

Behavioural Operational Research: The contributions of System Dynamics

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Presentation based on the forthcoming book [“Behavioral Operations Research” Kunc, Malpass and White \(eds\)](#)
[Palgrave MacMillan](#)

Agenda

- ◎ *The contents of the book*
- ◎ *Insights from Behavioural OR*
- ◎ *Behavioural insights from System Dynamics practice*
- ◎ *Conclusions*

The contents of the book

- ⦿ Increasing interest in Operational Research (OR) and the behavioural sciences: behaviour, its representation in models and its effects on how users respond to models, is attracting the attention of OR researchers and practitioners.
- ⦿ Novel is the emergence of a set of ideas and methods from other areas, such as economics and psychology, that may allow a more rigorous approach to addressing behavioural issues with more focus on the use of laboratory and field experiments of individual and team decision making.

The contents of the book

- ◎ The book is organized to cover broadly ‘Theory’, ‘Methods’ and ‘Practice’ perspectives. Within each of these sections the articles presented aim to cover themes relating to a simple logic: ‘Behaviour with models’, ‘Behaviour in models’ and ‘Behaviour beyond models’.
- ◎ These refer to models of human activity systems that incorporate behavioural factors, modelling of human decision making, focusing on cognitive factors and taking account of organizational and social norms and control, and an orientation on the effects of behavioural and cognitive factors on the activity of analysis and modelling itself and on the communication of results that affect its impact.

The contents of the book - Theory

1. Engaging with Behavioral Operational Research: On Methods, Actors and Praxis - L. Alberto Franco and Raimo P. Hämäläinen
2. Behavior with Models: The Role of Psychological Heuristics in Operational Research - Konstantinos V. Katsikopoulos
3. Behavior in Models: A Framework for Representing Human Behavior - Andrew Greasley and Chris Owen
4. Behavior beyond the Model - Leroy White

The contents of the book-Methodology

5. Simulation and Laboratory Experiments: Exploring Self-Organizing Behavior in a Collective Choice Model - Santiago Arango-Aramburo, Ann van Ackere and Erik R. Larsen
6. Misperception of Behavioral Operations and Bodies of Knowledge - Paulo Gonçalves and Sebastian Villa
7. Agent-Based Modeling and Behavioral Operational Research - Duncan A. Robertson
8. Modeling Behavioral Decision Making: Creation and Representation of Judgment - Martin H. Kunc

The contents of the book-Methodology

9. Big Data and Behavior in Operational Research: Towards a “Smart OR” - Leroy White, Katharina Burger and Mike Yearworth
10. Behavioural Issues in the Practical Application of Scenario Thinking: Cognitive Biases, Effective Group Facilitation and Overcoming Business-as-Usual Thinking - Stephanie Bryson, Megan Grime, Adarsh Murthy and George Wright
11. The Impact of Group Model Building on Behaviour - Étienne A.J.A. Rouwette

The contents of the book - Practice

12. Behavioral Operational Research in Practice: A Brief Overview - Katharina Burger and Jonathan Malpass
13. Healthcare: Human Behavior in Simulation Models - Sally C. Brailsford
14. Service Operations: Behavioral Operational Research in BT - Jonathan Malpass
15. Smart Cities: Big Data and Behavioral Operational Research - Leroy White, Katherina Burger and Mike Yearworth

The contents of the book - Practice

16. Mergers and Acquisitions: Modelling Decision Making in Integration Projects - Shanie Atkinson and Michael Shayne Gary

17. Supporting Strategy: Behavioral Influences on Resource Conceptualization Processes - Kenneth Huh and Martin H. Kunc

18. The Past, Present and Futures of Behavioral Operational Research - Geoff Royston

Insights from the Behavioural OR

- ⦿ Developing technically correct and valid models is not enough; we also need to design model-supported interventions by taking into account behavioural factors that could enhance or hinder their effectiveness.
- ⦿ It is important to empirically examine what people actually do within a system or when engaged in OR-supported processes, especially in complex settings.
- ⦿ Three-dimensional typology of OR interventions: Users (individual/group), Issue divergence (high/low) and Model use (instrumental/symbolic).

Insights from the Behavioural OR

- ⦿ Micro-level examinations of praxis that are common in practice and decision making studies within the behavioural, social and organization sciences need to be considered
- ⦿ How OR actors (doers and users) become competent in the application, use and interpretation of OR methods in praxis?
- ⦿ What are the interdependencies between OR methods, OR actors and OR praxis and how they affect and are affected by, OR outcomes?

Key behavioural insights from System Dynamics practice

- ◎ System Dynamics has always been focused on behaviour:
 - Morecroft, J.D., 1983. System dynamics: Portraying bounded rationality. *Omega*, 11(2), pp.131-142.
 - Sterman, J.D., 1989. Modeling managerial behavior: Misperceptions of feedback in a dynamic decision making experiment. *Management science*, 35(3), pp.321-339....and all the research originated from this paper which has more than 2500 citations
 - Gary, M.S., Kunc, M., Morecroft, J.D. and Rockart, S.F., 2008. System dynamics and strategy. *System Dynamics Review*, 24(4), pp.407-429.
 - Kunc, M.H. and Morecroft, J.D., 2010. Managerial decision making and firm performance under a resource-based paradigm. *Strategic Management Journal*, 31(11), pp.1164-1182.

Key behavioural insights for System Dynamics practice – Ch. 3

Method Name	Method Description	World View	Model Abstraction	Simulation Approach	Abstraction
Simplify	Eliminate human behaviour by simplification			None	Outside the Model
Externalise	Incorporate human behaviour outside of the model			None	Outside the Model
Flow	Model humans as flows	Continuous	Macro	Continuous Simulation	System Dynamics
Entity	Model human as a machine or material	Process	Meso	Discrete Event Simulation	Inside the Model
Task	Model human performance				Inside the Model
Individual	Model human behaviour	Object	Micro	Agent-Based Simulation	Discrete Event Simulation

Figure 3.1: Methods of modelling human behavior in a simulation study.

Key behavioural insights for System Dynamics practice – Ch. 6

- ◎ Bounded human rationality is due to two basic and related deficiencies in our mental maps (Sterman, 2000; Bendoly et al., 2010).
- ◎ First, our mental maps often capture a simplified and flawed representation of the actual causal structure of systems – which we name *misperception of feedback structure*.
- ◎ Four important mechanisms that involves misperception of feedback structure of a system are: heuristics, biases, motivation and the Fundamental Attribution Error.
- ◎ Second, even when we perfectly understand the structure of a system, we are unable to infer how it behaves over time, which we name *misperception of feedback dynamics*.

Key behavioural insights for System Dynamics practice – Ch. 6

- ◎ Uncovering the deficiencies in our mental maps (*misperceptions of feedback structure and feedback dynamics*) and their impact on decision making as well as on the performance in supply chains is part of the ability of SD.
- ◎ SD employing experimentation in decision making using simulation models is an important area to work on given the interest on behaviour.

Key behavioural insights for System Dynamics practice – Ch. 6

System	Stock	Flows	Delays	Behavioral Implications
Inventory Management	Inventory	<ul style="list-style-type: none"> • Production (+) • Shipments (-) 	<ul style="list-style-type: none"> • Goods on Order 	<ul style="list-style-type: none"> • Inventory Gluts • Shortages • Over/under Forecast • Unsatisfied Customers
Capacity Management	Capacity	<ul style="list-style-type: none"> • Capacity Investment (+) • Capacity Depreciation (-) • Capacity Divestment (-) 	<ul style="list-style-type: none"> • Capacity under Construction 	<ul style="list-style-type: none"> • Excess Capacity • Tight Capacity • Loss of Good Will
Human Resources	Employees	<ul style="list-style-type: none"> • Hiring (+) • Firing (-) • Quits (-) 	<ul style="list-style-type: none"> • Training • Hiring • Firing • Worker harder Policies 	<ul style="list-style-type: none"> • Over/under Hiring • High Attrition • Low Morale • Fatigue • Inadequate Training
Cash Management	Cash Balance	<ul style="list-style-type: none"> • Income (+) • Expenditure (-) 	<ul style="list-style-type: none"> • Loans Approval • Debt • Amortization 	<ul style="list-style-type: none"> • Cash Constraints • Bankruptcy • Excess Available Credit
Marketing	Customer Base	<ul style="list-style-type: none"> • New Customers (+) • Customer Attrition (-) 	<ul style="list-style-type: none"> • Time to Attract Potential Customers • Time to Awareness 	<ul style="list-style-type: none"> • Low Marketing Prospects • Low Awareness • Product Failure

Key behavioural insights for System Dynamics practice – Ch. 8

- ⦿ People infer or construct a percept from a collection of sensory cues that deliver incomplete and imperfect information (Goldstein, 2004).
- ⦿ Experimentation should follow representative designs rather than systematic design (Goldstein, 2004). Representative design implies the design of experiments should reflect the natural environment (stimuli and conditions), of the people subject to the experiments to reveal issues in judgement accuracy, known as ecological validity (Goldstein, 2004)

Key behavioural insights for System Dynamics practice – Ch. 8

- ◎ Proposition 1: In order to investigate and model decision making processes, a processual approach is required. The approach involves matching the level of knowledge of the person with respect to the task or the focus of the decision. Therefore, there are two important conditions to consider: how fast the person builds their knowledge and the initial level of knowledge.
- ◎ Proposition 2: Behavioural decision making must consider the physical impossibility to update knowledge before evidence is presented. Subjective perceptions are updated as evidence comes. Thus, decision making accuracy (including some of his manifestations in heuristics like overconfidence or preference reversals) is improved over time once the subject is able to interpret the evidence presented.

Key behavioural insights for System Dynamics practice – Ch. 8

- ◎ Proposition 3: Behavioural modelling of decision making must consider the diversity in environmental perception processes among subjects. Subjective perceptions of the same event may be completely different due to structural differences.
- ◎ Proposition 4: Anchoring-and-Adjustment processes are powerful heuristics, which may seem to represent basic decision making processes. However, anchoring-and-adjustment is affected, similarly to any heuristic, by the level of complexity of the environment. Modelling decision making may need to consider complexity as well as ambiguity in the environment. Subjective perceptions of events take time to calibrate and obtain a reasonable image of the environment.

Key behavioural insights for System Dynamics practice – Ch. 11

- ◎ The impact of group model building on behaviour seems to materialise along the following lines:
 - A group of participants is brought together because of their knowledge, power and/or interest in a dynamic problem.
 - There may be a degree of conflict between participants but all commit to spend a limited time on trying to better understand the problem.
 - A facilitator guides them through a process of building a model that attempts to explain the problematic behaviour over time.
 - Participants share their ideas on the problem, first drawing up a list and then relating ideas. The resulting diagram is modified on the basis of the group discussion, possibly compared to available data, and ultimately points to actions that may improve the situation.
 - Each phase that is completed successfully creates trust and lays the groundwork for the next stage. In the process participants build a joint understanding by constructing and relating frames.
 - Facilitation and modelling help participants, despite their differences in power, to bring relevant information out into the open.

Key behavioural insights for System Dynamics practice – Ch. 11

- ◎ The impact of group model building on behaviour seems to materialise along the following lines:
 - Unique information is shared but not more than in regular meeting.
 - Because participants receive new and relevant information that may lead them to reconsider some of their opinions, behaviour outside of sessions is also impacted.
 - Participants change their ideas on desirable ends, and about how means and ends relate. This is closely related to changes in attitudes and subjective norm.
 - If the information in the session does not only represent design logic, but also operator logic, perceptions of means and perceived behavioural control may also change.
 - Opinions on ends (attitudes), means (perceived control) and means-ends relations converge and create a strong subjective norm.
 - All of these contribute to changed intentions and ultimately behaviour.
 - Provided that the quality of the model is sufficient, implementation of proposed recommendations will help to change the situation for the better.

Key behavioural insights for System Dynamics practice – Ch. 16

- ⦿ SD models can help to aggregate multiple views of experts about the same process, e.g. M&A.
- ⦿ SD models contain a wide range of behavioural assumptions formulated as decision policies based on information feedback control theory.
- ⦿ These decision policies include selective filtering of information cues, biases, expectation formation, misperceptions of feedback, perception delays and implementation delays.

Key behavioural insights for System Dynamics practice – Ch. 17

- ◎ The development of models in groups can be influenced by factors affecting the group dynamics such as:
 - deliberateness, referring to the level of analysis employed in the conceptualization process;
 - overload, indicating the level of stress generated by the amount of information processed; and,
 - intra-group conflict, capturing the impact of conflicts on the selection of information and key variables and it can exist in two categories: functional task-related conflict (cognitive conflict) and dysfunctional emotion-related conflict (affective conflict).

Key behavioural insights for System Dynamics practice – Ch. 17

- ◎ The development of models in groups can be influenced by factors affecting the group dynamics. The results from evaluating two groups are:

Factors	Result	
	Group A	Group B
Mental model complexity	+++	++
Satisfaction	++	+
Level of deliberateness	++	+
Overload	+	+++
Cognitive conflict	++	++
Affective conflict	+	++

Conclusions

- ⦿ System Dynamics is one area in Operational Research (OR) which cognitive and behavioural factors are well recognised.
- ⦿ System Dynamics has the ability to represent characteristics of human thought and behaviour.
- ⦿ System Dynamics focuses on modelling not only the system but also the decision making processes within the system including quantitative and qualitative factors.
- ⦿ System Dynamics has been at a disadvantage for many years within OR given its focus on modelling behaviour.
- ⦿ However, the current interest in modelling behaviour represents an opportunity for System Dynamics within the OR community.