Proceedings of the 23rd UK System Dynamics Chapter Annual Conference

'Thinking big'

25th to 26th May 2021

Online

Timetable and contents

Tuesday 25th May	
16:00	*Getting Started with System Dynamics* Kim Warren (Strategy Dynamics)

Wednesday 26th May			
09:00	Conference online space opened – time to check your IT, make that coffee and chat with other delegates!		
0930	*Welcome by Chapter President* Peter Lacey (President of the UK Chapter of the System Dynamics Society)		
09:45	The use of space in Thamesmead: A participatory system dynamics study Nici Zimmerman (UCL)		
10:15	A Systems Thinking approach for understanding the complexity of cost overruns in transportation megaprojects Godawatte Arachchige Gimhan Rathnagee Godawatte (Heriot-Watt University)		
10:45	**Break**		
11:00	The dynamics of migration to national Gigabit connectivity David Exelby (Decision Analysis Services Ltd)		
11:30	Student Presentations Bilal Bugaje (University of Nottingham) Martin Lycko, (Nottingham Trent University) Garry Piepenbrock (Eton College)		
12:00	Chapter AGM		
12:30	**Lunch**		
13:00	Introduction to Breakout Sessions Peter Lacey (President of the UK Chapter of the System Dynamics Society)		
13:10	**Breakout 1** Developing a System Dynamics Model to support Waiting List Recovery Mike Woodall (The Strategy Unit)	**Breakout 2** Coronavirus variants of concern Peter Lacey (WSP)	**Breakout 3** Student colloquium Including Poster session
14:30	**Break**		
14:45	Awards Peter Lacey (President of the UK Chapter of the System Dynamics Society)		
15:00	A Dynamic Economy – Understanding the role of transport connectivity in Levelling Up the North of England Jack Snape (Transport for the North) Mike Costello (Steer)		
15:45	Chapter President: Concluding remarks Peter Lacey (President of the UK Chapter of the System Dynamics Society)		

Introduction

Welcome

A warm welcome to our 2021 Annual Conference. It's been a turbulent year and we're disappointed not to be able to meet in the flesh. The coffee time chat between the excellent material will be missed, but we're determined to make the conference a real opportunity to engage with the material and help all those present to take something positive away from the conference.

This year the contributions have suggested the theme of ***thinking big***. Whether it's megaprojects, pandemics or level-up a whole region, system dynamics is at home when there are big visions and messages to communicate. I hope you enjoy the conference!

I would like to thank the UK System Dynamics Policy Council for their contribution over the last year and for helping to arrange this event.

Peter Lacey (President of the UK Chapter of the System Dynamics Society)

UK Chapter of the System Dynamics Society policy council

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Presentation Abstracts

Getting Started with System Dynamics

Kim Warren (Strategy Dynamics)

This workshop introduces newcomers to the power of system dynamics modelling through an 'agile' process in which a model is built in incremental stages, ensuring validation at each stage. Participants follow along the simple steps to build a working model of a real-world issue, with easy-to-use online software, and explore the findings and policy implications of the model they build.

Kim Warren (LinkedIn profile) is an experienced strategy professional, teacher and publisher of online courses and teaching resources on business modeling. After senior corporate strategy roles, Kim joined London Business School's 's Strategy Faculty where he developed the powerful strategy dynamics modelling method for designing and managing strategy for any organisation or challenge. Kim is author of the prize-winning Competitive Strategy Dynamics (Wiley, 2002), the strategy textbook Strategic Management Dynamics (Wiley, 2008), and summary e-book now widely used in MBA and executive teaching – Strategy Dynamics Essentials (Kindle, 2011). He is also co-founder and director of Strategy Dynamics Ltd, which publishes 'serious games' and online courses exploiting the user-friendly modelling application, Silico.

Kim is a former president of the International System Dynamics Society

The use of space in Thamesmead: A participatory system dynamics study

Nici Zimmerman (UCL)

Irene Pluchinotta (UCL)

Giuseppe Salvia (UCL)

Well-designed natural and built environments are central to people's wellbeing. At the same time the interacting factors that make people use these spaces are not fully clear and can be differently understood by different stakeholder groups. This can be a problem if perceptions of what drives the use and quality of space differ between stakeholders who decide on the design of such spaces and those potentially using it. Using the Thamesmead area south-east of London as a case study, this research investigates different stakeholder groups' perceptions of what drives the long-term quality of green, blue and built spaces and their use. It introduces a method to understand stakeholder perceptions of system boundaries, which provides easy-to-understand visualisations of perception differences in participatory settings. It also presents a participatory process of engaging with stakeholders from problem scoping, to causal loop diagramming, problem refinement and the quantification of a system dynamics model. This research thus contributes to more holistic perceptions, cognition and decision-making in a collaborative multi-organisational decision-making process on the use and quality of spaces.

Nici Zimmermann is an Associate Professor in System Dynamics at the Institute for Environmental Design and Engineering, University College London. She is Co-I on grants related to systems thinking in the built environment, complex urban systems of sustainability and health, and sustainable water management in London. Her research addresses sustainability, city transformation and housing as well as organisational cognition, decision-making and change. She employs and analyses inter- and transdisciplinary research and likes to engage stakeholders from policy, private organisations and residents in her participatory work. She is a repeat Strategy Thread Chair at the International System Dynamics Conference and member of the Society Program Oversight Committee of the System Dynamics Society.

Nici developed this research with Irene Pluchinotta and Giuseppe Salvia, both Research Fellows at the UCL Institute for Environmental Design and Engineering.

Irene Pluchinotta is an environmental engineer and her areas of expertise include system dynamics and decision analysis to support decision-making in collaborative multi-stakeholder settings, e.g. for sustainable environmental policies, water management and urban planning for resilient cities. Based on a double PhD in environmental engineering and computer science (agreement for a joint research thesis), her work provides formal support to decision-makers involved in participatory and co-production activities, working on (participatory) system dynamics modelling and structured stakeholders' engagement activities.

Giuseppe Salvia holds a PhD in Design and is a qualitative researcher with a track record in international research projects addressing multi-scale socio-technical innovation especially in

favour of more sustainable patterns of production and consumption. At UCL, he explores stakeholder perceptions and priorities. Giuseppe has a key interest in developing participatory approaches for stakeholder engagement by drawing on co-design tools and methods, especially to minimise risks of unintended consequences and maximising the impact of applied research.

A Systems Thinking approach for understanding the complexity of cost overruns in transportation megaprojects

Godawatte Arachchige Gimhan Rathnagee Godawatte (Heriot-Watt University)

Research has shown that transportation megaprojects perform poorly in terms of cost. Although a considerable amount of research has been conducted to identify the causes of cost overruns in megaprojects, there is a lack of holistic understanding of the complex interrelationships between the causes of cost overruns. To fulfil this gap, this research adopted a qualitative systems thinking approach to understand the cost overrun causation in transportation megaprojects based on a case study project. California High-Speed Rail project was selected as the case study and empirical data were collected from a range of sources - interviews with key decision-makers, professionals, and stakeholders involved in the project, project reports, board meeting transcripts, and newspaper articles. Data were analysed using grounded theory method and systems thinking approach was used to develop a conceptual model (causal loop diagram) to understand the cost overrun causation in megaprojects.

Four causal loop diagrams - Ignorant Strategic Leadership, Immature Project Organisation, External Actor Relations, and Political Power Relations were developed from the analysis of data using grounded theory. The research shows that compared to the predominantly reductionist approaches in construction management research, the developed causal loop diagrams and systems thinking approach could be used as alternative tools for decision-making in megaprojects to explain and understand how cost overruns emerge as a result of multiple interrelated causes and events occurring at different levels and phases of a project.

Gimhan is an Assistant Professor in Quantity Surveying at Heriot-Watt University, Edinburgh. His professional background is very much into construction cost management, and he holds a bachelor's degree in Quantity, a master's degree in Construction Project Management, a master's degree in Quantity Surveying, and a PhD in Construction Management. His current research focuses on using system dynamics for understanding the complex behaviour of causes of cost overruns in construction megaprojects.

The dynamics of migration to national Gigabit connectivity

David Exelby (Decision Analysis Services Ltd) [Presenter]

Stephen Curram (Decision Analysis Services Ltd)

Richard Cadman (SPC Network)

Kim Warren (Strategy Dynamics)

The European Electronic Communications Code (EECC) adopted by the EU in December 2018 places an obligation on National Regulatory Authorities (NRAs) to promote investment in Very High Capacity Networks (VHCNs). These include full fibre to the premises offering stable Gigabit connectivity. The various EU countries are starting from variety of different positions with development of VHCNs, ranging from 12% coverage in Austria to 90% in Netherlands. As investment is largely in the hands of the private decisions of network operators and external investors, it is important to understand what determines where, when and how much these investors will make available to build VHCNs.

This talk will describe a research study undertaken on behalf of the Bureau of European Regulators for Electronic Telecommunications (BEREC) which sought to develop a qualitative systems-based model of a generic telecoms market and its use to describe alternative dynamics observed across different countries. The models were developed through extensive engagement with stakeholders across the system and literature review.

In addition, there will be a reflection on the process and the challenges of working with a large group of independent clients and introduction of new methodologies.

Dr David Exelby is a director at Decision Analysis Services Ltd (DAS). DAS is a team with a shared vision of solving strategic challenges facing government and industry decision makers. DAS offers novel solutions to its clients across a diverse range of sectors based on collective expertise in strategic management, cost analysis, risk management and systems modelling. David has over 25 years experience in the application of systems thinking and system dynamics as part of strategy consulting to government and private sector clients. Clients include those within oil and gas, electricity, pharmaceuticals sectors, defence aerospace and global brand owners of consumer goods. Government consulting has focused on defence analysis for UK MoD and USA DoD. David has been a policy council member of the International System Dynamics Society, is a founder of the UK SD Chapter and an experienced SD trainer.

Student Presentation

Simulating Bottom-up Supply-Side Residential Energy Systems with Non-linear Conversion Efficiency: A System Dynamics Approach

Bilal Bugaje (University of Nottingham)

Recent years have witnessed an increased interest in distributed energy generation and a larger number of stakeholders getting involved in energy planning. These trends provide an opportunity for new tools to model energy systems from the bottom-up. Existing models obscure crucial features of bottom-up energy models, like energy conservation, energy loss and the causal relationships among system elements. In addition to simple diagrammatic modelling of these features, a systems approach may have other benefits to models of supply-side residential energy systems, especially given that energy planning deals with systems that traverse multiple disciplines. This paper proposes an application of System Dynamics to model the supply-side of residential energy systems from the bottom-up. A case study is demonstrated where models are created and validated using data from project SENSIBLE in Nottingham, UK. The models feature energy conservation, energy conversion loss based on a non-linear efficiency curve, and causal connectedness. Furthermore, a System Dynamics approach can contribute towards a systematic validation of the bottom-up modelling process in the form of validity tests. System Dynamics can be a valid option among the tools used for modelling residential energy systems using a bottom-up approach. This study represents the first attempt to develop a bottom-up supply-side simulation of an energy system using System Dynamics.

Student Presentation

The performance development of software-as-a-service ventures

Martin Lycko (Nottingham Trent University)

The transition to software-as-a-service (SaaS) business models has significantly affected software providers' operations. SaaS business models have allowed digital ventures to scale their product on the marketplace rapidly. They also provide a viable business model to entrepreneurs with much lower growth ambitions and fixed company sizes. However, there are significant differences regarding the performance development of SaaS ventures. This project aims to investigate the performance development of SaaS ventures regarding two critical performance measures: their ability to grow the value they create for customers and their ability to capture a share of that value as profit. An empirically validated System Dynamics model has been developed based on growth process theories, which explain the dynamic changes of companies while they grow, and utilising two case companies. The model approximates ventures' abilities to create and capture value as well as accounting measures used in empirical studies to approximate these theoretical performance outcomes. Model simulations show that SaaS ventures that maintain a fixed number of employees have natural performance levels towards which they develop over time. While companies growing their employee number can achieve higher levels of value creation in the long term, they also experience lower shares of value captured in the short term. Thus, managers and entrepreneurs need to ensure that their SaaS ventures can sustain the lower ability to capture value during the growth period until the venture returns to its natural performance level. Moreover, SaaS ventures need to design business models with positive natural performance levels because their companies will develop towards them. SaaS ventures cannot, contrarily to many practitioners' belief, grow themselves profitable.

Student Presentation

Toward a Theory of the Evolution of the Global Political Economy

Garry Piepenbrock (Eton College)

My paper addresses two of the most important global problems that my generation will have to solve over the next 50 years: Inequality and the Climate Crisis, models of which have been called 'The Holy Grail' of Political Economy research (Acemoglu et al., 2005). My research demonstrates that the solutions to both problems have much in common at a system level.

Political economists from Smith (1776) to Marx (1859) have long explored how wealth is created and distributed within nations. More recently, Acemoglu (2012) and Piketty (2013) have focused on the role of institutions and capital growth rates respectively to explain this. I integrate these into my exploration of how different forms of advanced political economy function, create performance differentials and co-evolve with the environment (Piepenbrock, 2009). To explore how capital and labour function in different forms of political economy, I use Hall and Soskice's (2001) typology of liberal and coordinated market economies – LMEs and CMEs. To explore the evolution of the political-economic-ecological interactions, I use The Limits to Growth (Meadows et al., 1972) and bounded rationality (Simon, 1957).

My model comprises four submodels: the core capital-labour subsystem (Marx 1867; Kalecki, 1934; Goodwin, 1967), the investment-transfer behavioural decision rule subsystems (Simon, 1957, 1969, 1979, 1982, 1984), the carrying capacity subsystem (Forrester, 1971; Meadows et al., 1972, 1994 and 2004), and the global trade subsystem (Ricardo, 1817). I numerically simulate the nonlinear dynamic behaviour of constrained competition between LMEs and CMEs via coupled differential equations of multi-predator-prey interactions (Lotka, 1925; Volterra, 1926) which are demonstrated to generate overshoot (Forrester, 1971), limit cycles (Goodwin, 1967) and chaos (Sterman, 1989).

These results demonstrate the symbiotic nature of 'interspecies' competition between complementary forms of capitalism (Goodwin, 1967; Hall and Soskice, 2000; Piepenbrock, 2009; Acemoglu, Robinson and Verdier, 2017). The 'species' of economic actors emerge from the mathematical dynamics of the ecosystems. Evolutionary strategies of 'r-strategists' and 'K-strategists' (MacArthur and Wilson, 1967) are derived from the ecological differential equations: 'r' is the fractional growth rate, and 'K' is the carrying capacity.

The 'Holy Grail' quest for formal models capturing how political economies can solve Inequality and the Climate Crisis is indeed challenging. I hope that the use of System Dynamics can begin to shed some light on the nonlinear dynamic interactions between: 1) capital and labour within a political economy, 2) LMEs and CMEs in competitive international trade more broadly, and finally, 3) the global political economy and the supporting ecological ecosystem. The symbiotic interaction between capital and labour have been demonstrated to enable and constrain growth of wealth endogenously, while the environment enables and constrains growth of wealth exogenously. The simulations demonstrate that while LMEs outperform CMEs in the shorter term, the converse is

true in the longer term, with LMEs maximising capital wealth and efficiency and CMEs maximising labour wealth and equity. CME's greater equity and lower degradation of the carrying capacity sheds light on the solutions to Inequality and the Climate Crisis.

Breakout 1

Developing a System Dynamics Model to support Waiting List Recovery

Mike Woodall (The Strategy Unit)

Working with the national collaboration to coordinate covid-related analysis, and the NHSE/I Midlands region, the Strategy Unit developed a System Dynamics model of waiting lists for planned care.

For several years prior to the pandemic, waiting lists for planned care had grown; waiting times had increased; breaches of constitutional standards had become commonplace. Yet the analytics and management of waiting list had been largely perfected. We understood the dynamics of waiting lists and times. This certainty has gone. Covid changed many of the rules of the game simultaneously and radically.

Patients' willingness to present at primary care; their ability to get an appointment; GPs' willingness to refer to secondary care; the willingness of patients to take up hospital appointments; mortality whilst waiting; hospital staffing levels; diagnostic, bed and theatre capacity. All these parameters have changed. Some will return to pre-covid levels; others will find a new natural level.

Our model was developed to help local systems test how they might respond to the new dynamics and how their assumptions of how different strategies might fair under changing circumstances.

The presentation will cover the problem we were addressing, the development of the model and how our understanding of waiting lists has changed further since we developed the model.

Mike leads a team which specialises in quantitative evaluations and linked health and social care projects. He has led several evaluation projects including, the evaluation of the 'Rapid Assessment Interface and Discharge' Plus Test Bed Programme in Birmingham and Solihull and a Case Study Evaluation of the national Stranded Patients Programme.

Mike Woodall has developed a System Dynamics (SD) model to examine the impact of Covid on elective waiting lists (see link). Users can model the potential backlog created by the lockdown and test the Impact of any initiatives to reduce the waiting list as services restart. He is leading an Action Learning Set on SD modelling that started in October 2020.

Mike has over 20 years' experience of managing and analysing data across commissioners and providers within both health and social care. He can analyse and present complex data in a clear and concise format that can be used for decision making. He has developed monitoring systems and performance targets for integrated care metrics.

Breakout 2

Coronavirus Variants of Concern: how might these change our future…

Peter Lacey (Whole Systems Partnership)

There has been extensive modelling of the COVID19 pandemic with significant contributions from the SD community as witnessed by the event held by the Society back in May (link). One of those has been work by Whole Systems Partnership to support local demand and capacity planning in a number of regions of England. This Epidemiological model links to the risks of hospitalisation and death and has provided important insights and planning goals for a wide range of hospitals and related services.

With the second wave of COVID behind us and the probability of increased cases over the summer and autumn we ask the question about what impact new variants of COVID might have. With the experience of modelling the now dominant 'Kent variant' in the recent autumn and winter WSP use their model to explore how new variants such as those from South Africa, Brazil or India might impact on future infections, hospitalisation and deaths. This session will involve the opportunity for participants to engage with the model to explore possibilities and to consider how the Government might be advised to respond.

Breakout 3

Student Colloquium

Simulating Bottom-up Supply-Side Residential Energy Systems with Non-linear Conversion Efficiency: A System Dynamics Approach

Bilal Bugaje (University of Nottingham)

The performance development of software-as-a-service ventures

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Toward a Theory of the Evolution of the Global Political Economy

Garry Piepenbrock (Eton College)

Sustainable Development Strategies of University with System Dynamics Approach

Farhad Bolouri (University of Tabriz)

Network-based Product Ramp-up in a Demand Shock: Evidence from Ventilator Challenge UK

Nikolai Kazantsev (Alliance Manchester Business Schoool, The University of Manchester)

Long-term water security: an approach for systemic analysis of urban water supply

Walter Manoel Mendes Filho (Instituto Tecnológico de Aeronáutica)

A Dynamic Economy – Understanding the role of transport connectivity in Levelling Up the North of England

Jack Snape (TfN)

Mike Costello (Steer)

The UK Government has an objective to level-up the economy away from London and the South East to other parts of the country, including the North of England. This objective is based on the idea that the UK's productivity challenge is largely a result of some regions significantly lagging behind the capital, and that a turnaround in the UK's fortunes can only be achieved by correcting the imbalance and boosting productivity in these slower growing regions. To help address this the Government and Northern leaders established Transport for the North, a new statutory body, to make the case for transformational transport investment that would enable the North to function as a single economic area. By pooling the economies of the North's major towns and cities, labour markets and trade networks would be expanded to a level that could begin to compete with London. Although there are international comparators, this vision for a highly connected and inter-dependent polycentric region is a clear departure from traditional economic models, which do not capture the barriers that have developed over decades of poor connectivity between the North's cities. To address this, TfN and Steer have developed NELUM, the Northern Economy and Land-Use Model. NELUM is a System Dynamics modelling tool capable of representing dynamic feedback loops between transport investment and economic performance, and it is now being applied in major transport business cases and long-term strategy development.

In this talk, Mike will explain how Steer developed the underlying approach that NELUM is based on, and how it was implemented at a regional scale for the North of England. Jack will then explain how TfN is applying the tool to shape TfN's policies and strategies and how the tool will continue to be developed and applied.

Mike Costello is a Principal Consultant with Steer, a consultancy specialising in infrastructure, cities, and transport. After studying Civil Engineering as an undergraduate but deciding to follow an initial career in project management and management consulting, Mike later returned to university to study an MSc in Transport Planning and Engineering. Here, he developed an interest in transport modelling, and particularly land-use transport interaction modelling (LUTI), which he attributes to playing copious amounts of the computer game SimCity in his formative years. Since joining Steer, Mike has worked extensively with Steer's 'Urban Dynamic Model' – a LUTI model based on System Dynamics that is the foundation of TfN's NELUM.

Jack Snape has a PhD in physics and has worked as an analyst in the Civil Service and in Local Government across a range of policy areas, including higher education, manufacturing, climate change and transport. Jack is now the Analysis Manager at TfN, leading the development of TfN's Analytical Framework, a new suite of software tools that provides a consistent approach to data, modelling and appraisal across travel modes and regions of the North.

Poster Session

Sustainable Development Strategies of University with System Dynamics Approach

Farhad Bolouri (University of Tabriz)

In this study, an online questionnaire was prepared and the components of universities' sustainable development were sent to the experts (related professors and staff working in the field of university green management) of Iran's top universities for scoring. The components of "reducing energy consumption and using clean energy" with a score of 4.56, "active participation in sustainable local and national development" with a score of 4.41, and "attracting the support of senior managers, faculty and staff for more success in the green management of the university "with a score of 4.38 out of 5, they were ranked first to third, respectively. Then to obtain the interaction between the basic parameters of universities' sustainable development, namely society, economics, environment, university governance, and academic research; A systems dynamics model was developed. In the model, the clustering method was used according to the comprehensiveness of the topic of sustainable development. To model and relate the clusters to each other, all five clusters were linked to strategic variables (sustainability, campus, and university strategy) with equations. Then the strategic variables were related to the rate variable (green management) with equation writing, and finally, the stock variable, ie universities' sustainable development, was obtained using changes in the rate variable. By performing different scenarios on the system dynamics model, reliability was obtained. Intra-cluster, inter-cluster, and trans-cluster evaluations were performed and it was concluded that the effect of components on strategic variables, rate variables, and stock variables were not the same and for example, by applying a coefficient of 0.5 on The first-order component is the effect of its change on the rate variable twice as much as its effect on the accumulation variable. It should be noted that universities' sustainable development depends on the practice of all aspects of environmental, social and economic, governance and research, and can not be achieved only by acting on the desired components.

Network-based Product Ramp-up in a Demand Shock: Evidence from Ventilator Challenge UK

Nikolai Kazantsev (Alliance Manchester Business Schoool, The University of Manchester)

Currently, there is a grave uncertainty in ramp-up capabilities of modern supply networks. For many SME organizations the opportunities to increase capacity (i.e. capacity sharing) is constrained by the complexity of new collaborations (Kazantsev et al., 2018). Recent COVID-19 outbreak has provided an example how excellence in collaboration design and Industry 4.0 technologies allowed UK to cover the national need for ventilators in June 2020. The goal of Ventilator Challenge UK was to produce the lifesaving product and the goal of this paper is to capture the main lessons learned of ad-hoc supply chain operation dynamics and make it available for other supply networks facing ramp-ups.

We state the research question of our study as follows: How could we simulate the ramp-up dynamics of Ventilator UK Challenge (2020) and predict its further development? Stock and flow

diagrams have been developed to model the system (Akkermans and Van Wassenhove, 2018). As recommended by Sterman (2000, p. 158), we undertook an in-depth interview to validate the units consistency, get feedback on causal dynamics and get values for parameters. Whilst doing this work we were following the available project description in blogs, social networks, and industrial journals and on the official website of the project , so we were able to capture the full dynamics from the start until finish. The local production facilities ordinarily have combined capacity for 110 ventilators per week, which has been raised in the project up to 1,500 units a week within four weeks, against an industry norm of over 12 months. By mid-June they had made around 7 000 ventilators delivered, 29 June - 10 000 units. 4 July - end of the project - One completed ventilator every 88 seconds, 13 437 ventilators in total 12 weeks' time.

The dynamic model consists of balancing and counteracting loops that interact and allow to increase or decrease production dynamics. We started the model with capturing the gap between the initial number of ventilators (5 900) available in the UK NHS by March 2020 and the forecasted number- (20 000), which was calculated by the UK Government. This gap (14 100 units) has triggered formation of an ad-hoc supply network to ramp-up production of ventilators locally. We calculated the time slack (negative in the beginning) which was driving project motivation (possibility to work in double shifts), and supply chain bottleneck elimination (production efficiency against takt time), which reduced the overall time of production. In the heart of the model we placed the induction process of new employees, which was done remotely using 3D lenses that complied with social distancing practices. The rapid raise of experienced people who assembled the ventilator, reinforcing loops for raising motivation after each produced ventilator (not included into the model) was the driving force for meeting the required target in 12 weeks.

Long-term water security: an approach for systemic analysis of urban water supply

Walter Manoel Mendes Filho (Instituto Tecnológico de Aeronáutica)

Over the 21st century, climate change will most likely impact hydrological drought trends around the world. The temporary reduction in water availability triggers public pressure for action, which in the short-term can then result in the expansion of reservoirs to increase water availability. However, the problem becomes more challenging if the long-term socioeconomic vulnerability and damage to ecosystems are taken into account.

This paper presents the development of a generic system dynamic model for the analyses of interactions between reservoir operational policies and water supply systems in metropolitan regions. The developed reservoir system dynamics approach is applied to the Cantareira system, which supplies approximately 9 million inhabitants in the metropolitan region of São Paulo, Brazil. The results suggest that the developed model is capable to provide a practical means for identifying plausible long-term trends for water supply systems in metropolitan regions and under the effects of external drivers such as changing climatic and demand.