



*Routledge-Giappichelli Systems Management*

# **CYBERNETICS AND SYSTEMS**

**SOCIAL AND BUSINESS DECISIONS**

Edited by

Sergio Barile, Raul Espejo, Igor Perko and

Marialuisa Saviano

Assistant Editor: Francesco Caputo



G. Giappichelli Editore



# Cybernetics and Systems

Society is now facing challenges for which the traditional management toolbox is increasingly inadequate. Well-grounded theoretical frameworks, such as systems thinking and cybernetics, offer general level interpretation schemes and models that are capable of supporting understanding of complex phenomena and are not impacted by the passage of time.

This book serves the knowledge society to address the complexity of decision making and problem solving in the 21st century with contributions from systems and cybernetics.

A multi-disciplinary approach has been adopted to support diversity and to develop inter- and trans-disciplinary knowledge within the shared thematic of problem solving and decision making in the 21st century. Its conceptual thread is cyber/systemic thinking, and its realisation is supported by a wide network of scientists on the basis of a highly participative agenda.

The book provides a platform of knowledge sharing and conceptual frameworks developed with multi-disciplinary perspectives, which are useful to better understand the fast-changing scenario and the complexity of problem solving in the present time.

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### **Cybernetics and Systems**

Social and Business Decisions

*Edited by Sergio Barile, Raul Espejo, Igor Perko and Marialuisa Saviano with  
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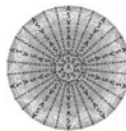
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# Foreword

*Raul Espejo*<sup>1</sup>

WOSC 2017, the 17th Congress of the World Organisation of Systems and Cybernetics, was planned as a conversational space about social dynamics underpinned by systems and cybernetics. Its conceptual thread has been made alive by a network of scientists, practitioners, and researchers from varied countries around the world (see Authors). Multiple conversations helped to integrate a variety of themes that are elaborated in this foreword and developed in over a hundred extended abstracts. The construction of its agenda was highly participative; efforts were made to support diversity within the shared thematic of Science with and for Society-Contributions of Cybernetics and Systems. This document is offered as a platform for the conversations we expect to hold in Rome from the 25th to the 27th of January 2017. We all agree that we are in an increasingly interconnected world. As expected our world is becoming more complex and therefore increasingly beyond our traditional response capabilities. The challenge is how we account for this complexity in the quest for a sustainable world underpinned by inclusion and fairness. More effective problem solving requires constructing a better world which enables individuals to offer their potentials and develop their capabilities. Dealing with an overwhelming complexity requires imaginative propositions and innovative behaviours that we believe can benefit from cyber-systemic problem solving.

Systemic thinking helps us visualise wholeness and avoid dysfunctional fragmentation; cybernetics helps us understand how to maintain stability in the interactions between people, institutions, and organisations. Systemic thinking gives us methodological tools; cybernetics gives us tools to manage the complexity of situations from the local to the global. Interactions among us and with the environment may reach regulatory capacity limits in which the situational complexity scales down or up as required by the need to maintain sustainability and viability. WOSC 2017 provided a platform to discuss the nature of our social and individual interactions and the constraints impinging in their success. Contributions to the Congress aim at exploring, debating, and clarifying what kinds of complexity management strategies are more likely to focus our societal and individual actions on desirable directions of sustainability, inclusion, mutual respect, democracy, effective organisation, and quality of life. The challenge is

making these strategies functional to societal interests and not to the interests of the few.

We started proposing three major themes for the Congress:

- A People, technology, and governance for sustainability
- B Democracy, interactions, and organisation
- C Cyber-systemic thinking, modelling, and epistemology

Theme A included tracks about human aspect of management, technology and innovation, and governance for sustainability; Theme B explored democracy and transparency, interactions, law, and organisation; and the last one offered the space for cyber-systemic thinking and modelling.

Proposed tracks for the first theme were human aspects of managing systems, smartness and sustainability, smart technologies and Big Data, the brain of the future, and governance in the Anthropocene. The human aspects of managing systems opened the space for psychological and social reflexions about interactions among us and with others in the environment. Interactions within organisations and between them and their environments give us the platform to discuss today's lack of fitness of governance in the Anthropocene; our society and its institutions need effective learning mechanisms, so far lacking, to cope with a fragile environment. Current information technology offers tools to foster smartness in the quest for sustainability. Effective communications and smart technologies make organisational structures sensitive to changing environments and able to distribute scalable responses from the local to the global. The application of digital technologies in organisations is disrupting their structures and increasing their capabilities to deal with complexity and interactions. These technologies are offering the potential for better organisational structures and more effective processes of governance. Cognitive machines, algorithms, deep learning, Big Data are all contributing to the brain of the future; while they amplify human capabilities, they may help introduce constraints in the environment to avoid overwhelming us with irrelevant complexity.

Beyond managerial and institutional matters, the second theme – democracy, interactions, and organisation – was proposed as a bottom-up theme that related the local decision making at multiple structural levels; this was a theme about democratic processes to align local needs and ecologies with organisations and political processes. This was a space to discuss self-organisation, transparency, and local influence in the global. Focus on the local opens reflections about interactions, complexity management, and constraints. The interactions revolution was thought of as emerging from, among others, social networks and the internet; it is about the increasing social and human fluidity allowed by digital technologies and also by the conceptual frameworks of systemic and cybernetic thinking. Ethical issues derive from the development of technologies in the world of e-government and law. Bottom-up processes provide a new perspective of organisational systems, including non-directive approaches to manage the complexity of social systems and the

emergence of constraint in complex adaptive systems. These issues are proposed as book tracks in the list below. Additionally, in this second theme we included the role of the educational system to respond to the challenges of sustainable development.

The third theme of WOSC 2017 was methodological and epistemological. Systems thinking in the 21st century reflects on applying systems thinking to current problems, such as social inequality, migration, global warming, and many more. Studying and dealing with these problems requires methodologies and tools; implying contribution to the practice of information and communication systems as well as to the systemic conceptualisation of 21st-century problems. Modelling problematic situations with the support of System Dynamics has proved to be a useful tool in a variety of situations. Formalisms of quantum mechanics have offered a novel platform to discuss modelling complex situations, such as the economy, organisations, psychology, artificial intelligence, human language, cognition, information retrieval, biology, and political science. These formalisms offer the opportunity for transdisciplinary insights and knowledge. Finally, at an epistemological level, this theme included contributions that challenged the scientific basis of traditional science; it referred to conversations about reflexivity, second order science, and conceptualisation of context.

These original three themes evolved into nine, which provided the scaffolding for WOSC 2017 and for this book of abstracts:

- Theme I: human aspects of managing systems
- Theme II: sustainability and the Anthropocene
- Theme III: smartness and Big Data
- Theme IV: democracy, transparency, and social dynamics
- Theme V: interactions revolution
- Theme VI: knowledge and organisation
- Theme VII: systems thinking and system dynamics
- Theme VIII: quantum modelling
- Theme IX: reflexivity, second order science, and context

The challenge for WOSC 2017 was their debate and discovering relations across these themes. Authors may read contributions to all nine themes, and hopefully reflect in their final papers the cross fertilisation of ideas. Abstracts related to all these themes are available on the Congress Website and authors can access them with the support of the Padlets collaborative tool ([Padlet.com](http://Padlet.com)), which allows leaving comments and developing conversations. Overall our purpose is to provide scientific contributions to the governance, organisation, and administration of social, environmental, economic business issues, with the support of systems and cybernetic ideas. This is referred in the book as the cyber-systemic approach, which aims at a holistic view of all these issues with a focus on the regulation, control, and communications among and between the multiple agents constituting their complexity. Regulation, control, and communications are the outcome of interactions and it is through these interactions that stable forms of relations emerge that constitute organisations.



The themes are connected and one way or the other all of them contribute to the overarching concern for a cyber-systemic appreciation of societal issues. Are together the abstracts submitted to these themes contributing to a richer and more powerful understanding of societal and organisational issues? This is a matter of individual and group discoveries. We would like to think that the nine themes have the potential to enable discoveries in the direction of making sense of the huge complexity that is overwhelming humankind currently. Hopefully WOSC 2017 turns out to be a small contribution to science with and for society.

Authors' contributions to the Congress were made in the context of nine keynote talks, two roundtables, and one experimental session to connect theatre and cybernetics.

A connecting line for the keynotes is the Congress aim to improve our understanding of the relationships between people, organisations, and their environments. It is widely acknowledged that we are affecting our environment in ways that anticipate significant problems for future generations. Dealing with these problems requires clarifying what are acceptable levels of balance between us, our organisations, and their environments; working out essential variables and related performance criteria at multiple levels of aggregation, from the local to the global, is necessary to support action towards a sustainable world. Since it is actions that are affecting the stability of our world, we need to produce repairing efforts, which imply distributed governance and action.

The Congress's first two keynotes in this book offer insights about these relationships. The first of these, "Sustainability Science: Linking Science, Policy and Society for a Sustainable Future" (by Kazuhiko Takeuchi), offers a framework for a sustainable future. The second, "Governance in the Anthropocene: Cybersystemic Possibilities?" (by Ray Ison), questions whether in the epoch of the Anthropocene, we are making sufficient use of governance options, technology, and education in the construction of a more sustainable world. What are possible cybersystemic contributions in this construction? The discussion on the governance of the Anthropocene, supported by sustainability principles and structural requirements for effective distributed governance is debated in Theme II "Sustainability and Anthropocene". This theme addresses specific aspects of smart use of technologies, distributed governance towards achieving global and local sustainability targets, and the role of education for sustainable development.

Human aspects of managing systems are many-sided. Among others, they relate to policy processes, people's behaviour, social dynamics, distribution of power, and ethics and norms. These human aspects shape our social relations. We had two keynotes, focused on democracy, participation, and current technologies. First, the keynote "Digital Bill of Rights" (by Richard Barbrook) opens the debate about regulating individual use of online activities not only in their interest but also the common interest, introducing the age of cybernetic citizens with rights and responsibilities in the world of algorithms and autonomous machines, and the second "Artificial Intelligence and Law: What Perspective?" (by Daniele Bourcier). It addressed ethical considerations and the potential of soft law to take into account the sensitive and evolutionary aspects of artificial intelligence applications in some areas of human activity (medicine, security, e-government, military robots, and law). These aspects affect the balance between individual rights and

the commons. Cybernetic ideas can help us to discuss freedom of expression, autonomy, and respect for each other. Related to these keynotes, three themes provide discussion in more depth issues of participation and social and individual behaviour in the cybersystemic age: first “Human Aspects of Managing Systems”, second “Democracy, Transparency, and Social Dynamics”, and third “Interactions Revolution”.

Present technological developments are enablers as well as threats to democracy. They are amplifying the scope of interactions in orders of magnitude, something that hugely increases social complexity and therefore the potentials for more participation and guided self-organisation, but also for exploitation, abuses of power, and fragmentation. These technologies have the potentials to connect social, economic, and sustainability issues; they pose challenges and open opportunities, but they also increase regulatory difficulties. These issues are explored by three keynotes. The “The Brain of the Future” (by Alexandre Perez Casares) explores how cognitive machines are altering social relationships and increasing the relevance of artificial intelligence in economic activities, to the point that human jobs may be replaced by inference machines, dominated by performative algorithms rather than by simplifying mappings. The second keynote “Knowledge for development vision 2030” (by Elias G. Carayannis) offers a reflection about the societal developments such as smart cities which connect technology, innovation, organisation, economic and social trends; and the third, “Design of a Regional System” (by Alfonso Reyes), provides, at a micro level, considerations for designing enablers for self-organisation and regional development. Three Congress themes enhance the debates offered by these plenaries: “Smartness and Big Data”, “Knowledge and Organisation”, and “Systems Thinking and System Dynamics”.

A most important concern of this publication is exploring the contributions that systems and cybernetics can make towards improving policy processes and policy making. A particular policy issue of great social significance was discussed in the keynote “From Precision Medicine to Systems Medicine: Clinical and Social Implication” (by Christian Pristipino). This particular policy arena, in the age of Big Data and real-time streaming, can offer a holistic approach to medicine of great significance for the future of health services. The transformation from reductionist medicine to holistic medicine is precisely an arena to discuss ethically appropriate individual-patient treatments with the support of systems thinking and cybernetic modelling. The keynote “Recognizing the Dangers of Simplicity Addiction” (by Michael Lissack), introduced the issue of cybernetics and policy issues. This keynote made apparent that though simplification is necessity to cope with complexity, too much simplification is dangerous and argues for requisite variety to achieve effective performance. It opens the space for innovative contributions to modelling and epistemological issues. Two related themes, “Quantum Modelling” and “Reflexivity, Second Order Science, and Context”, open discussion on related topics.<sup>1</sup>

## Note

Below, in the Overview of this book readers can have a more detailed presentation of the nine themes of WOSC 2017.

1 President of World Organisation of Systems and Cybernetics.

# Preface

Nowadays, society is facing challenges for which the traditional management toolbox is increasingly inadequate. Well-grounded theoretical frameworks, such as systems thinking and cybernetics, offer general level interpretation schemes and models that are capable to support understanding of complex phenomena and suffer less from the passing of time.

This book is the outcome of the WOSC 2017, the 17th edition of the Congress of the World Organisation of Systems and Cybernetics, a world organisation that invites scientists, policy-makers, professionals, and students across the globe to contribute to the debate of the dynamics underpinning contemporary societal problems from cybersystemic perspectives. WOSC offers a space for conversations about social dynamics from multiple points of view. A multi-disciplinary approach has been adopted to develop inter- and trans-disciplinary knowledge within the shared thematic of problem solving and decision making in the 21st century. Its realisation is supported by a wide network of scientists in a highly participative agenda.

The book provides a platform of knowledge and conceptual frameworks developed with multi-disciplinary perspectives, which are useful to better understand our fast-changing scenarios and the complexity of problem solving in the 21st century.

The book promotes a boundary-crossing knowledge creation process highlighting the necessity of adopting a multi-disciplinary approach to address the challenges of decision making and problem solving in the 21st century. Under the common view of the general frameworks offered by systems and cybernetics, the book addresses three macro-themes: first, people, technology, and governance for sustainability; second, democracy, interactions, and organisation; and third, cyber-systemic thinking, modelling, and epistemology. The contributions collected in the book are the outcomes of knowledge sharing processes and articulated methodologies and perspectives.

Sergio Barile  
Raul Espejo  
Igor Perko  
Marialuisa Saviano

# An overview

WOSC 2017 invited contributions to 16 tracks, which were finally structured into nine themes. Some of the tracks have maintained their identity while others have evolved constituting larger themes, incorporating two or three tracks. Some tracks, even if the number of received submissions were small, have remained. Here we introduce the reader to the nine Congress themes. This introduction relies on the abstracts proposed by the tracks and themes coordinators and abstract submissions.

## **Theme I: human aspects of managing systems**

This theme initiated by Sergio Barile, Marialuisa Saviano and Francesco Caputo invited theoretical and empirical contributions, centred on the debate of expected and potential disruptions and modifications in enterprises resulting from current technological and human changes. Direct and indirect modifications in social dynamics and the relevance of people (driving new consumer behaviour and manufacturers' attitudes) are central to evolving enterprises. Contributions were expected to define and interpret the impacts of the changing role and behaviour of people in complex organisations (enterprises, etc.) and also impacts of changing business and management systems on the behaviour of individuals. The proposed focus was mostly on human aspects and human processes that can be analysed at behavioural, cognitive, neurocognitive and affective levels (i.e. values, planning, decision making, memory, problem solving).

Received submissions emphasised aspects of intrinsic motivation and self-organisation in firms. They emphasised the importance of training to bridge cognitive gaps between employers and employees as well as of gender equality to have smart economies and to trigger ethical differences. They highlighted change management in social and labour relations and the emergence of new relations in the network economy, such as equity crowdfunding, dynamic capabilities and successful projects.

This theme is a pivot for many of the Congress contributions. Structural aspects such as centralisation are seen as inadequate for good decision making, highlighting the advantages of heterarchies and autonomy to support flexible adaptable learning organisations in which everyone learns from others. Digital data and

networking complexity are growing faster than people's data absorption capacity, triggering data handling weaknesses. This idea relates to Theme VI, "Knowledge and Organisation". Resilience and antifragility are necessary to enable self-organisation and self-regulation. Organisations need anticipatory smart systems as well as dynamic capabilities to reinforce interactions with their environments and structural adaptation to changes. These are all issues also related to Theme III, "Smartness and Big Data".

Acceleration of communications in organisations is associated to digital technology. This quicker pace of communications is increasing interactive imbalances, triggering sustainability issues in organisations (Theme II). The fastest, most agile, survives. Communication professionals' burn out in the digital era is increasing. Organisations need stronger response capacity (Theme V).

Human aspects in project management were highlighted emphasising the softer people aspects, raising questions about balancing cognition and interactions, for instance how to make use of managers' unavoidable bounded rationality to work out constraints and strategies to manage complexity. Management at the edge of chaos requires considering constraint as well as augmented reality.

Related to Theme VII, "Systems Thinking and System Dynamics," the need for soft systems methodologies is proposed. Reality is complex; it is socially constructed and a product of people's ongoing interactions (Theme V, "Interactions Revolution"). This interpretivist ontology triggers the ideas of grounding epistemology in ontology.

New institutional perspectives are emerging from changes in technology as well as better appreciation of human aspects of managing systems. There are trade-offs between internal efficiency and external legitimacy. Strategies to remain competitive could imply mimicking others' strategies to gain legitimacy but this mimicking may affect negatively intra-organisational relationships that are necessary to strengthen viability. The Viable Systems Model and Approach are used as two conceptual frameworks for management. Requisite holism is argued.

## **Theme II: sustainability and the Anthropocene**

Sustainability is required as a must for human activities from the most local to the global. It is at this global level that the Anthropocene is understood as a new geological epoch in which humanity is affecting the earth's dynamics. This second theme, as proposed by Marialuisa Saviano, Hernan Lopez-Garay, Sandro Schlindwein, Markus Schwaninger and Ray Ison, acknowledges that local and global are deeply intertwined. It covers all aspects of sustainability.

Smartness, as discussed in Themes III and I, is grounded in technology and recognises digitalised processes and telematic interactions in human activities. Sustainability is focused on successful human activities as well as in processes and interactions encompassing social, environmental and economic perspectives. How can we make smartness unavoidably linked to sustainability?

Unfortunately, we live in an ever-increasing unsustainable world. Systems thinking helps disclosing sustainability problems because of its focus on interactions

and relationships. These are problems deeply rooted in our social structures and culture. Unsustainability relates to human, organisational and environmental imbalances in the management of critical variables. Instabilities are disclosing critical situations. The challenge of sustainability requires transforming research and education from a descriptive-analytic mode towards a transformative one. Distributed educational programs are necessary to build capacity for understanding the systemic nature of our current unsustainable world and the real-world sustainability problems. These programs are necessary to educate future generations of decision makers, problem solvers, change agents and transition managers. We need to reflect upon and learn the competences, pedagogies and assessment tools needed for these purposes. In WOSC 2017 this theme wants to shed light into programs that use cybersystemic tools to educate a new breed of human being aware of the historical conditions we are in. The aim is people caring for the development of a harmonious sustainable world.

As proposed by Ray Ison, earth scientists are claiming that we have entered a new geological epoch: human influences have become so great that they are affecting “whole Earth dynamics” through a range of biophysical and social processes leading to complex global changes. Unfortunately, these changes are the outcome of happenstance more than of reflective governance systems. This calls for a critical reflexion of our past thinking, practices, institutions, patterns of investment and governance.

The Paris Agreement in December 2015 was a call for national, organisational and institutional commitments to take action towards a satisfactory balance between human activity and earth sustainability. This theme wants to reflect upon cybersystemic governance of social-ecological systems.

Contributions to “smartness and sustainability” are closely related to those to Theme III, “Smartness and Big Data”. Aspects of value co-creation between providers and customers, willingness to adopt data management technology to support sustainable behaviours are being proposed in both themes. In this context a major topic for debate is “smart cities”. Actors, smart technologies, designers and governance come together in sustainable cities; What is a sustainable city? How can systems thinking inform the design and management of smart cities? Can non-conventional conversational places, such as the Cybersyn operations rooms help in the ongoing design of smart cities? What can smart grids, as enabling technologies for interactions, do? These are questions that are also relevant to the themes “Knowledge and Organisation” and “Systems Thinking and System Dynamics”. Smartness and sustainability relate environmental, economic and social dynamics. A challenge for the Congress is debating an integrated framework for sustainability: algorithms, hard and soft approaches that weave sustainability and technology.

The Viable System Model offers a conceptual framework for the governance of local and global systems. Its reliance on the Law of Requisite Variety makes it relevant to the debates of the “Systems Thinking and System Dynamics” theme (Theme VIII).

Governing socio-ecological systems in the Anthropocene reveals the high dependency between nature and society. “Socio-ecological systems” are complex

and need to be adaptive. They need resilience to absorb change. The structural coupling between ecology and society is a wicked problem. We need models and tools to appreciate better the structural coupling of social systems and their ecosystems. They should help disclose critical variables and the relationships that need to be conserved over time. Contributions to this theme may enable debates about the governance in the Anthropocene using the metaphor of a triple helix between academy, government and industry. Universities should play a significant role not only in research but also in education for sustainability.

It can be appreciated that this theme also weaves several others.

### **Theme III: smartness and Big Data**

This theme, as proposed by Fabio Orecchini, Francesco Polese and Igor Perko, offers the opportunity for a more focused debate about Big Data. This is a disruptive technology in nearly all the domains of our interest. Big Data support interactions, decision processes, production and in general all kinds of services delivery activities fostering the co-evolution of agents of all kinds. Theme III aims at analysing the state-of-the-art and future of Big Data and smart technology's definition, design, exploitation, potentials and limits.

This theme is focused not only on smart cities but also on other kinds of social, economic and production services. Reflections on the smart city ecosystem, the disruptive nature of its relevant technologies, the disruption of traditional market balances to support the emergence of more efficient, effective and sustainable cities are ideas discussed in this theme. Smart cities are the arena for stakeholders' interactions (Theme V, "Interactions Revolution"). Contributors to this theme see cities as complex adaptive systems.

It is based on data collection, analytics and measurements for social, economic and technical systems. Big Data is disrupting the interactions within and between enterprises of all kinds, and over time is supporting the emergence of new relationships between firms and public organisations, between R&D and universities, and indeed the emergence of virtual networks and organisations. Discussions about the nature and characteristics of these relationships should help to visualise new social forms. Contributions to this theme have emphasised triple helix articulations between universities, the economy and society. Smartness helps to focus on stakeholders of all kinds, like youth, elderly, professionals, interest groups, unemployed and so forth. Big Data, analytics and measurement are relevant to each, and many more, of these groups to disclose communication channels relevant to them.

It is necessary to understand the capabilities of internet and data management companies. Enterprises like Amazon, Google, Facebook are shaping our interactions and relationships. Applications like the internet of things and the automation of transport activities will be shaping the way we live. Ubiquitous smart devices are increasing data collection at staggering speed. This growth in data collection capabilities will trigger further technological changes, like for instance quantum computers, linking this theme to the "Quantum Modelling" theme (Theme VIII).

To define a technology as smart it must be aware of its environment and must have capacity to co-evolve with environmental agents and self-configure its capabilities. This theme discusses the viability of smart service systems.

This theme, as well as the “Knowledge and Organisation” theme (Theme VI), is responding to the challenge of knowledge management in the 21st century. Big is not necessarily smart. Data management has the potential of being the pathway towards a smarter planet with better capabilities for solving social, economic or/and other human issues. This is a connection with the “Sustainability and Anthropocene” theme (Theme II). But also, this theme wants to discuss matching managerial capabilities to data, a topic connected to the “Interactions Revolution” (Theme V).

#### **Theme IV: democracy, transparency and social dynamics**

Amanda Gregory, Daniele Bourcier, Raul Espejo and Zoraida Mendiawelso-Bendek are coordinating this theme.

The theory of self-organisation, based on the premise that some form of overall order or coordination can arise out of the local interactions between the component parts of a system, has a long history and a wide field of application. Self-organisation is relevant to social systems constituted through local or virtual interactions. It reflects the assumption that self-organisation will emerge through the realisation of the benefits of autonomy, a positive orientation towards self-empowerment and purposeful action. Self-organisation happens in interactions of unequal complexity such as instances of societies facing extreme environmental problems, or dire economic pressures, or challenges of accommodating different values and norms of behaviour. While some self-organisation efforts flourish, others fail as economic, environmental, political and social factors can pose challenges that undermine them. Self-organisation may be dysfunctional to the point of threatening the fairness, justice and even the viability of the interacting agents. These are undesirable instance of social dynamics. Contributions to Theme V – the “Interactions Revolution” – and Theme VI – “Knowledge and Organisation” – also discuss aspects of self-organisation.

One of the contributions addresses the issue of the peace process in Colombia, which suggests the need for national cohesion and the enabling of self-organisation to overcome the entrenched corruption in some of the regions of the country. Corruption makes transparency and democracy unachievable. Citizens science is proposed as a tool to improve communications between citizens, experts and politicians. Democratic deficits, even in the most advanced democracies, pose the need for reflection and this is one of the aims of this theme.

Barbrook is proposing in this Congress the creation of a Digital Bill of Rights to avoid the threat of authoritarian states and monopolistic businesses in the age of the internet. This proposition requires attention to interaction spaces enabling self-organisation. Cybernetic principles of complexity management can enable the democratisation of internet services. As proposed by Espejo, Beer’s Viable System Model is one such framework for complexity management and the Law



of Requisite Variety offers a heuristic for the democratisation and transparency of these processes. The Liberty Machine, which underpinned Beer's design and development of the projects Cybersyn and Cyberfolk in the Chile of the early 1970s, offered an extraordinary vision of a utopian society in which the people could express themselves, individually or collectively, with autonomy. Today these projects can be undertaken with more sophisticated methodologies and epistemologies, which should support better processes of social construction (Theme IX: "Reflexivity, Second Order Science, and Context"). Also, as is discussed by the "Smartness and Big Data" theme (III), we have hugely more developed information and communication technologies, which should allow us to deal with complexity and support interactions at scales that were unthinkable 40 years ago. These conceptual and technological developments give us opportunities to transform our societies into more democratic and transparent ones. This theme has been proposed as a platform for contributions to discuss and illustrate the application of cybernetic principles and digital technologies to the design of participative and inclusive processes in the public, private and third sector spheres.

As proposed by Bourcier in this Congress the movement of Commons is not only protecting and improving the management of (scarce) resources but also offering the opportunity to renew democracy through a redefinition of state and market interactions with the support of systemic ideas. This theme wants to discuss this renewal from the "making of law" perspective. How to reach a consensus on regulation? The notion of Common good highlights the need for a different normative; it suggests a re-thinking of the legal framework towards the production of Common good. It is necessary to experiment building a normative system on local, global and interpersonal relations between social actors, and to implement collaborative legal tools, scalable, inclusive, integrative and experimental. This theme focuses on how have the Commons or Common good been integrated into the legislative texts? And, how can we rethink a normative process based on the social dynamics of the Commons? It is proposed to rethink existing normative tools in our democracies; how have new methods for writing norms emerged from the Commons movement?

Finally, this theme proposes to rethink democracy through legal tools designed in a cooperative and decentralised process. Further developments invite case studies in the various types of legal norms (constitutions, statutes, by-laws, customary laws), in soft law (ethics, charts, guides, Creative Commons licences, . . .) and smart contracts.

Scholte discusses in one of the submissions to this theme: "Varieties of Systems Theatre" is offered as a reflection about interactions and reflexivity. It is experimental in nature. He discusses, following Ross Ashby's assertion that "the discovery that two fields are related leads to each branch helping in the development of the other", how theatre experiments offer an opportunity for cross fertilisation between theatre and second order cybernetics. He is looking for cross fertilisation between "varieties systems theatre" and the cybernetics and systems community. First, he argues that theatre has cybernetic underpinnings; particularly it can be an instance of applied epistemology. Second, it links modes of cybernetic explanation

to processes of agent-based modelling (patterns of interactions). Third, it offers reflections about the theatre of the oppressed, which involves the audiences.

## **Theme V: interactions revolution**

This theme originally proposed by Espejo and Dominici wants to enable theoretical and empirical contributions about the increased speed of self-organising processes in today's world. Its focus is fluid interactions in the age of digital technologies. Its worldview is interactions and relationships between systems and their environments and also interactions within organisations. Its emphasis is dynamic and structural couplings and co-evolution rather than the study of the parts of a system. Today organisations and social systems need increased fluidity and agility to respond to environmental, social and economic pressures. Particularly these are requirements focused on the future and therefore this theme is connected to the Keynote "The Brain of the Future". The aim is to investigate opportunities and challenges for organisational and business systems in future scenarios that will require new strategies and policies to face increased fluidity in social structures.

It offers a space for digital technologies and transdisciplinary conceptual frameworks to disclose self-organised organisational forms that are more likely to anticipate and respond to environmental, social and economic changes. This is an 'interactions revolution' towards distributed value co-production and guided self-organisation. Problem solving is at the core of these self-organising processes; which interaction strategies increase response capacity and help, making sense of an often overwhelmingly complex surrounding? These are aspects related to requisite variety. Also, which interactive strategies help to maintain dynamic stability with this environment?

Contributions to this theme have not necessarily recognised this conceptual framework, but at its core are forms of interaction diagnosing, designing and discovering problem-solving strategies. Instances illustrate how people can benefit from current technologies in today's digital world to make their interactions – often dominated by information asymmetry, domination, abuses of power, inequality, lack of mercy and so forth – more humane and acceptable. The emergence of mercy in interactions – *eleogenetics* – as one of the abstracts proposes is not only a spiritual matter but also a matter of communicative capacity, say, between a mother and a child. Equally, lack of trust, corruption, unfairness relate to communicative capacity. There is much scope for an increased transparency, as well as exposure, in interactions. In a technical sense, algorithms and software code can break through murky communications.

A particular aspect of the abstracts to this theme is their foci on instances, such as a country's banking for sustainable development, language development to improve communications, smart cities to strengthen cohesion and improve quality of life, 3D printing technologies for personalised medication and health workers' interactions with patients to improve their services and so forth. One way or the other interactions are the currency of most of the other Congress themes; however in this theme the emphasis is instances of problem solving and

relationships. In the cyber-systemic perspective, this is a theme about variety engineering as proposed by the Viable System Model.

## **Theme VI: knowledge and organisation**

One of the topics proposed by Sergio Boria is knowledge to manage the knowledge society. Another, proposed by Andrée Piccq and Claude Lambert, is the role of emergence within organisations.

Together, they suggest that directive and invasive regulation is inappropriate to deal with complex systems, which far from being deterministic, are chaotic and unpredictable. Organisations don't lend themselves to precise analytical modelling but to learning processes through action. Organisations are complex systems which emerge from human interactions and create knowledge; these interactions may be enabled by management and training. To survive these organisations must be self-regulating and self-organising. Emergence, complexity, self-regulation are three inseparable concepts in all organisations.

Topics discussed by the abstracts range from technological unemployment as frictional unemployment to the extent that machines will replace the toil of work. Professional creativity and problem-solving capabilities will become ever more important in the future. Technological innovation will increase opportunities for new forms of work. One of the abstracts contrasts male and female brains and their contributions to organisation. Another contribution discusses building intellectual capital for sustainability in rural Ghana, and proposes sustainability as a source of knowledge. Fragmented communities fail generating knowledge. Yet, another argues that mainstream management is not the only way to manage social systems and suggests discussing new organisational forms. Consistent with Theme V one contribution suggests moving away from objects into relations and proposes quantum governance of human systems to overcome the idea of steering organisations as machines. The spirit of this theme is bottom-up, democratic, non-directive organisational learning.

## **Theme VII: systems thinking and system dynamics**

This theme opens debates about two interrelated topics, the first "how can systems thinking help to bring solutions to humankind problems in the 21st century?" and the second is about system dynamics. Organisations are subject to contradictory forces. Contradictions stimulate organizational change.

The first topic was mostly articulated by Marie Noelle Sarget from France: though at a first glance societal problems may appear mainly economic, political, geopolitical, environmental or demographic, our failure to solve them may be because of systemic obstacles requiring a systemic approach, and an understanding of their complexity with an interdisciplinary vision and action. The early years of the 21st century are proving increasingly complex. We have many challenges including a population explosion, an unprecedented population migration, a failure managing our finite resources, the wholesale abuse of our environment,

dysfunctional financial services, poorly regulated economies, inequality and corruption. We have still to grasp the full impact of technology upon human civilisation. If we, the collective human race, are to develop we should reflect upon how we organise ourselves and how to create policies relevant to our survival and how we turn them into feasible practicality. We believe that systems thinking and related information and communication tools have a significant part to play in policy development and to this end this topic is intended to surface ideas of value addressing some of the above-identified global challenges.

Authors were invited to submit papers addressing concrete problems, offering problem-solving practices going beyond general statements about systems concepts and abstract use of methodology. Each contribution should show how a systemic approach could contribute to understand situations better, bringing more effective solutions in the long term.

For issues like combating poverty the proposal is going beyond modelling economies, which are unlikely to solve problems, into systemic understanding of the roots of poverty. What are the limits to parametric economic modelling? Current trends in international trade: how to think systemically about trade? How can systemic obstacles to the inclusion of disabled people be overcome?

For observers to think systemically about a situation is different to accepting that they are part of a situation that is systemic. The latter is more about reflection and participation, as is proposed by Theme IX; the former could be more about using systemic thinking to gain advantage and power over those operating with a fragmented view of the world. Systems archetypes can be used as instruments to gain advantage in interactions; they may be used as competitive rather than collaborative tools. This reflection connects this topic to system dynamics modelling.

Didier Cumenal proposed the topic, “Systems thinking and System dynamics”.

Stefano Armenia, from Italy, and Didier Cumenal, from France, contributed to the articulation of this topic. The impacts of policy/strategy implementation have historically been very difficult to anticipate, due to the many complex and interconnected phenomena acting in the related situations. Decision-making accuracy and effectiveness are seriously affected by the use of old tools for new problems. This implies that policy making requires theories, models and tools that support complexity.

The topic wants to address the general issue of model-based governance, aiming at establishing whether systems thinking and system dynamics can constitute the correct mix of tools in order to effectively and accurately deal with complexity in policy making. Policy makers are increasingly challenged by Big Data (Theme III); modelling tools like system dynamics can help make sense of situations of uncertainty and unpredictability.

Are systems thinking and system dynamics effective tools for policy making? One of the contributions explores the meaning and purpose of the concept “reality of a theory”. It offers epistemological reflections; is a theory a deep approximation to reality? Contributions include reflections about teams for new product development, application of system dynamics to games, to space exploration,

prison systems and malnutrition. However, in the end, a few submissions are more about economics than systems thinking.

### **Theme VIII: quantum modelling**

François Dubois, from France, proposed this theme. It is a challenging and innovative proposition. It relates to other themes of this Congress, in particular to Theme V, “Interactions Revolution”. Ashby proposed variety as a measure of complexity, a concept which relates to entropy and in its turn this is a concept that relates to quantum laws of information; how can quantum strategies be, and should be, developed by regulatory processes to reach a better fitness? Or in the language of Theme V, better interactions?

The formalism of quantum mechanics offers a general framework to consider a variety of areas outside of the natural remit of physics, such as economics, organisations and social interaction, psychology, artificial intelligence, human language, cognition, information retrieval, biology, political science. The application areas addressed typically operate at a macroscopic scale. They may share many key properties with quantum systems including non-commutativity of measurement, indeterminacy, non-separability, contextuality, proposals to test temporal nonlocality in perception and cognition, study of non-commutative structures in learning behaviour.

What can we learn from quantum physics regarding the holism that systems thinkers postulate for social economic systems? How can quantum modelling help to produce learning curves for policy making? Does the present global trend towards deregulated markets threaten the long-range effectiveness of the energy system? Quantum models of semantic memories, eigen logic, interpretable quantum observables are instances relevant to this theme. A document can be represented as a semantic memory in the form of a matrix. Linear operators to semantic memories help determining meaning. Another contribution includes action amplification by stimulated emission of social energy . . . this is a contribution aimed at discussing the social consequences of a social laser model.

### **Theme IX: reflexivity, second order science and context**

This theme is supporting the encounter of about a dozen scientists from different parts of the world. Stuart A. Umpleby, from the USA, and Vladimir Lepskeyi, from Russia, have spearheaded it. As proposed by Umpleby,

several ideas are being used to describe a renewed emphasis in cybernetics on reflection and self-awareness. In addition to an early concern with controlling events in the world around us, cyberneticians have considered the role of the observer in creating descriptions and have conceived the scientist as an actor who participates in systems as well as observes them. There has been a strong

concern with ethics. Recently there have been challenges to the assumptions underlying science and efforts to improve, even reconceptualize the application of scientific ideas. Goals and purposes are now increasingly linked to the conceptualization of context.



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# Keynotes contributions





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# Knowledge for development vision 2030 (K4Dev\_Vision 2030)

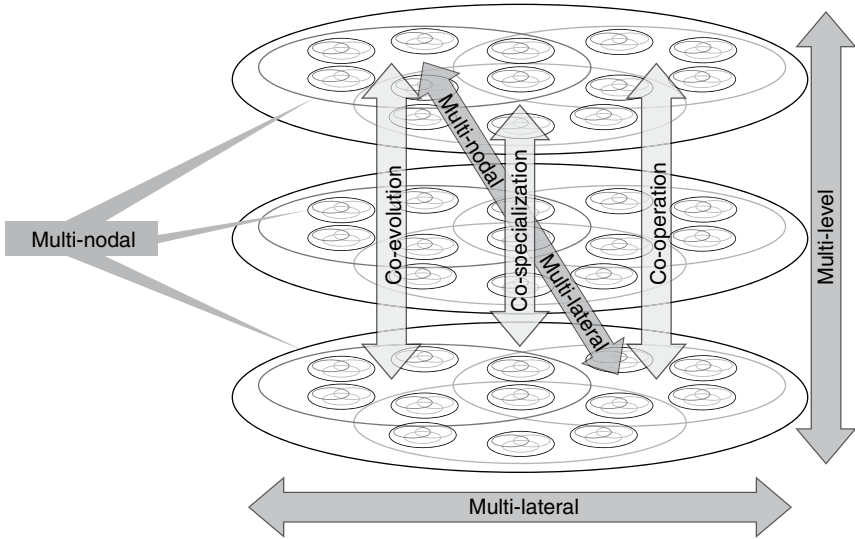
A systems perspective challenges and opportunities for theory, policy and practice

*Elias G. Carayannis*<sup>1</sup>

**Keywords:** *Quadruple and Quintuple Innovation Helix Models; knowledge for development; Vision 2030; systems perspective*

At the end of WWI (a century ago), President Wilson framed the vision to “make the world safe for democracy”. A century later and fifteen years after 091101, the Arab Spring events and side effects (such as the Syrian conflict and even ISIS) demonstrated the need to “make democracy safe for the world”. The future and sustained peace, prosperity and security of the WORLD require that we pursue and accomplish a reasonable modicum of BOTH of those visions and Knowledge for Development (K4Dev) and its related proposed roadmap (K4Dev\_Vision 2030) based on the concepts of Glocal (Global/Local) Network of Real and Virtual Incubators (G\_RVIN) (Carayannis et al., 2005) as well as the concepts of Strategic Knowledge Arbitrage and Serendipity (SKARSE ©) that play a central role in this set of challenges and opportunities.

The emerging *gloCalising* (globalizing-localizing) frontier of converging systems, networks and sectors of innovation that is driven by increasingly complex, non-linear and dynamic processes of knowledge creation, diffusion and use, confronts us with the need to re-conceptualize, if not to re-invent, the ways and means that knowledge production, utilization and renewal takes place in the context of the knowledge economy and society. Perspectives from and about different parts of the world and diverse human, socio-economic, technological and cultural contexts are interwoven to produce an emerging new worldview on how specialized knowledge, that is embedded in a particular socio-technical context, can serve as the unit of reference for stocks and flows of a hybrid, public/private, tacit/codified, tangible/virtual good, that represents the building block of knowledge economy, society and policy. Carayannis (2001) argues that the “*Mode 3*” model is the knowledge production system architecture that engages actively higher order learning (learning, learning to learn, learning to learn how to learn), in a multi-lateral, multi-nodal, multi-modal and multi-layered manner involving thus entities from government, academia, industry and civil society, as well as driving *coopetition* (competition-cooperation), *co-specialization* and *coevolution* resource generation, allocation and appropriation processes (C3) that result in



*Figure 1.1* Strategic knowledge, serendipity and arbitrage: multi-modal, multi-nodal, multi-lateral, multi-level C3 processes

Sources: Carayannis, E.G., GWU Lectures and Journal Publications, 2001–2016

the formation of modalities such as innovation networks and knowledge clusters (Figure 1.1).

*Strategic Knowledge Arbitrage and Serendipity (SKARSE ©)* are real option drivers of K4Dev that drive the C3 (see above). Strategic knowledge serendipity refers to the unintended benefits of enabling knowledge to “spill over” between employees, groups and functional domains (*“happy accidents” in learning*). More specifically, it describes the capacity to identify, recognize, access and integrate knowledge assets more effectively and efficiently to derive, develop and capture non-appropriable, defensible, sustainable and scalable pecuniary benefits, while strategic knowledge arbitrage refers to the ability to distribute and use specific knowledge for applications other than the intended topic area. It refers to the capacity to create, identify, reallocate and recombine knowledge assets more effectively and efficiently to derive, develop and capture non-appropriable, defensible, sustainable and scalable pecuniary benefits. To operationalize the K4Dev\_VISION 2030, we propose a set of initiatives and policies supporting smart, sustainable and inclusive growth via social innovation and leveraging social media modalities such as *crowd-sourcing*, *crowd-funding* and *crowd-storming* in complementarity to and synergistically with other broader initiatives. These initiatives and policies would be focused primarily but not exclusively at the places where most of the Earth’s population is accumulating, namely cities, aiming to transform as many of these urban locales and as profoundly as possible into *“smart cities”* organized around the concepts outlined above and especially based on the *Quadruple and Quintuple*

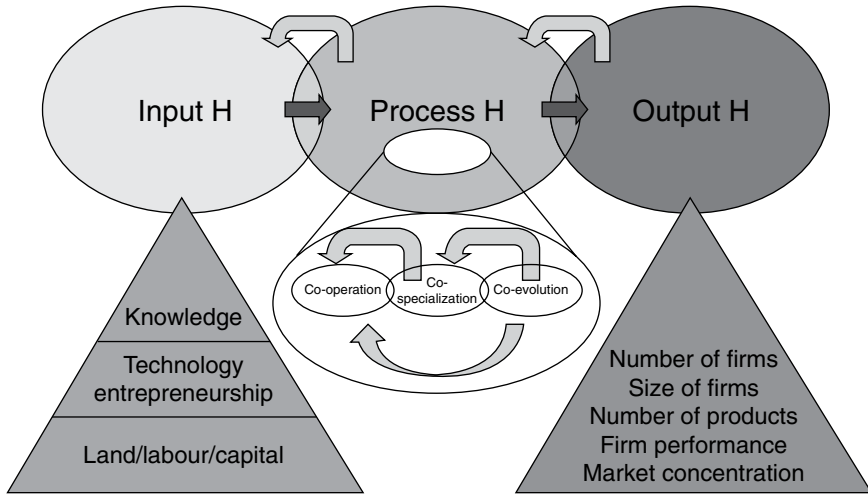


Figure 1.2 Heterogeneity dynamics – input, process, output

Source: Carayannis and Provan, 2008

*Innovation Helix models* (Carayannis et al., 2003, 2012) which empower civil society on a triple-bottom-line-centric basis (i.e. environmentally, financially and socially sustainable manner).

The *Quadruple Innovation Helix* bridges social ecology with knowledge production (Mode 3) and innovation. The most important constituent element of the quadruple helix – apart from the active “human agents” – is the resource of knowledge, which through a circulation known as circulation of knowledge, between social subsystems, changes to innovation and know-how in a society and for the economy. The quadruple helix, thereby, visualizes the collective interaction and exchange of knowledge in a state by means of the following four subsystems:

- Political System – formulates the direction of where the state/country is heading in the present and future, its laws, etc. (political and legal capital) (GOVERNMENT SECTOR)
- Education System – refers to academia, universities, higher education systems and schools (human capital) (UNIVERSITY SECTOR)
- Economic System – consists of industry/industries, firms, services and banks (economic capital) (INDUSTRY SECTOR)
- Civil Society (Media based/Culture based) – integrates and combines two forms of capital: culture-based public (tradition, values, etc. [social capital]) and media-based public (television, internet, newspapers [capital of information]) (CIVIL SOCIETY SECTOR)

Quadruple Innovation Helix models place a stronger focus on cooperation in innovation, and in particular, the dynamically intertwined processes of coopetition, coevolution and co-specialization, within and across regional and sectoral innovation ecosystems that could serve as the foundation for diverse smart specialization strategies. The European Commission RIS3 guide outlines a set of general principles as to how S3 strategies should be developed at the regional level and recognizes the significance and need for the Quadruple Innovation Helix approach by proposing to add a fourth group to a classical Triple Helix model. *The Quintuple Innovation Helix complements the Quadruple Innovation Helix by adding the (natural) environment as the fifth dimension and ensuring the sustainability of any bottom-up initiatives and top-down policies.* Moreover, the Quadruple/Quintuple Innovation Helix model puts innovation users at its heart and encourages the development of innovations that are pertinent for users (civil society). Users or citizens here own and drive the innovation processes which is the essence of *Social Innovation and in fact Sustainable Social Innovation bottom-up initiatives and top-down policies and practices.*

Related initiatives, policies and practices that could enact and enable the K4Dev\_Vision 2030 Roadmap we propose, could encompass networked, global/local, micro-enterprise and SME formation and growth as well diaspora, refugees and inner-city projects via the crowd-storming, crowd-sourcing and crowd-funding modalities as well as the engagement of all sectors of the Quadruple Innovation Helix model within the overarching Quintuple Innovation Helix sustainability framework (see Figure 1.3 as a conceptual reference model as well as the closing questions from the 2005 book that remain as valid today as they were more than ten years ago (Carayannis and Sipp, 2005).

- Should a developing economy adopt a development pathway that aims at fulfilling the macro-level development objectives and goals (following the transitioning economies' example), or would it be "*smarter*" for the *developing economy in question to focus on fulfilling the meso-level development objectives and goals?*
- In the case where the meso-level focus is chosen, *could this approach lead the developing country to "skip" the transitioning stage, "leap-frogging" towards developed economy status and what, if any, trade-offs might there be* (including the risk of technological, socio-economic and even cultural divides forming within a country as a result of a potentially uneven and unbalanced, accelerated development)? Moreover, *what would the implications be for how the developmental stage of countries is defined and enacted?*
- *Could such accelerated development trajectories necessitate the re-definition of what a transitioning economy is and could such a re-assessment and re-definition of objectives and goals lead to a "smarter" approach to development* (by enabling more functional congruence between development conditions on the ground and development goals and objectives in the numerous reports of the MDAs and the MDGs)?

## Three dimensions of analysis

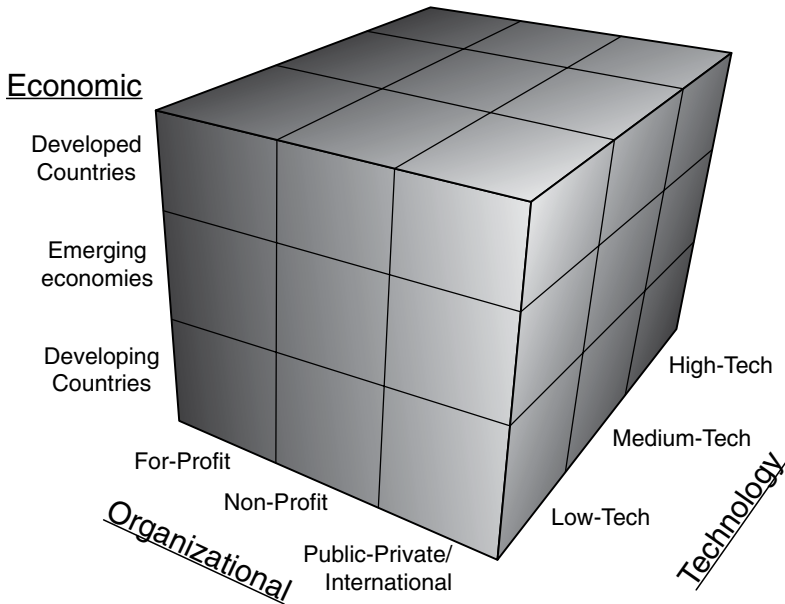


Figure 1.3 Dynamic cube of e-development intervention strategies. Three dimensions of analysis of e-development in the knowledge economy

Source: Carayannis and Sipp (2005)

### Note

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## **Interdependences of duality, systems theories and cybernetics in business systems**

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## Democracy, transparency and social dynamics

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## **The emergence and the interpretative process in the systemic approach of the organization**

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## **Artifact-dependent dialectic processes as enablers of self-organization in knowledge-driven teams**

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## **Driver or inhibitor for innovation? Modelling and simulating dynamic aspects and contradictory forces of team diversity**

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## A quantum-based model for textual semantics and information retrieval

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## Social laser model Stimulated Amplification of Social Actions

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