decades. But what do we know about the drivers of their performance? This paper provides a systematic review of both theoretical and empirical evidence on the factors that explain the variation in performance across insurance companies. The focus is on studies that use frontier efficiency methodologies; although papers based on traditional approaches such as ratio analyses are discussed. The most important determinants that have received significant attention in the literature include: organisational characteristics (for example firm size, form of organisation/ownership structure, diversification, firm specialisation, leverage, distribution system and governance factors) and the external environment (especially, the effects of deregulation and consolidation). Not only does this paper show the heterogeneity in the drivers considered in different studies, it also reveals that the direction of their effect on insurer performance is rather mixed with some papers showing positive effects, some negative and some insignificant effects. Finally, it reveals areas that deserve further research attention.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A178

Social and Financial Efficiency of Microfinance Institutions: Developing Markets, Macro Environment and Financial Inclusion

Natalie Soldatkova (*University of Economics, Prague*)

The microfinance industry was established with the main purpose to provide financial services to people who generally have no access to traditional banking because of their low, irregular or unpredictable income. The Microfinance industry is expanding rapidly with an annual growth of over 9% in the global portfolio of loans and the number of active borrowers serving around 123 million customers worldwide (Microfinance Barometer, 2017). Financial environments, where Microfinance institutions operate differ from country to country, from unregulated to highly regulated, from fully digitized to paper-based. A naturally raised question is what is the social efficiency, financial efficiency and relation between both for microfinance institutions when compared across different economies and to what extent market conditions and internal

strategic decisions impact the efficiency. Using the database of financial, operational and social performance indicators of service providers in 38 countries of Sub-Saharan African region, the first part of the work describes the results of an empirical study of social and financial efficiency based on Data Envelopment Analysis modelling approach for the period of 2004-2017. Further relation between internal institutional and external environmental factors and efficiency level is assessed using nonparametric tests. The internal factors included in the research are the presence of a deposit scheme, gender focus, customer target group and the prevailing term of the loan. Presence of legislation, interest rate limitations, presence of private credit bureau and public registry and presence of microfinance-focused projects run by international organizations providing support to developing countries in their fight with poverty.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A16

The Context-Dependent Total-Factor Energy Efficiency of Taiwan's Regions

Jin-Li Hu (*National Chiao Tung University*)

This research introduces the context-dependent total-factor energy efficiency (CD-TFEE) and applies it to find the TFEE efficiency frontier levels of Taiwan's regions in 2016. The CD-TFEE generates different outcomes from the context-dependent data envelopment analysis (CD-DEA) proposed by Seiford and Zhu (2003). The study collects annual data from each of Taiwan's 20 administrative regions in 2016. For the DEA model, there are five inputs (employed population, amount of productive electricity power consumed, amount of electricity consumed for household and non-household electric lighting, amount of gasoline sales, and amount of diesel sales) and one output (total real income in terms of 2016 price level). It is found that the 20 Taiwan's regions in 2016 can be categorized into five levels of TFEE frontiers for all four kinds of energy inputs. Taipei City (north), Keelung City (north), Penghu County (outer islands) are the three regions on the level 1 (most efficient) TFEE frontiers for all energy inputs. The central, southern, and eastern areas are relatively inefficient with respect to all kinds of energy inputs. The central area has the largest room to improve in various kinds of energy efficiency.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A17

The Meta-Frontier in Data Development Analysis and Room for Improvement in Energy Intensity

Ming-Chung Chang (*Kainan University, Taiwan*)

Governments typically employ the indicator of energy intensity as their target for national energy policies. This study finds that the indicator of room for improvement in energy intensity (RIEI) is correlated with energy efficiency (EE) and the energy technology gap ratio (ETGR), by using all European Union member states as a sample and dividing them into Baltic Sea region (BSR) and non-Baltic Sea region (NBSR) countries in order to compare regional economic and energy matters. The research results show that introducing advanced energy technology is one way in which the BSR states can reduce their RIEI. Regardless of whether BSR or NBSR countries are considered, all such countries ignore improvements in energy technology when

their GDP per capita increases. Finally, we note that the inverse U-shaped relationship between the RIEI and GDP per capita is a better economic development mode.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Not at all

03/09/2019, 13:30 – 15:00, Kennedy SR10

OR61A212

Development of Two-Stage Parallel-Series System with Fuzzy Data: Fuzzy DEA Approach

Sanjeet Singh & Alka Arya (*Indian Institute of Management Calcutta*)

A two-stage system composed of three sub-systems, where the independent two sub-systems of the first stage are linked in parallel and then linked to the third sub-system of the second stage in series, known as two-stage parallel-series system. The deterministic two-stage parallel-series system approach is extended to uncertain/imprecise environment, where the data are represented as fuzzy numbers. Using Zadeh extension principle, we develop fuzzy two-stage parallel-series system to determine the lower-upper bound fuzzy efficiencies of the decision making units (DMUs) with the help of α -cut and rank the DMUs using ranking index approach. Proposed methods are illustrated by Taiwan's non-life insurance companies.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A49

How Does Managerial Ability Influence the Non-Performing Loans of US Commercial Banks: An Application of Data Envelopment Analysis

B M Hasanul Banna, Rubi Binti Ahmad, Koh Hsieng Yang Eric, Shirina Aktar & Md. Rabiul Alam (*University of Malaya*)

During the 2008 financial crisis, many banks failed and suffered substantial loan losses. The quality of the bank management, especially the ability of the top managers is being questioned because of the rapid bank failure. Bank managers were also criticized for their inability to see the looming economic problems and manage their loan quality. Hence, this paper aims to quantify the managerial ability of US commercial banks and to investigate whether and what extent, managerial ability affects the non-performing loans. We obtain the panel data of 13,076 bank-year observations in the USA from SNL Financial for the period of 1991 to 2018. We employ data envelopment analysis (DEA) and Simar-Wilson Double bootstrapping regression approaches to quantify managerial ability and fixed effect panel model and generalized methods of moment (GMM) to investigate the relationship between managerial ability and non-performing loans. Our managerial ability proxy is statistically significant and economically valuable as well as more precise and easily measurable. We find that bank managerial ability has a negative association with non-performing loans. Specifically, more able managers appear to utilize the bank assets efficiently by investing intelligently, thus lower non-performing loans. In addition, we find a significant association of some bank-specific and macro-economic determinants with non-performing loans. These findings suggest that bank-specific and macro-economic factors also influence the non-performing loans. This more precise measure of bank managerial ability opens the door for the researchers or academic to conduct various studies related to the managerial ability that was difficult previously. Besides, this study

contributes to the understanding of the economic benefits of managerial ability in the banking industry and how it affects the loan portfolio management. Our study extends a growing literature in accounting, finance, and economics that examines the influence of managers on the organizational, investment, financial and accounting practices of firms.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A235

Measuring Efficiency of the Banking Sector: A Survey of Literature with a Focus on Ghana's Banking Sector

Barbara Oku & Meshach Aziakpono (*Stellenbosch University*)

Understanding the performance of the banking sector in any economy cannot be overemphasised. Owing to the significant impact of the banking sector on both the micro and macro economy, there has been a growing number of studies on efficiency of this sector. However, considering the expanse of work done, relatively less research has focussed on the efficiency of banks in developing and transitioning economies. This paper seeks to provide an extensive review of both theoretical and empirical literature on the subject matter. The paper categorises the empirical literature into studies in Africa and non-Africa countries. Existing literature have adopted both parametric (largely using the Stochastic Frontier Approach (SFA)) and non-parametric measures (largely the Data Envelope Analysis (DEA)) of efficiency. Based on the over 100 studies reviewed the evidence remains largely inconclusive. With specific reference to Ghana, besides the relatively few number of studies on the measure of efficiency in the banking sector, it is observed that there are notable discrepancies in the selection of input and output variables for both the DEA and SFA measures. Furthermore, it is observed that the different inputs and outputs and the methodology used most often only differentiate between efficient and inefficient banks but fail to provide any indication of the degree of efficiency. It is hoped that the extensive literature review undertaken in this paper will provide useful guide for future studies that aims to measure efficiency of banks in developing countries, in general, and in Ghana, in particular.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

03/09/2019, 16:30 – 18:00, Kennedy SR10

OR61A233

Comparing Airline Groups Performance in Annex 1 and Non-Annex 1 Countries: A Dynamic Network DEA Approach

Amir Arjomandi (*University of Wollongong*), **Eduardo Tola Losa** (*EY Global*) & **Jason Bloomfield** (*University of Wollongong*)

In the last two decades, various regulations have taken place as means to direct airlines towards minimising their fuel consumption hence reducing their Green Houses Gas (GHG) emissions. Such regulations have had considerable impacts on airlines' operational expenses in both short and long terms. Although GHG emissions from international aviation have not been subject to the limitation and reduction commitments of the Kyoto Protocol, it is expected that the fuel consumption of airlines in Annex 1 countries can be affected by such policies as

they can have an indirect impact on the operating expenses and hence profitability of the airlines. This study compares the performance of the world's largest airline groups from Annex 1 and non-Annex 1 countries during the period 2010 to 2016, utilising a dynamic network data envelopment analysis model. A new definition of capital is also introduced in this study taking into account the income-generating capacity of employed aircraft. The findings show that, although the aviation industry's emissions were not subject to the Kyoto Protocol, airline groups with hubs based in Annex 1 countries have generally done better in terms of managing the three main stages of their production processes. Hence, one may argue that the Kyoto Protocol has wielded a positive influence on airline groups' decision-making process in general, and their operations and services in particular.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A324

Longitudinal Study of Brazilian Privatized and non Privatized Airports Efficiency Using Parametric and non Parametric Analysis

Claudia Moreira, Robert Aldo Iquiapaza Coaguila (*Federal University of Minas Gerais - UFMG*) & **Christiane Correia** (*UEMG - State University of Minas Gerais*)

Performance analysis are widely used to aid managers, investors, and business owners. Brazil has been undergoing a process of privatization and deregulation of transport since the mid-1990s. Shifting the ownership of public ownership to private ownership is a trend. It occurs that there is controversy in the literature that privatization always leads to an increase in efficiency. To test this hypothesis, we used parametric and non-parametric models to measure the performance of 59 Brazilian airports from 2008 to 2018. This enabled us to measure the performance of the public company INFRAERO (Airport Infrastructure) and five airports that were privatized over this period, to efficiency. The variables used were landings, take-offs, cargo and mailings. The models used the data envelopment analysis (DEA), the Free Disposal Hull (FDH), Stochastic Frontier Analysis (SFA) and Fuzzy-DEA. Using a model based on Fuzzy DEA was an interesting technique because it captured the vagueness in input and output data from Brazilian National Aviation Agency (ANAC), an independent body of the federal government with elected board without intervention of the executive power. The DEA and Fuzzy-DEA models were subjected to bootstrap to control the random effects inherent to any sample. Fuzziness and randomness were controlled. This suggests that the management capacity and knowledge of airport management by INFRAERO was better all the methods, presenting better efficiency indices. The results suggest that the Brazilian policy makers should focus on changing bids legislation in which companies that have management know-how in airports can compete. Results show airports subject to potential privatization.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A81

Productivity Change of Airline Companies with Biased Technological Change: A Global MPI with Network Structure

Ming-Miin Yu & Li-Hsueh Chen (*National Taiwan Ocean University*)

Due to the deregulation of the European, North American and Far East airline industries and the entrants of low cost carriers, the air transport market has undergone an increased competition. Airline companies require utilize their resources more effectively and pursue innovation in their operations. Productivity analysis can provide long-insights in competitive advantage. Although the Malmquist productivity index is the most popular method applied in the studies of airline productivity, the conventional Malmquist productivity index is an adjacent index consisting of the geometric mean of two adjacent contemporaneous Malmquist productivity indexes. It is non-circularity, disparate measurements of productivity change of the components, and sensitivity to infeasibility. In addition, due to the unstorable feature of an airline's services, an airline's internal operation is a network structure and should be divided into the production stage and consumption stage. In the production stage, inputs are used to generate service capacity. In the consumption stage, service capacity is utilized to produce the consumed services. The productivity changes of different stages should be respectively computed and decomposed based on the network model. In order to avoid the drawbacks of the adjacent Malmquist productivity index, and open the black box of operational process of an airline company, this study constructs a novel network data envelopment analysis-based global Malmquist productivity index in measuring the productivity change of global airline companies from 2009 to 2016. Since the change of technology may be non-neutral, the proposed method not only decomposes the productivity change into efficiency change and technological change, but also considers the possibility of biased technological change. The results obtained from the proposed original method in this study may provide more valuable and useful information for airline operators and policy maker to understand the direction of improvement in productivity by mining the possible sources of productivity change.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A303

Impact of Transport Investment on the Efficiency of Regional Productivity Growth in Saudi Arabia: An Application of Data Envelopment Analysis

Saleh Alotaibi, Mohammed Quddus, Craig Morton (*Loughborough University*) & **Jobair Bin Alam** (*King Abdulaziz University*)

This paper evaluates the impact of transport investment on the efficiency of regional GDP growth in the Kingdom of Saudi Arabia (KSA). A non-parametric method - Data Envelopment Analysis (DEA) is employed to examine spatial and temporal economic data for the 13 regions of the country from 1999 to 2013. To address the inherent limitations of standard DEA models, and to evaluate the efficiency change of a region with respect to transport investment over time, Circular Malmquist Indices (CMI) are applied. The results show that, in general, both constant and variable return to scale DEA models exhibited overall efficiency improvement during the study period. However, an uneven level of productivity change existed among the regions in which the Madinah region was found to be the most efficient with an over-investment in the transport sector. Riyadh region, however, exhibited the highest productivity regress during the last three years. Interestingly, the results show that productivity growth progressed

for some regions such as Asir, Jazan, and Tabuk, which had been given less attention by the government in the past, indicating that this imbalance has been partially addressed. Most of the productivity changes were primarily due to the technical change rather than the efficiency change. The findings provide insights into the impact of transport investment for better decision making and policies in the KSA. Moreover, the results reveal unbalanced regional transport investment across the country which needs to be reconsidered by the government in order to achieve their strategic goals. This study is a unique in-depth efficiency analysis conducted for the KSA, especially after the newly announced strategy, included in the vision 2030, of reducing the reliance on the oil products by diversifying the economic activity of the kingdom.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Somewhat

04/09/2019, 09:00 – 10:30, Kennedy SR10

OR61A341

Evidence of Multi-Dimensional Herfindahl Hirschman Index from Linear Additive Directional Distance Function

Subhadip Sarkar (*National Institute of Technology Durgapur*)

Since its inception, application of Directional Distance Models has been in abundant. Such concepts along with Data Envelopment Analysis are found invaluable for assessing performance. Ample directions have been developed to satisfy a diverse set of criteria. The extant research is aimed to fulfil the sole objective of investigating and obtaining an inherent optimal Direction Vector emerging from the Directional Distance Additive Model. In this recourse the existence of a Multi-Dimensional Herfindahl Hirschman Index (MHHI) is also evidenced. The first Eigenvector of MHHI is selected as the optimal direction owing to the fulfilment of properties if Directional Distance vectors and also for its vitality to corroborate the competitive position of a set of firms. The output oriented model foretells the volume of desirable outputs to be escalated in view of attaining a superior position in the selling market from the same amount of resources. Principal Component Analysis plays a key role to identify the output-oriented directions from the non-central covariance matrix (MHHI) obtained from the output vectors.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Subject experts only

Is your talk accessible and relevant to practitioners? Relevant

OR61A351

On the Lack of Discrimination Power and the Fairer Assessment of DMUs in an Alternative 2-Stage DEA Structure

Marios Dominikos Kremantzis (*University of Southampton*)

Data Envelopment Analysis (DEA) is a well-established non-parametric approach for evaluating the performance of homogeneous Decision-Making Units (DMUs) that utilize identical inputs to produce identical outputs. Conventional single-stage DEA models ignore the internal processes taking place in the "heart" of a DMU; this results in shifting the research attention from the traditional single-stage to the 2-stage DEA models for detecting the sources of inefficiency and the most efficient DMU. A typical 2-stage DEA structure consumes inputs to

produce intermediate measures in the first stage. Then, the intermediate measures are converted into outputs at the end of the second stage. This paper focuses on the analysis of the novel 2-stage structure proposed by Yu & Shi (2014) with additional inputs in the second stage and part of intermediate measures as final outputs. In particular, the additive-based efficiency measurement and decomposition is suggested to assess a number of DMUs, formulating a CCR self-evaluation DEA model. In addition, this study contributes to the existing literature by proposing a Goal Programming-Multiple Criteria DEA (GP-MCDEA) cross-efficiency model as an alternative secondary goal to deal with the non-unique optimal multipliers of the above-mentioned model. CRITIC method is also applied to delineate the final weights assigned to the individual cross-efficiencies to obtain the ultimate cross-efficiency scores; this alternatively solves the aggregation problem in cross-efficiency. Last but not least, three Nash bargaining game common-weights DEA models are introduced for a fairer assessment of the DMUs, both in the entire system and its constituent parts. This is due to the satisfaction of the Pareto optimality condition. In the end, an application is illustrated to demonstrate the applicability of the proposed models. The results displayed that the proposed GP-MCDEA and Nash efficiency models can enhance the weight distribution and the discrimination power in such a 2-stage DEA structure.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Quite a lot

Is your talk accessible and relevant to practitioners? Somewhat

04/09/2019, 11:00 – 12:30, Kennedy SR10

OR61A208

Urban Water Institutional Reform and Impacts on Water Management in Peninsular Malaysia

Balamurugan Nallamuthu (*Monash University*)

The main objective of this study is to evaluate the efficiency of water utilities of Peninsular Malaysia (PM) during the periods of pre and post-institutional reforms introduced in in the year 2008. The technical analysis of 11 water utilities in PM from 1998-2016 is carried out using Two-Stage Data Envelopment Analysis (DEA). DEA is deterministic, and hence, confidence intervals cannot be estimated. A double bootstrap technology is employed to eliminate bias and construct confidence intervals and make statistical inferences. We employ an input led approach with employees, the length of water mains and operating expenditure per connection as inputs and the volume of water delivered as output. The institutional arrangement is incorporated with bootstrap regression to determine the influence of exogenous factors on the efficiency of water utilities. Past studies in Malaysia only used DEA scores to determine the efficiency and ranking of water utilities, but this approach gives more robust results on the efficiency of water utilities. Overall average technical efficiency of water utilities in Peninsular Malaysia was 72%, and Penang was the most efficient state with 94% efficiency rate. Population density, network density, non - revenue water, and reserve margin were positively related to efficiency. Nondomestic consumption was negatively related to the efficiency of water utilities. More importantly, the institutional reform did not have a statistically significant effect on the efficiency of water utilities in Peninsular Malaysia. This result indicates that water policymakers and regulators must review the institutional reform initiatives after ten years of implementation to ensure it significantly contributes to the efficiency of water utilities in PM.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A251

Rural Poverty Fighting Programs' Assessment in Angola - The Case of Cabinda

Miguel Rocha de Sousa (*Universidade de Évora*) & **António Cabeche** (*Universidade 11 de Novembro, Cabinda-Angola*)

This paper examines government poverty fighting policies in a specific South African country-Angola. We analyze the region or province of Cabinda, namely we assess poverty fighting policies in its four main districts: Cabinda, Cacongo, Buco-Zau and Belize municipalities, and finally all the 4 regions and last but not least all Angola. We use the HDI for a comparison with all Angola, for the Cabinda Province we construct the first (qualitative) regional HDI in those provinces in Angola, by assigning grades (in a rank from 1 to 5) through all the dimensions of the HDI. Finally we use the quantitative DEA method, which is data envelopment analysis to measure the efficiency of the poverty fighting and inclusion government policies. So, we rank and assess the value of technical efficiency across all the 3 components of the measures of HDI, as known income, health, and education in the poverty fighting programs. Preliminary results tend to show that Cabinda capital has more efficient programs than that the rest of the three areas, Cacongo, Buco-Zau and Belize. Besides, preliminary results tend to show that Angola as a whole is more efficient than all the 4 regions in Cabinda. Another interesting result is that most part of the HDI result in the four provinces in Angola comes from the income part. Another important aspect is that this is, as far as we know, the first effort to rank poverty issues through Data Envelopment Analysis, thus the newness of this paper and specifically the focus on Angola.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Quite a lot

Is your talk accessible and relevant to practitioners? Highly

OR61A211

Eco-Efficiency Considering CO2 Emissions and Data Envelopment Analysis

Ali Emrouznejad (*AI - Aston University*)

This work aims to conduct a comprehensive literature review on the publications which have used the Data Envelopment Analysis (DEA) (including Malmquist-Luenberger productivity index (MLPI)) to measure the efficiency and productivity of decision-making units (DMUs) with CO2 emissions as undesirable outputs. This work aims to conduct a comprehensive literature review on the publications which have used the Data Envelopment Analysis (DEA) (including Malmquist-Luenberger productivity index (MLPI)) to measure the efficiency and productivity of decision-making units (DMUs) with CO2 emissions as undesirable outputs. In doing so, we (a) examine the key-route main path of knowledge flows characterizing the topic researched, (b) provide basic bibliometric information about the most active journals and authors, (c) conduct a qualitative in-depth analysis of the identified most important studies and (d) focusing on the most recent period between 2000 and 2018, identify the research fronts and relate them to the emerging issues on the topic researched. Based on the insights of the literature review, a second part of the paper provides an in-depth analysis to critical review of papers on the key-route main path of this subject. The paper concludes with some recommendation for energy policymakers and future directions for prospective researchers in the field.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 11:00 – 12:30, Kennedy SR10

OR61A116

An Alternative Ranking of Countries According to Their Development Level by Data Envelopment Analysis

Ayhan Gölcükcü (*Süleyman Demirel University*)

There are many attempts to rank countries according to their development level, which develop its own ranking methodology and index. On this purpose, Data Envelopment Analysis (DEA) based on the pioneering paper of Charnes et al (1978) is also powerful methodology not only for ranking but also benchmarking approach by efficiency evaluation. It is even the most appropriate method for measuring the efficient use of limited resources and for improving resource utilization through best practices. Therefore, in this study, using the data of the United Nations Development Program (UNDP), countries will be ranked by DEA method, and the countries that make best use of their resources will be put forward and targets will be proposed for inefficient countries. In addition, it is aimed to demonstrate different models of DEA developed for the case of missing data due to disruptions in the provision of data. In this way, it will be also contributed to an increase of human welfare by minimizing inefficiency. In doing so, early work of Despotis (2005) will be mentioned and the change of results over time will be discussed.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A187

Labor Productivity Growth and Convergence in Manufacturing: A Non-Parametric Production Frontier Approach

Nader Alkathiri (*University of Sussex*)

Using a non-parametric frontier method known as data envelopment analysis, labor productivity growth in the manufacturing sector for each country is decomposed into efficiency change, technical progress, and capital deepening. The results suggest that labor productivity growth is mainly driven by capital accumulation and to a lesser extent technological progress, while technical efficiency is deteriorating over the period 1990-2014. We find that technological progress appears to be non-neutral, as the world manufacturing production frontier expands only at a higher capital intensity, benefiting more highly industrialized nations.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A104

Measurement of Efficiency of Indian Courts Using Data Envelopment Analysis

Maansi Gupta & Nomesh B. Bolia (*Indian Institute of Technology Delhi*)

A country's judicial branch is responsible for administering justice to its citizens by interpreting and applying the country's laws. The Indian judicial system is extensive and is plagued by several issues. These include high pendency levels, congestion, delay in disposal of cases, lack of adequate number of judges, and sub-optimal use of technology. Of these, judicial vacancies and lack of judges are often cited as the major reasons behind India's clogged judiciary. The performance of a country's judicature is often measured in terms of the pendency levels, and the average time taken by a case from its date of institution to the date of its resolution. The

present study aims to measure the efficiency of Indian courts using Data Envelopment Analysis (DEA). The scope of the study is limited to High Courts in India, which are at the head of the state's judicial administration. The model takes two inputs, namely, number of judges and number of staff members. The output has been bifurcated into two categories, number of criminal cases disposed and number of civil cases disposed. An output oriented DEA, with constant returns to scale has been proposed. A comparison between sanctioned number of inputs (judges and staff) and working strength of inputs has been done through multiple DEA models to determine whether lack of judges is actually the reason behind rising pendency levels. The performance of each court is analysed further according to the area (civil or criminal) where it's performing well, and where it's not. A Mann-Whitney U test has been proposed to study the relationship between efficiency of courts, and the profile of cases resolved by them, and the results are encouraging. Peers are identified for inefficient courts based on their comparison with courts following similar profiles.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A323

Infrastructural and Operational Effectiveness of Banks in India 2006-2016

Agha Ali (*Isenberg School of Management*)

Four major categories of banks in India—foreign banks, nationalized banks, private sector banks, and the state banks of India—employ over 1.25 million personnel, operating from over 125,000 branches across the country. The effectiveness of these four types of banks with respect to infrastructure and operations is relevant in light of the technological and societal changes that have taken place in India over the past two decades. This paper applies benchmark data envelopment analysis in a comparative study of the banks in these four categories over the decade spanning 2006 – 2016.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

05/09/2019, 13:30 – 15:00, Kennedy SR10

OR61A279

A Multidimensional Measure of the Global Digital Divide

Viverita Viverita (*Universitas Indonesia*), **Emily Cabanda** (*Regent University, Virginia Beach*) & **Ali Emrouznejad** (*Aston Business School*)

This paper attempts to measure the global digital divide among 166 economies using the ITU's information and communication technology (ICT) development index (IDI) indicators. We formulate the novel Data Envelopment Analysis (DEA)-IDI model using the composite index with three sub-indices: access, use, and skills indicators using the ITU's 2015 data sets with 11 variables as a multidimensional measure for a global digital divide in our DEA-IDI model. We have segregated the DEA index score results of 166 countries into six demographic regions: The Americas (32), Africa (37), the Arab States (16), Asia and the Pacific (32), Commonwealth of Independent States (CIS) (9), and Europe (40). New results show that there is a significant statistical difference of mean efficiency of the development of ICT between the six regions. This finding indicates that these regions have a different level of access to ICT, intensity and

usage of ICT, and capability of using ICT. Furthermore, when we compare the mean efficiency of ICT between the country in each region, we find that there are no statistical differences in ICT development between countries in Africa and in CIS regions. In the Africa region, countries are not significantly different in their index scores, implying that a digital divide exists in the region, with no African country obtained the optimal index score, and one African country was found at the bottom of the world ranking. America and Europe show that a digital divide does not exist any longer since countries in these regions have reached the highest 95-100 range in DEA-IDI range score, including the CIS region. While Asia & Pacific and the Arab States are closing faster the gap of the digital divide. These new empirical findings indicate that a digital divide is closing faster among regions, except Africa, implying good ICT infrastructure, access, and use.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A239

Efficiency Analysis of Indonesian Hotel Industry

Viverita Viverita & Ratih Dyah Kusumastuti (*Universitas Indonesia*)

The tourism sector plays an important role in enhancing employment and economic development in Indonesia, especially in the region which heavily relies on the sector. As the number of foreign tourists increases, it will enhance foreign exchange income that will, in turn, increase the national economic development. This paper presents empirical evidence of hotel efficiency in 31 provinces across Indonesia, in the period of 2009-2016. The output variables are the total number of tourist arrivals and average hotel occupancy rate. The input variables are the total number of hotel beds and the total number of employees. We use variable returns to scale (VRS) model with output orientation to calculate hotel technical efficiency. The results show that the average technical efficiency of the hotel industry is around 84.5%. In addition, based on slack analysis, we find that the Indonesian hotel industry needs to increase the tourist arrival in order to be efficient.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A346

Evaluating Urban Sustainability at the Borough Level: A Case Study of London, England

Sadiye Eylul Sadanoglu (*Coventry University*)

This paper provides a comprehensive framework for simultaneously evaluating urban sustainability from three perspectives—economic, environmental and social. We assess the urban sustainability of 32 boroughs in London from 2012 to 2015 with the aim of identifying the best practices of and the lessons learned by the borough councils. Given the performance measures constituting both desirable and undesirable outputs and dynamic changes, the Malmquist–Luenberger Index (MLI) approach is applied. The results indicate that: (1) Twenty-five percent of the boroughs showed productivity growth over the three-year period. (2) Reducing energy consumption has a significant, positive effect on sustainability, while density, industrialisation and deprivation have a negative effect. The geographic spread of boroughs also affects performance. (3) The power of politics and finance play a critical role in overall

performance. This research takes a novel approach in studying urban sustainability at the borough level to determine how local authorities contribute to overall urban sustainability.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

Forecasting



Organisers: John Boylan and Robert Fildes

04/09/2019, 09:00 – 10:30, Kennedy SR5

OR61A153

Incorporating External Evidence in Dynamic Survival Models to Avoid Implausible Forecasts: A Case-Study

Benjamin Kearns, Matt Stevenson, Kostas Triantafyllopoulos (*University of Sheffield*) & **Andrea Manca** (*University of York*)

Generating forecasts of the future survival of patients receiving different treatments is an important task in economic evaluations. Decision-makers will often use these forecasts as evidence to inform the decision of if a treatment should be funded. However, different models can provide markedly different forecasts of future survival, implying that funding decisions are sensitive to the chosen forecasting model. In these situations, the choice of model may be based on the clinical plausibility of its forecasts. We illustrate these issues via a re-analysis of a trial comparing two treatments for lung cancer. For the original analysis, two models were considered. The first extrapolated a decreasing trend in the hazard of overall survival. These forecasts were criticised as implausible, as over-time they fell below that of the age-matched general population hazard. The second model avoided this by forecasting a constant hazard. However, this model was also criticised as ignoring the trend in the hazard observed during the trial. We introduce dynamic relative survival models, a novel extension of dynamic survival models to incorporate evidence on general population survival. We demonstrate that these models are able to both forecast the trends observed in the trial and ensure that extrapolated hazards do not fall below those of the general population. The dynamic relative survival models may be interpreted as forecasting the excess hazard; the additional hazard of death due to having a disease (or equivalently, the survival of patients with a disease relative to the survival of the general population). Different assumptions about the long-term behaviour of the excess hazard may be reflected by different model specifications. The focus is on the practical application of dynamic relative survival models, although technical specifications are also discussed.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A192

The Extrapolation Performance of Dynamic Survival Models with Linear and Damped Trends Compared with Standard Survival Models: A Simulation Study

Benjamin Kearns, Matt Stevenson, Kostas Triantafyllopoulos (*University of Sheffield*) & **Andrea Manca** (*University of York*)

Healthcare systems operate with constrained budgets, so need to decide which treatments to fund. Consistent decision making often requires estimates of survival for a lifetime horizon, which usually requires forecasts due to incomplete evidence. Current practice is to use standard parametric survival models for forecasting. An alternative approach is to use dynamic survival models (DSMs). These combine time series methods with survival models, and may be viewed as the application of dynamic generalised linear models to survival data. The aim of this study was to compare the forecasting performance of DSMs when compared with standard survival models. We used a simulation study, with a two-mixture-Weibull model as the data generating mechanism, giving hazard functions with multiple turning points. We considered nine scenarios: three different lengths of follow-up and three different sample sizes. Standard survival models were the exponential, Weibull, Gompertz, log-logistic, lognormal, gamma and generalised gamma. DSMs are local models: they allow model parameters to vary as a time-series. Two DSMs were considered: one extrapolates a constant trend; the other extrapolates a trend that is damped over time until it becomes zero. The primary outcome measure was the mean-squared-error (MSE) compared to standard models. This penalises for both lack of accuracy (bias) and variance. Both of the DSMs had lower MSE values than standard models for all of the scenarios considered. The damped trend DSM always had the lowest MSE and less variation in values than the non-damped model, although differences were small. Significant improvements in MSE were observed in five and three scenarios for the damped and non-damped models, respectively. Results were robust to using bias as the outcome measure instead of MSE. These results suggest that when forecasting survival outcomes, DSMs should be used in preference to standard survival models. Future work could consider alternative data-generating mechanisms.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A90

N-Estimates: A New Algorithm for Rating Sports Teams

Simon Rookyard (*Quintessa Ltd*)

Well-matched competitive events are key to the success of any sport. This is true from elite athletes to amateur and youth levels, where the enjoyment arising from playing close, competitive matches is known to be an important factor in increasing participation. Matches that are overly one-sided can cause boredom or demoralisation and cause loss of players or spectators. It is therefore important for competition organisers to group together teams with similar abilities to ensure an appropriate level of competition. However, absolute ability cannot be directly measured and is subject to both long-term systematic changes and (often large) stochastic variation from match to match. Instead, a simultaneous (and continually updating) calculation of abilities for all teams in the system is required. This must be based on the only measurements available: relative performance in single-match interactions between direct competitors. This theoretical work presents a new algorithm (the "N-estimates" algorithm) to assign teams a numerical rating. N-estimates uses a novel data-driven statistical modelling

approach to calculate not just the ratings, but also the uncertainty, based on results from recent performances. The method is presented in a generic form which can be applied to a wide range of sports. A test case is also presented, using 12 seasons of football results. Winning margins in matches are predicted based on the ratings of the two teams. The predictions are shown to be more accurate for N-estimates compared to a leading existing football-specific rating algorithm. The N-estimates method requires fewer historical results to converge to give reliable predictions, hence it may be of particular value to respond to new competitors entering the system.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 11:00 – 12:30, Kennedy SR5

OR61A332

KEYNOTE: Intermittent Demand Forecasting and Inventory Management

John Boylan (*Lancaster University*)

The problem of forecasting and managing the inventory of service parts has challenged the OR profession for over sixty years. These parts are often characterised by intermittence (frequent periods of zero demand) and lumpiness (erratic demand sizes). As review intervals and lead-times have become shorter, intermittence has also become an issue for retailers and, with the growth of on-line retailing, customer returns need to be taken into account. Also, as OR methods become more widely used in emergency planning, the importance of managing the intermittent demand of medicines and other critical supplies is becoming more widely recognised. The main theme of this talk will be on the effective integration of the forecasting and inventory management of intermittent demand items. The literature on this subject is widely dispersed and the aim will be to bring it together into a coherent whole. Topics will include: advances in the measurement of service levels; evidence on the effectiveness of demand distributions and distribution-free methods; measurement of forecast accuracy (including a new measure for 'net demand', after taking into account returns); and recent innovations in state-space modelling for intermittent demand. There are many open questions in this field of research. This paper will focus on two: firstly, the modelling of demand when customer returns become a significant issue; secondly, the scope for machine learning to improve intermittent demand forecasting. The talk will conclude with an agenda for intermittent demand research and software development.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A286

Storm on the Horizon-Correcting Bias in Forecasting Systems Using Weather Forecasts

Stephanie Kiss & Kjeld Jensen (*BT*)

For a large company with a workforce of many thousands, accurate and responsive planning is an essential task as it determines whether the company can provide good quality services and products. This relies on robust and precise forecasting systems in particular where the volume of work depends on external factors, such as the weather. However, forecasting methodologies based on point-forecasts similar to those widely published, are likely to produce

a persistent bias in the forecasts, in particular for longer lead times. Evidence suggests that bias stems from the processing of ensemble forecasts from numerical weather prediction models, with published forecasts using the median rather than the mean. This bias causes planning difficulties as values are systematically understated and there is high variance between values for the same date at different lead times. Our work focuses on correcting the existing bias by removing the bias inherent in the weather forecasts to provide a less volatile and more stable prediction in a way that does not require access to full ensemble weather forecasts. Using statistical analysis on historical weather forecasts, we derived a bias correction method using linear regression and compared it with multiple well known bias correction methods quantile mapping, fitting Gamma distributions and scaling. We show that the regression method reduces the bias significantly across all regions of the UK geography compared to the alternative methods.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A317

Two Sides of the Same Coin: Rethinking of Corporate Social Responsibility from the Perspective of Financial Transparency

Sadaf Ehsan (*COMSATS University Islamabad, Lahore Campus*)

Accounting scandals in world's renowned corporations like Enron, WorldCom, Toshiba, Daqing Lianyi and Xerox exposed the managerial discretion in reporting accounting numbers that are called as earnings management (EM). These scandals raised serious issues about the corporations' corporate social responsibility (CSR) practices because financial transparency and accountability are among the most vital of firms' socially responsible behaviors. These events fueled a debate on whether CSR is an effective tool in motivating firms' managers to promote healthy relationships with diverse stakeholders to pursue sustainable growth and performance under the long term perspective or CSR is used as an effective strategy by firm's managers to hide out their involvement in EM practices under the managerial opportunism perspective. The present study adopts a systematic review approach through the lens of EM to determine why companies engage in CSR activities. Results show that majority of selected studies supports the long-term perspective as they found that CSR and EM are negatively related to each other. Nevertheless, some studies also found the positive relationship in CSR-EM and established that CSR is used by firms' managers to mask their opportunistic behavior such as EM. Further, there are few studies that have checked the direction of causation in this relationship, explaining the mixed results. In addition, the review finds a significant moderating effect of some country- and industry-specific factors in this relationship, yet a few studies have seen organizational factors like ownership structure, group affiliation, and corporate governance as important moderators. Moreover, although research on the CSR-EM relationship is limited, what there is has produced mixed results because of the lack of sufficient theoretical support, inappropriate research designs, mis-specified research models, varying approaches to measuring CSR, and unconventional ways of measuring EM.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A359

Predictive Resource Modelling with Simulation at Sellafield Ltd

Paul Hinsley (*Sellafield Ltd*)

The Sellafield site in West Cumbria is one of the most complex and hazardous nuclear sites in the world. Our vision is to safely and securely remediate Sellafield to benefit the industry, nation and region. To deliver its mission, Sellafield Ltd strives to attract and retain necessary skills, diversity of talent, and capability. The Science, Environment and Technology (SET) capability group are responsible for ensuring that Sellafield Ltd has the appropriate level of technical resource both in terms of overall head count and specific knowledge areas in order to deliver the technical work scope of the business. To support resource planning in the SET capability, a resource tool was developed to predict the future health of the SET community. Using simulation, current resource capability is input into the tool and is then evaluated according to a set of logical rules including progression routes, progression rates, and attrition. New resource can be introduced into the simulation from future dates to represent a recruitment plan. The tool generates a results forecast that can be used to compare projected capability against required levels. The input data and logic is customisable meaning that different scenarios can be evaluated, enabling the tool to provide value by informing recruitment, succession, and training strategies.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

04/09/2019, 15:30 – 17:00, Kennedy SR5

OR61A259

Automatic Robust Estimation for Exponential Smoothing: Perspectives from Statistics and Machine Learning

Devon Barrow (*University of Birmingham*), Nikolaos Kourentzes (*Lancaster University*), Rickard Sandberg (*Stockholm School of Economics*) & Jacek Niklewski (*Coventry University*)

A major challenge in automating the production of a large number of forecasts, as often required in many business applications, is the need for robust and reliable predictions. Increased noise, outliers and structural changes in the series, all too common in practice, can severely affect the quality of forecasting. We investigate ways to increase the reliability of exponential smoothing forecasts, the most widely used family of forecasting models in business forecasting. We consider two alternative set of approaches, one stemming from statistics and one from machine learning. To this end, we adapt M-estimators and boosting to parameter estimation for exponential smoothing. We propose appropriate modifications and inverse boosting, a novel modification that we argue is more appropriate for time series forecasting tasks. We evaluate the various estimation methods using multiple real datasets and find that several approaches outperform the widely used maximum likelihood estimation. The novelty of this work lies in (1) demonstrating the usefulness of M-estimators, (2) a proposed new approach to boosting coined inverse boosting, which outperforms standard boosting approaches, and (3) a comparative look at statistics versus machine learning inspired approaches.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A295

Retail Forecasting Using K-Nearest Neighbours, an Unusual Practice

Carlos Eduardo Rodriguez-Calderon (*Lancaster University*)

k-Nearest Neighbours (k-NN) is a promising technique used for classification, to impute missing values and to perform regression for particular applications. E.g. forestry. Previous researchers have discussed the capabilities of the algorithm to perform predictions, to optimise the algorithm by improving variable selection, distance calculation, and the number of neighbours to be used. Nevertheless, despite some applications for time series for electric and water demand, there's a scarcity of applications or adaptations of the current literature to retail forecasting problems. In this work, we discuss the use of k-NN for a retail problem as an alternative to linear regression for a particular situation to open a discussion about the performance of the algorithm, its capabilities and limitations.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A54

Dynamic Model Selection in Demand Forecasting Using Supervised Learning on Data Set Characteristics

Matthias Ulrich, Hermann Jahnke, Roland Langrock (*Bielefeld University*), **Robert Pesch & Robin Senge** (*inovex GmbH*)

Retailers usually supply a wide range of stock keeping units (SKUs), which may differ for example in terms of demand quantity, demand frequency, demand regularity, and demand variation. Given this diversity in demand patterns, it is unlikely that any given model for demand forecasting will show the highest forecasting accuracy for all SKUs. To save costs through improved forecasting accuracy, there is thus a need to match any given demand pattern to its most appropriate model. Here, we propose a dynamic model selection framework for demand forecasting using supervised learning. Specifically, we consider model selection as a classification problem, where the classes correspond to the different models available for forecasting. Based on the most recent data for the SKU of interest, we identify past occasions with similar characteristics and classify according to the different models' performances for those test instances. The performance is measured taking into account asymmetric underage and overage costs, as specified by the retailer. As benchmark for our approach, we consider several methods that are commonly applied, namely individual selection, aggregate selection, and combination forecast. The methods are evaluated in a case study using data from an e-grocery retailer, where we compare the out-of-sample predictive performance.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

Healthcare Applications



Organisers: Mohamed Reda Lebcir, Soheil Davari and Amanda Relph

03/09/2019, 11:00 – 12:30, Kennedy SR6

OR61A275

Harnessing the Power of Cutting-Edge Data Science to Improve the Outcomes of Critically Ill Children

Christina Pagel (*University College London*)

Advanced data science has been hailed as a game changer in delivering better health care. However, while the UK NHS has many large datasets, these are messy and hard to interpret, and the use of advanced data science techniques is still in its infancy. Operational Researchers could be key in meeting the challenge of how to mesh the highly technical world of data science with the realities of front-line clinical decision making. The UK Turing Institute for data science runs regular Data Study Groups (DSGs) where a hundred top data scientists from all fields gather for a week of intense work on real-world problems. Great Ormond Street Hospital (GOSH) has a unique high resolution vital sign dataset of 5500 children in intensive care and contributed a problem to the DSG for April 2019.

When children are on life-support, their vital signs are monitored continuously. Clinical staff make treatment decisions informed by current snapshots of these signs. The challenge was to develop predictive algorithms that out-perform clinical decision-making for one high-risk decision faced for every patient: optimal timing for a trial of breathing without life-support.

I am an Operational Researcher and will discuss how I worked closely with GOSH and others to conceive of, negotiate, plan, execute and interpret the hospital's foray into new data science. I will go through the challenges involved in this kind of work and some thoughts on where operational researchers can fit into the "advanced data science" world.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A78

Improving Performance in Home Health Care Systems Using Operational Research: A Systematic Literature Review

Luca Grieco, Martin Utley & Sonya Crowe (*University College London*)

The efficient deployment of resources to deliver home-based care is critical for the sustainability of health and social care systems in the UK and elsewhere, particularly given the trend towards ageing populations with more complex care needs. The aim of this study was to identify operational research approaches offering performance improvements in home health care. We identified a set of interlinked decisions covering strategic, tactical and operational

planning levels based on existing descriptions of supply chains in home health care and on discussions, meetings and workshops held with stakeholders in the field. We then carried out a systematic literature review of operational research approaches used to address our decisions of interest. We complemented our search by identifying approaches used in other fields that could be readily adapted to address questions in home health care neglected in the current literature. In agreement with previously published reviews, we found that studies are mainly focused on operational decisions, with very few integrative approaches considering the interplays between decisions at different planning levels, and that there has been very little adoption of operational research-based approaches by home health care organisations. However, we observed a recent increase in the number of publications dealing with uncertainty in demand and/or operations and publications focusing on multi-objective optimisation. The latter highlight the increasing need for more effective approaches able to determine trade-offs between contrasting stakeholder perspectives within the same decision domain. Informed by the literature review, we are currently developing a suite of operational research models including already published and newly conceived approaches covering all decisions of interest and enabling analysis of those decisions in different, plausible combinations and hierarchical orderings. We will use this framework to analyse and select promising strategies for more efficient decision-making in home health care.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A245

Configurations of Lean Practice Bundles and their Impact on Performance in Hospital Sub-Units

Martin Roeger, Leroy White & Mark Johnson (*Warwick Business School*)

Purpose – The presented study is part of a bigger project investigating the impact of different combinations of Lean practices in the healthcare setting. It isolates one hospital trust and takes an in-depth perspective on operational performance impacts in several organizational sub units. Design/methodology/approach – A mixed method approach was conducted, namely fuzzy-set qualitative comparative analysis (fsQCA). The main data set includes documentation reviews of rapid process improvement workshop (RPIW) reports, monthly executive reports and external assessments. In addition, in-depth executive interviews were conducted assessing the degree of implementation for each Lean practice. Findings – Only two configurations were found to be classified as sufficient for a superior performance impact on lead time. One contained staff empowerment while the other included the process flow analysis. No solutions were found for quality improvement. Practical implications – This study highlighted that there are two different pathways to achieve superior lead time improvements. Furthermore, the findings allow Kaizen promotion officer and other involved executives to implemented only the sufficient practices and save further resources. Originality/value – While these findings support the Lean bundle theory of previous manufacturing studies, contrarily this study indicates that only limited practices are actually required to achieve lead time improvements. Furthermore, the Lean literature is extended by explanations of specific relationships of Lean practices on a sub unit level.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A215

Public Value of the e-Sick Leave System in the Emirate of Abu Dhabi

Mouza Almansoori (*Department of Health Abu Dhabi*)

E-Sick Leave system is 'a digital cybernetic platform that integrates different systems in different institutions to understand, and so to enable, regulation of the behaviour of different sub-systems and their players'. The Department of Health (DOH) established this system in Abu Dhabi in 2012 to control misuse of sick leaves and to protect the rights of employees, employers, and doctors. Until now, no other country has implemented a programme using cybernetics theory to understand how this medico-legal system can regulate the behaviour of the actors involved. It is the first to provide a framework for understanding human behavioural control mechanisms using an information system. This recognizes that the case study of the e-Sick Leave in Abu Dhabi is concerned with controlling costs, the misuse of sick leave, and the co-ordination of agencies. Thus, the UAE became the first country in the world to establish a scientifically grounded e-Sick Leave System based on cybernetic principles and international evidence-based standards. This study takes a unique approach in describing the implementation and evaluation of the new medico-legal system on public administration. This research filled several knowledge gaps. It was the first to define the e-Sick Leave system from a cybernetic perspective, and thus is considered to be a contribution that introduced cybernetics into the healthcare sector and public administration. It was also the first to use the benefits maps methodology in mapping the relations between the enablers and the benefits. Finally, this research was the first to apply a public value framework to a medico-legal system in the UAE.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

03/09/2019, 13:30 – 15:00, Kennedy SR6

OR61A101

The Capability of System Dynamics in Evaluating Cost for Policy-Making in Health: A Review

Nidhee Jadeja, Nina Jiayue Zhu (*Imperial College London*), **Reda M Lebcir** (*University of Hertfordshire*), **Franco Sassi & Raheelah Ahmad** (*Imperial College London*)

System Dynamics (SD) modelling is increasingly being recognised for its application in health, as it offers capabilities over other soft systems methodologies by integrating qualitative and quantitative elements to model human behavioural aspects and by engaging policy-makers in the process. SD can support decision makers through robust evidence and the analysis of scenarios and consequences of policies and actions. A gap remains however, in the incorporation of health economic analysis in the approach which is crucial to support policy-makers in their decision-making. This review assesses the capability of Systems Dynamics to evaluate the cost impact of policy interventions and how this compares with other modelling methods in addressing complex problems. A systematic search was conducted to identify articles published from January 1999 to May 2019 from the Scopus, Medline, EMBASE, Web of Science and Econlit databases. Papers eligible for inclusion were those that described applications of economic analysis in SD modelling to support policy at any level of government, with a particular interest in healthcare and antimicrobial resistance. This study examines the range and nature of economic analysis in SD methodologies, identifies gaps in the literature, and discusses future directions of its application for healthcare. Policy analysis tools such as Systems Dynamics can help guide appropriate investments and policy measures and this

review provides insights for SD practitioners and policy makers/researchers on the capability of SD in evaluating the cost aspects of addressing complex health problems.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A284

An Empirical Study of Factors that Influence the Uptake of OR in Healthcare

Sonya Crowe & Martin Utley (*University College London*)

Healthcare faces important challenges that academic operational research has the potential to address. However, academic OR has failed to make a significant impact in influencing decision-making to date. To increase understanding on how operational researchers can work more effectively in healthcare, we conducted an empirical study of non-technical influences on the uptake of academic OR in healthcare. We elicited the perspectives and experiences of OR practitioners working in academic healthcare OR using social science approaches to data collection and analysis. Our findings contribute useful insights regarding the praxis of individual operational researchers and OR groups, and the interactions between these. In particular, our work highlights the importance of considering trajectories of praxis beyond individual projects / interventions. We will discuss which of our findings are likely to be specific to healthcare and those that might translate to academic OR practitioners working in other fields, and present our work in relation to current discourses in the emergent field of behavioural OR.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A31

Understanding the Distribution of Health Needs Using Population Segmentation: An Applied Comparison of Methods

Richard Wood, Ben Murch (*National Health Service*) & **Richard Betteridge** (*Cerner limited*)

This paper presents the first comparison of descriptive segmentation methods for population health management. The aim of descriptive segmentation is to identify heterogeneous segments according to some target observed measure. In healthcare it can be used to understand how utilisation is distributed among a population, and to identify the patient attributes which explain the greatest differences (knowledge of which can help shape segment-tailored services). In reviewing a number of segmentation methods that are both employed on the ground and explored more experimentally within the academic literature, this paper aims to open up a range of options allowing clinicians and managers an informed choice on which approach to use for their situation. Results support the recommendation that decision tree approaches are on-the-whole most suitable, being configurable to local data and providing the best inter-segment discrimination. More basic judgemental splits on patient attributes can be powerful, with the count of chronic conditions being a key variable. Prescribed binning methods such as Bridges to Health are unlikely to achieve high levels of discrimination but do have easily interpretable segments and could be useful for benchmarking. Clustering methods are found to lack discriminative power, which can be attributed to a lack of conceptual appropriateness to the problem.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

03/09/2019, 16:30 – 18:00, Kennedy SR6

OR61A198

System Level Knowledge Mobilisation in Healthcare: Capturing Professional Norms, Regulative Forces and Cultural Influences

Raheelah Ahmad, Nina Zhu, Nathan Peiffer-Smadja (*Imperial College London*), **Cliona McNulty** (*Public Health England*), **Reda Lebcir** (*University of Hertfordshire*) & **Ewan Ferlie** (*Kings College*)

In highly professionalised organisations, Knowledge Mobilisation (KM) impacts only once knowledge of what is 'acceptable' practice is developed and negotiated collectively within and across professional groups, teams, or organisations. Structural and cultural environments mediate this process. Whilst the societal threat of antimicrobial resistance is recognised amongst healthcare professionals, we do not know what impact different KM activities targeted at GP teams, community pharmacists and patients have and need a systems level perspective to accelerate progress. Empirical research reports that up to 30% of antibiotic prescribing by GPs may be inappropriate, and numerous mandatory and persuasive interventions have been implemented aimed at individual healthcare professionals, organisations as well campaigns for patients and the public. In this study, we report the novel use of participatory system dynamics simulation to address the following research question: how can we optimise knowledge mobilisation between and across the core triad (GP teams, community pharmacy, patients) involved in antibiotic utilisation in the community setting? By co-constructing a systems map of drivers and inhibitors of regulatory, cultural, and professional influences, we show how this process itself has the potential to advance KM in these different groups. Knowledge mobilisation in healthcare organisations is a non-linear process driven by multiple stakeholders from different sectors and is highly reactive. System dynamics simulation captures the dynamic and complex flow and draws on key elements of KM including necessary engagement for model fidelity evidence synthesis, knowledge co-creation and exchange. By initiating primary research in one geographical area in England we capture effects at the whole health-economy level and present the causal loop diagram using a system dynamics approach. Systems thinking approaches can be further applied to systematically evaluate impact of KM activities, and help construct new theoretical frameworks to enhance impact in health care practice.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A23

Reducing Referral to Treatment Times for Bladder Cancer in Cornwall Using Simulation Modelling

Daniel Chalk (*NIHR CLAHRC for the South West Peninsula*), **John McGrane, Mark Mantle, Sarath Vennam** (*Royal Cornwall Hospitals Trust*) & **Neil Trent** (*University Hospitals Plymouth*)

Bladder cancer is the seventh most common cancer in the UK, and around a quarter of bladder cancers are muscle-invasive. However, patients with muscle-invasive bladder cancer have typically poor outcomes, and require rapid cystectomy treatment, as the cancer is aggressive and worse outcomes are associated with delayed treatment. Unfortunately, the process of

diagnosing muscle-invasive bladder cancer is complex, requiring multiple investigations. Consequently, significant delays can accrue between referral and treatment. In 2016, we developed a simple Discrete Event Simulation model of the pathway for bladder cancer patients at Royal Cornwall Hospitals Trust, from initial referral to definitive treatment. We used this model to first identify the key bottlenecks within the pathway. We identified two key delays - the wait for the Transurethral Resection of Bladder Tumour (TURBT) to remove any identified tumours following cystoscopy, and the wait for a nurse specialist to speak to the patient to confirm their diagnosis and discuss treatment options. The model was demonstrated to a group of consultants and other clinicians involved in the pathway at the hospital, and we asked them to discuss the results and suggest potential changes that they could make, that we could then "live test" in the simulation model. Two of the changes that the clinicians proposed were predicted to lead to significant reductions in referral to treatment times. Within 24 hours, the Cancer Lead for Urology rewrote their protocol to enact the proposed changes, specifying that patients with suspected muscle-invasion at cystoscopy should be fast-tracked to TURBT, and that the nurse specialist should speak to the patient about their diagnosis and treatment options whilst they are on the ward for their TURBT. Analysis of data three months post-implementation showed that the average referral to treatment time has reduced by five weeks, including an 11 day reduction for patients without muscle-invasion.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 09:00 – 10:30, Kennedy SR6

OR61A274

Designing Cancer Care with Learning Through Patients Experiences: A Perspective of Self-Determination Theory

Jiun-Yu Yu (National Taiwan University)

Cancer patients are experiencing a number of pain points in their current journey through the cancer care continuum. In order to understand thoroughly the causes of the pain points, multiple research methods are applied. In-depth interviews are conducted with cancer patients and medical professionals and are analyzed using Grounded Theory. The integration of qualitative analysis generates unique insights about the underlying causal loop structure that creates those pain points. To fundamentally solve the problem, the theory of basic psychological needs is incorporated. The perspective of healthcare facilitated networks is proposed, and the design guidelines for this model is developed.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A306

Estimating Costs and Benefits of Stroke Management: A Population-Based Simulation Model

Steffen Bayer (University of Southampton)

The paper demonstrates how a system dynamics approach can support strategic planning of health care services and can in particular help to balance cost-effectiveness considerations with budget impact considerations when assessing a comprehensive package of stroke care interventions in Singapore. A population-level system dynamics model is used to investigate

12 intervention scenarios based on six stroke interventions (a public information campaign, thrombolysis, endovascular therapy, acute stroke unit (ASU), out-of-hospital rehabilitation, and secondary prevention). Primary outcomes included cumulative discounted costs and quality-adjusted life years (QALYs) gained, as well as cumulative net monetary benefits net monetary benefit by 2030. All intervention scenarios result in an increase in net monetary benefit by 2030; much of these gains were realized through improved post-acute care. Findings highlight the importance of coordination of care, and affirms the economic value of current stroke interventions.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A276

Evaluating Pediatric Drug Safety and Prescribing Behavior in Taiwan: A System Dynamics Approach

Jiun-Yu Yu & Yi-Rou Ruby Lei (*National Taiwan University*)

Drug formulation used in pediatric patients should be appropriate, safe, as well as be adapted to children's needs. The use of inadequate drug formulation and the pulverizing medicine phenomenon are widespread in Taiwan. Many existing treatments are not suitable for children, which often leads to medical malpractice. Although the advocacy of pediatric drug safety from non-government organization, the improving regulations from government regarding current clinical situations remain stagnant. In order to evaluate the pediatric drug safety issue, this essay uses system dynamics approach to analyze the results that come from different prescribing behaviors. The analyses found out problems generated from pulverized medicine caused drug safety, drug efficacy, and cost issues, causing the decrease of the relative safety and efficacy of treatment, illustrated by balancing loops in the system dynamics. On the other hand, the reinforcing loops in the system dynamics generated from pediatric drug formulations created incentives to drive doctors to prescribe more pediatric drug formulations, leading to better drug safety and drug efficacy of treatment for children. Therefore, the system dynamics depicts the whole structure of pediatric drug safety issue came from different prescribing behaviors, letting us have a clear picture to address this problem. Four key issues that need to be addressed to stimulate the further improvement for pediatric drug safety in the medical system are identified: (1) building the network of medical institutions to promote pediatric safety; (2) set up online platforms and use of existing data to transmit more medication knowledge; (3) collect more clinical feedback and patients' outcome to improve the development and the utilization of pediatric drug formulation (4) take the responsibility of saving more medical resources, helping government to save the cost in order to address drug safety and many other issues.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

Locational Analysis: Theory and Application



Organisers: Nader Azizi and Chandra Ade Irawan

03/09/2019, 13:30 – 15:00, Kennedy SR3

OR61A112

Network Design Under Uncertain Demand: An Alternative Capacitated Location Decision Framework

Diego Ruiz-Hernandez (*Sheffield University Management School*), **Mozart B C Menezes & Oihab Allal-Cherif** (*Neoma Business School*)

In this work we address the problem of designing a distribution network for a new product (or, alternatively, for the release of a product in a new market). The complexity of this problem becomes magnified because location and capacity decisions are made long before the product is released to the market and, thus, knowledge about demand is limited. The relevance these decisions is better appreciated by considering that about 80% of the supply-chain costs are locked-in once facilities' location and capacity are fixed. In short, we analyse the problem of simultaneously locating facilities and determining their capacities under demand uncertainty. The problem is formulated as Newsvendor model integrated in a p-Median facility location framework. Additionally, we assume that production can either be fully manufactured in-house or partially outsourced, giving our model certain flexibility with respect to capacity decisions. We propose a heuristic for solving the simultaneous location/capacity problem and compare the solution against the one obtained when the problem is solved by the independent use of a p-Median formulation and a Newsboy approach for capacity determination. Although the deterministic variant of the capacitated facility location problem has been thoroughly addressed in literature, and demand stochasticity has also been included in location frameworks, to our knowledge this is the first time that the problem of simultaneously locating facilities and determining their capacities is addressed with explicit consideration of demand's uncertainty. We show that for the single facility case, the expected profit of the strategic problem is non-decreasing and concave in the facility capacity, resulting in a uniquely determined optimal capacity. We further show that when the facility's location is fixed, the problem of choosing the capacity becomes a variation of the classical Newsvendor model. A critical-ratio based heuristic is proposed for the multi-facility case. An illustrative example is provided.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A32

The Capacitated Multi-Source Weber Problem in the Presence of Facility Fixed Costs: A Hybrid Constructive Heuristic

Martino Luis (*University of Exeter*), **Nur Shifa Farah Ain Jamil**, **Syariza Abdul-Rahman** & **Aida Mauziah Benjamin** (*Universiti Utara Malaysia*)

The continuous capacitated location-allocation problem, also known as the capacitated multi-source Weber problem, in the presence of facility opening cost is investigated. We consider a continuous fixed cost function where a small change in location may produce a significant change in the facility opening cost. A heuristic framework that hybridise a discretisation technique and the furthest distance rule (FDR) is put forward to solve the problem. The idea behind this method is to discretise a continuous space into a discrete number of cells while implementing the FDR within the search. The discretisation technique, called as Cell Selection-based technique, divides the distribution of customers into smaller sets of promising potential locations in order to find the best facility configuration in profitable areas. The FDR is then applied to select locations of facilities that are far apart from each other and prohibits new found locations to be sited nearby previous selected locations. The well-known data sets in the literature are used to assess the performance of the proposed hybrid method. The results show that the hybrid method, though simple and easy to understand, yields competitive results when compared with previous published solution methods. Some potential issues for future research directions is also briefly recommended.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A328

Modelling a Special Case of Location-Routing Problem to Distribute Construction and Building Materials

Dung Tran & **Nader Azizi** (*University of Edinburgh*)

In this research we present a location-routing challenge faced by a company that distributes heating systems and plumbing products to a set of geographically scattered customers from Midlands to Northern England. In the context of this project, we describe the problem and propose both exact and heuristic approaches to solve instances of the problem created using problem-specific information. The problem is first modelled as a Vehicle Routing Problem with Time Window (VRPTW) and then extended as a special case of location-routing problem. Computational results will be presented and discussed for instances up to 50 customers using real-world data.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A334

A Computational Study of FLOWLOC Model with Multi-Level Hub Capacity

Nader Azizi (*University of Edinburgh*)

In this research, we present and discuss a FLOWLOC model with multi-level capacity. An MIP formulation for the single allocation case is presented and used to solve instances of CAB

dataset. We will also discuss how this model can be extended to design robust hub-and-spoke systems.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

03/09/2019, 16:30 – 18:00, Kennedy SR3

OR61A281

Maximal Coverage with Ellipses

Sergio Garcia Quiles (*University of Edinburgh*) & **Víctor Blanco** (*Universidad de Granada*)

In a covering location problem there is a set of demand points and a set of potential sites for locating facilities. A point is covered by a facility only if it is within a certain distance from the facility. These problems have applications in areas like the location of emergency services or nature reserve selection. In the Maximal Covering Location Problem introduced in the 1970s, a fixed number of facilities must be located so that the amount of covered demand is maximized. The geometric shapes used to cover the demand points are circles. Motivated by applications to wireless telecommunications networks, in this talk we will present a variant of this problem where the covering shapes are ellipses. We will discuss different non-linear formulations existing in the literature. Then we will propose the first linear formulation for this problem using a geometric property of convex sets. We will illustrate the efficiency of this formulation with a computational study.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A135

A Solving Method Using Lagrangian Relaxation for the Radius Formulation of the P-Median Problem

Minerva Martin del Campo & **Sergio García** (*University of Edinburgh*)

The p-median problem is one of the most important problems in discrete location. The most recent exact method to solve the p-median problem is a radius formulation where the problem is formulated as a set covering problem. The algorithm proposed there starts with a partial formulation and develops a row generation technique to add more inequalities as needed. This strategy is embedded in a branch-and-bound algorithm and it is able to solve large instances with several thousands of nodes. However, it does not work so well for problems with small values of p. In this work we have developed a solving method based on Lagrangian relaxation and branch-and-bound to obtain optimal solutions. The radius constraint is relaxed to form the Lagrangian dual problem and subgradient optimization was used to solve it. If the full set of radius constraints is relaxed, the dual problem can be solved quickly. This relaxation is used in a branch-and-bound algorithm to find lower bounds at every node. The branching procedure is done by selecting violated constraints and ensuring its feasibility. We carry out a computational study to test the efficiency of this method.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Somewhat

OR61A228

A Reformulation Local Search for the Continuous P-Centre Problem

Gabor Nagy (*University of Kent*), **Abdalla Elshaikh** (*University of Misurata*), **Said Salhi** (*University of Kent*) & **Jack Brimberg** (*Royal Military College of Canada*)

The methodology of shifting between a continuous location model and a discretization of this model is explored for the case of the p-centre problem on the plane. This is based upon the new concept of reformulation local search (RLS) originally applied to the multi-source Weber problem. A systematic feeding of tighter Z values as the new upper bounds when solving the problem at the discrete phase showed to speed up the search considerably. Allowing the search to take into account the multiplicity of facility configurations to relax the stopping criteria is also examined alongside new efficient enhancements on the RLS approach including the construction of forbidden regions and the use of an injection scheme based in the discrete phase. Our computational experiments, using several large existing data sets (TSP-Lib) with various values of p, show that the proposed RLS is a powerful tool that outperforms existing local search based methods and competes favourably with recent metaheuristics.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A68

A Compromise Programming for Solving the Bi-Objective Closed-Loop Green Supply Chain Network with CO₂ Emission Consideration

Martino Luis (*University of Exeter*), **Chandra Ade Irawan** (*University of Nottingham Ningbo China*) & **Said Salhi** (*Kent Business School*)

Traditional closed-loop supply chain focuses on minimising the total cost of the supply chain and its reverse logistics network. As the environmental consciousness of the public is growing, many organisations have started embracing an eco-friendly framework into their logistics network. This paper proposes a sustainable model for closed-loop green supply chain network (CLGSC) to minimise the cost elements of reverse logistics network and concurrently to reduce CO₂ emission. These two objectives are well-known conflicts in practice. We design a bi-objective mixed integer linear programming model to deal with this problem. The model aims to find the number and location of distribution centres and recycling centres with their respective capacities. The proposed model also determines the transportation options used by manufacturers, selected distribution and recycling centres together with their corresponding product flows within the CLGSC network. To address the problem, two solution frameworks based on compromise programming are put forward. The first employs an exact method while the second applies a matheuristic method. The performance of the proposed solution methods are examined using a set of newly generated numeric instances. In terms of solution quality as well as computational effort, the proposed matheuristic performs better than the exact solutions obtained by a commercial software. Some potential directions for future research are also discussed.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

Logistics and Transportation



Organisers: Niaz Wassan, Gabor Nagy and Wipawee Tharmma

04/09/2019, 09:00 – 10:30, Kennedy SR3

OR61A269

Emerging Trends in Freight Transport Logistics: Case of Vehicle Routing Problem

Niaz Wassan (*University of Kent*)

In recent past, the Freight Transport Logistics area of research has seen a lot of developments. In this session, we shall keep our focus on the recent advances and developments around in the vehicle routing transport logistics area of research. The presentation includes the developments in modelling and applications, solution methodologies and emerging trends in this particular area of research. In this presentation, we shall provide, in general, an overview of the grand challenges due to the growing technological developments and the varying needs of modern business and management. However much of the focus of the discussion will remain on how the meta-heuristics and hybridization of such methodologies based research is developing to cope with these changing developments and demands by exemplifying their role in widespread applications and in particular in the area of vehicle routing in transport logistics.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A124

Vehicle Routing Problems Applied to a Logistics Problem in Ecuador

Ivona Gjeroska (*University of Edinburgh*)

A company in Ecuador has to provide a service to around 1,500 small retailers. Each of them needs to be visited once a week by one of the 10 sellers. Every retailer places an order when visited with a certain probability, and the company sends one of its 2 trucks to deliver the demanded goods on the following day. The 10 sellers meet at a convenient location with their manager at the start of each day, and return to the depot when their task is completed. Both trucks are loaded at the depot and return there at the end of the day. So far, there is a simple strategy where the retailers have been put into groups – one for each day, and further subgroups – one for each seller. These groups, as well as the routes that the sellers follow are constructed using common sense but they have not been optimised. The meeting points for the sellers are currently fixed. We propose to use mathematical programming to solve this problem. The retailers are clustered depending on the optimal routes that each truck should take on the following day. These clusters are further optimised for the sellers, constructing their individual routes. We use a different approach where the starting point for all the sellers' routes

in each cluster is an additional variable in the problem – which makes this problem a special case of the Open Vehicle Routing Problem (OVRP).

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A202

A Sim-BR Algorithm for the Stochastic Vehicle Routing Problem with Sustainability Dimensions
Hassana Abdullahi (*University of Portsmouth*), **Lorene Reyes-Rubiano** (*Public University of Navarra*), **Djamila Ouelhadj** (*University of Portsmouth*), **Javier Faulin** (*Public University of Navarra*) & **Angel A. Juan** (*Open University of Catalonia*)

The transport sector leads to detrimental effects on the environment and social welfare. These negative impacts refer to negative externalities, which increase the logistics costs. During recent years, sustainability indicators have been proposed to quantify them. These indicators are measured in terms of economic, environmental and social dimensions. In addition, uncertainty in demand and travelling time information can have an expensive consequence on the route performance and overall costs. Travelling time uncertainty can have major consequences on driver working hours and customer time windows. Furthermore, government regulations may also restrict the number of hours of work a driver can work without breaks. Concerning the impact of demand uncertainty on the environment, an increase in fuel consumption results in an increase in emissions. Instinctively, considering that the vehicle is a conventional vehicle, the amount of fuel consumption is proportional to the amount of emissions. Thus, it is important to account for uncertainty in vehicle travelling times and demands during route planning. The social impacts considered in this paper are uncertainty around demands, which might lead to route failures and increased costs. This paper addresses the stochastic capacitated vehicle routing problem considering the sustainability dimensions. We provide a formal description of the problem and propose a stochastic optimisation model based on recourse strategies. The optimisation model considers random vehicle load and travelling time, and failure types and recourse policies are proposed. We design a simheuristic algorithm and conduct a set of extensive computational experiments. Results of the experiments offer insights into the relative impact of each objective based on its importance weight. We develop a set of scenarios offering a combination of weights and present a sensitivity analysis to measure the impacts of the sustainability indicators and quantify the trade-offs among the dimensions.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A344

Distance Growth Insights for Balanced Node mTSPs

Wolfgang Garn (*University of Surrey*)

The mTSP is solved using an exact method and two heuristics, that balances the number of nodes per route. The first heuristic uses a closest node approach and the second assigns the closest salesman. A comparison of heuristics with test-instances being in the Euclidean plane showed that the closest node approach delivers better solutions and a faster runtime. On average, the closest node solutions are approximately one percent better than the other

heuristic. Furthermore, it is found that increasing the number of salesman or customers results in a linear distance growth for uniformly distributed nodes in a Euclidean grid plane. In this context we reviewed the expected distance of two uniformly distributed random (real and integer) points. We derived the minimum distance of a node to n uniformly distributed random (real and integer) points and expressed the functional relationship. This gives the theoretical underpinning for the previous empirical distance to salesmen growth insights.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 11:00 – 12:30, Kennedy SR3

OR61A289

Tactical and Real-Time Integrated Railway Scheduling and Routing with a Variable Neighbourhood Search Algorithm

Banafsheh Khosravi, Kullachet Korpattanachaijaroen & Djamila Ouelhadj (*University of Portsmouth*)

Railway scheduling and routing problems are significant for railway operating companies who face increasing demand and high expense of construction or modification of infrastructure. In operational level, dispatchers need to respond to disruptions in daily railway operations. In this study, we address integrated railway scheduling and routing problem which can be implemented in tactical and operational level planning. Integrated railway scheduling and routing problem is formulated as a Modified Parallel Machine Job Shop Scheduling (MPM-JSS) model to minimise delay propagation due to the interconnectivity of trains in the railway network. A Variable Neighbourhood Search (VNS) algorithm is developed to solve the mentioned problem by using four neighbourhood structures. We conduct computational experiments to evaluate the performance of the suggested optimisation model and VNS algorithm. The computational experiments investigate different disruption scenarios including blocked tracks on a single-track section, blocked tracks on multiple-track section, and longer running/dwell time in a real-world case study of London Bridge area in the UK railway network. The results show the effectiveness of VNS algorithm in terms of solution quality compared to the optimisation model implemented using CPLEX.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A267

An Investigation into Possible Alternatives for Britain's Options to Reduce Carbon Emissions from the Railway

Rachel Purkess (*BAE Systems CORDA*)

The need to reduce Carbon Dioxide (CO₂) emissions is well-documented, and in 2018 the Minister of State for the Department of Transport issued a challenge to Britain's rail industry to phase out diesel-only traction by 2040 and provide plans to decarbonise rail. To understand the options and roadmap for achieving this target in relation to traction energy, the Rail Safety and Standards Board (RSSB) engaged a consortium led by BAE Systems to investigate the options and evaluate the economic case for these. This study set out to establish the possible alternatives for installed power and on-board energy for Britain's autonomously powered fleet

(including bi-mode trains), and look in greater depth at those options that could help to significantly reduce carbon emissions from railway traction. This included: An evaluation of the options from a technical perspective through industry consultation, review of key published policy and technical publications, investigation of initiatives in heavy duty transport globally, and a series of calculations and estimations to determine the practicality and benefits of different options; An investigation of the cost implications of the options, and development of a decision support tool to assess emissions benefits and costs of alternative decarbonisation schemes. As a result we were able to develop a series of roadmaps for meeting potential industry targets, leading to a suggested approach for moving rail to an increasingly low carbon future.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A258

Sim-Biased Randomised Variable Neighbourhood Search for Railway Scheduling in the Presence of Uncertainties

Nattapol Paisarnvirosrak, Nattapol Paisarnvirosrak & Banafsheh Khosravi (*University of Portsmouth*)

Railway scheduling and rescheduling play a central role in day-to-day railway operations. Trains on a railway network are scheduled and controlled according to a timetable. However, trains are not always run based on the proposed timetable because there might be some unpredictable disruptions due to excessive dwell times at stations, infrastructure and/or train faults, and the late arrival of crew. In this research study, we aim to minimise the total delay of trains while considering passenger safety and regulation principles including running times, headway and signalling system constraints. The problem is formulated as a Modified Blocking Job Shop Scheduling (MBJSS) model, which is adapted from the classical job shop scheduling model. We propose the Sim-Biased Randomised Variable Neighbourhood Search (SBRVNS) to solve the railway re-scheduling problem in the presence of delays caused by travelling/dwell time delay and late departure time. The SBRVNS algorithm starts with Monte Carlo Simulation (MCS) to generate stochastic random delays, then uses a biased randomised heuristic to generate an initial solution and VNS to improve the initial solution. To evaluate the performance of the proposed optimisation model and the solution method, we have conducted computational experiments using a real-world case study from the railway network in Thailand. The results have shown that the SBRVNS algorithm has promising results in decreasing the total train delays.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A261

Biased Randomised Variable Neighbourhood Search for Airline Crew Scheduling

Djamila Ouelhadj, Phornprom Rungrueang & Banafsheh Khosravi (*University of Portsmouth*)

Airline crew scheduling is a complex problem that is faced by airline companies. The crew scheduling problem is divided into two sub-problems: crew pairing and crew assignment. The crew pairing problem defines a sequence of flight legs of the same fleet which begins and ends

at the same crew base location. Pairings are controlled by some complex constraints such as flying time restrictions, rest requirements of crew member, daily working hour of crew and connection time between two flights. The assignment problem assigns the pairings to crew members. In this research, we propose Biased Randomised Variable Neighbourhood (BR-VNS) to solve the crew pairing problem and formulate the problem as a set partitioning model. Biased randomisation heuristic is used to generate the initial flight schedules. Moreover, Variable Neighbourhood Search (VNS) is used to sequence the flights in the pairing schedule. Experimental analysis have been conducted to evaluate the performance of the proposed model and solution method using benchmark problems from the literature. The experimental results have shown that BR-VNS outperforms the results in the literature.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 11:00 – 12:30, Kennedy SR3

OR61A264

Scheduling and Charging of Urban Electric Buses

Bilal Messaoudi (*LORIA Laboratory*) & **Ammar Oulamara** (*University of Lorraine*)

Road transport is responsible for a large part of greenhouse gas emissions. These emissions have a negative impact on the health of citizens and cause major problems for the world's governments in defines, g public health and environmental policies. Several cities have already adopted drastic policies by introducing low-emission zones where the most polluting vehicles are regulated. In such zone vehicles with higher emissions either cannot enter the area or have to pay expensive fees if they enter the low emission zone. On the other hand, incentives are provided for vehicles with alternative fuels, such as electric cars and hydrogen cars. Several professionals have already switched to the use of electric vehicles or offer services with electric vehicles (car sharing, etc.) as well as urban transport operators are testing electric buses in demonstration phases or pilot programs around the world. Indeed, electric buses have been successfully tested in several projects and experiments. In addition, with the reduction in manufacturing costs of battery systems, electric buses have become increasingly competitive with diesel buses. However, the reduction in the operational performance of electric buses, particularly the limited range, remains an obstacle to their massive deployment, nevertheless this obstacle can be overcome by intelligent management of the use of the fleet between transport service and bus charging operations. The objective of this work is developing models algorithms that optimizing and managing a fleet of electric buses in order to schedule transport and charging operations, based on a concrete case study of an urban transport operator in France.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A105

Event-Driven Synchromodal Planning for RORO Transportation

Karam Kharraz, Karam Kharraz & Martin Leucker (*ISP, University of Lübeck*)

Roll-on-Roll-off (RORO) transportation is the dominating ferry-based transportation within the Baltic region. To ensure an efficient operation of transportation, sophisticated planning is mandatory. The current planning, however, has many disadvantages in terms of efficiency regarding delays and unplanned events, lack of collaboration, poor capacity usage and environmental issues. Synchromodality is an emerging concept in the logistic area, extending multimodal transport approaches. With the focus on rescheduling routes based on real-time information available in a collaborative network. Until now, automation of this concept is topic under research mainly using mathematical models and optimization algorithms based on heuristics. Another possible automation solution could be based on sophisticated data-processing and monitoring where the full potential of available information is aggregated to propose optimal routing. One of the main problems is the lack of shared information and diversity of stakeholders. Harbors are a natural hub where multiple transport modalities interact in the logistic chain. A harbor concentrates relevant data for dynamic transportation planning along the logistic chain. In this presentation, we follow the second approach and concentrate on RORO Cargo traffic in the Baltic sea area with Lübeck's port as main hub. We are developing a synchromodal planning and transportation solution at the harbor of Lübeck to complement analytical models, using a real time event-monitoring and complex data-processing to ensure efficient, sustainable and transparent transportation. While other approaches are agent centric and thus selfish, our approach is based on collaboration and ensures shared profit. To illustrate such powerful implementation of synchromodality, we consider reacting to arrival delays and monitoring planned departures and capacities of its carriers, our approach proposes an opportunistic synchromodal rerouting using all available services at the reaction time. We also report on the experience gained from this approach.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A343

The Impact of Catchment Areas in Predicting Bus Journeys

Wolfgang Garn, Christopher Turner, George Kireulishvili & Vasiliki Panagi (*University of Surrey*)

The catchment area along a bus route is key in predicting bus journeys. In particular, the aggregated number of households within the catchment area are used in the prediction model. The model uses other factors, such as head-way, day-of-week and others. The focus of this study was to classify types of catchment areas and analyse the impact of varying their sizes on the quality of predicting the number of bus passengers. The classifications considered: "overlapping" bus routes, infrastructure as well as other demographics. Machine Learning techniques, such as Random Forest, Neural Networks and C5.0 Decision Trees, were compared regarding solution quality of predictions. An overarching method that finds the optimal catchment area was introduced. The study discusses the sensitivity of catchment area size variations. Bus routes in the county Surrey in the United Kingdom were used to test the quality of the methods. The findings show that the quality of predicting bus journeys depends substantially on the size of the catchment area.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Highly

05/09/2019, 13:30 – 15:00, Kennedy SR3

OR61A96

A Real Time GRASP Metaheuristic for Contingency Logistics

Said Salhi (*University of Kent*), **Brian Gutierrez** (*Priority Freight*), **Niaz Wassan & Shaomin Wu** (*University of Kent*)

Time-critical freight logistics (also known as contingency logistics) is an area within logistic research where the shipper's orders need to be received relatively urgently while a third party logistic (3PL) needs to provide a quote (bid) to the shipper within a very short period. An effective and easy to use and implement Greedy Randomised Adaptive Search Procedure (GRASP) with additional novel attributes is developed for this purpose. The approach performs order consolidation, locates trans-shipment points and performs an optimal assignment of shipments to the selected consolidation points dynamically and in real time. The performance of this decision support system is tested on a real life situation resulting in an increase in both the economic and environmental benefits.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? Some
Is your talk accessible and relevant to practitioners? Very

OR61A185

The Selection of Freight Transportation Suppliers with Presence of Scheduling

Rukiye Kaya (*University of Kent*)

We investigate the integration of supplier selection and truck scheduling problems. The latter relates to the area of time critical freight logistics, also known as contingency logistics, for third party logistic providers. Though in this talk, we will focus more on the first stage, some linkages with the second will also be presented. We will present a simple but effective deterministic scheme to combine existing selection rules when full knowledge exists, and provide a new mechanism in the case of incomplete information by integrating three MCDM approaches with Bayesian networks.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Somewhat

OR61A33

A Real-Life Container Drayage Problem with Availability Constraints

Abdelaziz Benantar, Mohamed Nezar Abourraja, Jaouad Boukachour, Dalila Boudebous & Claude Duvallet (*Le Havre University*)

This paper discusses a containers' drayage by trucks, which is motivated by a real-life application arising in the transport of containers in France. This problem considers not only the classical assumptions of the intermodal transportation, but also introduces the containers' availability as a new concept. For this purpose, we first describe the industrial context and provide the mathematical modelling which combines a set of known and new constraints. We then solve it to optimality by a commercial solver. Moreover, the model can be effectively used

to evaluate several distribution policies, which results in a set of routing decisions and can adopt the best policy in a distribution network with competing rail and road transport services. Finally, we evaluate the performance of the proposed model on real data sets under different transportation scenarios to show to our industrial partner the performance of each policy.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A260

More Environmentally Efficient Urban Commercial Waste Collection Through Zoning

Tim Pigden (*Optrak Distribution Software Ltd*)

In the UK, commercial waste collection is undertaken by many companies in a free market. One consequence of this is that in a single commercial street, there can be over 200 individual waste collection journeys in a single week. At the same, recycling rates for small businesses such as shops are typically low – as they must pay separately for each waste stream collected. This talk presents the results of a consultancy exercise, that looked at how recycling rates could be improved, and waste collection journeys reduced, through Zoning – allocating all bin collections for each waste stream to a dedicated contractor.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

Making an Impact - Workshops



Organiser: John Medhurst

MAI Team members at OR60

John Medhurst, *Larrainzar Consulting Solutions Ltd*

Paul Thomas, *Strive Insight*

Steve Welch, *Model Citizens*

Davin Parrott, *West Midland Police*

Rob Smithies, *Atkins*

Luke Huxtable, *Dstl*

03/09/2019, 11:00 – 12:30, Sibson SR2

OR61A237

Engineering Better Care: A Systems Approach to Health and Care Design and Continuous Improvement

Alexander Komashie, Alexander Komashie & P. John Clarkson (*Alexander Komashie*)

Engineering Better Care (EBC) is the landmark report published in 2017 by the Royal Academy of Engineering (RAEng) in collaboration with the Royal College of Physicians (RCP) and the Academy of Medical Sciences (AMS). This report defines an engineering-informed 'systems approach' to health and care improvement, in response to a growing body of literature calling for systems thinking to be used to improve health services. The EBC systems approach was developed over 18 months through a series of workshops with a range of experts including clinicians, systems engineers, improvement specialists, policy makers and patients. The strength of the work is the clarity with which it defines a systems approach, effectively translating the V-diagram of the International Council on Systems Engineering (INCOSE) into an accessible framework based on a set of questions to be addressed during improvement. This framework is designed to be as relevant to local quality improvement projects as to high-level service redesign initiatives, and to be complementary to all existing approaches to healthcare improvement such as the IHI model for improvement, Lean, and Six Sigma. Since the launch of the EBC report, the Engineering Design Centre (EDC) at the University of Cambridge has been developing a toolkit to support the effective use of the systems approach, to help healthcare practitioners and improvement specialists put this into practice. This work has been informed through consultation and operational experience, involving improvement experts from clinical medicine and engineering domains. This workshop will introduce the EBC systems approach, focusing on its four key perspectives and a series of iterative questions which may be used to explore these. It will also briefly present the working version of the toolkit. Participants will have the opportunity to explore the approach and the toolkit through hands-on activities, and provide feedback that will inform its ongoing development.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? None
Is your talk accessible and relevant to practitioners? Highly

03/09/2019, 16:30 – 18:00, Sibson LT2

OR61A122

Women in OR

Frances O'Brien (*Warwick Business School*), **Niki Jobson** (*Dstl*) & **Annunziata Esposito-Amideo** (*University of Kent*)

At OR60, we heard from a group of students who had undertaken their MSc projects conducting research on the theme of Women in OR. One of their key recommendations was that the OR Society establish a network for Women in OR. Planning for the network is now well underway, with a launch event in the autumn 2019 – watch this space. In the meantime, we are continuing to encourage interest in this area with an event planned for OR61. The Women in OR event will take place toward the end of the first day of the conference and will consist of two components. Firstly we will run an interactive, round table, activity which will give participants the opportunity to share their stories of their careers and lives. Secondly, we have a Pimm's reception, kindly sponsored so far by SIMUL8 (whose CEO and CTO are women) and Bays Consulting (an all women consulting company!). Whilst the event is targeted at Women in OR, we welcome everyone to join us and support the ORS Women in OR network!

What is the nature of your talk? Very practical
Does your talk require prior knowledge of the subject area? None
Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 09:00 – 10:30, Sibson PC1

OR61A247

Data Science; What it is and how to Approach it

Davin Parrott (*West Midlands Police*), **Paul Thomas** (*Strive Insight*), **Robert Smithies** (*Atkins*) & **Stephen Welch** (*Model Citizens*)

Data science is currently gaining great currency and momentum in a variety of areas in the public and private sectors. Machine learning, AI, predictive analytics and big data all fall within the remit of data science. This stream, over the course of four workshops aims to provide an introduction to data science - what is it, how is it different from other forms of analytics undertaken in organisations, how is it undertaken, how can the results from projects be communicated and what are its implications? This first workshop will explore what data science is and how it can be useful in a variety of different settings and how to practically approach a data science project and frame the research question.

What is the nature of your talk? Very practical
Does your talk require prior knowledge of the subject area? None
Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 09:00 – 10:30, Sibson SR1

OR61A209

The Work of the ORS Education Committee, Focusing on the OR Specialists Level 7 Apprenticeship and the "OR in Education" National Programme

Alistair Clark (*The OR Society and UWE Bristol*), **Alec Waterhouse** (*Dept. for Business, Energy & Industrial Strategy*) & **Evelyn Hardy** (*The OR Society*)

This session will: Very briefly introduce participants to the OR Society's Education Committee (EC), where it sits within the OR Society, and what it does. More substantially, brief practitioner/employer participants on our Level 7 Apprenticeship initiative, which is now up and running with a Trailblazer group chaired by Alec Waterhouse of BEIS/GORS, and encourage employers to take advantage of it, once it is approved by the Institute for Apprenticeships, to educate and qualify their graduate OR employees at MSc level (which is at Level 7). Also substantially, tell participants about the newly rebranded "OR in Education" outreach programme (Renamed and expanded from "OR in Schools" so as to include universities). We will cover the reasons behind the name change, what the "OR in Education programme" has achieved so far, our goals for the future, how you can get involved and why we'd love for you to work with us. Open discussion on the above with Q&As.

This workshop is repeated at 15:30.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 11:00 – 12:30, Sibson PC1

OR61A335

Data Science; Practical Application - Basic Analyses and EDA

Davin Parrott (*West Midlands Police*)

Continuing from the first workshop which outlines what data science is and how it can be approached, this second workshop will introduce you to the practice of data science via the exploration of a dataset using the software R.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 11:00 – 12:30, Sibson SR1

OR61A315

Artificial Intelligence and OR: Interactions and Future Directions

Michael Mortenson (*University of Warwick*)

This Making an Impact session will present the findings of the OR Society's Task and Finish Group on Artificial Intelligence (AI). The will incorporate perspectives on a range of issues, including the growth of AI, its applicability to organisational use-cases, the ethical and societal implications, and the overlaps that AI has with operational research (OR). To the latter, the session focuses on how AI and OR interact, the opportunities that this growing interest may present to the OR community, and the role the community can play in enabling and maximising the impact of AI. Additionally, the session will provide a forum and discussion allowing

delegates to share their experiences of working with AI methods, to learn more about the field, and to help shape the OR Society's future strategic directions.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

04/09/2019, 11:00 – 12:30, Sibson MBA

OR61A321

Data Mining with modeFRONTIER: Quick and Effective Techniques to Deepen the Understanding of your Data

Novella Saccenti (*Enginsoft S.p.A.*)

Data mining is a key solution in extracting knowledge from information: This is especially important in the current climate of 'Big Data' where companies are storing huge amounts of data. It is also the most effective way to discover patterns and relationships among a set of data, composed by a lot of different interconnected factors. The workshop will focus on statistical techniques that engineers can use to analyse different data sets. For this workshop, Data will be processed using the optimization platform modeFRONTIER (<https://www.esteco.com/modefrontier>) which is able to import, analyse and visualize data in a smart way. During the workshop, attendees will be able to understand how: To easily import data from an external source: external sources can be experimental data, or data coming from a previous computation, such as an optimization process. To distinguish which are the real input and the output variables of the process. To clean data: if some data presents an omission it is necessary to decide how to fill the gap. To understand which are the most important variables, able to condition the results to improve development. To understand which are the best strategies to understand how to proceed with further computation and refinements. To be able to visualize data allowing information to be transferrable to the whole team. To be able to make decisions based on statistical analysis. The understanding of these steps brings scientists deep inside the behaviour of data, making it possible to highlight the important components of a process and consequently make better informed decisions.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 11:00 – 12:30, Sibson SR2

OR61A327

Use of Systems Thinking Concepts and Methods Within OR

Philip Jones & Niki Jobson (*Dstl*)

This workshop will introduce some simple systems concepts and practical tools that can be applied within an OR intervention. The workshop will be interactive and include some instructive, and fun, practical activities. Topics covered will include: What is a system? What types of system are there? A practical demonstration of the importance of feedback. Considering system boundaries. The use of systems context diagrams to promote problem exploration and scoping an OR intervention. A tool for encouraging different levels of thinking. Tools for problem reframing and thinking from different perspectives.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 11:00 – 12:30, Sibson SR5

OR61A173

Visualising and Managing Value Creation Through Integrated Reporting Practices: A Dynamic Resource-Based Perspective

Martin Kunc (*University of Southampton*) & **Federico Barnabe** (*University of Siena*)

The workshop combines the Dynamic Resource-Based View (DRBV) of the firm on the basis of the idea that strategic resources are interconnected and have to be managed with the collaboration of all stakeholders in order to inform governance actions and create value with a holistic perspective. We use “resource mapping”, which is a DRBV-based visual and analytical technique representing the causal relationships between resources and governance actions, and a recent tool for corporate reporting, the Integrated Reporting. The workshop will have two parts. Firstly, a short introduction to DRBV to explain the logic of the framework and the methodology. Secondly, an application of DRBV using a new form of corporate reporting called Integrated Reporting is demonstrated based on the report from a global energy company. Finally, discussions about its application in other areas and with other methods will be performed.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

04/09/2019, 11:00 – 12:30, Sibson SR6

OR61A352

OR and Grand Challenges: The Future of Mobility and Healthy Aging?

Miles Weaver (*Edinburgh Napier University Business School*) & **Simon Barnes** (*University of Kent*)

When launched in 2017 the future UK Industrial Strategy focused on one shortcoming and four Grand Challenges for the UK as the first industrialised nation. The shortcoming we need address is productivity, in the widest sense, increasing this from the aspect of ideas, people, places, infrastructure and the business environment. Of the four future Grand Challenges[i]for OR61 we have decided to look at two specifically: Future of Mobility Healthy Aging From the perspective of the Future of Mobility we want to understand how we can use road space for trucks more effectively in Kent. Up to 5,500 trucks per day travel each way through Kent and from France. One small delay at the port or tunnel quickly results in long queues and delays. We will hear from those responsible for managing the impact of this congestion. We would like to learn from you how a more proactive, systems approach to our challenge might help. In the case of Healthy Ageing we do not believe we handle the process of ageing in the best way for the individual or the economy. Research has shown us that maintaining social networks and keeping active helps. So would a more graduated, flexible approach to care, tailored to the individual. We would like to understand how a personal plan that is effective, is of value to the economy can help us lead fulfilled lives. We'll help our guests to structure, analyse and respond to the challenge(s) posed. The feasibility of each action will be considered as a potential Pro Bono project, research funding bids, consultancy projects and/or student projects.

[i]Future of Mobility, Clean Growth, Healthy Ageing, AI/data.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 15:30 – 17:00, Sibson PC1

OR61A336

Data Science - Practical Workshop; Predictive Analytics

Davin Parrott (*West Midlands Police*)

The third workshop in the data science series will continue the practical theme through using R to undertake more advanced analyses including approaches to building predictive (machine learning) models and how this can feed into the organisational decision making process.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A337

Data Science - Roundtable Discussion and Q&A

Davin Parrott (*West Midlands Police*), **Paul Thomas** (*Strive Insight*), **Robert Smithies** (*Atkins*) & **Stephen Welch** (*Model Citizens*)

The final workshop in the data science series will take the form of a roundtable discussion and Q&A around data science, its use and potential concerns around its use.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 15:30 – 17:00, Sibson SR1

OR61A209

The Work of the ORS Education Committee, Focusing on the OR Specialists Level 7 Apprenticeship and the "OR in Education" National Programme

Alistair Clark (*The OR Society and UWE Bristol*), **Alec Waterhouse** (*Dept. for Business, Energy & Industrial Strategy*) & **Evelyn Hardy** (*The OR Society*)

This session will: Very briefly introduce participants to the OR Society's Education Committee (EC), where it sits within the OR Society, and what it does. More substantially, brief practitioner/employer participants on our Level 7 Apprenticeship initiative, which is now up and running with a Trailblazer group chaired by Alec Waterhouse of BEIS/GORS, and encourage employers to take advantage of it, once it is approved by the Institute for Apprenticeships, to educate and qualify their graduate OR employees at MSc level (which is at Level 7). Also substantially, tell participants about the newly rebranded "OR in Education" outreach programme (Renamed and expanded from "OR in Schools" so as to include universities). We will cover the reasons behind the name change, what the "OR in Education programme" has achieved so far, our goals for the future, how you can get involved and why we'd love for you to work with us. Open discussion on the above with Q&As.

This is a repeat of the earlier workshop.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 15:30 – 18:30, Sibson SR2

OR61A311

Attending, Responding, Becoming - Living Learning Inquiry in a Naturally Inclusional Playspace

Louie Gardiner (*University of Hull*)

What does it mean to be a systemic practitioner-researcher in a complex, interconnected world in which everything is connected to everything, directly or indirectly and our capacity to make things happen on demand is limited? What does this mean for us? About our roles? And about what we do and how we engage other stakeholders who are implicated, impacted and need to be involved one way or another? What does it mean to be a practitioner-researcher in service to our clients - when we cannot separate ourselves nor isolate the unintended impact we (may) have on and from the system? This workshop introduces you to a suite of systems thinking frameworks that have emerged before and during my doctoral inquiry. We will start by setting the scene using the SAM - Symmathesic Agency Model. I hope to do this through a digital prototype that will give you a visual-kinaesthetic sense of the landscape we will be exploring. I will then take you on a reflective journey to help you better understand how to situate, position and articulate your research using the Systemic Research Framework (aka Natural Inclusional Playspace). We will do this through creative means including engaging in reflective inquiry. Following on from this, using a Gold Fish bowl approach, we will venture into (potentially) three interactive spaces in which you will choose which systemic approach(es) you would like to explore/experience further: PAI (Point Attractor Inquiry); Participation Compass or Presence in Action. What happens in this phase of the workshop will be sourced by those in the room and what is 'present' and 'current' for them. We will engage in an emergent, exploratory way which may raise as many questions as answers for you. The final part of the workshop will give us a chance to share experiences, insights and questions.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

04/09/2019, 15:30 – 18:30, Sibson SR5

OR61A196

How to be Creative

Dennis Sherwood (*The Silver Bullet Machine Manufacturing Company Limited*)

So, you've done your OR analysis, and run some forecasts. The results don't look good. What next? What next is all about creativity. If the future doesn't look good, something has to change to make it so: perhaps something needs to be designed differently, perhaps there needs to be a significant change in the context in which a system is operating, perhaps someone (or some people) needs to change his/her/their mind(s). None of which will happen by themselves; they can happen only if the corresponding idea is tabled first. And having good ideas requires creativity. But how does creativity actually happen? What, fundamentally, is creativity anyway? Can you have great ideas 'on demand'? Do you have to be a 'design thinker'? Or can an 'ordinary' person like me be creative? These are important questions, and answering them is what this session is all about...The workshop will be led by Dennis Sherwood, an expert in creativity, modelling and systems thinking. Dennis now runs his own business, having previously been a consulting partner with Deloitte Haskins + Sells, and Coopers & Lybrand; an executive director at Goldman Sachs; and MD of the UK consulting operations of Stanford Research Institute (SRI). He is also the author of numerous journal articles, and eleven books.

What is the nature of your talk? Very practical
Does your talk require prior knowledge of the subject area? None
Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 15:30 – 18:30, Sibson SR6

OR61A339

The Common Good Game

Ariella Helfgott (*University of Oxford*)

The Common Good Game is a gamified process to explore our collective aspirations for society, and the kinds of actors and institutions that support them, in the face of difficult social and environmental justice issues. Essentially, it is an experiential way to rethink The Common Good for a better shared future. In this session we will play the game. We live in a divisive and polarizing era. Societies are increasingly fragmented. We are losing trust in our institutions and governments to act in our interests. We have growing economic divisions, ideological divisions and contests over values. In various parts of the world we are facing disintegration of the social contract, failure of planned economies, losses of human dignity, the decline of politics and the public service and environmental unsustainability. Have we lost sight of "the common good"? The way societies negotiate "the common good" will have a large impact on the shape of future societies and on the capacity of those societies to cope with increasing social and environmental pressures. Thus, it is ever more important to create dialogue on "the common good". However, fragmentation and polarization makes such conversations increasingly difficult. The Common Good Game was developed to overcome these difficulties. It provides a shared context and facilitates articulation of the types of societies we would like to live in, irrespective of our positions within them. It is based on extensive research into social differentiation and its impacts on life outcomes, the environmental consequences of the way we live, and how these factors can be mediated by policies. Rather than assuming a universal or hegemonic understanding of "common good" it allows each group of people to negotiate the common good in their own context. It's also fantastic fun to play!

What is the nature of your talk? Very practical
Does your talk require prior knowledge of the subject area? None
Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 15:30 – 17:00, Kennedy KENPC3

OR61A361

Building Hybrid Simulations with SIMUL8

Tom Stephenson (*SIMUL8 Corporation*)

For some models, utilizing the discrete elements of a simulation alone can be limiting. Hybrid simulations can incorporate the best of other techniques. In this workshop we'll explore two uses cases and get you building some simulations yourself! Our first use case will look at how to use an agent feature of SIMUL8 called State Charts to add agent into your discrete event simulation. Participants will work on a healthcare scenario where the patient's disease progression impacts their flow through their care pathway. Our second use case will look at how to incorporate tanks and pipes to model liquids and other continuous processes in manufacturing, as well as discrete we'll also show some agent being used to model equipment failure rates, showing the ultimate hybrid – all three in one!"

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 11:00 – 12:30, Sibson SR6

OR61A216

The Systems Thinking Practitioner Apprenticeship: an Introduction for Organisations, Individuals and Training Providers

John Rogers (*Wiltshire Council*) & **Ian Cammack** (*Lancaster University*)

The Systems Thinking Practitioner Apprenticeship is aimed at practitioners working in complex problem situations which require cross boundary collaborations within and between organisations. It is likely that this apprenticeship will be attractive to individuals (and organisations) working in central and local government; as well as those working in multilaterals, the health service, defence or globalised corporations with complex supply chains and/or partnership relationships. This workshop is aimed at providing an overview of this apprenticeship. This coverage will include the: * purpose, value and anticipated focus of the practitioner's work* knowledge, skills and behaviours included in the apprenticeship, * requirements for the end point assessment. It is likely that this presentation will be of interest to:* organisations seeking to invest their apprenticeship levy in the development of middle level practitioners, and in some instances in the development of future senior managers; * individuals seeking to understand the opportunities for professional development and recognition* training providers (including universities)/potential EPAOs interested in offering this apprenticeship and its assessment to employers The workshop will be run by John Rogers; chair of the trailblazer committee for the Systems Thinking Practitioner Apprenticeship.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

Multi Criteria Decision Making



Organiser: Val Belton

03/09/2019, 11:00 – 12:30, Sibson SR5

OR61A133

Practical Preferences: Introducing Multi Criteria Decision Analysis to Support International Trade Policy

Zoe Gordon & Ian Mitchell (*Dept. for Business Energy & Industrial Strategy*)

This presentation describes the experience of developing a requisite Multi Criteria Decision Analysis methodology to support discussion of possible portfolios of options enabling international trade. It illustrates the importance of the social as well as technical factors in design and use of a bespoke model to address vital questions. The technical approach used the framework of workshops discussing options and criteria then scoring and weighting with sensitivity analysis to explore divergent viewpoints.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A82

Developing a Multi-Criteria Framework for Aviation Biofuels Evaluation

Salman Ahmad & Bing Xu (*Heriot-Watt University*)

Air transport has become an integral part of the day to day life of the modern world-swift and safe way of worldwide social contacts and business developments. However, from operational side air transport is facing many challenges: reliance on fossil jet fuel; being the leading contributors to the total greenhouse gas emissions, and facing daily fossil fuel prices volatility. Therefore, like the road transport sector, global aviation is also showing a keen interest in aviation biofuels. Unlike conventional jet fuel production, aviation biofuels can be produced via a combination of chemical processes and feed-stocks. The current literature focusses on the techno-economic analysis of a single conversion pathway (chemical process plus feedstock) while there is a lack of literature on multi-criteria evaluations of several conversion pathways. In this research, a survey instrument is developed in which 106 experts participated in evaluating thirty-eight performance criteria across six production technologies along the aviation biofuels supply chain. The criteria for preliminary value tree are obtained by an extensive literature review. Likewise, conversion pathways are chosen after consulting the experts and verified through literature. Also, chosen conversion pathways are the ones certified for aviation biofuels. The recommendations of this work are to be utilized as a foundation for stakeholder assessment of aviation biofuels planning. This work presents the initial results of the survey.

What is the nature of your talk? Very practical
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Highly

OR61A291

Unmasking Uncertainty in Multiple Criteria Decision Models

Patrick Driscoll, Matt Dabkowski, Patrick Dubois & J. D. Cadell (*U.S. Military Academy*)

Every decision involving uncertainty has a non-zero likelihood of becoming a "good decision with a bad outcome," which if left unexposed introduces decision regret (remorse) that can leave doubts in a decision maker's mind regarding the utility and efficacy of OR analytical support. We introduce a straightforward approach that leverages simulation to provide a decision maker with insights into this likelihood (and others) in the space of potential outcomes. While not eliminating this risk altogether, the results of this 'Level 1 and Level 2 analysis' help shape decision maker expectations past the decision point, thereby reducing potential surprises (negative or positive) that may affect future opportunities for OR support in this setting. A practical application of this approach will be discussed for illustration.

What is the nature of your talk? Practical
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Very

03/09/2019, 13:30 – 15:00, Sibson SR5

OR61A163

Random Spanning Trees to Elicit Preferences from Pairwise Comparison Judgements

Sajid Siraj (*University of Leeds*), **Salvatore Greco** (*University of Catania*) & **Michele Lundy** (*Dublin City University*)

Inconsistency in pairwise comparison judgements is often perceived as an unwanted phenomenon and researchers have proposed a number of techniques to either reduce it or to correct it. We consider Spanning Trees Analysis which is a recently emerging idea for use with the pairwise comparison approach and which represents the plurality of mindsets in terms of a plurality of prioritisation vectors. We propose a novel methodology taking an approach similar to Stochastic Multi-criteria Acceptability Analysis, that is, considering all the rankings of alternatives corresponding to the different mindsets, our methodology estimates the probability that an alternative attains a given ranking position together with the probability that an alternative is preferred to another one. Our approach can also be applied to incomplete sets of pairwise comparisons. We demonstrate the methodology's usefulness with the famous example of the school selection problem. We estimate the probabilities of each school attaining a given ranking position together with the probabilities of one school preferred over other. The usefulness of statistical sampling is further demonstrated with the help of another real-life policy making issue involving the selection of telecom networks in rural areas.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Somewhat

OR61A190

Modified Best-Worst Method with Decision Maker's Uncertain Confidence About the Best and Worst Criteria

Amin Vafadarnikjoo (*University of East Anglia*) & **Konstantinos Chalvatzis** (*Norwich Business School*)

The best-worst method (BWM) utilises two vectors of pairwise comparisons including best-to-others and others-to-worst. The ranking of BWM is reasonable but it suffers from a shortcoming which limits the applicability of BWM in a real-world decision-making problem. That is, decision maker's confidence about the provided pairwise comparisons has not been taken into consideration. In other words, in the original BWM, the decision maker is fully confident on the chosen best and worst criteria and correspondingly on their provided comparisons. In this study, we propose a modified BWM to rectify this shortcoming by introducing two values as the DM's confidence on the best-to-others and others-to-worst preferences respectively.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR & Strategy



Organisers: Martin Kunc and Frances O'Brien

03/09/2019, 11:00 – 12:30, Kennedy SR5

OR61A121

The Challenge of Managing Resources for a Sustainable Urban Environment: A System Dynamics-Based ILE

Federico Barnabè (*University of Siena*), **Stefano Armenia** (*Link Campus University, Rome*), **Alessandro Pompei** (*Sapienza University of Rome*) & **Rocco Scolozzi** (*UniTrento Digital University*)

The paper builds on the current debate on how facing the challenge of managing limited resources in a sustainable way, specifically addressing the issue of urban sustainability. As many reports underline, our urban environments are on the brink of a huge collapse; unfortunately, several reasons are causing this problem (e.g., overcrowded population, traffic-congestion, CO2 emissions) and a systemic approach is advocated both by academics and practitioners. Specifically, this paper aims to: understand how strategically relevant resources can be identified, formally represented and managed in a simulated urban environment (a System Dynamics model mimicking the management of a medium-sized city); test the System Dynamics simulation model in the form of an Interactive Learning Environment and with specific scenarios, in order to explore how we can achieve sustainable urban management and a balanced societal metabolism, while taking into account formal decision-making process. Two streams of research are used for this paper. First, the paper relies on the Resource-Based View to identify and conceptualize which are the most relevant resources and capabilities used to manage a business system or environment, here a city. Second, the paper builds on the concept of "urban metabolism", which aims to identify and analyze the interactions between the natural and the human systems in a specific region (or environment), and subsequently, explain how this interaction generates an array of impacts and consequences (also harmful side-effects). From a methodological perspective, a System Dynamics model is used to portray the urban environment (the simulated city) under analysis; the SD model is then transformed into an Interactive Learning Environment subsequently used to explore the effects of managerial decisions related to the concept of urban metabolism. Notably, the SD model and the ILE are two outputs of the joint research ERASMUS+ project "SUSTAIN" (Project Reference no. 2017-1-EL01-KA203-036303).

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A24

The Health Service Modelling Associates (HSMA) Programme - The Future of Operational Research in the NHS. Report from HSMA 2018

Daniel Chalk, Michael Allen, Sean Manzi, Kerry Pearn, Andrew Salmon, Martin Pitt & Ken Stein
(NIHR CLAHRC for the South West Peninsula)

In 2016, the NIHR CLAHRC for the South West Peninsula launched the Health Service Modelling Associates (HSMA) Programme. In this programme, NHS analysts and other skilled staff are released from their usual work for a day a week for a year to undertake a modelling project that addresses an important question for their organisation. PenCHORD academics provide training and ongoing mentoring throughout the project. The 2016 pilot saw six HSMAs recruited to the programme, undertaking projects looking at Emergency Departments, mental health delays, hospital discharge processes, ambulance transport for cardiac arrest, and frailty pathways. The HSMA projects led to three £multi-million business cases to develop new services. We presented an overview of the 2016 programme as part of the OR Society President's Medal competition in 2017. In 2018, in collaboration with the South West Academic Health Science Network (AHSN) we launched the second round of the HSMA programme - HSMA 2018. The 2018 programme saw a more than tripling in the number of HSMAs recruited (up to 19 from 6), a switch to teaching of Free and Open Source software to promote sustainability of the skills taught, an additional three month problem structuring and development phase, and the introduction of collaborative "hackathon" events. The 2018 projects explored a range of problems in areas including Continuing Healthcare Assessment, glaucoma treatment, surgery cancellation, ambulance dispatch and delayed discharge. The projects have already led to the development of "Crisis Cafes" in Devon to support those in mental health crisis, the reduction of Continuing Healthcare Assessment backlogs to reduce hospital discharge bottlenecks, and improvements to the way in which ambulances are dispatched within the South West. In addition, HSMAs have had OR work built into their roles moving forward, and new job adverts are being posted specifically requesting analysts with Operational Research skills.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

03/09/2019, 13:30 – 15:00, Kennedy SR5

OR61A174

KEYNOTE: A Guide to Practice Strategy Analytics

Martin Kunc *(University of Southampton)*

Given the increasing availability of data, we need to define a common ground at the interface of strategy and management science/business analytics which I called Strategic Analytics: Integrating Management Science and Strategy. This presentation will combine strategy content with strategy process through the lenses of management science/business analytics with a focus on the practice from the perspective of managers. I will discuss a strategy problem, such as competition, and continue with an explanation of the strategy process using management science/business analytics tools such as simulation. In facilitating the process of strategic decision making through the lens of management science/business analytics, managers can integrate topics that are usually in conflict: strategy and quantitative methods. I will introduce attendees to few strategic management topics from the following topics: managerial capabilities for a complex world; politics, economy, society, technology, and environment; external environments known as exogenous factors (PESTE) and endogenous

factors (industry); industry dynamics; industry evolution; competitive advantage; dynamic resource management; organisational design; performance measurement system; the life cycle of organisations from start-ups; maturity for maintaining profitability and growth; and finally, regeneration.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A128

Designing Start-Up Finance Contracts when the Entrepreneur and Investor have Conflicting Objectives

Thomas Archibald (*University of Edinburgh*) & **Edgar Possani** (*ITAM*)

This paper models the contract between an entrepreneur, whose primary goal is the survival of a new venture, and an investor who seeks to maximize expected net present value. Theoretical results and numerical investigations provide some insight on the likely outcome of contract negotiations. It is argued that both the entrepreneur and the investor are better off under a contract which involves repayments and a share of the start-up company. We observe that the actions of the entrepreneur become riskier as the repayments increase up to the point where the company has no chance of success. Contracts giving the investor a share of the company can bring the objectives of the two parties closer together.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR Applications in Public and Government Services



Organisers: Ross Wyatt, Ben Lavelle and Rudi Narendran

03/09/2019, 11:00 – 12:30, Sibson SR1

OR61A200

Who Cares About What in the UK? Small Area Estimations of UK Petition Data

Colin Stewart & Alastair Stewart (*More Metrics Ltd*)

The UK Parliament has been using petitions as a way of engaging with the public for many years with the current petition website providing results from 2010 onwards (<https://petition.parliament.uk/>). Under this scheme any British Citizen or UK resident can set up an online petition calling for a specific action the government should take. Petitions that obtain more than 100,000 signatures are considered for debate in parliament. As at May 2019 there have been more than 20,000 petitions in the current parliament of which 57 have achieved the 100,000 signature threshold. Roughly a third of these relate to Brexit, with the remainder covering a wide variety of other topics. This presentation will show how we have analysed individual petitions to provide neighbourhood estimates of the propensity of individuals to sign. We have applied our own Small Area Estimation method ("disaggregation") to published, open-source counts at Parliamentary Constituency level to achieve this outcome. Propensity estimates are modelled down to 230k output areas across the UK, with further estimates modelled by a range of geo-demographic categories at a national level. An overview of the disaggregation method will be given, before looking in more detail at some specific results for a range of petitions. We will show how our analysis can be used to provide insight into the inherent bias of e-petition data and how a quantification of this bias can be used to help adjust the modelled results to make them more representative of local communities across the UK. We will conclude the presentation with some thoughts on how studies like ours could be developed further to improve the engagement of local communities in issues of national importance. We think this is an important topic to discuss at a critical time for UK parliamentary democracy.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A221

To Sample or not to Sample? Re-Assessing Surveillance of Salmonella in Poultry Food Chain in Light of Regulation Changes and Brexit

Andrew Hill (*University of Surrey*)

EU Regulation requires that poultry slaughterhouses sample carcasses for Salmonella to monitor trends in contamination status and protect public health. However, based on an

appropriate risk analysis, Member States can decide to not sample smaller producers. Therefore, the UK Food Standards Agency (FSA) put in place a sampling framework that meant producers slaughtering less than 1 million birds per year did not have to sample. Since the original introduction of mandatory sampling in 2005, Salmonella contamination rates fell across the EU. Thus in 2011, the regulations around sampling were tightened. Previously, producers were required to take action if 7/50 samples were positive for Salmonella, but this was reduced to 5/50. This more stringent criteria implies the appropriate level of protection is now lower – which raises the question of whether the original derogation for smaller producers is still appropriate. With the UK leaving the EU, there are also now further questions around equivalence between future UK and EU Regulations. We thus conducted a quantitative risk assessment to assess the risk of Salmonella from smaller producers, and whether introducing sampling into these slaughterhouses would assist to mitigate potentially higher risks. We conclude that the current derogation based on smaller throughputs is likely acceptable. Salmonella in the UK flock as a whole is under control, and thus the burden of Salmonella entering slaughterhouses – especially serovars of public health concern – is low. Only 1% of UK poultry is processed by smaller producers, thus the population risk is also low. In addition, our simulation model suggests current sampling regulations are only effective at detecting very high increases in Salmonella contamination, which on the available evidence would be rare in UK poultry production.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A47

The Perfect Crime

Dennis Sherwood (*The Silver Bullet Machine Manufacturing Company Limited*)

Every year a breath-taking crime is committed. A crime with over 1.5 million victims, most of whom don't even know that a crime has been committed. So they don't complain. So the perpetrator is free to commit the same crime the following year. As has been happening year-on-year since at least 2010. The crime is the award of the wrong GCSE, AS or A level grades. So, for example, in summer 2018, 6,627,978 grades were awarded. Of which more than 1.5 million were wrong. And potentially denying important life chances to many of the victims. This presentation tells the story from a systems thinking study commissioned by Ofqual in 2013, which identified the fundamental problem, through some detailed statistical analyses carried out over 2015/16 to quantify it, to a policy decision taken by Ofqual in 2016 to cover it all up. The story continues to 2017 and 2018, and a press campaign orchestrated to make the problem publicly visible. As a result of this public pressure, in November 2018, Ofqual published data on grade reliability, stimulating yet more press coverage, as well as a series of blogs on the website of the Higher Education Policy Institute. Ofqual continue to be reluctant to take action, and so by the time of the conference, the intention is to carry out a major survey, to exert even more pressure. This story is important. The (un)reliability of exam grades casts doubt on a huge number of decisions, such as college entrance and employment. Let alone the impact on the individual's self-confidence. The story is also about real OR. Yes, the analysis can reveal insights and the truth. But what happens when the user does not wish to recognise that truth?

What is the nature of your talk? Very practical
Does your talk require prior knowledge of the subject area? None
Is your talk accessible and relevant to practitioners? Highly

03/09/2019, 13:30 – 15:00, Sibson SR1

OR61A262

The Application of Automatic Speech Recognition in Our Contact Centre

George Kelly (*Ministry of Justice*)

HMCTS National Contact Centre in Loughborough handles over 20,000 hours of calls every month. The information within these calls contain insight into the customer experience and can inform the design of future services. Manually transcribing these calls for analysis would be an almost impossible task. We have therefore used Automatic Speech Recognition to generate transcripts of a sample of these calls. This has allowed us to cluster calls to understand the key reasons that customers are phoning, informing decisions about improvements to our services.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Relevant

OR61A318

Open Data in Cross-Departmental Trade Modelling

Fruzsina Gajdos, Esther Harris & Elliot Delahaye (*GORS / Dept. for International Trade*)

Countless trade datasets report values for trade by product type and partner countries but to understand UK trade performance we need a benchmark value which indicates how much the UK should be exporting. Gravity modelling is a widely used econometric model which builds on relationships between trade, distance and GDP but there are multiple underlying factors such as trade agreements and culture and their influence on trade are not intuitive. Therefore, we wanted to know if classical gravity models can be improved with neural networks. As transparency is lost in neural networks, we needed particular scrutiny on model comparability and have a very clear definition of the purpose of the analysis. To create a reliable model, we not only had to choose the right dataset but also had to find a suitable method to fill in missing values. As data cleaning methods diverge reproducibility becomes an issue even for the most meticulous notetaker. We in DIT and DExEU tackled this issue using expert insight and elements from the Reproducible Analytical Pipeline approach to create a unified, clean trade dataset. This transparent dataset of multiple tariff, trade, GDP and macroeconomic sources enabled us to perform comparable analysis using different methodologies. The steps shown here of gathering, cleaning, imputing and analysis are fairly transferrable to most patchy data sets. This creates stronger parallel models and allows for innovative use of analysis without compromising quality or the single version of the truth.

What is the nature of your talk? Practical
Does your talk require prior knowledge of the subject area? None
Is your talk accessible and relevant to practitioners? Relevant

OR61A350

Tactical Reconstruction and Fast OR at the Maritime Warfare Centre

Stephanie Monks (*Dstl*)

The analysis team at the Maritime Warfare Centre is responsible for supporting the delivery of tactical and operational advice by military staff to the Front Line Royal Navy. One of the team's most important activities is tactical reconstruction. This involves the detailed post event understanding and analysis of a range of data in order to understand the performance or effectiveness of maritime units during an event, operation or exercise. The team collate large quantities of quantitative and qualitative signal data from maritime units, and re-create maps of actual activity which can be critically analysed to understand the situation and decisions made by key players; and identify areas of improvement for current and future Royal Navy tactics. This analytical approach was recently applied in a fast paced, intense environment for Exercise Joint Warrior 19-1, and provided near-real time advice to the Navy to inform war-fighting insights, ultimately validating tactics and doctrine. DSTL/PS116755© Crown copyright (2019), Dstl. This material is licensed under the terms of the Open Government Licence.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

03/09/2019, 16:30 – 18:00, Sibson SR1

OR61A204

Evaluating Compliance Initiatives in HMRC: How we Stop Businesses Getting Their Tax Affairs Wrong Before They get it Wrong

Benjamin Follows, Bethan Dullely, Rosa Romita & Sam Wong (*HMRC*)

Traditional compliance approaches to maintaining a healthy tax system are not sustainable in the digital world, with taxpayers increasing in number and complexity. For example, face-to-face tax interventions are not always a cost-effective response to simple taxpayer errors. HMRC are now taking an increasingly data-driven approach according to the HMRC Data Strategy. This includes actions to ensure taxpayers get tax affairs right first time (upstream) rather than responding to errors after the fact. HMRC have established effective collaboration and governance routes between strategic decision-makers, operational staff and analysts to understand and identify priority compliance risks fit for an Upstream Compliance approach. Impact analyses have been undertaken on upstream activity, for example: providing education for customers; working through tax intermediaries; harnessing relationships with large businesses; and implementing digital nudges and prompts. Evaluation is often challenging, due to sampling constraints, operational feasibility and complexities of disproving the counterfactual. Given the need for efficient and effective evidence gathering, alternatives to gold standard Randomised Control Trials are often essential including trend analysis and further corroborating evidence through qualitative approaches and web analytics. Impact analyses are increasingly presented to decision-makers alongside a "Strength of Evidence Framework" to weigh up evidence against the risk of making a wrong judgement. Through understanding impact and certainty of results, decision-makers can build insight and make effective operational policy decisions to move to a more tailored compliance approach. A continuous improvement and learning culture has been established. Where unexpected results or mild conclusions are found, this may lead to further information gathering; or to decisions to iterate on alternative compliance approaches. Where there is strong evidence of effectiveness, tax benefits and cost efficiencies have been quantified to inform further roll-out.

We will give an overview of the upstream activities, focussing on evaluation techniques and how evaluation results feed into decision-making.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A265

The Prison Scrutiny Search Tool

George Kelly (*Ministry of Justice*)

There are several monitoring boards that report into the state of prisons in the UK. The information in these documents is invaluable to identify, understand and fix issues within our prisons. Using Natural Language Processing (NLP) and Machine Learning techniques, we have built an app that allows our users to interrogate these reports with more precision and at greater speed. We have constructed a data pipeline that allows key users to control the upload of reports, with our models automatically scraping text from PDFs and re-processing our models using Airflow.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A70

Robustly Measuring the Impact from a Big-Bang Rollout of a Government Service, which Prevented the Creation of a Traditional Control Group

Jeraldine Kay (*Dept. for Work and Pensions*)

Randomised Control Trials with a robust no-treatment group as counterfactual are often held as the gold standard for evaluating an intervention. But what if there isn't a control group available? Here we'll discuss DWP's flagship Work Programme, the largest employment programme to be run by DWP, and set out how we've begun to understand the impact it has had since it launched in 2011. We'll cover some of the challenges we've faced and how we're using Propensity Score Matching techniques and exploiting the contractual end of the programme to support evaluation.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR for Sustainable Approaches in Community Contexts



Organisers: Martha Vahl and Eliseo Vilalta Perdomo

03/09/2019, 16:30 – 18:00, Sibson SR4

OR61A270

Alternative Partitions to Support Sustainable Communities

Gerard de Zeeuw (*University of Amsterdam*)

Individual and collective acts tend to be partitioned into a number of parts – one the formulation of objectives, the other a delineation of the resources that may help to realise the objective. Serious difficulties arise when we use this type of partition to improve life in a community, i.e. a village or an organisation. Collective objectives as well as what resources can be made available prove difficult to agree upon. A different type of partition may help. A number of alternatives are discussed and compared. One is shown to lead to an effective and efficient method to support and sustain a community's self-organisation.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A283

Sustainable Research Approaches in Community OR

Martha Vahl (*CICT*)

The paper explores the notion of sustainability and of how it may be supported by research. The issue is becoming more urgent as many methods to support communities and the way their members live depend on the political and cultural context in which they function. This implies that many of the data that can be collected are biased to the point that removing the bias does not leave anything and destroys the data. These data include values, objectives, personal experiences of the here and now. They determine the extent to which communities show variety and diversity and hence be considered sustainable. This issue explains the difficulties encountered when trying to increase sustainability, especially in communities when using popular research methods. A number of attempts to deal with the difficulties are brought together and are redesigned as part of an appropriate generic research method.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A313

Towards 'Systemic Sustainability': Assessing the O.R. Contribution

Miles Weaver, Hock Tan & David Duddy (*Edinburgh Napier University Business School*)

The emerging 'sustainability paradigm' presents challenges and opportunities for the next generation of leaders. However, Howieson, Burnes and Summers (2019) acknowledge that organisational leadership is based (generally) on a neoliberal paradigm and cite the United Nations (2015) Paris Agreement on Climate Change, recognition that this has contributed to an 'intolerable situation'. O.R. has a considerable role to play in understanding the complexity and interconnectedness between the 17 Sustainable Development Goals, that offer a blueprint of these challenges (i.e. poverty, inequality, climate, environmental degradation, prosperity, and peace and justice) and in seizing the abundance of opportunities (i.e. in growth areas such as mobility systems, healthcare, energy efficiency and clean energy solutions). This is perhaps part of the reason why the UN with, the WHO and the OECD in 2017, highlighted "systems thinking" as a key leadership skill. To reframe organisational leadership around a 'sustainability paradigm', we must move towards practising 'systemic sustainability'. Laszlo and Laszlo (2011) suggest that systemic sustainability is a process of development (individual, organisational, or societal) involving an adaptive strategy of emergence that ensures the evolutionary maintenance of an increasingly robust and supportive environment. This is apt within a 'Community O.R.' standpoint, concerned with the 'meaningful engagement of communities' (Midgley, Johnson and Chichirau, 2018). In this paper, we wish to assess the O.R. contribution and draw on these definitions/perspectives to consider (1) how to build capacity for "systems thinking" in individuals; (2) shifting organisational leadership to a 'sustainability paradigm' to include the crafting and demonstrating of 'purpose'; (3) building active relationships with multiple stakeholders who share values and wish to address common concerns; plus (4) the interdependence of business within multiple ecosystems. This requires boundary judgements, understanding of complex problem situations, mitigating conflict, drawing consensus on ways forward and co-creating solutions that lead to purposeful action.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

PRESIDENT'S MEDAL PRESENTATIONS

04/09/2019, 13:30, Sibson LT3

The President's Medal is awarded for the best **practical application of OR** submitted to the competition (a wide definition of OR is used). Entries are accepted from both academics and industry-based OR workers and consultants. One of the main qualifications for entry is that the work has been implemented before submission.

Criteria for judging include:

- The level of demonstrable benefit
- The intellectual and novel content of the solution
- The likely longevity of the solution
- The excellence of the OR process

Conference delegates attending the President's Medal plenary session will have the opportunity to express their views as to their preferred candidate. The judges are required to take into account the views of the audience, but are free to arrive at their own decision. Ballot papers will be distributed at the start of the session.

PRESENTATIONS

04/09/2018, 13:30 – Sibson LT3

Optimising capacity requirements for a centralised stroke service

Richard Wood, Ben Murch (*NHS Bristol, North Somerset and South Gloucestershire CCG*), **Phil Clatworthy & Justin Pearson** (*NHS Bristol*)

Centralisation of stroke services has been shown to improve patient outcome and is now being rolled out nationally as part of the recently announced NHS Long Term Plan. But with significant upheaval to the patient pathway and few learnings available from other such reconfigurations, there are many difficulties and uncertainties to address in the crucial planning stages. This raises problems for one of the country's largest healthcare systems in the Bristol area which, with three NHS Trusts and a one million population, has a large number of possible patient pathway options to examine. Of particular interest to the Stroke Executive Committee are estimated capacity requirements associated with the various configurations. And the stakes are high: estimate too many beds and waste scarce NHS funds, too few and risk bottlenecks and patients failing to benefit from hyper acute specialty.

This talk will describe the approach taken by the multidisciplinary project group firstly in developing a sufficiently generic simulation model to support the capacity evaluation, and secondly in how this has been used within the options appraisal of the programme's business case. It will be explained why it has been necessary to develop the model from scratch and how the novelty of the solution has led to its recent JORS publication. Finally, the talk will address the legacy of the modelling, not just in providing a tool whose user interface is now being upgraded through a Health Foundation sponsored project to promote use nationally, but also in terms of the level and depth of OR thinking that has been imparted to a wide-ranging group of senior individuals not usually exposed to the benefits of OR.

04/09/2018, 14:00 – Sibson LT3

The Safety Diagnostic Tool: Harnessing Operational Data to Make Prisons Safer

Philip Macdent and Martine Wauben (*Ministry of Justice*)

The Safety Diagnostic Tool has been developed by the Ministry of Justice Data Science team to help front-line prison staff better manage violence and self-harm in their institutions. It visualises near-live operational data at the individual and population levels, relevant to both everyday operations and governance teams. It automatically generates statistics on the levels of violence and self-harm, provides predictive scores to characterise a person's tendency for violence, and shows how these trends are changing over time. The tool is now being used across the whole estate and has 250 unique users every day. Making the data accessible and impactful has also improved data quality, as staff recognise its value. It has empowered staff from the front line all the way to governance to make timely, data-driven decisions on offender management. Come to this session to learn how we have revolutionised the impact of statistics in a low-tech, people-first environment.

04/09/2018, 14:30 – Sibson LT3

Fishing for Mules with Nets

Andreas Schaefer, Jen Houle and Daniel Clegg (*RBS*)

Fraud is an ever-changing problem faced by financial institutions. Criminals must launder their funds acquired through fraud and other criminal activities in order to access their money. Banks have a duty to prevent the laundering of fraudulent funds in order to protect their customers and society. There is also increased focus with the Industry Code on Authorised Push Payment Scams in 2019). Many standard fraud-finding techniques rely on analysing discrete data, meaning that connections between bad actors cannot be identified. Where common statistical models struggle because of class imbalance, graphs offer a simple and accessible approach. We demonstrate a unique application of network analysis which enables us to trace customers, accounts and transactions linked to fraud. These links to known bad actors are like needles hidden in a haystack. We built a network at a scale of millions of nodes in Python from bank event data to find these suspicious connections. We cover common problems like super connected nodes and the opportunity in delivering tangible benefits using open source software. This network allowed us to identify mule accounts that we would not have otherwise found and prevent laundering of victim funds.

**Problem Structuring Methods
Special Interest Group (SIG) Meeting**

Open to all

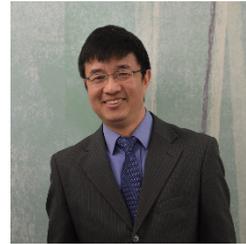
05/09/2019, 11:00 – 12:30, Sibson MBA

First Meeting and Review of the Problem Structuring Methods Special Interest Group (SIG)

Martin Parr (*Dst*)

The meeting will include an introduction to the SIG from co-chairs Christina Phillips and Martin Parr. We aim to review the various options for renaming the SIG. Based on the recent survey sent out to SIG members, discuss what future activities would be most useful to SIG members and begin to indentify what research should be undertaken. We are looking for members who will participate to create an active and growing SIG that can make this future happen.

Reliability and Applied Stochastic Processes



Organisers: Philip Scarf and Shaomin Wu

05/09/2019, 11:00 – 12:30, Kennedy SR4

OR61A329

KEYNOTE: A Comparison of Simulation and Analytical Methods for Cost Modelling in Maintenance Strategy Optimisation for Infrastructure Assets

Wenjuan Zhang (*Warwick University*)

Cost models have attracted a great deal of attention from infrastructure industries because they can help to identify the optimal maintenance strategy with the least cost while maintaining safety. This paper presents a novel research which adopts semi-Markov process to model the asset's degradation, then the maintenance strategies can be optimized through the whole life cycle. Since the inspection is not cost free, the optimal inspection time will be identified as well. Due to practical limitations, industries normally prefer to use simulation as a way to optimise the maintenance strategy. However, simulation only produces approximate results, which needs to be verified against the results obtained using the analytical methods. This paper compares the results obtained from simulation and the analytical methods using a case study.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A80

Default Probability Models Applied to a Mexican Peasant Institution

Maria Rosa Nieto (*Investigaciones Y Estudios Superiores S.C*) & **Jose Morfin** (*Universidad Anahuac Mexico*)

Credit risk models failure to forecast crises has become especially important since the global economic crisis of 2008. The mortgage backed assets that started the crisis had excellent credit ratings. Since then, global credit risk regulators, such as The Basel Committee, are converging to have more efficient regulations which aim to develop accurate credit risk models. One of the goals of The Basel Committee is to supervise and recommend standard credit risk models, which are correctly calibrated to the specific conditions of each credit institution. This research postulates that the Value at Risk forecast of a peasant financial company is more accurate if an endogenous stochastic model is used to calculate the default probability, which is an input variable to its calculation. A variety of models were tested on the historic data of the peasant financial company to find the best fit one. The results show that a Zero-Adjusted-Inverse-Gaussian model is the best fit for this type of credit institution. Hence, the Value at Risk forecast of the peasant financial company is improved. It was also found that Mexican credit risk regulations are undesirable, as they prohibit institutions from calculating their credit risk

parameters through internal models. On the contrary, Mexican regulators give a generic value for the default probability vector to each institution. In other words, if the current credit risk regulations in Mexico changed to allow institutions to calculate their risk parameter through internal models, they would improve the calculation of its Value at Risk, and therefore the whole sector would have more accurate risk measurements.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A326

The Geometric Process, its Extensions, and Applications in Improving the Efficiency of Water Systems

Shaomin Wu (*University of Kent*), **Adiel Almeida** & **Cristiano Cavalcante** (*Federal University of Pernambuco*)

The geometric process (GP) was introduced by Lam[1] in 1988. Many variants have been developed since then. The GP is mainly used to model the failure process of a technical system and assumes that the times between failures after repairs become shorter and shorter. Although the GP has a rigorous assumption that the times between failures are independent, it has been widely applied in scheduling maintenance policies. Asset management in the water sector is so important that a level of availability can be ensured. This paper reviews different variants of the GP and then investigates potential applications of the GP in modelling of the reliability of water systems.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 13:30 – 15:00, Kennedy SR4

OR61A113

Dynamic Pricing with Finite Price Sets and Unknown Price Sensitivity

Athanasios Avramidis (*University of Southampton*)

We study the pricing of perishable inventory over multiple selling seasons in the presence of demand uncertainty. There are n feasible prices. Each season consists of periods during which demand is a Bernoulli random variable whenever the i -th price is offered. The purchase probabilities, $\mathbf{p} = (p_1, \dots, p_n)$, are unknown to the seller, whose objective is to maximize the expected revenue. We propose an algorithm that estimates \mathbf{p} in a learning phase and in each subsequent season applies a policy determined as the solution to a sample dynamic program, which modifies the underlying dynamic program by replacing \mathbf{p} by the estimate. Revenue performance is measured by the regret: the expected revenue loss relative to the optimum achievable under knowledge of \mathbf{p} . For a given number of seasons n , we show that if the number of seasons allocated to learning is asymptotic to $(n^2 \log n)^{1/3}$, then the regret is of the same order, uniformly over \mathbf{p} . We also develop a multi-armed bandit alternative whose regret is $O(\log n)$, but is (asymptotically) at least gap times the number of gap -suboptimal arms, for any $\text{gap} > 0$. Numerical results demonstrate the effectiveness of our approach.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A134

Pricing of Reusable Resources Under Ambiguous Distributions of Demand and Service Time with Emerging Applications

Xuan Vinh Doan (*University of Warwick*)

Monopolistic pricing models for revenue management are widely used in practice to set prices of multiple products with uncertain demand arrivals. The literature often assumes deterministic time of serving each demand and that the distribution of uncertainty is fully known. In this paper, we consider a new class of revenue management problems inspired by emerging applications such as cloud computing and city parking, where we dynamically determine prices for multiple products sharing limited resources and aim to maximize the expected revenue over a finite horizon. Random demand of each product arrives in each period, modeled by a function of the arrival time, product type, and price. Unlike the traditional monopolistic pricing, here each demand stays in the system for uncertain time. Both demand and service time follow ambiguous distributions, and we formulate robust deterministic approximation models to construct efficient heuristic fixed-price pricing policies. We conduct numerical studies by testing cloud computing service pricing instances based on data published by the Amazon Web Services (AWS) and demonstrate the efficacy of our approach for managing revenue and risk under various distributions of demand and service time.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A56

Analysing Implied Volatility Between Stock and Dividend Markets

Enoch Quayle (*University of Kent*)

We propose a computational approach to compare the information in the implied volatility of stock index options to the information in the implied volatility of index dividend options. The approach uses the implied volatility surface (IVs) as a stochastic state variable accounting for the evolution of the underlying asset price process. The proposed method explicitly allows for variability in time-to-maturity, and outlines a computational process for the aggregation of volatility measures under the Black-Scholes, the Black model and model-free approaches. The approach illustrates how the implied volatility term-structure of option contracts with time-to-maturity exceeding "9-months" move enough to be justified by subsequent fluctuations in dividends although contracts with time-to-maturities around "1-month", "1-3 months" and "3-9 months" move too much to be justified by subsequent changes in dividends. The IVs term-structure shows that the implied volatility of stock index options consistently exceeds that of index dividend options, thereby confirming previous criticism based on novel financial data and instruments. However, the magnitude of excess implied volatility declines with long-dated time-to-maturities, suggesting that the discrepancy between the two implied volatilities is sensitive to investment horizon.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A288

Analysis of an Extended Double-Exponential Jump-Diffusion Model with Nonhomogeneous Jump Sizes to Reflect Varying Severity of Jumps

Daniel Wei-Chung Miao (*National Taiwan University of Science and Technology*)

In the study of jump-diffusion financial models, Kou's (2002) version is considered to be a standard one as its double-exponential assumption on jump sizes nicely captures the leptokurtic feature of the impact from an unexpected event. Its popularity is also due to the fact that the European option price can be derived in analytical form which ensures the computational convenience. However, the homogeneous jump sizes assumed in this model makes it less realistic especially when investors hold a view that the severity of subsequent jumps may change (e.g. before/after a particular event such as presidential election). This gives motivation for us to extend Kou's model to allow for nonhomogeneous jump sizes. In this study we assume parameters in subsequent jump sizes may change through time (no longer i.i.d.). We give a full mathematical analysis for this extended jump-diffusion model and derive the European option pricing formula in analytical form. In our numerical analysis we assume that the jump size parameters form a geometric series and investigate the effects from the varying severity of jumps through a number of examples.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

Simulation



Organisers: Lucy Morgan and Anthony Waller

03/09/2019, 11:00 – 12:30, Kennedy SR4

OR61A175

STRESS: A View from System Dynamics Practice

Martin Kunc (*University of Southampton*)

A previous study (Monks et al, 2019) developed a standardised checklist approach to improve the reporting of discrete-event simulation, system dynamics and agent-based simulation models within the field of Operational Research and Management Science. The objective is to reduce the set of incomplete or ambiguous reporting so simulation studies can be reproducible or reuse findings. The study derives general good practice principles and three 20-item checklists aimed at Strengthening The Reporting of Empirical Simulation Studies (STRESS): STRESS-DES, STRESS-ABS and STRESS-SD for discrete-event simulation, agent-based simulation and system dynamics, respectively. At this moment, there is no evidence from the field on its use or perspectives in terms of its adoption. This talk presents initial exploratory findings from the System Dynamics perspective.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A170

STRESS for DES: Simulation of Critical Care

Christine Currie, Dandan Shi & Honora Smith (*University of Southampton*)

We provide an example of using the STRESS guidelines for building a discrete event simulation (DES) model. The model describes an intensive care unit (ICU) within a busy UK hospital, which has been used to assess the impact of reducing the number of late admissions to the ICU. Here, we define late admissions to be patients admitted to the ICU more than a day after entering the hospital. The presentation will provide some background to the STRESS guidelines and their aims as well as describing their implementation in this particular example. We will also provide some results of the modelling study.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A106

STRESS: Guidelines for Agent-Based Simulation Reporting in Research and Practice

Stephan Onggo (*University of Southampton*)

STRESS (Strengthening the Reporting of Empirical Simulation Studies) guidelines provide a standardised checklist approach to improve the reporting of discrete-event simulation, system dynamics and agent-based simulation models within the field of Operational Research and Management Science. The objective of the guidelines is to improve the clarity of the reporting of a simulation study either in research or in industry. In addition, a clearer reporting will make it easier for us to reproduce findings (hence enhancing our knowledge and understanding of the system being modelled) as well as to enable model reuse. This is especially important for agent-based simulation because the models tend to be more complex. In this presentation, we will demonstrate how STRESS guidelines are used to document several agent-based models. We will also compare STRESS and alternatives such as ODD (Overview, Design Concepts and Details).

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

03/09/2019, 13:30 – 15:00, Kennedy SR4

OR61A356

KEYNOTE: Digital Twins in Advanced Manufacturing Current and Future

Ruby Hughes (*University of Sheffield*) & **Lucy Morgan** (*Lancaster University*)

One of the key industrial challenges of today's manufacturing companies is to adopt new technologies to transform their manufacturing processes, to be able to make things in a "smarter" way. One of the promising ways to become smarter is the so-called digitalisation of the manufacturing system in the context of industry 4.0. In which, digital twins play an important role within this digitalisation journey. Since recent years, the Digital Twin has become a synonym for the cyber-part of a cyber-physical system (CPS) (Kunath & Winkler, 2018). It is predicted that companies who invest in digital twin technology will see a 30 percent improvement in cycle times of critical processes (IDC, 2018). The future of digital twin development is foreseen to be able to embed with artificial intelligence (AI) technologies such as genetic algorithm models, machine learning and deep neural networks to accelerate decision-makings processes and support manufactures to improve efficiency and productivity. This paper describes the key elements within the technology architecture of digital twin models and presents on-going digital twinning projects within the Advanced Manufacturing Research Centre (AMRC) including current projects and future research areas.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A280

SIMPRAC: Digital Twin Creation and Symbiotic Simulation Within Ford Powertrain Operations

John Ladbrook (*Ford Motor Company*) & **Lucy Morgan** (*Lancaster University*)

We will outline the advances made in streamlining the production of effective WITNESS Simulation models for Powertrain operations across Europe. The aim is to create accurate Discrete Event Simulation models of new & future facilities to run wide experimentation quickly

and answer management questions in a timely manner. Leveraging the latest technologies, previously manual processes that once took weeks can now be accomplished in hours; reducing lead time whilst increasing the resulting model quality. Due to the success of the approaches developed, the use of simulation within Ford has grown significantly with manufacturing facilities now adopting simulation as a trusted problem solving tool. The latest step in this journey is a project that sees Ford working with Lanner, the HSSMI and the University of East London to automatically update models from live Ford systems data. We will explain the processes, innovative research undertaken and the lessons learned during the development of the tool.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

03/09/2019, 16:30 – 18:00, Kennedy SR4

OR61A285

Are you Building a Digital Twin or a Simulation?

Frances Sneddon (*SIMUL8 Corporation*)

Gartner and Forrester have declared that every organisation must have a digital twin. They predict by 2020 that 50% of all manufacturing enterprises will have a digital twin. So by 2020 50% of manufacturing organisations will have a simulation of their production line, right? For many that's the logical implication because many protest that a digital twin is just a simulation like we've been building since the 70s, certainly that was the assertion at this year's WinterSim conference. What do you think? Is a digital twin just a simulation by another name? Come and join the debate and discuss (argue!) - what is the future of simulation in this new digital era? How must simulation evolve to stay relevant for the new world?

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A241

Business Analytics Within a Simulated Supply Chain System

Nicoleta Tipi (*University of Huddersfield*)

Business Analytics approaches are used by organisations to generate value from the data available to them. A number of business analytics approaches have been identified and discussed in the literature that directly affect an organisation, still, organisations are not operating in isolation. They form links and connections with other organisations who at the same time aim to create value from the internal and external data available to them and maintain their competitive position in the current market. This material aims to clarify the possible opportunities offered by business analytics in the context of a supply chain system when data generated in one part of the chain within an organisation are being taken into consideration in the decision making process in another part of the chain by another organisation. A supply chain simulation model has been constructed using a discrete event simulation approach. A number of different simulation scenarios have been investigated, tested and analysed. Large sets of data are being generated at different points in the chain where the opportunity to work with this type of data in a supply chain environment is being explored. Within a simulated scenario, data can be made available in real-time, where the

benefits of using this in a practical setting is being enquired. The benefits of this work are twofold. This study will capture the opportunities offered by business analytics within a complex setting such as that of a supply chain system. At the same time, this work brings forward a supply chain simulated model that operates with large sets of data and has the capacity to explore a number of different scenarios. Characteristics of modelling complex supply chain systems using a discrete event simulation approach are also emphasised in this work.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A256

Front-Loading NPD Projects Through set-Based Concurrent Engineering: Analysing the Impact of Project Type Using a System Dynamics Modelling Approach

Saeed Taheri (*Nottingham Trent University*)

To survive in today's fast-changing market environment, companies are always trying to improve the performance of their New Product development (NPD) projects, by implementing new approaches. Nevertheless, applying such approaches is not straightforward, mainly due to the high level of interdependency between development activities and the role of dynamic effects in the project performance. This research studies the impact of implementing Set-Based Concurrent Engineering (SBCE) as a unique approach for front-loading NPD projects on the project performance. While different types of NPD projects based on their levels of complexity and innovation are defined and executed in companies, it is not clear if SBCE approach has the same effect in all project types. To investigate this a system dynamics modelling approach is used, due to its capacity in modelling feedback loops, iterations and rework cycles, as underlying factors which determine the time, cost and quality performance in projects. The calibrated model used for the policy analysis by defining different scenarios based on the number of iteration cycles during the conceptual design phase, number of initial design concepts and the type of project. It is concluded from results that although the performance of all types of projects improves when moving towards the SBCE approach, the degree of improvement for projects with higher levels of complexity is more profound. In addition, for projects with the high level of complexity, increasing the number of initial concepts has a positive impact on all project performance measures.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

05/09/2019, 11:00 – 12:30, Sibson SR1

OR61A50

The Development of a Proactive Manufacturing Based Building Energy Management System

Victoria Mawson (*University of Strathclyde*), **Ruby Hughes** (*AMRC*) & **Ben Hughes** (*University of Strathclyde*)

Manufacturing facilities are high-energy consuming dynamic environments. Management of such facilities are commonly analysed at both building level and machine level, but predominately in isolation. Improving the energy efficiency of heating, ventilation and air conditioning systems (HVAC) has been performed through improvements in system

technology and retrofit systems, however work into the interaction between manufacturing processes and HVAC control is limited. Through the use of simulation, this study proposes a proactive building energy management system based on manufacturing kilowatt-load as opposed to the traditional reactive thermal comfort based control. Thermal heat gains from manufacturing equipment is quantified, with HVAC systems adjusting to such thermal flows in order to adopt the concept of heat recovery, resulting in a reduction in energy consumption from chiller and boiler systems. A case study is presented to illustrate the effectiveness of the proposed method, with improved energy efficiency of the HVAC system, whilst maintaining comfortable working air temperature and humidity levels. The analysis of manufacturing operation alongside the facility building should give better control of the energy consumption whilst improving the management of operations within manufacturing facilities.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Somewhat

OR61A266

Using Distributed Simulation to Make Sellafield Safer Sooner

Tom Barnard, Panos Frangos & Panayiotis Frangos (*Sellafield Ltd*)

The Sellafield site in West Cumbria is one of the most complex and hazardous nuclear sites in the world. Our vision is to safely and securely remediate Sellafield to benefit the industry, nation and region. Sellafield's Business Analytics team developed a Distributed Simulation tool to model the retrieval of 10,000m³ of solid and effluent waste from a legacy facility. The tool allows the composition of large-scale simulations consisting of a number of facility models using distributed computers. The integration of the infrastructure links between the facilities, such as shared resources and transport, provide a realistic view of the world which would have missed if the models were developed in isolation. The tool uses a Distributed Simulation controller which manages the entire simulation. The controller uses communication channels that link the simulation models, through which messages and model entities are exchanged. It also allows the individual models to run independently using their own local clocks to a common synchronisation time that has been specified by the controller, based on communication feedback from the individual models. The Distributed Simulation tool supports a number of multimillion strategic decisions to deliver Sellafield's mission, safer and sooner.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

05/09/2019, 13:30 – 15:00, Sibson SR1

OR61A58

Developing Hybrid Simulation Models to Minimise Disruption and Maximise Customer Experience for Eurostar Travellers

William Jones (*Kent Business School*)

In 2018 Eurostar International Limited carried 11m passengers between the UK and continental Europe via the Channel Tunnel. The high-speed train operator carries thousands of passengers each week between cities, including London, Paris, Brussels, Lille and (newly added) Amsterdam, also running seasonal trains to the South of France during the summer, ski trains to the Alps in the winter and services to Disneyland Paris. Demand for Eurostar services is high.

In order to exploit the full commercial potential, particularly of the new Amsterdam route, and achieve its vision for the business “to be Europe’s most loved travel experience”, Eurostar must increase station capacity and passenger throughput, which has become a bottleneck, particularly in London St Pancras International (SPI) and Paris Gard du Nord (GdN). Sophisticated simulation models of SPI and GdN have been developed using a hybrid agent-based modelling (ABM) and discrete event simulation (DES) approach in AnyLogic. ABM is well suited when the aim is modelling individuals’ behaviours. Although it is possible to replicate many of the benefits of ABM using a traditional DES approach, the hybrid approach used here was found to help reduce the communication gap between modeller and stakeholder. Among several others, these simulations have provided the following benefits; firstly, informing design decisions for a new security and border control layout in GdN resulting in a 20% passenger throughput improvement; secondly, supporting the expansion of SPI to increase the departure area capacity by 15% and; further, developing a tool to control peaks in passenger arrival in all stations by modifying recommended arrival times on passengers tickets. Due to the stakeholder-led development approach used and the powerful visualisations outputs the simulations produce, the models are now fully integrated into Eurostar’s station team’s operational planning processes. They have been used to educate staff about optimal ways of working.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A210

Real-Time Prediction of the Optimal Configuration of an Intelligent Gateline System Using Queueing Theory

Eric Longomo (*Portsmouth University*)

This research seeks to develop and operationally demonstrate --using the existing knowledge in the field of Queueing Theory, a gateline that is capable of automatically self-reconfiguring to maximise peak throughput while preventing station overcrowding. The proposed technology will be equipped with means to: (1) Identify flow of people within the station environment, and learn to predict the crowds before they arrive at the gateline, (2) reconfigure the direction of individual walkways in a safe and controlled manner, freeing the staff at the gates to engage and support customers. It will inform and aid staff to make operational decisions on gate configuration or temporary station closure, which if sub-optimal, adversely affect network capacity, safety and customer experience. Overhead sensors are used to record in real-time: passengers’ ID, timestamps, coordinates within the desired field of view, and passengers’ directions. A queue simulation model is developed based on the distribution of the inter-arrival times, a uniformly distributed service time and the number of available service gates. The minimisation of the overall customers’ waiting times will be considered as the objective function of the optimisation model. In order to reduce the mathematical complexity, the convexity of the objective function is established. The objective function being convex, the global optimum is found by computing the minima. Experimental results are provided for system evaluation. From the output of the simulations (based on real station passenger flow data) it can be concluded that the Gateline efficiency (in terms of passenger throughput) can be increased using Intelligent Gatelines for a typical station with rush hour peaks in the morning and evening. It can also be inferred from the data that a spike in passenger numbers will make

Intelligent Gatelines suggest a change in gate direction (one or more walkways) which will reduce queuing and congestion.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

Soft OR and Problem Structuring



Organisers: Guillaume Lame, Ian Cammack, Mark Ashforth and Alberto Paucar-Caceres

03/09/2019, 11:00 – 12:30, Sibson SR3

OR61A304

Resilience Problem Structuring Methods Applied to a Networked Organisation

Jason Valette & Maurizio Tomasella (*University of Edinburgh Business School*)

We design and validate a novel Problem Structuring Method (PSM) which integrates a decision analysis framework devised through a Design Science (DS) methodology, a facilitated process and the application of resilience attributes to frame a wicked problem through a resilience lens. The PSM process guides participants through the co-construction of a contextually rich model, exposing the constituent issues of the problem, enhancing resilience learning and supporting congruence of possible resilience attribute facilitated outcomes. The facilitated application of multiple resilience attributes to individual issues provides for convergence of possible areas in which to focus ongoing attention to enhance resilience regarding the identified root definition applied to the problem situation. In our work, we view resilience as the ability to withstand, recover from or improve post-hoc in the face of disturbance. Our method is designed particularly to help structure resilience in a networked organisational context. We give a demonstration of our method by presenting insights from a recent project carried out in the UK in collaboration with a major air transport organisation.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A290

How TOC can Complement OR Methods for Better Solutions

Vicky Mabin (*Victoria University of Wellington*)

Tradeoffs are ubiquitous in real life and many OR models set out to find optimal or satisficing solutions to these tradeoffs. For example, optimisation models using LP, MIP and non-linear programming, as well as EOQ, simulation, heuristics, and MCDA models, all are based on the premise that there is no one best solution that meets all objectives. Hence there is a need to trade off one objective against another. The purpose of the OR model is to find the 'best' solution, given these competing factors. Theory of Constraints also focuses on these competing factors or constraints, but does not view them as givens. TOC provides a range of methods to manage or alleviate constraints and uncover and challenge hidden assumptions leading to win-win solutions. This presentation will illustrate how solutions found using traditional OR methods, often with tradeoffs at their heart, may be improved on using methods

drawn from the Theory of Constraints (TOC) (Goldratt, 1990, 1992, 1994; Dettmer, 2007). Some examples of using TOC methods for structuring and solving such problems are provided along with the benefits and synergies gained by using TOC methods in sequence or in combination with traditional OR methods.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A75

A Framework to Enhance the Public Policy Cycle with Soft Systems Methodology: Implementing Environmental Policies in the City of Franca (Sao Paulo, Brazil)

Melissa Franchini Cavalcanti Bandos (*Centro Universitário Municipal de Franca - Uni-FACEF*) & **Alberto Paucar-Caceres** (*Manchester Metropolitan University*)

This paper aims to assess the use of Systemic Thinking (ST) to support Public Policy (PP) implementation. We survey extant literature in ST and PP and propose a systemic framework, which combine Soft System Methodology (SSM) a systemic Management Science MS/OR methodology with the Public Policy cycle to capture the complexity of public policy implementation as an iterative learning and participative system with all the stakeholders involved in the process. Our aim is to use the proposed framework in the process of implementing public policy in the area of Environmental Green and Blue Public Policies. This is a work-in-progress report; in this part, we advance the framework and in the second part of the study, we plan to use it in a real-world case to assist the implementation of a set of public policies on sustainable management in a municipality, The Municipality Green Blue Program in Franca (Sao Paulo). Findings will be used to corroborate that SSM can complement the public policy process and enhance its implementation and monitoring stages. We envisage that the application will also point out that the enhanced framework, with SSM as part of it, has the potential to make government planning processes more structured for policy makers. The paper contributes to the current debate on the expanding use of Problem Structuring Methods practice in MS/OR demonstrating that the use of a systemic methodology in public policy implementation can bring tools that will help both public policy managers and the beneficiaries of public policies.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A30

Model-Based Problem Structuring and Risk Analysis in Healthcare Organisations: A Qualitative Study in the English NHS

Guillaume Lame (*University of Cambridge*), **Elisa G. Liberati**, **Graham Martin** & **Mary Dixon-Woods** (*The Healthcare Improvement Studies Institute (THIS Institute), University of Cambridge*)

High-reliability industries often rely on systems modelling techniques such as Failure Modes and Effects Analysis, Hierarchical Task Analysis, or process mapping to prospectively assess the risks present in industrial systems. It has been suggested that these methods have potential for improving the safety of healthcare. We present results from the evaluation of a pilot application of these techniques in health services in the UK. Data were obtained through

interviews, ethnographic observation and document analysis in fourteen sites participating in the Health Foundation's Safer Clinical Systems programme. Systems modelling techniques were used during the programme's diagnostic phase, aimed at characterising routine and taken-for-granted clinical processes, gaining deep insight into the targeted clinical pathway, and drawing frontline clinicians' attention to the safety issues being addressed. The findings were often described by participants as revelatory: they identified often highly unreliable clinical systems that were fraught with risk for patient safety. Clinical pathways were situated within multiple other interacting microsystems, all strongly influenced by wider organisational and institutional contexts. Using formal risk appraisal tools lent legitimacy to the process and helped to build relationships between diverse staff. Site teams especially valued the systematicity of the approach, including the use of specific, dedicated tools and techniques and the emphasis on detecting hazards in existing systems. Programme implementation was not straightforward, however. Getting the right people in the room was essential to the diagnostics, but was hard to achieve. Teams often struggled to come up with risk controls and to implement them. These findings show that it is feasible and useful to use systems modelling methods to diagnose risks in healthcare pathways, but that the methods need to be supported by appropriate organisational infrastructure and embedded in broader structures, and implemented as part of a process to secure positive changes after the diagnostic phase.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

03/09/2019, 13:30 – 15:00, Sibson SR3

OR61A69

From Stories to Systems: The use of Narrative in Understanding Complexity

Tom Bashford, Alex Komashie & John Clarkson (*Engineering Design Centre, University of Cambridge*)

Eliciting stakeholder needs is a fundamental requirement across a range of linked disciplines including Design, Engineering, Soft OR, and Quality Improvement. Within the context of a systems approach, these needs may be used – alongside other information - to characterise systems and their requirements. However, many people do not explicitly think in terms of complex systems and the challenge for the researcher is to generate sufficient information to infer these. Techniques such as workshops, focus groups, structured and semi-structured interviews, and surveys may all be used to obtain qualitative insight, however each of these imposes a degree of constraint depending on the methodological framework with which they are constructed. Narrative, or storytelling, provides a vehicle by which stakeholders can relay complex, contextualised information about the system of interest as experienced in their own lives. Multiple narratives provide a rich source of interconnected, co-created data, which can allow the researcher to develop a deep understanding of both the physical and semiotic aspects of the given system. We have explored this technique cross-culturally in the both the UK National Health Service (NHS) and in Yangon, Myanmar. In each case narrative was used to explore a clinical delivery system, both in real time through participatory diagramming, and retrospectively through the lens of a systems approach. The strengths of this technique are the richness of the data and the lack of constraint imposed upon the interviewee. However, the obvious limitations are that the data created is unstructured, biased, and open to variable interpretation. These limitations can be ameliorated by the use of multiple overlapping narratives, group moderation, and iteration. This approach has roots in the Design, OR, and

Engineering literatures but has conceptual overlap with both Phenomenology and Actor Network Theory.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A244

Further Exploration of SSM Mode 2 in the Case of Online Distance Education

Sulafah Basahel (*Arab Open University*) & **Jose-Rodrigo Cordoba-Pachon** (*Royal Holloway, University of London*)

In knowledge realms like problem structuring methods (PSM) or applied systems thinking (AST), soft systems methodology or SSM has become a popular enquiring approach that can help researchers understand and manage complex situations. More recently, increasing awareness on how researchers elaborate and present models using SSM and other methodologies has led some to argue that there needs to be more in-depth understanding of behavioural dimensions in processes of model building and dissemination (Hamalainen, Suoma and Saarinen, 2013; Franco and Hamalainen, 2015). This paper extends understandings on the use of SSM by focusing on its mode 2 of use (Checkland and Scholes, 1990) to suggest new avenues for enquiry in relation to how introverts (Cain, 2012) would use this mode. A case study on exploring online distance education or ODE in a higher education institution in Saudi Arabia is crafted to highlight different learning cycles and supporting conceptual models emerging from considering issues of access by an introvert researcher. The insights of the study are used to propose key learning and practice SSM mode 2 strategies which could help introvert researchers deal with complexities encountered in similar situations.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A46

Using Soft Systems Methodology to Develop a Data Driven HR

Hazel Challenger (*Ministry of Justice*)

What actually is a "Data Driven HR"? I was tasked with moving HR towards being Data Driven without a clear steer as to what was understood by the phrase; a typical "messy problem", just begging for a Soft OR methodology to be applied. Come and find out how I used Soft Systems Methodology to create a common understanding of what was meant by Data Driven HR, identifying along the way the key issues that needed addressing and enabling me to map out a route ahead for achieving the final goal.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A236

Corporate Social Responsibility and Earnings' Management: An Issue of Measurement, Reverse Causality and Endogeneity

Sadaf Ehsan (*COMSATS University Islamabad, Lahore Campus*)

Purpose: This research investigates whether firms' commitment to Corporate Social Responsibility (CSR) is induced by the long-term perspective in order to satisfy their stakeholders or is it driven by managers' opportunistic behavior such as Earnings' Management (EM) for a developing economy of Pakistan. Further, it also examines whether CSR-EM relationship is unidirectional or bidirectional. In addition, we also examine whether this relationship remains the same or varies across different measures of CSR (disclosures and CSR monetary spending ratio) and EM (accrual and real). Approach: Two-Stage Least Square (2SLS) is used to control for endogeneity by using a panel data of Pakistani listed manufacturing firms from 2006 to 2015. Findings: Overall results largely support the long term perspective of CSR and EM relationship and it is bidirectional. However, this relationship is asymmetric across different measures of EM and CSR. The negative relationship remains constant across all measures of CSR and real EM. Contrary to this, in case of accrual EM, the relationship is negative with CSR Disclosures (CSR-D) whereas positive with CSR Monetary Spending Ratio (CSRMSR). Originality/value: This study extends the work of previous studies by providing the first empirical investigation of the relationship between CSR-D and both types of EM (accruals and real) while addressing the problem of reverse causality and endogeneity. Current study also established the multidimensional CSR financial construct and explores its association with both types of EM for the first time. Previous studies have attempted to explore this link but all of them have used AEM and social indexing approach to measure CSR but there is still a gap with respect to REM and CSR-D as well as little knowledge is known about CSRMSR and EM association. Present study fills this gap and found that CSR-D-EM link is asymmetric and bidirectional.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

03/09/2019, 16:30 – 18:00, Sibson SR3

OR61A226

KEYNOTE: The Development of 'Soft' Operational Research and Problem Structuring Methods: Surveying the Trends in the Last Decades

Alberto Paucar-Caceres (*Manchester Metropolitan University*)

Although the term 'soft', as introduced by Checkland was initially associated with his 'soft systems methodology', it quickly came to be common currency within the Systems community, when other interpretative approaches emerged. The term then travelled to the OR camp and the label 'soft OR' started to appear in OR literature, even though this was never fully accepted by OR practitioners and researchers. In 1989, Rosenhead published 'Rational Analysis for a Problematic World' and coined the term 'Problem Structuring Methods' (PSM) to group the increasing number of 'soft methodologies' used in MS/OR practice in the UK. It can be argued that by the late 80s, Soft OR/PSM practice reached its peak of popularity in academic and practitioners OR/MS communities and then started to decline. However, during the 90s there was a revival of Soft OR/PSM approaches, mainly due to the emergence of multi-methodological practice. But by the early 2000s, the decline of Soft OR/ PSM seemed to be more evident. Against this backdrop, this paper presents a survey of the development of 'Soft'

OR/PSM using a text-mining tool for visualizing the structure of concepts and themes populating the field over the last 20 years. Our main aim is to explore the development of these concepts/themes and to ascertain the reasons behind the cycles of popularity and seemingly decline. In line with an emerging research orientation to conceive the OR/MS field as both dominant and eclectic, we propose a systemic framework to account for these stages travelled by soft OR. We identify key PSM knowledge concepts/themes emerging from analysing and mapping the academic and practitioners activity in the journals EJOR and JORS. Our findings suggest that Soft OR concepts and approaches resurface over time. Also, results seem to indicate strong links between the particular scope and editorial scope/interest of each journal.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A127

Mixing Problem Structuring Methods in OR Interventions

Harry Kogetsidis (*University of Nicosia*)

Problem structuring methods (PSMs) provide a collection of participatory modelling approaches that can be used to address problematic situations, characterised by multiple actors with different perspectives and quite often conflicting interests. Following their acceptance as a distinct field of Operational Research in the 1990s, papers on the application of problem structuring methods frequently appear in OR journals and PSMs have now become a regular stream in the annual conference of the OR Society. The OR literature includes several cases where particular problem structuring methods, such as Soft Systems Methodology or Strategic Choice, have been used either on their own or in combination with other OR methods and tools coming from the hard or soft stream of the discipline. This presentation will explore the application of problem structuring methods in OR interventions based on a review of recent publications in relevant OR journals. The presentation will focus on whether these methods are used on their own or are mixed with other methods and discuss the expected benefits as well as possible difficulties when mixing different OR methods in the same intervention.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A169

Where is Soft Operational Research & Problem Structuring now and Where Might it be Going?

Martin Parr (*Dstl*) & **Christina Phillips** (*University of Leeds*)

The need for tools, frameworks and methodologies to address the 'softer' side of Operational Research has been talked about since Ackoff's notorious paper of 1979. There has been waning academic activity in the field of Soft Operational Research & Problem Structuring (SORPS) in recent years, as the submissions to the Problem Structuring stream of EJOR evidence. However, many companies and organisations are using a variety of methods to address problem structuring and human perception, but where is development and interest concentrated? As part of the relaunch of the SORPS Special Interest group (OR Society, UK) we take a look at the state of the field in practice and where possible compare this with academia. As a community we are riding the analytics revolution as many hard OR approaches are taken into practice on a wider scale than ever before. Soft techniques, which enable structuring of

messy domains, problem solutions and change management, are needed now more than ever as the world becomes increasingly complex. This paper presents the state of the field so that we might draw together a SORPS body of knowledge for the benefit of practitioners and academics; and from this gain some insight as to what may be important in SORPS in the future.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

05/09/2019, 13:30 – 15:00, Sibson SR6

OR61A205

Getting to the Root of the Problem: Improving the Working Lives of New Parents

Christine Peachey-Pace (*Dept. for Work and Pensions*)

A case study showcasing the early stages of a project which used OR techniques to capture and understand the problems faced by expectant and new parents in the DWP analytical community. The project aimed to understand the root causes of these problems thus enabling the development of targeted solutions to improve the working lives of new/expectant parents and aid their line managers. This talk will cover how large interactive group sessions and collaborative group working were used to capture the challenges face by a large number of parents across the DWP analytical community. It will also cover a discussion of how fishbones and "5 whys" techniques were practical applied to understand the root causes of problems from large volume of symptoms.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A137

Alternative Thinking Capability as an Approach to Improve Appropriate Challenge

David Arnold & Jim Squire (*Dstl*)

Building on the recommendations of the Chilcot report and resulting 'Good Operations Policy Handbook'; challenge is encouraged in UK military planning and operations. After 5 years of research and development, the Defence Science and Technology Laboratory (Dstl) have developed an 'Alternative Thinking Capability' (ATC). This capability has been tested and improved over 5 'Joint Venture' (JV) exercises supporting the Standing Joint Force Headquarters (SJFHQ). Dstl have provided a team of systems thinking practitioners during the planning and execution stage of these exercises to: Challenge 'the commander'. Challenge their staff. Facilitate better sense-making. Coach and mentor on Systems Thinking.

The ATC is a way of building in sufficient challenge, diversity of thought and critical thinking into a host organisation; it also provides time to reflect, think strategically and debate robustly from a range of perspectives. Challenges can either be self-generated by the host organisation (facilitated by the ATC where necessary) or raised directly by the ATC. Whilst ATC operates physically alongside the host, it should remain separate from most business as usual activities. For the JV series of exercises, the concept aimed to enhance the sense-making capability of a military HQ at the operational level of command through the construction of alternative views of the operating environment. These views were used to constructively challenge the assumptions that may have developed within the HQ and encourage divergent thinking

between staff. The overall intention was to improve command team understanding of the operational environment, improve decision-making and operational planning and reduce the likelihood of surprise as the scenario progressed. This presentation will explain the concept and provide examples from Joint Venture 19, where SJFHQ trained alongside United States European Command in Stuttgart, Germany.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A85

What shall we do with SS Richard Montgomery?

Mark Ashforth (*Dstl*)

SS Richard Montgomery (SSRM) is a US WWII ship that sank in the Thames Estuary in 1944 while loaded with bombs. The ship broke in two in shallow water just over a mile off the coast at Sheerness and the aft half was emptied of its cargo at the time. The fore half still contains thousands of munitions, equivalent to a total of 1,400 tons of TNT, which have now been submerged in sea water for 75 years. My paper will describe support given to the Department for Transport, which is responsible for the wreck, in understanding the problem in a way that supports the decision on what should be done. While the SSRM Expert Advisory Group has conducted annual detailed remote surveys of the deteriorating wreck and concentrated research efforts on trying to evaluate the likelihood of a devastating detonation, our approach starts from the view that the likelihood is immaterial if it is non-zero. A systems approach was taken to exploring all the factors involved in the problem, and understanding the perspectives of all of the stakeholders in those factors. Following the pattern of multi-layer security, mitigations were considered in three domains: reducing the likelihood of detonation (ideally to zero); reducing the impact of a detonation; and optimising the return to normal following a detonation. The next step, not yet begun, would be to weight the factors and perhaps score and cost options in a multi-criteria decision analysis, or similar. So far the Department for Transport has not picked up on these recommendations.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A83

Causal Mapping to Analyse Stakeholders' Views on Sustainable Aviation Biofuels Development

Salman Ahmad & Bing Xu (*Heriot Watt University*)

Negative environmental impacts, fossil jet-oil price volatility and developing a green image has compelled the aviation sector to consider aviation biofuels as a feasible option. In this regard, our work focusses on 1) identifying the challenges in developing a sustainable aviation biofuel supply chain, 2) develop a mental model of each stakeholder(s) along the supply chain. To have a holistic perspective of the problem, we identified stakeholders across the whole spectrum of aviation biofuel supply chain-from feedstock providers to actual users. To elicit the beliefs, and perceptions regarding the future of aviation biofuels, semi-structured interviews were conducted. Our premise is based on Personal Construct Theory which sees "man as a scientist", constantly evaluating the environment to make the best decision. This research presents a novel application of causal mapping from soft OR to analyse diverse stakeholder

perspective. The causal mapping tool is justified for the kind of data we have accumulated, i.e., individual interviews. We are presenting the preliminary results of the study. Finance and policy have emerged to be the major challenges to be addressed urgently. Due to the capital intensiveness of aviation bio-fuel projects governments need to take initiative and partner up with the private sector. Surprisingly, technology development is not of much concern at the moment. Stakeholders perceive that in due course of time technology will eventually mature bringing the capital and operational cost down. Likewise, feedstock availability is considered as a bottleneck in aviation biofuel development. Other issues identified are a steady growth in demand for the fuel and to have a level playing field for airlines using aviation biofuels.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

Sustainable Development Goals



Organisers: Honora Smith and Tolga Bektas

03/09/2019, 11:00 – 12:30, Sibson SR4

OR61A298

Designing OR Capacity Building Workshops to Tackle Sustainable Development Challenges in Southeast Asia

Maria Paola Scaparra (*University of Kent*), **Stefano Starita** (*Thammasat University*) & **Trung Hieu Tran** (*University of Nottingham*)

This talk summarises the process and findings of the workshop “Operational research and analytics to solve real world problems: Building capacity and new collaborations in transport, logistics, healthcare, disaster management and the design of smart cities”. The workshop took place in Hanoi, the capital city of Vietnam, in May 2019 as part of the conference “Building a Resilient Research Environment in South East Asia” organised by the Research Services of the University of Kent. The workshop brought together delegates from Cambodia, Laos, Myanmar, Thailand and Vietnam to discuss urgent development needs that could be tackled using analytics and OR methodologies. The World Café methodology was used to explore three main issues in each country: key development needs, stakeholder engagement and data availability. The workshop identified key challenge areas common to all countries, including urban planning, transport infrastructure development, and waste management, as well as problems specific to each country (e.g. flood disaster management in Myanmar and Vietnam). Key stakeholders to engage with to address each challenge were also identified and problems related to data availability and accessibility were discussed. Overall, the workshop highlighted that OR offers an ideal set of tools to tackle sustainable development challenges in Southeast Asia. This talk is a call for action to the OR community to take an active role in tackling such challenges.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

OR61A292

Sustainability and Operational Research in Thailand

Stefano Starita (*SIIT, Thammasat University*)

Unsustainable development and the resulting climate change are widely recognized as the biggest threats of the 21st century. Within this context, developing countries are particularly vulnerable as they experience stronger negative effects of unsustainable development and have less resources to cope. Addressing these problems requires all stakeholders, from governmental bodies and multinational companies to SMEs and private citizens, to take informed actions. Focusing on Thailand, this talk will discuss some of the urgent problems related to UN sustainable development goals and suggest how Operational Research can be

used as a support tool to achieve such goals. As an example, a case study on sustainable logistics is presented to show the impact of off-peak delivery in Bangkok, one of the most congested city in the world. Finally, a more broad discussion is provided, focusing on the current status of Operational Research in Thailand and to reflect on the future steps necessary to ensure that Operational Research can be effectively used to support sustainable development and make an impact.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Somewhat

OR61A218

HEART - A Visual Knowledge Tool to Help Support Behaviour Change Within a Development Setting

Philip Jones (*Dstl*)

The Human Environment Analysis Reasoning Tool (HEART) is a visual knowledge base developed by a NATO group to help analysts and planners to consider approaches to behaviour change at all levels - from individuals to societies. They are relevant to many forms of development challenge. This presentation will provide a guided tour of HEART. I will walk through the some of the main behaviour change knowledge maps. I will also highlight the analytical resources HEART contains - many drawn from a development background. Those attending the presentation will be given login details so that they can access HEART. I will also encourage a discussion about how this work could be exploited, updated, and added to, by analysts and academics working in the sustainable development area.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A277

Gender in Operation Research

Phuong Dang (*Kent Business School*)

The UK government is among UN member states strongly committed to gender equality and empowerment, in policy and practice, and as part of the global Sustainable Development Goals. UK government-funded research projects now require a Gender Equality Statement even when gender is not a primary focus of the project. Gender mainstreaming in any project is considered to be good practice, including, for example, disaggregation of data, equal opportunity measures, gender-responsive programming, and gendered indicators. This presentation provides information on current gender issues in Myanmar and Vietnam. Based on recent experience within the GCRF-OSIRIS (Optimal Investment Strategies to Minimise Flood Impact on Road Infrastructure Systems in Vietnam) project, the presentation discusses the difficulties in integrating gender-related data into Operational Research and mathematical models to make them gender-responsive. The presentation suggests that gender cannot be integrated into management science tools unless such integration is planned at the outset, and concludes that existing OR tools may need to be adapted, or new specific tools developed to fulfil this purpose.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

03/09/2019, 13:30 – 15:00, Sibson SR4

OR61A43

Plastic: Can we Clean up the Mess?

Veronica Earle & Priyanka Roy (*University of Hertfordshire*)

Plastic is an important and ubiquitous material in our economy and daily lives. It has multiple functions that help tackle several of the challenges facing our society. However, too often the way plastics are currently produced, used and discarded fails to capture the economic benefits of a more 'circular' approach and harms the environment. There is an urgent need to tackle the environmental problems that today cast a long shadow over the production, use, and consumption of plastics. Plastics currently represent 7-20 percent of household waste (Wendling et al., 2018, Jambeck et al., 2015). By 2020, waste generation will almost double if current practices do not change (Gorham et al., 2019). There is an urgent need to concentrate on this issue as plastic pollution is continuously damaging the groundwater sources, human beings, and wildlife. The aim of this research is to investigate the plastic reduction strategy adopted by European and Asia region for the past 20 years. Identify the gap between each strategy and solution implied to recommend potential strategies for developing countries, mainly South East Asian countries, who want to shift from a conventional and costly grow first, clean up later path to a greener trajectory (Wendling et al., 2018). This research will also critically analyse the audit tools currently being used in various organisations and propose a valid audit tool which can be used at the University of Hertfordshire to effectively measure and reduce the usage of single-use plastics. The audit tool will be used for record taking of disposed and unwanted plastic.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A52

Why Geoengineering can save the Planet - A Systems Analysis

Dennis Sherwood (*The Silver Bullet Machine Manufacturing Company Limited*)

Cambridge University's newly-opened Centre for Climate Repair (<https://www.bbc.co.uk/news/science-environment-48069663>) represents an important milestone in tackling the challenges of 'geoengineering' - the invention and development of potentially large-scale technologies that directly affect the atmosphere and the climate, such as attenuating the solar radiation striking the earth, and the removal of carbon dioxide and other greenhouse gases directly from the atmosphere. Geoengineering, however, is not well known: the international treaties, and government policies, focus on reducing emissions, and barely reference geoengineering, if at all. This contribution is a systems thinking analysis of geoengineering, developing causal loop diagrams that illustrate: * The main elements of James Lovelock's Gaia theory, which describes the entire planet as a single, complex, self-organising system... * ...showing why global warming results in increasingly violent storms... * ...so driving a feedback loop resulting in a reduction of the human population, as caused by famine, disease and war... * ...unless man can intervene wisely, and in time, to avert this catastrophe. Two inferences from the causal loop diagram are that (1) A key determinant of the earth's equilibrium temperature is the quantity of greenhouse gases in the atmosphere, which is a stock. Emissions, however, are a flow, implying that reducing emissions has the effect of causing that stock to accumulate more slowly. Reducing emissions therefore slows down the rate at which the earth's temperature increases, but cannot solve the climate crisis problem. (2) To solve the

problem, either the sun's radiation needs to be attenuated, or the stock of atmospheric greenhouse gases needs to be depleted. This is exactly what geoengineering seeks to do: as stated on page 7 of the Royal Society's 2018 report Greenhouse Gas Removal, "It is increasingly clear that reducing emissions is not enough – we must also actively remove greenhouse gases from the atmosphere" (<https://royalsociety.org/~media/policy/projects/greenhouse-gas-removal/royal-society-greenhouse-gas-removal-report-2018.pdf>).

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A263

Multi-Criteria Decision Making: Decision Making for Sustainable Public Lighting Systems

Hassana Abdullahi, Djamila Ouelhadj & Ramazan Esmeli (*University of Portsmouth*)

In the context of sustainability and smart cities, public lighting is considered to have a great deal of economic, environmental and social impacts. These can be seen from the point of view of economic costs, energy consumption, harmful emissions, mobility and community integration. The need to reduce environmental impacts, improve energy security and boost economic competitiveness, researchers establish that energy efficient lighting technologies and their design can significantly impact on street lighting costs and improve other economic, environmental and social impacts. The Smart Light Concepts (SLIC) Project aims to develop a Decision Support Tool (DST) to aid decision makers (policymakers, public lighting authorities, technical expert) in the implementation of the smart public lighting technologies and the selection of optimal actions to take in order to improve the performance of a given public lighting system in different environments alongside a set of multiple conflicting criteria and constraints; operating costs, investment costs, emissions and health and safety. The DST will contribute towards aiding managing authorities towards an increase in the adoption of low-carbon technologies and applications in other sectors that have the potential for a high reduction in greenhouse gas emissions. We present the DST conceptual framework, the multi-criteria decision making optimisation model, and the economic, environmental and social dimensions. Acknowledgement: We acknowledge and thank the Interreg 2seas Mers Zeeen European Regional Development Fund for funding the Smart Lights Concept (SLIC) project. www.smartlightconcepts.eu.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 09:00 – 10:30, Sibson SR4

OR61A99

KEYNOTE: The Sustainable Development Goals: What does OR have to offer?

Honora Smith (*University of Southampton*)

In 2015, the United Nations set out 17 Sustainable Development Goals (SDGs)[1] to transform our world by 2030. These wide-ranging interlinked goals include the dimensions of no poverty, zero hunger, good health and quality education while targeting sustainable cities, responsible consumption, climate action and life below water and on land. The SDGs are an expansion of the 8 Millennium Development Goals (MDGs), set out in 2000 by the World Bank for achievement by 2015. This paper looks back to the Operational Research (OR) contribution to achievement of the MDGs and presents a view of current research focusing on the SDGs.

During the period of the MDG targets, Leroy White and team's 2011 review of OR in developing countries[2] found that OR studies in less developed countries fell into two categories: firstly, standard developed world models reapplied in developing countries, and, secondly, new models with an MDG focus. Developed world OR methods that were well suited to developing conditions included DEA, Systems Dynamics, Optimisation, Locational Analysis and "Soft" OR methods. OR contributions for the MDGs were often focused on healthcare needs, reducing childhood and maternal mortality, and combatting HIV/AIDS, malaria and other diseases, as well as humanitarian logistics. In times when there is increasing world-wide pressure to "save the planet", the SDGs are looking increasingly vital to achieve. It is encouraging to see the Global Challenges Research Fund given such a high priority by UK research funders. Will we continue to apply "Global North" methods to the "Global South" or will the SDGs bring a new focus to OR? This paper concludes with several case studies that show diverse modelling methods particularly suited to the conditions of developing countries, with some novel differences from classical models

[1]<https://www.un.org/sustainabledevelopment/>[2]<https://doi.org/10.1016/j.ejor.2010.02.015>

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A302

Analysis of Food Bank Sustainability in Indonesia using System Dynamics Simulation Approach: A case of FoodCycle Indonesia

Ratih Dyah Kusumastuti & Salsabila Izzati Syalianda (*Universitas Indonesia*)

Foodbank is an organization that obtains food from donor organizations and individuals, proceeds the donated food products at storage facilities and distributes them to the end users, either directly or indirectly via charitable institutions. Foodbanks have been developed in several countries to tackle food waste and hunger problems. This research uses the case of FoodCycle Indonesia as one of the food banks in Indonesia that has been in operation since 2017 in Jakarta. The purpose of this study is to analyze the sustainability of FoodCycle Indonesia using system dynamics simulation approach to identify the factors that influence its sustainability. We develop the initial model based on literature and modify it according to interview results with representatives from FoodCycle Indonesia and its two partners (charitable organizations that redistribute the donated food to beneficiaries). The simulation results show that FoodCycle Indonesia will be sustainable as long as the growth of the food supply is constant, and the organization has the financial ability to support the distribution of donated food to the beneficiaries.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A199

Exploiting System Dynamics to Achieve the Sustainable Development Goals: Synergistic Effects of Nutrition and Antenatal Care on Maternal and Neonatal Health

Nina Zhu & Raheelah Ahmad (*Imperial College London*)

The individual and synergistic effects of health-seeking during pregnancy and maternal nutrition interventions on neonatal and maternal outcomes are needed to make improvements in the Sustainable Development Goals (SDGS), SDG 2 (no hunger), SDG 3 (good health and well-

being), SDG 5 (gender equality) and SDG 10 (reduced inequities). We modelled health-seeking behaviours in Pakistan, where poor maternal and neonatal outcomes persist with wide disparities. A multilevel hybrid Markov system dynamics (SD) model, employing SD to simulate population utilisation of ANC and nutrition interventions and a Markov model to describe individual health-seeking behaviour, was developed and parameterised. The model was used to determine neonatal and maternal mortality for pregnant women according to antenatal care received within a pluralistic health system and two different types of micro nutrients received (iron with folic acid and multi-micro nutrients). Three health-seeking scenarios were tested. Increasing uptake of ANC had stronger impact on decreasing neonatal mortality, while increasing either type of nutrient supplementation was more influential in reducing maternal mortality. The first trimester is the most critical time in both ANC and nutritional intake, if the optimal neonatal and maternal outcomes are to be achieved. SD modelling can guide policy implementation as it allows capture of complexity of health-seeking behaviours and synergetic impact with nutritional interventions. In Pakistan, pregnant women lack access to required micro nutrition from diet alone due to poverty, geographic isolation, and disadvantaged position in household decision-making. By targeting women during the first trimester of pregnancy, and integrating services to provide micro nutrient supplementation and ANC, improvement in maternal and neonatal mortality can be maximised. Simulation of potential impact of multiple interventions by considering structural enablers/barriers to access, cultural contexts and strong social network influences are needed to realise SDGs in eliminating hunger and poverty, improving health, and promoting gender equality.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

04/09/2019, 11:00 – 12:30, Sibson SR4

OR61A273

Citizen-Driven Disaster Management in Smart Cities: The Role of Operational Research and Information Technology

Pavel Albores, Oscar Rodriguez-Espindola & Soumyadeb Chowdhury (*Aston Business School*)

Smart cities are not a new concept. However, disaster management has not been included in the smart cities initiatives. Recent natural disasters have shown the need and potential to harness citizen involvement in disaster management. We argue that citizen-driven disaster management should become an integral part of policies to make cities smarter and more resilient. In many situations of natural disasters, citizens who were not affected by the incident generally make significant efforts to provide relief to those affected (donating food, water, medicines, clothing and any other goods necessary for basic survival; or participating in the rescue, care of victims in the shelters, providing medical attention or distributing the aid, etc.). Unfortunately, they face problems of lack of information, coordination or are subject to logistical restrictions. As a result, their efforts are not as effective as they could be if there were a network that coordinates these efforts and directs the help to all the places where it is needed. This project studies the way in which Operational Research and Information Technologies can be used for the generation of citizen networks that serve as a support to increase the effectiveness and timeliness of efforts aimed at providing assistance to citizens affected by a natural disaster. A framework of the different stages of disaster management and potential OR and IT techniques is presented. This is illustrated through a case study of earthquake response in Mexico.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? A little
Is your talk accessible and relevant to practitioners? Very

OR61A193

Optimizing Pre-Earthquake Mitigation Measures to Improve the Efficiency of Evacuation Operations

Betul Coban, Maria Paola Scaparra & Gabor Nagy (*University of Kent*)

The O.R. literature on disaster operation management (DOM) is very vast, as evidenced by the numerous review papers published on this topic. Traditionally, there are four DOM stages: mitigation, preparedness, response, and recovery. Most existing papers have addressed problems in each DOM stage separately, whereas only a few studies have considered integrating operations in different stages. However, pre- and post- disaster activities are not completely independent from each other in the disaster cycle. We propose an integrated optimisation model for selecting mitigation projects by considering their impact on post-disaster evacuation operations. As resources for pre-disaster operations are typically quite limited and strengthening the entire transportation network, all buildings and facilities is not financially viable, it is crucial that mitigation investments are optimised to achieve maximum post-disaster response efficiency. The model aims at identifying the best mix of three different types of retrofitting projects to enhance community resilience against earthquake disasters. Specifically, mitigation measures include (1) road network projects to reduce transport system vulnerabilities, (2) building projects to reduce the number of casualties, and (3) critical facility (e.g. hospitals) projects to increase the hospitals resiliency and preserve their capacity. Road conditions directly affect the delivery of time-sensitive services after an earthquake as the evacuation of people from the affected areas. The implementation of type 1 projects affects the survival status of roads in the aftermath of an earthquake and, consequently, has a clear impact upon the evacuation of people. Type 2 projects have an impact on the resilience level of buildings and therefore affect the number of injured people who need to evacuate to hospitals. Finally, type 3 projects affect the structural resilience of hospitals and, consequently, their service capacity. Overall, the model aims at identifying optimal mitigation strategies to maximize the efficiency of evacuation operations and minimise losses.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? Some
Is your talk accessible and relevant to practitioners? Relevant

OR61A144

Modelling Secondary Disaster Effects and Roadway Network Uncertainty in Routing Disaster Relief Shipments

Qorib Munajat, Konstantinos Zografos & Juliana Sutanto (*Lancaster University*)

The timely distribution of disaster relief supplies is crucial for the post disaster support of communities affected by large scale natural disasters. A problem frequently arising in disaster relief distribution operations is the dynamically evolving condition of the roadway network due to secondary disaster effects. For instance, a tsunami generated following an earthquake may render parts of the underlying roadway network impassable. Therefore, it is important to develop routing models to capture this important feature of the disaster relief distribution problem. To meet this requirement, we propose a dynamic vehicle routing problem and we employ continuous re-optimization using Variable Neighborhood Search (VNS) heuristic

algorithm to minimize disaster relief delivery time and unmet demand. We report results from the application of the proposed model and the associated solution algorithm using realistic size problem instances.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A45

Shelter Location and Evacuation Routing: A Meta-Analysis Approach to Develop Real-World OR Models

Annunziata Esposito Amideo, Maria Paola Scaparra & Kathy Kotiadis (*University of Kent*)

Shelter opening and evacuation of vulnerable populations are key activities within disaster response, one of the four phases of the Disaster Operations Management. Optimization (and, more broadly, OR) has attempted to capture several issues related to shelter location and evacuation routing through the development of different models over the years. Nevertheless, despite advancing the knowledge of this research area, such models are not yet comprehensive. Hence, the aim of this work is to define the challenges currently emerging to devise real-world optimization models combining the shelter location and evacuation routing problems, and eventually outline a road-map for future research in this area. Existing disaster management surveys are analysed and cross-compared in terms of research focus, journal outlets, time-frame, state-of-the-art, and future research suggestions. Then, a critical analysis of the most recent combined models is provided, including insights from the authors of the existing papers, gained through a questionnaire as a supplemental validation tool. The analysis highlights numerous gaps and research opportunities, such as the need for future optimization models to involve stakeholders, include evacuee behavior (e.g., evacuee demographics, warning signals) as well as system behavior features (e.g., congestion, fairness), be application-oriented rather than theoretical or model-driven, and, most importantly, interdisciplinary.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

04/09/2019, 15:30 – 17:00, Sibson SR4

OR61A278

Optimal Location of Large Hydropower Dams in the São Francisco River Basin, Brazil: Balancing Renewable Energy and Environmental Impacts

Jesse O'Hanley (*University of Kent*)

Hydropower is expected to rapidly increase in many areas of the developing world (e.g. the Amazon, Congo, and Mekong basins). Although renewable energy is vital to reducing poverty and supporting economic growth, hydropower is far from being a "green" option. Dams disrupt the natural connectivity of rivers, often leading to the loss of aquatic biodiversity and negatively affecting poor, rural communities dependent on subsistence fishing. To support eco-friendly hydropower planning in developing regions, a mixed integer linear programming model is presented for optimally locating dams in order to balance tradeoffs between hydropower generation and migratory fish species richness. The dam optimisation model incorporates two special features. First, it is tailored to the dispersal of tropical migratory fishes, which require long, unimpeded river stretches to complete their life-cycle. Second, it combines decisions about dam placement and removal, thus facilitating opportunities for hydropower offsetting.

We apply our model to the São Francisco River basin, Brazil, an area of hydropower-freshwater biodiversity conflict. We find that dams have reduced weighted migratory fish richness 51% compared to a pre-dam baseline. Moving forward, optimising new dam sites to increase hydropower by 20%, rather than selecting the fewest number of large megawatt dams, could reduce fish species losses by 89%. When decisions about locating new dams are combined with removing a few existing dams, a win-win can even be achieved with 20% greater hydropower and 19% higher species richness.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A206

Impact of the Government's Subsidy Policy on Environmental Quality and Land Price: A Case Study of Nottingham, the United Kingdom

Trung Hieu Tran, Yong Mao & Peer-Olaf Siebers (*University of Nottingham*)

The project of "Sustaining urban habitats: An interdisciplinary approach", funded by Leverhulme Trust, has addressed the issue of maintaining sustainable cities and communities, one of the 17 sustainable development goals set out by the United Nations. In the project, we have built an integration of agent-based model and mathematical programming to capture and train the attributes and behaviors of agents (e.g., citizens, households and firms) in response to the government's policy change, and to suggest the appropriate policies for an urban sustainable development. In this paper, we introduce the application of this integrated model to investigate the impact of the government's subsidy policy on the quality of living environment and land price under the typical behaviors of firms (i.e., manufacturing and service) and employees (i.e., low-/high- income). A case study for Nottingham, the United Kingdom is used to demonstrate the effectiveness of the proposed model. In addition, the predicted simulation results for Nottingham in 2050 are provided to support strategy planners in finding the appropriate policies.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A203

A Framework for Life Cycle Sustainability Assessment of Environmental Impact of Energy Production

Ken Cheng (*University of Kent*)

Sustainability studies in operational management is developed on the basis of integrating environmental and social concerns into corporation management. This idea was developed into the triple bottom line considering three aspects from people, the planet, and profit. However, operations researches have assumed a base-line to guarantee the continuation of activities even though all management activities to some extent interact with the natural environment. This interaction is especially apparent in energy production. Hence considering from the perspective of energy flow, environmental sustainability should be considered from more physical basis in energy production process. Based on this, a new assessment level in the production framework is considered holding chronological process of energy production activities. This work there on, describes this framework for sustainability assessment from the physical view and the analyses how the classical sustainable assessment in operational research can then be rested.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Somewhat

OR61A191

A Decision Support Tool for Long-Term Flood Mitigation Planning in Urban Areas

Siao-Leu Phouratsamay (*Kent Business School*), **Trung Hieu Tran** (*University of Nottingham*) & **Maria Paola Scaparra** (*University of Kent*)

It is widely documented that flood and extreme rainfall events have surged dramatically in the last few decades, causing massive economic and life losses in vulnerable countries. Due to climate change and fast urbanization, it is estimated that the number of flood events and their intensity will keep growing at an even faster rate in the next decade. To respond to this emergency, the number of academic studies focusing on flood risk management has grown significantly in recent years and the topic has raised the interest of researchers in a wide range of disciplines. This talk describes the work conducted within the GCRF project "Optimal Investment Strategies to Minimize Flood Impact on Road Infrastructure Systems in Vietnam" (GCRF-OSIRIS), a project funded by the British Academy within the Cities and Infrastructure Programme. The project brought together academics from different disciplines (e.g. hydrology, climatology, transport economics and operational research) and government stakeholders (e.g. the Vietnam Ministry of Transport) to develop a scientific tool to drive future flood mitigation planning decisions. The core of the tool is an optimisation model that identifies the optimal mix of mitigation strategies to minimise infrastructure damage and traffic congestion due to flood events of different intensities. The proposed mixed integer programming model uses results from flood event simulations to determine long-term planning of flood mitigation measures so that both criteria (damage and congestion) are optimised. We assume that a limited budget is available in each time period. We develop a GRASP heuristic approach to solve large scale instances of this problem and provide an experimental analysis using real data for Hanoi, the capital city of Vietnam. The solution approach is integrated into a decision support tool to facilitate its use by policy makers and urban planners. A demonstration of how the tool works will also be presented.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

Sustainable Supply Chain Management



Organisers: Adolf Acquaye and Andrea Genovese

05/09/2019, 11:00 – 12:30, Sibson SR3

OR61A98

Preventing Empty Batteries in the Route Planning of Electric Trucks

Marcel Turkensteen & Sune Lauth Gadegaard (*Aarhus University*)

Electric trucks have the advantage that they generally pollute less than diesel trucks: Local pollution is largely avoided and, depending on the electricity mix, greenhouse gas emissions can be reduced as well. However, in order to enable transport with electric vehicles, one should ensure that a planned route includes charging stations where the truck's batteries can be replenished. This is necessary, because charging takes time and because charging stations are not abundant. Current planning approaches for this planning problem, the so-called Green Vehicle Routing Problem, compute the shortest routes for electric vehicles, while ensuring that trucks reach charging stations before the battery is empty. The power usage is typically deterministic in these approaches. However, power consumption can vary with driving conditions and is therefore hard to predict precisely, even with extensive vehicle and driving data. One way to address the uncertainty in the power usage is by having a buffer on the battery in the planning. The question is whether such a buffer reduces the likelihood that an empty battery occurs before reaching a charging location (or the driver has to take corrective action to prevent this), and whether it increases the driven distance strongly. In our study, we determine the consequences of setting different buffer capacities for the battery through numerical experiments. We generate instances with both random and actual locations and solve them for different battery buffer sizes. Then, we simulate the likelihood of running into an empty battery by varying the driving conditions along the obtained routes artificially. Our preliminary results indicate that for some instances, a limited buffer could reduce the likelihood of an empty battery significantly with a small distance increase. We determine whether this holds true for different geographies, sets of charging locations, and constraints to the routes.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Somewhat

OR61A268

Sustainable Supply Chain Performance: Do Organizational Culture and Supply Chain Integration Really Matter?

Martin Osei, Thanos Papadopoulos & Adolf Acquaye (*University of Kent*)

Organizational culture and supply chain integration have been found to exert an influence on sustainability performance. However, research on the relationship between the concepts is not

forthcoming. This study addresses this gap by examining the impact of organizational culture on sustainable supply chain performance and assessing the mediating role of supply chain integration. In particular, this study examines the relationship between organizational culture and sustainable supply chain performance, organizational culture and supply chain integration, supply chain integration and sustainable supply chain management and lastly, the mediation role of supply chain integration on the relationship between organizational culture and sustainable supply chain performance. In this research, organizational culture is operationalized through the use of competing value framework which categorizes culture into developmental, group, rational and hierarchical culture. In this study, it is hypothesized that, the elements of organizational culture positively influence economic, environmental and social performance of firms. Moreover, it is hypothesized that supply chain integration will exert a complete mediation between the organizational culture and sustainable supply chain performance. The study will be conducted in the food and drink manufacturing industry in the United Kingdom and the list of firms were obtained from the FAME database. An online questionnaire will be sent to the firms and the hypotheses will be tested through the use of structural equation modelling. This study contributes immensely to supply chain literature by suggesting that firms with the right culture need a solid internal, customer and supplier collaboration to effectively implement sustainable supply chain practices to increase economic, social and environmental performance.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A182

Reconceptualising Sustainable Energy Portfolio Diversification in Energy Mix Planning

Charles Turkson, Wenbin Liu & Adolf Acquaye (*University of Kent*)

Policy-makers make long-term energy generation decisions by considering the cost and risk associated with various generation technologies in a portfolio optimization model. Portfolio theory has therefore seen wide application in energy literature for risk diversification by generating an optimal portfolio of technologies. Awareness of environmental and social impacts of energy generation throughout its supply chain has resulted in the incorporation of sustainability as relevant concern in such energy mix planning decisions. Consequently, traditional approaches to such cost/return-risk analysis have added external and environmental costs dimensions to operational (economic) costs in the analysis to cater for sustainability. It is shown in this study that combining the various cost dimensions using an additive relationship erases the relevance of some of the dimensions therefore making some dimensions more important than others resulting in optimal portfolios which are inconsistent with sustainability. In this study, we argue for the use of multiplicative relationship between the dimensions to reassess how environmental and external cost components in the generation cost can be combined with operational costs. We explore the impact of interaction and other relationships between the various components on the technology ranking and the optimal portfolio. Data envelopment analysis is employed in examining the impact of the relationship between the cost dimensions on the technology ranking. The mean variance-framework is then used to construct and the optimal portfolios based on the different dimension relationships. The result is the selection of generation portfolios that are more consistent with sustainability consideration.

What is the nature of your talk? A mix
Does your talk require prior knowledge of the subject area? Some
Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 13:30 – 15:00, Sibson SR3

OR61A231

A Literature Review of Circular Economy Indicators at a Supply Chain Level

Tommaso Calzolari & Andrea Genovese (*University of Sheffield*)

The increasing interest of policy makers in promoting sustainable development of production and consumption systems, highlights the necessity to measure in a rigorous way the transition towards the Circular Economy. This literature review aims at recognizing and classifying all the indicators and measurement systems that have been developed with the aim to track the transition towards a Circular Economy in a supply chain context. The intention is also to survey applications to real cases, in order to assess the level at which a supply chain is able to reduce its waste streams through various interventions, converging towards a closed loop system, where products and materials are recovered before becoming waste. This will be done with the method of systematic literature review, considering both the academic and the grey literature. Key findings include the identification of a restricted set of key performance indicators, which could be utilised by practitioners and policy makers for keeping track of the effectiveness of Circular Economy interventions at a supply chain level.

What is the nature of your talk? Theoretical
Does your talk require prior knowledge of the subject area? Some
Is your talk accessible and relevant to practitioners? Highly

OR61A131

Policies for Inventory Models with Product Returns Forecast from Past Demands and Past Sales

Chee Khian Sim (*University of Portsmouth*)

We consider a finite horizon, periodic review inventory system that remanufactures a type of product from two types of core: buyback cores and normal cores. A model for returns of buyback cores forecast from past demands (Model A) and that for returns forecast from past sales (Model B) are proposed. We obtain an optimal inventory policy with a simple structure for the system with Model A. For Model B, a feasible inventory policy for the system is proposed instead, as its optimal inventory policy is unlikely to be tractable. The proposed feasible inventory policy is closely linked to the optimal inventory policy for the system with Model A. We derive a theoretical result that quantifies the closeness of the feasible policy to optimality, with further numerical results that show how the system cost under the feasible policy compares with the optimal system cost.

What is the nature of your talk? Theoretical
Does your talk require prior knowledge of the subject area? Quite a lot
Is your talk accessible and relevant to practitioners? Somewhat

Systems Thinking



Organisers: Gerald Midgley, Giles Hindle and Angela Espinosa

03/09/2019, 11:00 – 12:30, Sibson SR6

OR61A354

Deeper Systems, Wider Practices: A Workshop to Explore the Application of Systems Tools to 'Grand Societal Challenges'

Joe Ravetz (*University of Manchester*)

This workshop is a path-finding exploration of an emerging landscape. Many human problems contain a 'deeper' complexity, with different systems overlaid and contested (social, technical, economic, political etc). To understand and respond we need a 'wider' set of methods and tools and stakeholder roles. But there are many ways to structure the problem and many methods in response. So this workshop aims at least to start a process of meta-mapping and meta-design. Aims: a systematic review evaluation & comparison of different methods / tools, in application to a selected range of problems / challenges. Methodology: this is based on recent experience with the Synergistic '4-S' method with 'visual co-creation'. (The Synergistic method combines various approaches, including SSM, ANT, PSM, CLA, ALS etc, with a focus on the co-creation of 'collective systemic intelligence') Beforehand: participants will be asked to prepare a ½ page summary outline: a problem / challenge they are working on, and a systems-type method / tool which they are using. This summary could include both text, concept diagrams and visuals if available. At the start, participants cluster in tables, and select a case study problem / challenge for joint exploration (this can be changed if needed). Each participant has a role to play, either as a 'actor' in the problem, or as 'vector' testing methods & tools in the 'meta-system'. The process is based on the Synergistics methods and tools, and includes 4 stages: 'systems' analysis of the present and problem / challenge: 'scenarios' for alternative futures: 'synergies' for future potential and vision: and 'strategies' to achieve or mobilize the selected goals.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Quite a lot

Is your talk accessible and relevant to practitioners? Very

03/09/2019, 13:30 – 15:00, Sibson SR6

OR61A355

Learning Loops in the Public Realm: Implications for Systems Analysis and Design

Joe Ravetz & James Evans (*University of Manchester*)

Management of the urban environment is often complex, controversial, multi-level and multi-sector: features which call for system thinking in an OR context. This paper reports on current research from the JPI project 'Looper' (Learning Loops in the Public Realm)

(<http://looperproject.eu/>). The project has set up Living Labs in three cities (Brussels, Manchester, Verona). The learning loops are based on citizen led environmental monitoring, with information then fed into co-design of various interventions, with loops for both community learning and policy learning. In the background are three strands of social science: Social / organization learning theory, systems cybernetics and 'collective local intelligence' Local government theory and the challenge of democratic public participation. Civic co-design and co-production in the urban environment. There is also the added technical challenge in citizen-based monitoring and data analysis: The paper builds on the front line work, to explore the application of system cybernetics in the context of a 'collective local intelligence'. This raises a challenge of 'framing', i.e. to define the appropriate level of problem, the actors and the solution space: for instance, local traffic congestion might be framed in terms of engineering, gentrification, or social use of space, at different levels of space or time. Another challenge is that of 'conflict / controversy', where benign cooperation may be lacking: if learning leads to 'intelligence' then it seems crucial to define who is learning what, where and why. The paper aims to analyse this experience, and then to suggest practical ways forward for this very topical issue.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

03/09/2019, 16:30 – 18:00, Sibson SR6

OR61A338

KEYNOTE: Transformative Collaboration: Towards Sustainable and Equitable Food, Water and Energy Futures

Ariella Helfgott (*University of Oxford*)

The transformations required in global food, water and energy systems to sustainably and equitably meet the needs of a growing population, in the face of significant environmental change, are immense. Systemic transformation calls for multi-actor collaboration and systemic approaches. However, we live in a divisive era, societies are increasingly fragmented and politics increasingly polarized, making collaboration for systemic change increasingly difficult, and at times seemingly impossible. Can we find new ways of working together with people with diverse values and viewpoints from our own - some of whom we might not agree with, like or trust - in order to address our most urgent challenges? In this talk I describe experiences of transformative collaboration in food, water and energy systems around the world through a number of CCAFS and EU research programs; and through my work on energy transitions with Shell. These programs involve innovative use of visioning, back-casting, scenario planning and games. My aim is to provide practical methodological frameworks, and to motivate the open and humble mindsets and behaviours that are essential, not just to these frameworks working as intended, but also to our shared capacity to create better futures.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 09:00 – 10:30, Sibson MBA

OR61A148

The Innovative Food Systems Teaching and Learning (IFSTAL) Programme: Our Experiences of Creating Future Change Agents in Higher Education

Harley Pope (*University of Reading*)

The Innovative Food Systems Teaching and Learning (IFSTAL) Programme is a consortium of five higher education institutions in the UK. Since 2015, it has helped create an alumni network of participants who have received food systems thinking and professional skills training with the aim of helping them become future change agents within the food sector. As a voluntary, interdisciplinary, and non-assessed teaching and learning programme, IFSTAL has had to reflect hard on how to create and deliver training in food systems thinking to a non-technical audience in engaging and effective ways. Moreover, since its inception the programme has found itself in an increasingly busy marketplace as the use of the term 'food system' has become more prevalent in academic and policy discourse, and education providers are competing to offer their own versions of 'food system' courses. Now entering its fifth year, we reflect on the lessons we have learnt on teaching and facilitating workshops on food systems thinking, and the ramifications of how often food system training fails to incorporate some element of systems thinking. By undertaking a boundary critique of the programme, and investigating the values that underpin it, we demonstrate ways that training workshops and food systems pedagogy can be adapted to engage and support participants from a wide variety of contexts in whatever journey they find themselves on.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A48

Murder on the Academic Express

Dennis Sherwood (*The Silver Bullet Machine Manufacturing Company Limited*)

"Universities told to end 'spiralling' grade inflation." That's the headline to a BBC news item (<https://www.bbc.co.uk/news/education-46604765>), just one of many reports about the steady year-on-year increase in the number of 1sts and 2:1s awarded by universities in general, and some universities in particular. But is this data evidence of 'spiralling' grade inflation? Or of steadily better achievement, resulting from better university courses, better teaching, more conscientious students, and a higher quality of university admissions, itself resulting from better courses, better teaching, more conscientious students at schools? For the last few months of 2018, the debate raged. But this debate is not new. A similar debate raged a few years ago as regards GCSE grades - a debate to which the author made a significant contribution resulting from a systems thinking study which was material in causing the exam regulator to 'draw a line in the sand' to intervene, causing GCSE grade inflation to cease. This presentation is about that study: the systems thinking, the effect on policy and the decisions taken; it is also about the relevance of the study to the university debate - what are the systemic similarities between school exams and university exams, and what are the differences? But most importantly, this presentation is about the validity of evidence. What is 'evidence'? And, if it can be shown that certain 'evidence' explains actually observed behaviour, does that imply that this evidence is a true explanation of what is going on? And hence used to determine policy? At the end of Murder on the Orient Express, Hercule Poirot gives two, very different, explanations of the murder. Both explained the observable facts. But it was impossible to

'prove' either. Is 'grade inflation' a similar problem? A problem with two, perfectly plausible, but very different, explanations, neither of which can be 'proven'?

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A294

Towards an Integrated Vision for Systems Thinking

Andrew Basden (*University of Salford*)

Systems theory has many roots and many branches. What is the 'trunk' that we call "systems theory"? Is it to do with things and their parts, things and their 'purpose', things in their environment, and the processes involved, including autopoiesis? Is it to do with boundaries, with *Weltanschauungen* as Soft Systems Thinking proposes? How may we resolve the conundrum in social systems theory, that each social individual system is the environment for the other? How does the idea that 'the system' imposes unwarranted constraints on people's lives fit into systems theory, in which we are inside the system rather than being the system? How is complexity manifested in physical, biological, psychological, technical and social systems? What is the normativity of systems? How valid is it to reduce this to the Critical Systems idea of emancipation? And how do all these issues work out in practice, especially in the challenges that face us (e.g. environmental)? This paper discusses how the philosophy of Dooyeweerd might cast new light on these issues. Dooyeweerd approached philosophy from a unique direction, questioning many of the presuppositions that usually deeply underlie much current systems thinking. In place of entity or process, emphasis is given to meaning. Dooyeweerd emphasises everyday experience and its diversity and coherence, which gives that which is rooted in his philosophy an holistic, practical flavour. As a result, it might be possible to identify the 'trunk' of systems theory in which all the roots and branches come together. This will be done from the perspective of practical situations.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Quite a lot

Is your talk accessible and relevant to practitioners? Very

OR61A149

Rapid Problem Structuring with the BigPictureCanvas – A Simple and Efficient Way to Improve Shared Views of Complex Challenges

Andreas Hieronymi (*University of St. Gallen*)

Decision-makers in a VUCA world (an environment of volatility, uncertainty, complexity and ambiguity) face questions such as: Are we addressing the right problem? Do we agree on the relevant parameters and perspectives to address the problem? How can we avoid neglecting critical problem features in times of change? "Problem structuring" has been promoted, among others, by Rosenhead and Mingers (2001), and its value is widely acknowledged in academia. However, the transition to practice involves some challenges, such as how to embed these activities within the busy schedules of companies and governmental settings. Problem structuring must be time-efficient and easy to communicate in order to gain wider adoption across different fields and levels. To achieve this efficiency and ease of communication, a new framework is proposed, called BigPictureCanvas. It is a structured map that provides an overview of critical aspects of a problem space. The framework involves several dozen aspects

in six large categories, relevant for systemic and interdisciplinary problem-solving. While a traditional and linear approach would be possible, a more agile and iterative approach is suggested. A first iteration of the BigPictureCanvas takes less time than a typical business meeting. Further iterations and elaborations can be done when new events and changes occur. Additional training equips a group to select specific methods that best fit their problems and projects. The BigPictureCanvas has a broad scope, but is still user-friendly; it allows people to look at a problem from many different angles, without being overwhelmed by too much information. It further reduces the risk of blind spots before turning towards solutions. Additionally, it simplifies the comparison of different perspectives of problems and communicating complex projects to a wider audience. The proposed framework is in an early research and development stage and will undergo further improvement. Feedback and critique are welcome.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 09:00 – 10:30, Sibson SR2

OR61A314

“Quantum” Leaps of Complexity of Large-Scale System which is Included in Constantly Complemented Reality

Dmitry Reut (*Bauman Moscow State Technical University*)

The digital economy arose as a range of emergent results of scientific and technical progress and shows prompt and poorly controllable development. The mankind is not ready to solve this problem. We even do not understand the nature of the phenomenon created by us. Digitalization of daily occurrence imperceptibly led to arising of hybrid reality. It is a product of human activity. The hybrid reality is the dynamic essence which is being created in each timepoint by an incalculable set of acts of human activity. The hybrid reality is a set of perceptual reality and virtual reality which consists in the relation of continuous simultaneous mutually generation. The perceptual reality is perceived by our sense organs without means of channels of mass information and communication at present. The virtual reality is perceived by our sense organs only by means of the specified channels. We approximate these realities by corresponding spaces. Real economic activity arose and develops in perceptual space. The virtual space arose in the course of digitalization of daily occurrence. It represents the model of virtual reality. Subjects of activity from perceptual space can be projected in virtual space in the form of the community being ordered according to domain names and practicing network communication. Subjects and objects of perceptual space can have projections in virtual space and vice versa. Interventions in perceptual and information spaces can be weaved into chains of consecutive and parallel operations directed by vast sets of activity subjects. “Quantum” leaps of complexity of the global system happens unpredictably. The subjects of communication randomly distort information flows because they act in their own interests. They lower stability of the global system, perhaps, to critical level. The control system of digital economy has to be able to hold the global system in a safe evolutionary corridor.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A301

Stress, Feedback, Control and Learning

Tony Wright

This presentation describes a project which explores the question: What is the relationship between stress and learning? Its purpose is to develop (in Gregory Bateson's terms) 'a pattern which connects', in this case a pattern which connects stress to learning. I reasoned that our feelings of stress might be some sort of indicator (possibly as a kind of feedback) to guide us through life, giving us a sense of our state of wellbeing at any particular time. Taking a human being as a relevant transformation system, and applying the standard goal-oriented, feedback and control, single loop learning model, proved inadequate to represent this process. However, this led to the development of a higher level co-evolutionary learning model, in which a human being and its environment are both inputs to, and outputs from, a higher level transformation process. At this level, the relevant transformation system becomes the system of interactions between a current human being and its current environment, from which a human being is continually emerging as a new being; thus a human being is always in a state of becoming. Likewise, its environment also emerges changed by these interactions. From the perspective of human beings, this system is partially controlled by the interactions between mind, body and emotions which, mediated by our stress levels, enable us to learn to navigate our way through an ever-changing environment. At its root is the stress response to our experience of difference throughout our lives. This model of co-evolution can be used to represent human activities at all levels of organisation, from the personal to the planetary, and poses questions about how we might deal with the predicted effects of climate change on the sustainability on the human race.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

OR61A293

Diagnosing Problems in an Evolutionary System

Anita Murray-Jones (*Dstl*)

It is understood that systems evolve over time either consciously (for example, to meet a new need) or unconsciously (for example in response to new people or personalities being introduced into the system). Systems generally not designed to ensure evolution is integrated into the system, lacking the built in self-awareness mechanisms to understand when systemic change has happened and to respond accordingly throughout the system. This work investigated a system for reporting incidents to understand the risks to an organisation. A number of changes, including a large organisational change had occurred. The systems owners questioned why people were not following the processes laid out in policy, which although overly detailed, appeared to be substantially sound in terms of mechanics. Systems techniques were employed in order to indicate problem areas. For instance the application of the Viable Systems Model showed that there was a lack of any management activity considering delivery across the entire enterprise (operational management). However the key to diagnosing the issues was the analysis of a broad range of perceptions from those involved in the system to understand why there appeared to be no operational management layer. This showed there was a lack of common understanding of the system, impacting on aspects such as: The purpose of the system, affecting the emphasis and focus of activity for the rest of the system; The roles and responsibilities of key organisations in the system; and The importance

of undertaking key activities such as analysis of incidents. All these issues could be traced to the changes that had been made over time which showed that the systems wasn't being considered or managed as a system over time. © Crown copyright (2019), Dstl. This material is licensed under the terms of the Open Government Licence.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A167

Re-Incorporating Subjective Empiricism in Systemic Intervention Theory and Practice

Louie Gardiner (*University of Hull*)

Neither by intention nor design Through my research I find myself confronting the fragmenting, abstracting nature of the philosophy of science and traditional approaches to research. Given the unusual nature of my undertaking and its surprising outcomes, I have found it impossible to distil what is encompassed within its pages, into a single title – two complementary phrases are needed; the first as per the title for this session; and the second, speaking to non-academicians: "Attending, responding, becoming ~ living, learning inquiry in a naturally inclusional playspace" In short, I am presenting a challenge to academia by illumination: what 'becomes' when we attend and respond, beyond design? What potentialities are unleashed when we use the full dimensionality of ourselves as researchers not abstracted from the research process, but as the primary research instruments who are simultaneously holding the research and being changed by it? Becoming flow, in space in time. Who would have thought that undertaking a PhD would catapult me into a form of expression that previously had had no fascination for me? Overwhelmed by the monumental magnitude of reading that loomed ahead of me, I found myself communicating through diverse modes of expression I have come to name 'statewaves'. Most surprisingly, I found myself turning to 'Aesthetic-Poetic' forms that augmented my intellectual, visual and embodied expressions, with which I was more familiar. During my doctoral years, my Aesthetic-Poetic has given birth to 33 poems – some deeply personal; and some expressing my synthesis of the complex material I was encountering. My 'Navigator-Narrator' guides my flow through the turns and tumbles of my 'Intellectual-Theoretic' grappling with abstract, alien constructs. The fruits of this, find form and illumination through novel 'Visual-Kinaesthetic' expressions. Through these State-waves I shall convey the emergent, re-incorporating, essence, content, form and outcomes of my living, learning research process.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 09:00 – 10:30, Sibson SR3

OR61A89

Methodological Inefficiencies for Investigating Digital Strategy; Application of Appreciative Systems Models for Longitudinal Studies

Behrooz Golshan, Patrik Elm & Anita Mirijamdotter (*Linnaeus University*)

Strategic Information Systems research has faced a significant methodological shortcoming in recent decades. That is, while scholars appreciate the systemic nature of effects and consequences of digital technologies on operational and competitive environments, and the

two-way relationship between investments in digital technologies and strategic moves are well emphasised, mainstream analytical approaches fail to grasp and implement those fundamental assumptions. Consequently, cumulative research does not provide comprehensive contextualization and theorizing the implications of emerging digital technologies on digital transformation of organizations, markets and industries. Investigating the process of digital transformation in an insurance company through the lenses of the Appreciative Systems Models for over eight years, we believe that the model can serve as the philosophical underpinning to devise new analytical models for investigating strategic information systems in a holistic perspective. The model starts with two stranded ropes that depict the constant flux of events and ideas in the day-to-day life. Actors perceptions of such events and ideas could lead to interventions, or actions, that are justified through judgments and standers. The key point here is that both appreciations and actions affect not only the future flux of events and ideas, but also standards and values that future appreciations would be judged against. In the contexts of digital transformation, the flux of events and ideas represents technological innovations, disruptions and other emerging factors that shape the operational and competitive environments. Appreciations represent strategic intents that are formed by the managements perceptions and judged by the firms experience in acquiring and leveraging digital technologies. Actions represent business model reconfigurations in order to execute strategic intents. Using this model to develop a timeline based on each time that the organization undergo a change process, could help scholars, and practitioners alike, better understand emerging strategic intentions against the organizational technological and strategic know-how.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A358

Complexity Management and Multi-Scale Governance: A Case Study in an Amazonian Indigenous Association

Angela Espinosa (*University of Hull*)

Even if Community Operational Research provides methodologies and tools to support community development, there are no published works illustrating how we can support an assessment of self-governance in an indigenous community using COR tools. In this paper we present exploratory research to provide such support to an indigenous association in the Amazon jungle. To address issues of multi-culturalism, we used a creative choice of methods, which included elements of boundary critique, the Viable System Model, rich pictures and social cartography research. We explore the possibilities that this mixed methods approach to COR offers to clarify the core dilemmas and paradoxes of self-governance for sustainability that such communities are facing. The analysis is done through VSM mapping of the community, at different levels and scales of organisation. Our analysis reveals key paradoxes and dilemmas of self-governance, which is helping them to collectively decide on action paths and their needs to (re) develop certain adaptive capabilities. In particular, we show that loss of power from traditional (spiritual) authorities, and loss of rituals and other cooperative practices have negatively affected indigenous ways of implementing life plans and respecting sustainability principles. This research contributes to COR, in presenting an innovative application of the VSM in an indigenous community, supported by expert facilitation, as the basis for reflecting on their self-governance challenges and acting upon them. It takes into account a more critical and

ethnographic approach to research, capable of better dealing with the variety of a multi-cultural context.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A67

Beyond Command and Control

John Seddon (*Vanguard*)

Humankind invented management; we can change it. Command-and-control management is the primary cause of sub-optimisation; organisations that change to a systems-based organisation design achieve outstanding economic and human results. Leaders who cross that Rubicon can't go back. John will describe the means by which leaders cross the Rubicon. Unusually the change requires no plans or cost/benefit analyses; instead it requires leaders to study their organisations as systems in order to learn counterintuitive truths. As a consequence leaders develop an organisation design based on systems principles, the most important of which focus on the means for control. John will illustrate how better controls result in far superior economic performance and, as a by-product, a tremendous impact on employee morale. The practical examples will be drawn from public- and private-sector service organisations.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A257

Performance Management on Performance Trees

Yu Ye (*University of Kent*)

Issues in the area of Performance management (PM) are typically complex and multidimensional, but both academic research and practical application tend to be based on simplified and partial settings. Although simplification makes the research easier to carry out, and explicit and simple construction of the PM Models bring "easy -to - use" in a practical application, but they have come to a price of increasing ambiguity and restriction in research and application for different contexts. To help mitigate these issues, this study puts forward the performance tree (PT) management framework as a research tool even a practical approach for describing and managing the structure and operation of organisational performance generation and management systems in a more holistic manner. Based on the critical realism (CR) paradigm and its causal mechanism theory, the framework was developed from the relevant literature and from our observations in case studies and experience. In particular, it elaborates the performance generation and management processes into a performance network and performance tree based on causal chains. Grounding on analysis of the underlying performance generation process, the PM is mainly to manage key factors in it by certain mechanisms that suit the actual situation of the organisation. The study also finds the global coordination in an organisation is an essential mechanism for PM. Anecdotal evidence suggests that the PT management framework provides a useful research tool to widen and deepen scope for studying the design and operation of a performance management

system. Meanwhile, it also can be used to develop new PM model for the business and industry who are eager for a more effective PM approach that is different from the existing ones.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 09:00 – 10:30, Sibson SR5

OR61A296

Systemic Intervention in a Food Bank: Negotiation Strategies to Obtain and Retain Donors

Alex Ricardo Murcia Cucaita & Luis Arturo Pinzon Salcedo (*Universidad de los Andes*)

In the last years, the problem of food loss and waste has taken surprising values around the world. In Colombia, one-third of the food produced for human consumption is lost or goes to waste. This paper presents a systemic intervention in a food bank, an organization that receives all its raw material and workforce under the modality of donation. Using systems thinking tools such as Soft Systems Methodology, the different perceptions of the current situation were used to identify leverage points to improve the functioning of the Bogota Food Bank and present a more structured problem. After presenting a conceptual model, a group of feasible strategies has been proposed so that we can generate impact in vulnerable populations (hunger problems) and improve the indicators of the problem of food loss and waste. Finally, the author presents the initial results of a donation network that includes different stakeholders in the mentioned problem.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A125

Exploring Drivers and Challenges for Ageing Society Regarding New Technologies Using Systems Thinking

Sarfraz Iqbal & Paivi Jokela (*Linnaeus University*)

Ageing is an unavoidable and complex phenomenon. In order to obtain a holistic, systemic view of the ongoing process of integrating new technologies in the health development, two complementary paradigms should be taken into account: curative (pathogenesis) and preventive (salutogenesis) health care. The curative perspective focuses on supporting the caregivers, cooperation between caregivers and exchange of information between caregiver and patient. The health promotion perspective implies individual empowerment, life-long learning and capacity to adapt to the changes. Many people including elderly use different types of wearable health care devices which might range from wrist bands to more sophisticated healthcare wearable devices. However, the users of these health care devices are also greatly concerned about health and privacy risks of the Internet of Things, and in particular healthcare wearable devices. Since, the implementation of EU-GDPR, data regarding legal or healthcare information, sexual orientation and "race" is considered extra sensitive and the organizations involved in collection of such data are required to have specific controls in place for data processing. Hence, there is a need for more research to examine the factors that drive the consumers to use wearable health care devices, challenges pertaining to the security and privacy of consumer's data, and how the care providing organizations are handling the data. We are in the process to apply systems thinking ideas and techniques to explore the

drivers and challenges for Ageing society regarding new technologies. There are a lot of issues that needs to be explored such as social isolation, independent living, healthcare requirements, special needs including disabilities, learning the new technologies, wearable devices adoption and privacy issues, EU GDPR data handling, protection and control. The knowledge gained through this research could lead us to generate a holistic view both for consumers and the developers of new technologies for Ageing society.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Somewhat

OR61A154

Developing Contextual Understandings Through Sociotechnical, Systems Approaches

Christine Welch (*University of Portsmouth*)

In the modern world, we have become accustomed to the idea that technological developments will continue to make time and place less and less relevant to our daily lives. However, it is important that we remember that technologies come about through the endeavours of people, generating creative ideas and harnessing developments in co-creation of purposeful systems. In the Systems movement, we have tended to focus on 'people-based' situations or messes using 'soft 'and/or 'critical' perspectives, in the expectation that 'hard' methods could then be used to address more clearly defined issues, including technological problems. However, such a separation is artificial, and may actually distort our perspectives when seeking to address complex issues of the digital age. It is argued that sociotechnical approaches are needed, emphasizing collaborative, multidisciplinary and contextual understandings to support improvement. A number of factors that are vital to consider in building useful, sociotechnical understandings. A traditional concept of 'organization' for instance, meaning identifiable unities with clearly-defined boundaries, may no longer provide a useful model in considering human activity. Networks of interaction and landscapes of practice, which are perceived to be dynamic and in a constant state of flux, may provide better vehicles with which to consider emergent but impermanent 'wholes'. Such a perspective requires an Open Systems view, since such 'wholes' are (re-)constituted from moment to moment by the interactions among individuals who join, leave and participate in context. Individual, multi-layered contextual understandings empower creation of multiple and temporary 'realities' or ontologies. Thus, care in drawing and critiquing boundaries around relevant systems, including boundaries in time, become increasingly important. Recognition of multiple, unique Weltanshauungen, enabling flipping of perspectives, is necessary. Tools and techniques are required that will support sociotechnical analysis, building productive learning spirals, and shifting horizons of complexity to allow shifts between 'soft' and 'hard' dimensions.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A151

On System Thinking and Information Security

Lars Magnusson, Patrik Elm & Anita Mirijamdotter (*Linnaeus University*)

Security problems we have to deal with today regarding Internet are created by ourselves. Internet, initially created to handle US Government data traffic, evolved to become communication between different research institutes. The protocols that were used had no

security at all. Today we still use this network to almost everything and the complexity has grown tremendously. Compared to when the network initially was created, we now try to protect assets rather than just communicate, divide users according to permission and accessibility, and deal with privacy issues. Basically, everything is depending on the network that initially was created with no security. Privacy has been a critical security aspect for the EU, but with the event of the GDPR privacy is both a legal aspect and an auditable ICT concept. GDPR includes topics like owning your own data, independent of who collected it and where it is stored, and the right to be forgotten. Each data collector also needs to have a complete data-flow map, describing any privacy data sets in a flow, to make these traceable and ready for audit inspection. Any organization handling EU residents' data, needs to adhere to proactive Information Security processes. GDPR is based on the principles of Governance, Risk, and Compliance. It is not a purely legal construct; it is a management and strategy issue, not an IT issue. Further examples relate to cloud services with distributed resources, which illustrate the complex problem situation. There is a need for a new perspective, moving from systems management to data flow management. We propose a systemic model which illustrate processes and flows within a fractal structure; we build on Beer's Viable System Model. Such a model enables mapping of complexity and data flows and provide a tool for auditing and, thus, enable meeting the requirements of GDPR.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

04/09/2019, 09:00 – 10:30, Sibson SR6

OR61A53

Nested Adaptive Systems Analysis of Approaches to Managing Health Risks Associated with Water Quality in New Zealand

Bryan Jenkins (*University of Adelaide*)

A comparative analysis of approaches to managing health risks associated with water quality in Canterbury, New Zealand was undertaken using nested adaptive systems analysis. New Zealand has adopted World Health Organization (WHO) recommendations with requirements for water safety plans for drinking water supplies, guidelines based on the Annapolis Protocol for contact recreation, an alert framework for cyanobacteria in water bodies based on WHO guidelines, and, hazard analysis and critical control points for commercial shellfish harvesting. However, the status of drinking water supplies in Canterbury indicates large areas graded as unsatisfactory or unacceptable. Only 56% of monitored lake and river sites are graded as suitable for contact recreation. Eighty percent of river recreational sites have exceeded the alert criteria for toxic algal mats and nearly 30% have exceeded action criteria. Based on nested adaptive systems analysis shortcomings in the management approaches are identified. Water safety plans for drinking water provide a sound basis for considering contaminant failure pathways, however, the approach does not address socio-economic issues like affordability. Recreational water quality management actions for unacceptable bacteriological or toxic algae levels are limited to public warnings that water bodies are unsuitable for contact recreation. This is similar for recreational harvesting of shellfish where a public health warning is the primary management action for phytoplankton levels exceeding health criteria. The hazard analysis and critical control points approach for commercial shellfish harvesting is much more comprehensive but management actions are focused on product contamination and do not address sources of contamination. The systems analysis highlights the need for management

interventions to include proactive catchment management to prevent contamination. It also shows the need for sufficient organizational scale to achieve technical critical mass for water infrastructure management while maintaining local political control to manage the affordability of interventions.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A74

The Art and Practice of Systemic Leadership - Developmental Capacity Building to Tackle Australia's Complex Challenges

Liz Skelton & Kerry Graham (*Collaboration for Impact*)

Despite ongoing prosperity, there is increasing inequality in Australia. This inequality most notably shows up as persistent locational disadvantage where communities experience little change in issues such as unemployment, poverty, contact with the justice system, homelessness and child maltreatment despite decades of investment (Vinson & Rawsthorne, 2015). Locational disadvantage is a complex challenge. Addressing complex problems requires behaviour change to happen concurrently in many parts of the system. The nature of complex problems requires co-creation of solutions, with citizens, leaders and organisations agreeing to a common agenda and then aligning their efforts and resources to achieve measureable large-scale change. There is growing acceptance that well-designed and effective systemic collaboration is at the heart of initiatives that bring about deep, lasting large scale social change. This way of working is counter to most institutions culture, processes and what they incentivise. Without increased capacity and learning, most collaborative efforts revert back to status quo. Collaboration for Impact (CFI) will share learnings on the practice and methodology for building developmental capacity in systemic thinking and leadership practice. This approach will be presented through case studies of their work across Australia providing embedded capacity building support to cross sector collaborations with communities. From international evidence and work to date CFI is calling for investment to be made into building capacity to think and work systemically. There is potential and opportunity to accelerate the rate and quality of learning, capacity building and curation of the thinking, skills and structures required to achieve systems change. CFI is currently building the foundations for the development and application of Australian systemic leadership practice, collaborative practice and systemic impact measurement. The session will reflect on insights from this practice and provide learnings from this approach, giving participants tools and principles for practice to take away and apply.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A65

Lessons from a Programme to Embed Systems Thinking and System Dynamics Modelling in the Kent Health Care System

Peter Lacey (*Whole Systems Partnership Ltd*), **Jo Tonkin**, **Mark Gilbert**, **Abraham George** & **Emily Weitzel** (*Kent County Council*)

Kent County Council secured funding from the Health Foundation Advancing Applied Analytics programme to support the development of a community of practice (CoP) across the health

and care system with a focus on the development of systems thinking and system dynamics modelling to inform responses to strategic challenges facing the Sustainability and Transformation Partnership (STP). The programme ran from the autumn of 2017 to spring 2019 and is being formally evaluated by Southampton University. Support to the project was provided by the Whole Systems Partnership, a specialist provider of system dynamics modelling, who trained and mentored individuals and teams in the application of the approach. This paper will describe the conception and development of the CoP, its goals and objectives together with lessons learnt and the benefits accrued to the system in terms of the spread and adoption of systems thinking. In addition, the paper will outline specific pieces of modelling work undertaken by members of the CoP with limited or no previous experience in this field. Examples will include the modelling of critical care capacity in the East of Kent and models that were developed to help understand the impact of new support services for children with autism or with other mental health needs.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Highly

OR61A103

Assessing Food Systems as Complex Adaptive Systems: Conceptual Views and U.S. Applications

Ken Meter (*Crossroads Resource Center*)

Food system assessments may be able to simplify their approach, and foster more effective action, by framing the food system to be assessed as a complex adaptive system (CAS): that is, as a system in which component entities are learning from each other and adapting to what they learn. These shifting interactions, often involving the core dynamics of the system itself, may pose considerable difficulty to more linear approaches to measurement. As one example, by the time a given data set or interview is compiled and published, the findings may no longer reflect current conditions. Introducing a conscious approach to adaptive complexity reaps several rewards. First, it harnesses quantitative and qualitative data to illuminate core system dynamics. Secondly, it taps essential wisdom from community members, helping to identify the essential levers that can move a given food system to greater sustainability. Third, by so doing, this approach facilitates community foods initiatives that develop systemic theories of change, for which indicators cut across issues that are often separated by disciplinary divides. These suggest measurement approaches that illuminate how system dynamics have shifted, and whether systems levers have moved, rather than focusing solely on programmatic outcomes. While this approach is discussed in the U.S. context, the core elements can be applied in any other country. (This summarizes my chapter from a forthcoming book to be published by Routledge in late 2019: *Sustainable Food System Assessment: Lessons from global practice*. Edited by Alison Blay-Palmer, Damien Conaré, Ken Meter, and Amanda di Battista).

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

04/09/2019, 15:30 – 17:00, Sibson MBA

OR61A79

Social Evolution Unfit for Purpose – A Pathway Towards a Better Future

Gordon Dyer

My original world-view was formed through WW II evacuation, RAF service including participation in UK H-Bomb trials and flight-testing of avionic-systems for TSR2 and Concord. Then followed change and development within systems-thinking, powerful influence from Banathy and his hypothetical grandson's question: "What kind of world are you leaving for me?" Hence my action research track into his proposals for "social system design" (SSD), encompassing guidance for social evolution not over-dominated by technological development, achieved by a consensus-seeking style of dialogue ("conversation") as opposed to debate, participatory ethics, and education transformation. These proposals have not had traction as: its application difficult at large system levels, systems community concentration on "feasible and desirable" and "here-and-now" practice, politicisation of school education and HEI focus on qualifications and consultancies. Nevertheless, experience with various small groups has indicated SSD ethics and "conversation" can help nudge perceptions towards a process of co-creating a better future for themselves. Many "small-fires" could change the larger systems that contain them, and eventually the world systems mankind has allowed to evolve whose behaviour/effects create immense concern. An outline methodology for targeting small social and work groups is offered, which explores shared values and a future vision, interdependence, rights and responsibilities, is ongoing, highly adaptable to context used in part or full, with or without written agreements. Only a limited number of systems concepts need clarification with group to achieve effect. Members develop concern for evolution of the group's future, are thus encouraged to monitor their environment, reducing the chance of counter-intuitive outcomes. The process could particularly help a group suffering low morale or which has experienced trauma caused by recent mismanagement or exposure to new external factors. Examples/suggestions for maintaining ongoing creative synergy and avoiding conversation breakdown are offered.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A299

Extending the Potential of Multi-Sectoral Collaborations for Communities. Historicity in Complex Critical Decisions

May Seitanidi (*University of Kent*) & **Gerald Midgley** (*University of Hull*)

Community Operations Research (C-OR) employs a critical and ethical approach (Midgley & Pinzon, 2011; Foote et al., 2007) to advance systems thinking solutions across multiple domains and policy areas by identifying problem opportunities and novel analytical methods to contribute to theory and practice (Johnson, Midgley & Chichirau, 2018). Despite the engagement of C-OR with the public (Bardach & Patashnik, 2016), the community (Midgley, 2000; Friend, 2004) and private sectors (Midgley et al., 2018) there is limited engagement with collaborative approaches across multiple sectors to address global challenges at multiple levels of analysis. Addressing complex social issues at the individual, organizational, and system levels is important for practitioner and academic communities as the solutions can potentially affect hundreds of millions (Gould, 2010). Although the field of cross-sector social partnerships (CSSPs) rests on the promise of innovative solutions (Austin and Seitanidi, 2012b;

Selsky & Parker, 2005; Waddell et al 2014) the extent to which such solutions explicitly address system gaps providing clear links between critical decision moments and social change remains unexplored. The paper aims to address this gap in the CSSPs literature by focusing on the 're-imaging' promise of C-OR (Johnson, Midgley & Chichirau, 2018) employing a historical approach to re-examine past CSSPs, giving 'voice' to alternative possibilities that have not occurred within a partnership system in the past. Using documentary evidence and interviews the paper aims to map the problem opportunities during the three analytical stages of CSSPs (Seitanidi, 2010): formation, implementation, and outcomes. Although participatory approaches embrace the voices of the participants they do not necessarily ensure that participants can capture the full spectrum of solutions. Employing historicity we develop a novel C-OR method that aims to demonstrate the evolution of alternative futures based on a series of critical decisions in the past in the three stages of partnerships.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A72

Mapping Systems of Causes and Efforts for Reducing Racial and Economic Achievement Gaps

Kirsten Kainz (*University of North Carolina at Chapel Hill*)

Persistent education inequality is a complex problem in the United States, shaped by economic, residential, social, and individual forces. Characteristics of families, neighborhoods, and schools are highly related to student academic performance and subsequent education attainment, and the causal relations among these factors are not easily identified or agreed upon. Consequently, there are no silver bullets ready to remedy the situation. Multiple theoretical orientations and methods are needed to operate productively in this space. The purpose of this paper is to report findings from a design process conducted with school principals (n = 15) in one public school district in the United States. The design process combined aspects of Human Centered Design with Soft Systems Methodology, Systemic Intervention, and Problem Structuring Methods. Principals worked collaboratively through a facilitated process to identify, visualize, and analyze the root causes of racial achievement gaps in their school system. Following root cause analysis, principals produced a visual mapping of their primary efforts to reduce achievement gaps. The purpose of the mapping was to identify and explore inconsistencies between reported beliefs about causes of achievement gaps and the current outlay of resources and efforts. Findings from the mapping will be presented and a proposal for subsequent design efforts will be offered for consideration and feedback from the audience.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Very

04/09/2019, 15:30 – 17:00, Sibson SR3

OR61A64

Crisis in Systems Thinking

Janos Korn (*Middlesex University*)

For the present considerations the current field of systems thinking consists of : Attempts at development of a 'general systems theory' [Rousseau, 2017], and A variety of views, methods

and a number of organisations involved with these views such as : What systems thinking is about, Soft systems methodology, participatory systems mapping, International Society of Systems Science and so on. Strand 1. although proposed by early, and later, workers, has not made acceptable progress, strand 2. suggests a state of confusion, fragmentation and speculation. Lack of progress in strand A. and the state of strand B. can be interpreted as a 'crisis situation'. Fundamentally the systemic or structural view of parts of the world or the field of systems thinking is seen as universal, empirical, indivisible and hierarchical [Korn, 2018]. A resolution of the crisis in the form of a 'new science of systems' is proposed to cater for this view in addition to its being supportive to the view's 'problem solving' or 'design of systems and product' nature. The presentation intends to : Describe the expected features of a candidate for a resolution, Describe the historical background of the 'crisis situation', Outline details of the 'new science' illustrated by an example consisting of 'three general principles' and 'linguistic modelling' and making use of 'conventional science of physics' at the 'object or agent' level which suggests an integrated 'scientific enterprise of creativity' to introduce 'linguistics' as the symbolism in addition to 'mathematics'. The 'new science' is rooted in accepted branches of knowledge, has 'discipline features', highly teachable, facilitates problem solving at professional and everyday level in a methodical way and can lead to operational models. However, it needs peer review, software development and applications.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

OR61A129

The MIPG Model: A Systemic Approach to Public Management

Maria Alejandra Torres Cuello & Maria del Pilar Garcia (*Administrative Department for the Public Service*)

During the last couple of years the Colombian government has made several efforts for innovating in the public sector. One of such efforts has been directed towards introducing systems thinking concepts within the structure of the state and the way in which public sector organizations carry out their operations and fulfil the goals for which they have been established. For this reason, the Administrative Department for the Public Function has designed the Model for Integrated Planning and Management (MIPG for its acronym in Spanish). This model constitutes a reference framework for public sector entities intended to direct, plan, execute, follow-up, control and evaluate their institutional management by taking into account the rights, problems and necessities of internal and external citizens, as well as the goals for which they have been set. The most significant systems thinking elements that have been addressed by means of the MIPG model are related to having a holistic view not only of the steps of the model, but also of each one of the systems and sub-systems that it addresses, the multiple perspectives and interests that must be taken into account in order to design processes and the structure of the organization, the need to understand and take into account the interrelationships between multiple stakeholders, organizational processes and between the procedures that need to be carried out to achieve them. The development of this model represents an opportunity for improving not only public sector organizational management but also the way in which the operation of such organisms takes place. This becomes fundamental in focusing in good practices and in aligning such practices in a way in which the public can see the impact of the work that is being carried out.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A108

A Systemic Intervention to Design Interagency Responses to Wicked Problems: Creating a Common, Cross-Agency Understanding

Pamela Sydelko (*Fat Node Consulting & University of Hull*)

Wicked problems are open-ended, highly interdependent issues that cross agency, stakeholder, jurisdictional, and geopolitical boundaries. In response, there has been advocacy for interagency working. However, this confounds conventional approaches to government because policies and budgets tend to be aligned within organizational boundaries and not across them, making it difficult to bring the appropriate talent, knowledge and assets into an interagency approach to tackle the interdependencies of whatever wicked problem is at hand. In addition, the purposes, perspectives and values of the various government agencies and other stakeholders can often be in conflict. This is one of a pair of presentations reporting on research to develop and evaluate a systemic intervention approach involving the use of multiple methods underpinned by boundary critique to address a wicked problem. In this first presentation, the major focus is how to create a common understanding of a wicked problem among multiple agencies using a new participatory problem structuring method called 'systemic perspective mapping'. This was trialled on the wicked problem of international organized crime and its interface with local gangs in Chicago, USA. Our research found that the combined use of boundary critique and systemic perspective mapping was able to generate enough of a common understanding to provide a foundation for the design of an interagency organization using the viable system model (the latter is reported in the second presentation in the pair).

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

OR61A109

A Systemic Intervention to Design Interagency Responses to Wicked Problems: A Viable System Model Board Game

Pamela Sydelko (*Fat Node Consulting & University of Hull*)

Government agencies struggle to address wicked problems because they are open-ended, highly interdependent issues that cross agency, stakeholder, jurisdictional, and geopolitical boundaries. This is the second of two linked presentations reporting on research to develop and evaluate a systemic intervention approach involving the use of several methods underpinned by boundary critique to address a wicked problem: international organized drug crime and its interface with local gangs in Chicago, USA. In the first presentation, the major focus was on how to create a common understanding of the wicked problem among multiple agencies using a new problem structuring method, 'systemic perspective mapping'. This second presentation explains the design of an interagency meta-organization that would be capable of more effectively addressing drug crime at multiple scales. This design was accomplished through a novel use of the viable system model (VSM), implemented through a board game. This allowed multiple agency representatives to intimately interact with their representation of the wicked problem and with each other in order to clearly delineate new agency responsibilities, communication mechanisms and channels, adaptive operations

management, and an anticipatory function – all tailored to address the wicked problem they had structured as a group. The research findings indicate that this VSM board game, used as part of a larger mixed-method systemic intervention, offers significant promise for the design of interagency responses to wicked problems.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Highly

05/09/2019, 13:30 – 15:00, Sibson MBA

OR61A271

A Proposal to Include Systems Thinking Skills in an Industrial Engineering Curriculum

Ricardo Barros-Castro & Adriana Díaz (*Pontificia Universidad Javeriana*)

According to UNESCO, engineering has had a critical role in solving the societal challenges in education, natural resources, health, energy, transport, climate change, among others. In this context, the National Academy of Engineering and the Royal Academy of Engineering recognize the need to transform engineering curricula to achieve an emphasis on problem solving and systems thinking. This need proposes reflections about how to include these skills in curriculum design. Following this way, this paper presents a proposal of the inclusion of, in particular, systems thinking skills in an industrial engineering curriculum. The program is based on the ideas of the CDIO (Conceive – Design – Implement – Operate) initiative and the definition provided by the IISE (Institute of Industrial and Systems Engineering), which mentioned that industrial engineering has to deal with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. The proposal, then, considers three levels of involvement. First, a specific class to teach basic systems concepts and methodologies; second, a set of classes and projects to explore systems (related to problem situations) and apply methodologies; and third, a general approach of systems based on disciplinary concepts, for instance, sustainability or teamwork, that need systems thinking skills. This proposal highlights the need of both, conceptual and practical knowledge, to understand concepts, model systems, solve problems using systems models and, evaluate those models. The curriculum designed is presented and reflections about further work regarding the implementation of this proposal and the engagement of faculty and students in that design are provided.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Somewhat

OR61A243

Inquiring Systems in the Management Classroom: A Way to Rediscover Creativity?

Jose-Rodrigo Cordoba-Pachon (*Royal Holloway, University of London*)

This paper/book in progress presentation aims to maintain dialogue between applied systems thinking and creativity initially proposed by Córdoba-Pachón (2019) by focusing on how inquiring systems designs, as initially proposed by Churchman, could be enhanced to help enhance if not rediscover creativity. The argument developed is that the integration of enquirers (students, teachers) within the system itself (classroom) could be transcending so as to promote reconciliation of dualities including subject-object or subject-environment. This needs critical and self-reflection on the trajectory of inquiry to go beyond established classroom and

educational boundaries of an experiential system under study, so that self-other assumptions could be reflected and debated upon. Together with an identified natural notion of creativity that seems to encompass our efforts to nurture creativity in management, the ideas of Bela Banathy and Salvador Paniker are presented and further developed.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A166

Education for Sustainable Business Decisions Through a Multi-Criteria and Multi-Stakeholder Method

Solange Garcia dos Reis (*USP University of Sao Paulo*), **Ian Thomson** (*University of Birmingham*) & **Luiz Antonio Titton** (*Startup New is Cool Educational Technology*)

Business education for sustainable decisions includes learning about distinct disciplines, interests and values. There is a gap in appropriate techniques for multidisciplinary sustainability curriculum, which requires a holistic and integrative perspective, including systems thinking skills. We propose a Learning Tool for Sustainable Decision Making (LTSDM) based on theoretical foundations of Experiential Learning Theory (ELT) in teams and Multi-Criteria Decision Aid (MCDA). The stages of the Kolb's experiential learning cycle serve to structure an interactive and iterative process and MCDA assist decision-makers in organising alternatives and criteria, calculating indices, and providing a heuristic path for the joint resolution. Our LTSDM address some criticisms against MCDA supporting sustainable decisions: the lack of a democratic and inclusive process for stakeholders to define preferences and; the use of aggregation techniques with a high degree of compensation among the criteria, which disrupts the premise of strong sustainability (which does not allow the compensation between environmental and socioeconomic performances). ELT provides a simulation process where students role-play the stakeholders' interests going through the four stages of the Kolb cycle in several iterations. At each iteration, MCDA calculates the stakeholders' position in relation to an ideal alternative from their preferences. The aggregation procedures for calculating the positions draw on the Composite Programming (CtP), a hierarchical method based on the distance to an unreachable point. CtP uses a geometric metric and, therefore, the degree of compensation between criteria is partial. At each iteration, the indices make visible different interests, trade-offs and sacrifices of each group, supplying the bases for discussion, construction of collective knowledge and multi-perspective evaluation. The preliminary findings demonstrate LTSDM can broaden the students' competencies for dealing with the interconnectedness of social, environmental and economic-financial issues. We argue that LTSDM offers a useful and complementary contribution to business teaching for sustainable decisions in different learning environments.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A316

Create Purpose Driven Regenerative Systems, Re-Pattern Linear Thinking and Elevate Diverse and Inclusive Cultures

Maureen Cooke (*H3Uni a university for the third horizon*)

Create purpose driven regenerative systems by developing a deeper understanding of their dynamics which enables optimizations to become emergent outcomes. Through praxis, re-pattern and break away from linear thinking to discover new opportunities for addressing system complexity, chaos and interdependencies. Learn new forms of education through methodology that expands and further develops our wisdom by engaging with those capable of navigating and adapting. Elevate diverse and inclusive cultures by embracing ancient wisdom and adopting news ways of living by re-patterning our lives. Every individual travels on a unique journey and our perception develops through numerous personal challenges, relationships and experiences. Unfortunately, ones perception may have a variety of influences that can cloud one's view and lower their level of gratitude. Individuals are capable of re-perceiving when their basic needs are met, they feel valued as a contributor in their work/communities and develop their future consciousness. The underlying critical factor is to establish the belief that a positive way forward requires us to collaborate, create and learn together. An important message for us is to elevate our level of respect and protection of the world's sacred resources. Water already serves us daily as part of the core of our existence and in return we need to demonstrate our appreciation.

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

05/09/2019, 13:30 – 15:00, Sibson SR2

OR61A28

Climate Change: A Catalyst for Human Emergence (Systems Thinking to Save the World)

Kerry Turner (*University of Hull*)

This paper proposes that climate is changing but humanity fundamentally is not and explores the implications. I present three causal loop diagrams: one on the powerful feedback loops driving the Earth's temperature system; one on the system controlling human temperature; and one on the system driving human behaviour when faced with potential future danger. Then I explore their similarities, linkages and potential future outcomes. The Earth model builds on work done by Dennis Sherwood and incorporates new thinking by Walter Jehne. The human behaviour model emerged from a Systems analysis of the Grenfell Tower fire disaster presented at OR60. The paper argues the need for a comprehensive System Dynamics model capable of assessing the full potential for regeneration and answering key questions such as "what is the carrying capacity of the Earth given a fully operational carbon/water cycle?" However, this must be accompanied by efforts to overcome the inertia in human behaviour change. In this, reaching children (as the key stakeholders of the future) with clear systemic insight and thinking tools is the longer term system fix. Systems thinking tells us we must consider the whole, yet systems thinkers have persisted in optimising the parts. Ultimately, in terms of the planetary system, there is only one whole. All other things are parts of that whole. They are subsystems. Climate change reminds us of this basic truth. We can save humanity (and ourselves) from major impacts with the small yet hugely significant decisions we take each day of our lives, and how we treat the land in our care. In those decisions lies the chance

for us to emerge as truly systemic beings with a strong and reverent connection to the single system we are all a part of.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Very

OR61A222

Awareness-Based Systems Change: Deepening Systemic Appreciation and Practice

Megan Seneque (*Presencing Institute*) & **Eva Pomeroy** (*Concordia University, Montreal*)

The theory and practice of the social field addresses the less visible levels of social reality creation – the dynamics, processes and particularly the levels of awareness that underlie and shape the behaviour we see more readily. Otto Scharmer in *The Principles of Theory U: Core Principles and Applications* (2018) defines the social field as “the quality of relationships that give rise to thinking, conversing, and organizing, which in turn produce practical results” (p. 14). The concept of the social field is a theoretical innovation with significant implications for changing practice and taking a fresh look at what is needed to shift social systems. Systems are typically viewed from the outside, third person perspective, with the aim of understanding leverage points to shift a system. The analysis of a social field looks at the interior experience of systems so that a social system, (e.g. a group, an organisation or cross-organisational team), not only develops the ability to see but also to sense and experience itself with greater awareness. Theory U assumes an attention-based perspective that is grounded in the later work of Francisco Varela (2000). Here, Varela signals an epistemological turn that results in a new path to understand social systems not by stepping back to focus on the “abstract whole” through methods of disembodied knowing....., but by stepping forth to connect with the concrete particulars of a social situation through using methods of embodied knowing to “presence” what Bortoft (1999) calls the “authentic whole” (Scharmer in press). Through case studies of multi-stakeholder collaboration, this presentation reviews the action research conducted by the Presencing Institute (Cambridge, MA) which addresses complex global challenges by using an awareness-based framework and methodology to impact social fields as the key leverage point for sustainable change.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A164

Socio-Cultural Conflicts and Social Consent: “Thinking-Activity Organization of Communication” Model

Viacheslav Maracha (*The Russian Presidential Academy of National Economy and Public Administration*)

One of the principal challenges for systems thinking and OR is the problem of preventing and resolving socio-cultural conflicts. In this paper the socio-cultural conflict refers to situations of social tension expressed in the collision of positions, which difference is generated by cultural diversity. Cultural policy is seen as a way to reduce social tensions for the sake of achieving social harmony and ensuring further peaceful co-existence of socio-cultural units. A socio-cultural unit is called the “cell” of a society, which preserves its “cultural code” (or identity) as a pattern for social relations of a certain kind. Socio-cultural unit as a system includes the social and cultural subsystems. In contrast to the material unit of a substance, it does not exist

“independently of us”, but due to the implementation process of certain cultural norms by the participants of social relations, which is reproduced for a historically long time in continuously emerging new situations. The interaction of two socio-cultural units is sustainable when it is institutionalized. This condition is not always fulfilled – but even in such cases, heterogeneous socio-cultural units must live together peacefully in a common environment, without problematizing the basis of each other's existence. The authors distinguish two extreme cases of the co-existence of socio-cultural units. In the first case, this co-existence is harmonious (public consent), in the second – conflict (socio-cultural conflict) which crucial case is “unsolvable” conflict. The paper proposes a new approach to achieving public consent, containing systemic tools for resolving socio-cultural conflicts and governing communications in “unsolvable” conflict situations. This approach is based on the stabilizing role of institutions and the Thinking-Activity scheme, integrating the key components of a conflict situation and defining “Thinking-Activity Organization of Communication” Model (TAOC Model). Main principles of this system model are “recognition of the Other”, “reflexive equilibrium” and “overlapping consensus”.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Relevant

OR61A51

Critical Systems Strategic Thinking: A Conceptual Framework

Hong T. M. Bui (*University of Bath*) & **Thien Ho** (*University of Johannesburg*)

Individual strategic thinking and critical systems thinking are vital not only for strategy development and implementation, but also more importantly for individual learning and development. There is a lack of critique in the extant literature of how critical systems thinking is reflected and augmented in individual strategic thinking and a more general lack of critical exploration and discussion of forging connections for individual learning and emancipation. To advance knowledge in this interdisciplinary area, we develop a conceptual framework called critical systems strategic thinking that presents a different perspective of individual strategic thinking when integrated with critical systems thinking. The concept of critical systems strategic thinking amalgamates two concepts of individual strategic thinking and critical systems thinking, and provides an insight of how to strengthen individual strategic thinking by representing the value of critical systems thinking more reflexively, which also exposes power relations between the two concepts. It offers a new angle on individual emancipation.

What is the nature of your talk? Theoretical

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Relevant

05/09/2019, 13:30 – 15:00, Sibson SR4

OR61A320

Taking a Systems Leadership Approach to the Delivery of Operational Research

David Lowe (*David Lowe*)

Systems Leadership has been heralded as the key to delivering “deep changes necessary to accelerate progress against society's most intractable problems” through fostering “collective leadership within and across collaborating organizations” (Senge, Hamilton & Kania, 2015). This talk will describe how Systems Leadership has enabled the Defence Science and Technology Laboratory to transform the way in which it delivers Operational Research to its

government customers. In particular it will detail how, over the past two years, this has led to closer working relationship with key customers, increased agility in how we prioritise our work and greater collaboration with our industry and academia partners.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A115

21st Century Tracing Boards - Systems Thinking for Public Policy Design. Practical Applications of Systems Thinking in the Public Sector

Ian Mitchell (*Dept. for Business Energy & Industrial Strategy*)

This presentation describes practical applications of Systems Thinking in the Public Sector, considering technical and social aspects. It describes the use of Senge's mapping symbology to facilitate groups of non-analysts with diverse viewpoints to develop a shared visualisation of a policy area as a Causal Loop Diagram. Such diagrams have a similar role in the design of public policy as the tracing boards used in major building projects in former times. These big wooden boards provided a medium on which to lay lines and trace out designs for the builders to follow, enabling them to build the intended structure with regularity and propriety. Physical representations have also been used to assist military planners and commanders for many years to understand, develop and communicate operational plans. Systems Thinking enables models to be built of more complex situations mixing tangible and intangible components. The experience has demonstrated the need to introduce the differences of participative map building from other forms of analysis, especially figures emanating from a model run in a small back room purporting to be the "Answers". The case studies cited show the role of the facilitator as focal point for inputs by a group to develop the map and then to consolidate a coherent view of use to the client. Checkland's Soft Systems Methodology complements Senge's symbols to shape discussion building the map but also to help the analyst understand the context for the map. The presentation concludes on the vital importance of a supportive Owner for the process to function. It considers the catalytic effect of a turbulent policy Environment on this with examples supporting the adage "Good work begets more work."

What is the nature of your talk? Very practical

Does your talk require prior knowledge of the subject area? None

Is your talk accessible and relevant to practitioners? Highly

OR61A357

Updating the Systems Concept Within SSM

Giles Hindle (*University of Hull*)

SSM has always used a systems concept within the conceptual thinking element of the methodology. Originally this concept was named a human activity system and in practice was formally checked against a 'formal systems model'. This was a compilation of management components required for a set of activities to comprise a system capable of purposeful activity (Checkland 1981). It draws upon the concept of a system used by Jenkins in his systems engineering methodology (Jenkins 1969) and follows Churchman's Anatomy of Systems Teleology (Churchman 1971). Those familiar with the Viable Systems Model will also see significant similarities here too. Over time Checkland changed the name of the systems concept to purposeful activity system and dropped the use of the formal system model entirely from descriptions of SSM. However, despite this reduction in emphasis, the basic nature of the

systems modelling has remained the same – to construct a model of a purposeful activity system viewed through the perspective of a pure, declared worldview. This presentation examines the utility of the purposeful activity system concept when viewed through alternative theories of business. In particular, business models affected by technology and the notion of a service dominant logic.

What is the nature of your talk? A mix

Does your talk require prior knowledge of the subject area? Some

Is your talk accessible and relevant to practitioners? Very

OR61A227

Business Development Operations: Tools for Integrating Systems Thinking

James Kainz (ARA) & Kirsten Kainz (UNC)

As companies grow, business development needs grow exponentially. Measuring and determining the effectiveness of business development activities is vital to ensure time and effort are focused on expanding opportunity for revenue. Current progressive business development enterprises in the US emphasize strategic metrics. However, metrics can represent discretized subunits of larger systems, and consequently the focus on metrics can distract attention from salient system dynamics. Increasingly business leaders around the world are using systems thinking to improve understanding of complex dynamics shaping the inputs and outputs of business development. Systems thinking can shed new light on perpetual questions in business development such as: How do you best understand where your market is? How do you make sense of market trends? What are the emerging needs/technologies? Can we transform the market through “push” or “pull” activities (e.g. do you have superior innovation/technology that transforms the market such as the smartphone, which we never knew we needed until it was pushed; or which current crises pulling more innovative responses). Operational research tools can serve to integrate a systems perspective into business development practices for successful outcomes. Specifically, problem structuring methods and system visualization techniques, such as those used in Soft Systems Methodology, represent innovations for the US engineering business development field that can promote systems thinking. This paper explores insights and opportunity relevant to the engineering and physical sciences sector.

What is the nature of your talk? Practical

Does your talk require prior knowledge of the subject area? A little

Is your talk accessible and relevant to practitioners? Somewhat

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