Translational Systems Sciences

Volume 13

In 1956, Kenneth Boulding explained the concept of General Systems Theory as a skeleton of science. He describes that it hopes to develop something like a "spectrum" of theories—a system of systems which may perform the function of a "gestalt" in theoretical construction. Such "gestalts" in special fields have been of great value in directing research towards the gaps which they reveal.

There were, at that time, other important conceptual frameworks and theories, such as cybernetics. Additional theories and applications developed later, including synergetics, cognitive science, complex adaptive systems, and many others. Some focused on principles within specific domains of knowledge and others crossed areas of knowledge and practice, along the spectrum described by Boulding.

Also in 1956, the Society for General Systems Research (now the International Society for the Systems Sciences) was founded. One of the concerns of the founders, even then, was the state of the human condition, and what science could do about it.

The present Translational Systems Sciences book series aims at cultivating a new frontier of systems sciences for contributing to the need for practical applications that benefit people.

The concept of translational research originally comes from medical science for enhancing human health and well-being. Translational medical research is often labeled as "Bench to Bedside." It places emphasis on translating the findings in basic research (at bench) more quickly and efficiently into medical practice (at bedside). At the same time, needs and demands from practice drive the development of new and innovative ideas and concepts. In this tightly coupled process it is essential to remove barriers to multi-disciplinary collaboration.

The present series attempts to bridge and integrate basic research founded in systems concepts, logic, theories and models with systems practices and methodologies, into a process of systems research. Since both bench and bedside involve diverse stakeholder groups, including researchers, practitioners and users, translational systems science works to create common platforms for language to activate the "bench to bedside" cycle.

In order to create a resilient and sustainable society in the twenty-first century, we unquestionably need open social innovation through which we create new social values, and realize them in society by connecting diverse ideas and developing new solutions. We assume three types of social values, namely: (1) values relevant to social infrastructure such as safety, security, and amenity; (2) values created by innovation in business, economics, and management practices; and, (3) values necessary for community sustainability brought about by conflict resolution and consensus building.

The series will first approach these social values from a systems science perspective by drawing on a range of disciplines in trans-disciplinary and cross-cultural ways. They may include social systems theory, sociology, business administration, management information science, organization science, computational mathematical organization theory, economics, evolutionary economics, international political science, jurisprudence, policy science, socio-information studies, cognitive science, artificial intelligence, complex adaptive systems theory, philosophy of science, and other related disciplines. In addition, this series will promote translational systems science as a means of scientific research that facilitates the translation of findings from basic science to practical applications, and vice versa.

We believe that this book series should advance a new frontier in systems sciences by presenting theoretical and conceptual frameworks, as well as theories for design and application, for twenty-first-century socioeconomic systems in a translational and trans-disciplinary context.

More information about this series at http://www.springer.com/series/11213

David Rousseau • Jennifer Wilby
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General Systemology

Transdisciplinarity for Discovery, Insight and Innovation

Foreword by Prof. Kyoichi Kijima

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Foreword

I am excited that this insightful and challenging research is now published as a volume of the Translational Systems Science Book Series. Over the past several years I have had a number of opportunities to learn about the progress of this ambitious research towards establising General Systemology, led by the team of authors. The research project is brought into shape here.

The pace of discovery in science is accelerating, and so also is the pace of innovation in the engineering disciplines, bringing new opportunities both to improve human quality of life and also to do so in sustainable ways. However, as science and technology advances, the specializations become more arcane to each other, raising the barriers to collaboration between the fields; slowing the flow of insights across disciplinary boundaries; and complicating the translation of urgent human and social needs into penetrating research projects, of scientific findings into effective technical solutions, and of solutions into beneficial practical use.

These challenges prompted the establishment of translational sciences, which aim to accelerate these transfers. Our increasing sensitivity to the systemic complexity of the world has resulted in the emergence of translational *systems* sciences, scientific disciplines that enhance the effectiveness of translational science by taking into account the systems perspective, or that show how to derive practical benefits from specialized systems theories.

Traditional translational science is grounded in establishing and maintaining a mapping between the advances, needs, resources, and values of different specialisms, connecting them while preserving their individuality. In this way the barriers between them are made permeable, and researchers and technologists can more readily collaborate with or be inspired by their colleagues from other disciplines. However, the challenge of keeping the barrier permeable is very substantial, because of the continuous introduction of new or modified concepts, terms, insights, and achievements on each side of the interdisciplinary interface.

This problem was already noted in the 1950s. Even then it was evident that many scientific activities were inefficient or duplicating efforts due to lack of effective communication across disciplines, and that progress in the human and social sciences was mismatched to our emerging technological powers, engendering substantial risks and problems for ecology, society, and individual well-being. This problematic trend is still continuing today, and the rising complexity of the sciences makes the need for more effective translational sciences more urgent than ever.

One approach to solving this problem, envisioned in the 1950s by Ludwig von Bertalanffy, Kenneth Boulding, Ralph Gerard, Anatol Rapoport, and others, was based on the idea of establishing a scientific general theory of systems, the principles and concepts of which would be a natural common ground shared by all the specialized disciplines. This would enable a new kind of translational capability. Rather than building specialized connections between the disciplines it would establish a common foundation the specialisms can all rest on, and which would not be weakened by specialized advances. Indeed, specialized insights would often be seen to be contextualized exemplars of general systems insights or even heralds of new general systems principles, thus strengthening and expanding the transdisciplinary foundation provided by the foundational scientific general theory of systems. Moreover, the knowledge of general systems concepts and principles would inspire and accelerate discovery and innovation within the specialized areas, in addition to making such innovation easier to communicate or engage with across the boundaries.

The discipline that is concerned with discovering, integrating, and putting into transdisciplinary use, scientific general systems insights and principles, is General Systemology, and I am delighted to provide a Foreword to the first book to employ that term in its title, and the first book to take the quest for a scientific general theory of systems beyond a grand vision and preliminary heuristics and put it on a principled scientific foundation. The work presented in the present volume has the potential to transform the effectiveness and efficiency of the translational sciences in general, and the translational systems sciences in particular.

Via this book the team of authors amply demonstrates both the necessity and the value of multidisciplinary collaboration, bringing together as they do expertise in science, mathematics, operational research, enterprise architecture, engineering, philosophy, management science, design science, and several systems sciences. Their collaboration has delivered breakthrough advances for the systems sciences, and opened up the way for a foundational scientific general systems theory to achieve the potential foreseen by the founders of the general systems movement.

I gladly and strongly recommend both their book and their collaborative style of working. The impact of this work on the translational systems sciences, and its value to our society, may take some time to become visible, but I am sure the positive contribution they have made toward bringing about a general systems transdiscipline cannot be doubted or underestimated. I keenly anticipate the developments that are sure to follow.

Tokyo, Japan
2018

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Preface

Our knowledge of the world is fragmented, and given the complexity of the world this may be an enduring condition for humanity. However, the world itself is a unity, and thus we are always at risk of unintended negative consequences when we apply our limited knowledge. The growth of unsustainable practices, the increasing interconnectedness of the world, and the rising complexity of the systems we now seek to create, transform, or nurture have only served to increase this risk. Although a true unity of knowledge might be an unattainable goal, an increasing consilience of knowledge is not out of the question. One possible route to such consilience is offered by the vision of a general theory of systems. If everything in the world is a system or part of one, then general systems knowledge would not only be of transdisciplinary relevance, but afford deep insights about the interconnectedness of everything, and readily reveal to us important insights that cannot easily be seen from any specialized point of view.

The quest for a scientific general understanding of systems began with an inspiring vision presented in the 1950s by the founders of the general systems movement, led by Ludwig von Bertalanffy, Kenneth Boulding, Anatol Rapoport, and Ralph Gerard. Their motivation was not merely the scientific value of understanding something fundamental about the nature of the world, but rather the social value of recognizing that the world is more like a great organism than a great machine. Such a paradigm, they felt, would restore to humanity the dignity and value that mechanistic models tend to first ignore and then erode.

The promise of the founders' vision was clear but the path was not, and in the early years, conditions in academia were largely unfavorable for a project that would require such interdisciplinary collaboration. Consequently, dedicated research was limited and progress slow. In recent decades, however, conditions have become supportive of such projects, and the need for a general systems theory (GST) has become more urgent.

We, the present authors, came together in 2013 with a view to rekindle the enthusiasm for establishing a scientific general systems theory and operationalizing it as a transdisciplinary methodology for effective and efficient exploration, design, and theory building, and as a framework for visualizing the submerged land connecting

our islands of knowledge. We felt that such a systems science framework would be essential for meeting the growing challenge of translating the progress in one area of knowledge to others who can benefit from it, and thus be a unifying framework not only for the sciences generally but for the Translational Systems Sciences particularly.

We felt that progress would require the collaboration of multiple specialists, and so we launched our *Manifesto for General Systems Transdisciplinarity* in 2015 not only to highlight the promise and key challenges of this research but to inspire and recruit researchers who would work together to accelerate progress toward attaining the vision of a practically useful general theory of systems. We were pleased to find our manifesto well received, and the present volume presents the work done by us and colleagues over the last few years. We are grateful to the organizations and individuals who have supported, inspired, and guided us as we developed and delivered a range of conference presentations, workshops, webinars, and publications. This communal effort is now starting to deliver practical results, and in this volume, we present not only the unifying conceptual framework that we called for in our *Manifesto* but also the first scientific systems principles that are of general relevance. We hope that this will prove to be the thin end of a thick and sturdy wedge, and that this book will serve as an invitation and a call for others to join the various teams working on establishing and leveraging a fully fledged general systems transdisciplinarity (GSTD).

In compiling the present volume we drew heavily on the contents of the publications and workshops we produced in the GSTD program, and we are greatly indebted to all who helped to shape the ideas presented here.

We express our gratitude to the many organizations who encouraged, supported, funded, promoted, and facilitated our work, in particular the International Society for the Systems Sciences, the Centre for Systems Studies in the University of Hull, the Centre for Systems Philosophy, the Bertalanffy Center for the Study of Systems Science, the International Council on Systems Engineering, the INCOSE Foundation, the Center for Agent-Based Social Systems Sciences in the Tokyo Institute of Technology, the European Meetings on Cybernetics and Systems, and the International Federation for Systems Research.

We thank the editors and reviewers of our papers published in the journals *Systems Research and Behavioural Science*, *Systema*, and *Systems*, and of our chapter published in the volume *Disciplinary Convergence in Systems Engineering Research*, for their helpful comments on drafts of these works.

We also thank colleagues who participated in or facilitated our workshops and webinars for providing us with stimulating debates, challenging questions, and general encouragement, who commented on drafts of our publications, who gave us advice and other help, and who engaged with us in building up a community of interest around the vision of General Systems Transdisciplinarity. In particular we thank (in no particular order) James Martin, Kyoichi (Jim) Kijima, Javier Calvo-Amodio, Debora Hammond, Richard Martin, Duane Hybertson, Gerald Midgley, Yasmin Merali, Mary Edson, Peter Caws, Alexander Laszlo, Ray Ison, Gary Metcalf, Ricardo Barrera, Raul Espejo, Andreas Hieronymi, Cecilia Haskins,

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We owe you more than we can express, and we look forward to ongoing collaboration with you and new colleagues as together we develop General Systemology for the benefit of society and our world.

Surrey, UK — David Rousseau
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Contents

Abbreviations

ASEM	American Society for Engineering Management
AKG model	"Activity Scope – Knowledge Base – Guidance Framework" model of a discipline
BCSSS	Bertalanffy Center for the Study of Systems Science
CCP	Conservation of Properties Principle
EMCSR	European Meetings on Systems and Cybernetics
GSSPs	General Scientific Systems Principles
GSMs	General Systems Methodologies
GST	General Systems Theory
GST*	General Systems Theory, meaning the foundational theory of the nature of systems
GSTD	General Systems Transdisciplinarity
GSW	General Systems Worldview
IFSR	International Federation for Systems Research
INCOSE	International Council on Systems Engineering
ISSS	International Society for the Systems Sciences
PLT model	the "Principles-Laws-Theories" model of modern science
SRBS	Systems Research and Behavioral Science (journal)
SSPs	Scientific Systems Principles