Translational Systems Sciences

Volume 8

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 transdisciplinary context.

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

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Systemic Design

Theory, Methods, and Practice

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This book is dedicated to the memory of Dr. Ranulph Glanville, former president of the American Society for Cybernetics and fellow traveler with the authors in this volume, connecting the systems disciplines through his life and career. To Ranulph, design and cybernetics were two different sides of constructivist sensemaking in the world, and not separate disciplines as we are schooled to believe. I learned from him the understanding of cybernetics and systemic problems led to designing, as the most befitting course of informed action. Ranulph spent much of the last decade of his career bringing these fields together, very clearly in several essays and talks, including his final public lecture at Relating Systems Thinking and Design (RSD3) in October 2014. Dr. Glanville's inclusive insistence on co-informing theory and practice across cybernetics, systems thinking, and design inspire values shared by many of us seeking wiser ways across related fields of practice today.

Design and systems theory both gain from the influence of timeless ideas, the cross-appropriation between frameworks and models, and the intimate and often guild-like relationships with leading practitioners. These chapters call forth too many authors and thinkers to recognize with concision here, but if we were to list the most influential first- and second-generation leaders in design and systemics, I might suggest we acknowledge Ross Ashby, Gregory Bateson, Buckminster Fuller, Margaret Mead, Herbert Simon, Fred Emery, Eric Trist, Heinz von Foerster, Hasan Özbekhan, West Churchman, Christopher Alexander, Horst Rittel, Stafford Beer, Erich Jantsch, Alexander Christakis, John Warfield, Gordon Pask, Humberto Maturana, Russell Ackoff, Charles Owen, Victor Papanek, and of course Harold Nelson, a co-founder of RSD.

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Preface: Taking Stock and Flow of Systemic Design

The following book is an edition in the Springer Translational Systems Sciences series and addresses the continuing development of systems theory and methods for complex design contexts. This volume aims to make progress towards a continuing absence in the systems sciences and the discontinuity of design as theory and method for innovation, change, and process implementation. Systems and cybernetics practices have made several notable attempts to resolve this discontinuity, some with extensive publishing and project track records and others more quietly successful.

Systemic design has emerged to address this developing interdisciplinary area of practice, growing from leadership within design studies and its intersection with systems sciences through dedicated collaboration and respectful cross-appropriation. The nine chapters published in this collection were developed by authors from the proceedings of the fourth Relating Systems Thinking and Design (RSD) symposium[1] held in Banff, Canada, in 2015. These authors clearly overlap and share multiple influences and earlier systems programmes that have led to the recent confluence of systems thinking and design.

The broad fields of design and systems have both historically presented approaches to general-purpose problem solving, with domain-independent methodologies based on design rationale (Moran & Carroll, 1996) or scientific principles (Simon, 1962) for holistic problem solving (Fuller, 1969; Jones, 2011). As "thinking" modes, both design thinking and systems thinking promise effective, cross-disciplinary approaches to complex problem resolution. Perhaps, the most prominent interdisciplinary approaches of systemics and design thinking were developed in the Ackoff and Banathy-era social system design schools that promoted whole system approaches to the challenges of the modernist technological era.

[1]Ryan, A., & Jones, P. (2015). *Proceedings of Relating Systems Thinking and Design (RSD4) 2015 Symposium*. Banff, Canada, September 1–3, 2015. systemic-design.net/rsd-symposia/rsd4-proceedings

The systems science origins of systemic design can be traced to the influential operations research and planning schools, the East Coast schools (Ackoff, Özbekhan from University of Pennsylvania, Senge from MIT), and the West Coast (Horst Rittel, C. West Churchman, Christopher Alexander, and Harold Nelson all from U.C. Berkeley). Social systems theory and methods, perhaps the first inclusion of systemics as a design practice, evolved from the 1970s following the Club of Rome prospectus titled *The Predicament of Mankind* (Ozbekhan, 1970). We can trace references and ideas from today's systemic design from the social systems methodologies that followed in this era, such as Peter Checkland's soft systems methodology (1975), Erich Jantsch's evolutionary design (1973), Russell Ackoff's idealized design (1985), Bela Banathy's social system design (1997), John Warfield's generic design science (1985), and Alexander Christakis' dialogic design (2006). All of these projects shared approaches and values in common, such as a strong orientation to boundary and perspectives as opposed to problem solving, post-positivist (or constructivist) epistemologies, the adaptation of complementary modes of thinking, and the necessity of stakeholder participation.

These social schools of thought argued against many of the precepts of the predominant systems thinking methods of the time, systems thinking as modelling and intervention (Meadows, 1999), and systems dynamics (Senge, 1986). Social system design did not achieve the broader acceptance of hard systems sciences, in part due to the superior fit of the hard systems thinking mindset to modernist culture in the late twentieth century and the perceived ambiguity (and lack of method) of social systems processes and technologies.

However, on behalf of design scholars and professionals, I might argue that the design functions of the social systems methodologies were not ever designed for the human uses and applications needed from extensive sociotechnical development projects. Social systems never evolved to become "designerly"; with its roots in systems theory, its applications remained too abstract and removed from human behaviour. For too long we have included design thinking as a peripheral passenger in the systems journey, following along with the Herbert Simon definition of design as a "move from a current situation to a preferred situation.[2]" If we do not fully embrace designing as an advanced way of knowing and enacting with the sociomaterial world, we risk failure in desired transformation.

The recent designerly turn in systems thinking must credit Buckminster Fuller's early exploration (1960s) of what we now call transdisciplinary design, in his "comprehensive anticipatory design science" for complex problems of industrial production, transportation, habitation, and environmentally sensitive design. At least three other significant designers from the 1970s era, architect Christopher Alexander, Victor Papanek (with critical social design), and John Chris Jones (design methods originator), influenced a new generation of designers. Their design practices were well integrated and did not reveal much in the way of formal cybernetics and systems theory, even if their approaches were deeply informed by systemics. We recognize this integration of knowledge, experience, and sensitivity as the "designerly

[2]Simon, Herbert A. (1969). *The sciences of the artificial*. Cambridge, MA: MIT Press, p. 130.

way of knowing," as Nigel Cross (2002) has referred. Perhaps, the designerly aim might be to emulate these designers for their integrated practices and not to disclose the many, possibly confusing, contributing references making up the practice.

Systemic design draws on the wellspring of a half-century of discourses from both systems theory and design practices, fruitfully developing a research base and new methods. It provides a welcoming field for emerging design practices to plant theoretical ideas that reach across disciplines. Several recurring precedents in the evolution of systemic design are prominent within these chapters and symposia, including:

- Design cybernetics, especially second-order reflexivity in design practice (Glanville, 2009; Krippendorff, 2007)
- Design thinking for wicked problems (Buchanan, 1992)
- Systems-oriented design (Sevaldson & Vavik, 2010)
- Systemic design approach to ecological design (Bistagnino, 2011)
- Product-service systems (Manzini & Vezzoli, 2003; Morelli, 2002)
- Transformation design (Sangiorgi, 2011)
- Transition design (Irwin, 2015)
- Dialogic design (Christakis, 2006)
- Design for conversation (Dubberly & Pangaro, 2015)
- DesignX (Norman & Stappers, 2016)

Design is an essential partner in transformative projects and is an essential mindset and discipline when facing "actual" wicked problems—the sort that Rittel meant as contexts that resist problem-solving mindsets. These situations, messes and meta-messes, require our capacity to rethink received notions, to reframe and redirect, to creatively inquire, to engage many skills and senses, to powerfully communicate central ideas to others, and to produce campaigns for change. We may reform, improve, innovate, or otherwise *design* systems but fail to change outmoded cultures, create effective new practices, or inspire positive norms. We also risk losing the unique critical power of systems thinking to transform organizations and practices when advancing theories of change without fully integrating design. Systemic design advances an integrative interdiscipline with the potential to implement systems theory with creative methods and mindsets, by bringing deep technical knowledge, aesthetic skill, and creative implementation to the most abstract programmes of collective action. The cases and practices in the following chapters attest to these new modes of thinking and acting with stakeholders on such problem domains, in healthcare, urban development, informatics, and public service.

Relating Systems Thinking and Design

For 7 years, the Relating Systems Thinking and Design (RSD) symposium has convened a design-oriented conference to develop the intersection of systems science and theory and design practice, methods, and education. This intersection between

systemics and design has not been addressed by other scholarly or practitioner conferences, as these two fields have actually drifted apart while often invoking the languages of "systems" and "designing" without truly understanding the core methods of each discipline. We have aimed to develop a strong relationship between the disciplines that brings out the best in each tradition.

Systemic design has developed through integration of design research programmes at several universities participating in the RSD symposium series. These schools have evolved systems-oriented design programmes for roughly a decade, in some cases longer, in search of powerful approaches to transdisciplinary design for complex sociotechnical contexts. While a small number of design scholars have worked and thrived rather naturally in this intersection throughout their careers, awareness of the import of systems thinking was fragmented and inconsistent across design specializations. There was no common understanding of a practice or a canon of theory for design applications. In fact, judging by the prevailing popular themes at design and systems conferences, the fields were continuing to drift apart. Design and architecture have been moving into advanced service and interaction design for big data, urban systems (e.g. smart cities), healthcare, and other complex systems applications, but without a foundation of systems methods or well-understood cybernetics concepts. Similarly, in systems thinking and sciences, the increasing attention to organizational, service, and social systems led to new models and theory, but little design of prototypes or exemplary applications. These gaps appeared as far more than missed opportunities for a complete design discourse, but rather as the necessary emergence of an integrated discipline better adapted to our problems than its component disciplines.

The symposium expresses an intent as "relating" two worlds, between two wide-ranging, continually contested disciplines of systems thinking and design. Many observers in the past have attempted to join features of these fields together to achieve expected synergies between the perspectives and logics of the systemic and, the sensemaking and form-giving of design. Earlier attempts at forging a relationship, a net new identity between these discourses, have generally failed to connect to the current generations of scholars and endure beyond initial forays. Mature, developed scholarship from preceding conferences was previously published in the online design journal *FORM Academic (FORM Akademisk)*, which has edited a special issue for developed symposium work since RSD2. The design journal *She Ji* published a collection of five articles developed from RSD5 (Toronto, 2016) as a theme issue[3] in late 2017. This issue follows their support for the emerging DesignX[4] discourse only 2 years prior.

[3]Jones, P. (2017). The systemic turn: Leverage for world changing. *She Ji: The Journal of Design, Economics, and Innovation, 3*(3), 157–163. https://doi.org/10.1016/j.sheji.2017.11.001

[4]Norman, D. A., & Stappers, P. J. (2016). DesignX: Complex sociotechnical systems. *She Ji: The Journal of Design, Economics, and Innovation, 1*(2), 83–106.

Significance of the Collection

As the RSD conference has grown in reach each year, the breadth of scholarly work has expanded, and the variety of interests and directions expressed by the author community has greatly increased. We believe the interstices between these highly conceptual disciplines and their creative intellectual practices afford a productive field of play for studies and practices with sufficient power to address the critical concerns of the day.

The title suggests variety across the contributions in three designations of theory, method, and practice. After continuing to read and work with the ideas in these ten chapters, it becomes clear that few papers neatly fit one category fully, or at the expense of the others. We might consider most of the chapters as integrative, as their research intent is to integrate systemics and design practice as adaptive methodologies that enable significant transformative capacity within particular wicked problem contexts. These chapters all show methodological integration, with an appropriate theoretical perspective, for collective power in various human practices.

Readers will discover a wide range of theoretical positions informing the design rationale in the reported studies and cases. For several reasons—editorial selection and the developmental progress of systemic design over several years—these analyses avoid the conventional tropes of systems thinking and complexity presented as theory, force-fit to design practice problems. Rather than drawing on systems methods or concepts for supporting observations, most of these studies show deeply integrated models and present new frameworks founded on social and/or systems theories.

The first three chapters are integrative practices and models, not pure theory or case studies but rather connecting a theoretical basis for a systemic design methodology in particular areas of practice. The collection opens with the editor's chapter *Contexts of Co-creation: Designing with System Stakeholders*. Over the last decade, we have been studying and designing collaborative practices for multistakeholder engagements in technology and organizational strategy (Jones et al., 2008), governance and policy planning, and collaborative foresight in long-horizon R&D (Weigand et al., 2013). We have collected observations and compared applications to propose effective practices for stakeholder identification and discovery, problem framing, and continuity. New contributions in the article include a review and critique of co-creation, analysed here by contexts (stages in progression) based on John Warfield's (1998) domain of science model. This model enables us to compare and transfer learning from dialogic design applications to systemic design, which is a recent discipline developing without a canon or shared standards. A new framework is proposed for stakeholder convening, transferring learning, and practice development across purposeful venues. System design and stakeholder planning projects require longer-term collaborations than provided by structured encounters such as design workshops. Therefore, a pragmatic concept defined as collaborative efficacy is proposed to assess engagement in continuous complex design situations.

Chih-Chun Chen and Nathan Crilly built a theoretical framework for integrated design, *A Framework for Complex Design: Lessons from Synthetic Biology*. Their work presents the value of an integrated design approach using synthetic biology as a learning model, reminding us that synthetic biology is itself a design-oriented practice. The chapter develops a model of designing for complexity where problems and solutions, as framed for design, are complex conditions themselves. Their proposals for systemic design practice intrigue the reader to observe, avoid, exploit, and compensate for inherent complexity in problematic contexts. They suggest both "rational" and black-box strategies for street-lighting proposals that trade off complexity features for a case problem of "designing out crime" through such interventions. Their work provides a theoretical basis for identifying and designing for characteristics in any complexity context (as they suggest swarm robotics, policy formation, and healthcare) that share similarities in complexity.

Peter Pennefather and colleagues Deborah Fels and Katie Seaborn share work from a continuing study investing electronic health records systems for health promotion for the aspiration of human flourishment. *Inclusive Systemic Design for Health System Flourishment* is a unique contribution due to the mix of disciplines and research intent, including systems biology, human factors, and information studies. Although systemic design has oriented to the ecological concept of flourishing for several years, the idea of flourishment has co-evolved as a quality of individual eudaimonic flourishing, a human phenomenon associated with psychological wellbeing, analogous to nourishment in the relationship to bioecological energy. The authors develop a link to reinforcing flourishment through registrations of human data and narratives within health records and information systems in system design. The chapter develops a framework based on social neuroscience, psychology, and inclusive human-centred design that expresses a virtuous cycle of flourishment transactions within a system of patient-centred collaborative care, in this proposal, as designed for people living with chronic pain.

Part II, Theoretical Foundations, presents four foundation studies, including resilience theory, design ethics, a systems theory of settlement, and a German cultural history of systems thinking influences and its continuing relevance to design. Wolfgang Jonas presents a "German narrative" of the history and disciplinary development of systemic design in Considerations to the Jonas title in *Systems Design Thinking: Theoretical, Methodological, and Practical*. Jonas builds on theories of first- and second-order cybernetics, complexity, and system evolution. He explores foundational systems concepts, such as irreducible complexity, the problem of control in complex systems, and the function of inquiring systems in design. Jonas proposes a scenario design methodology based on his APS (Analysis – Projection – Synthesis, Jonas, 1997) model of design and research. He positions his own work in the tradition of three precedent systems thinkers, Frederic Vester (sensitivity modelling), Jürgen Gausemeier (foresight), and Peter Schwartz (scenario analysis), leveraging scenario modelling as a design visioning process. Jonas incorporates his model and practice of Research Through Design as a core methodological framework around which the Analysis, Projection, Synthesis process is carried out. Jonas develops RTD as a design/inquiring system specifically suited for high uncertainty

in complexity, building on scenarios as an analytical design method. In this way, Jonas' chapter provides a strong link between systems thinking and strategic foresight, through the projective modes of design research.

Design cyberneticist Ben Sweeting contributes to the design ethics discourse in *Wicked Problems in Design and Ethics*, a cybernetic inversion of the common normative inquiry. He reminds readers that ethics is not a settled body of knowledge or theory that we use to judge or guide design decisions in practice—that ethical inquiry is implicitly entangled with the situation, our perspectives, and our possible knowledge of options. Because ethical insight and outcomes are deeply dependent on the theories we bring to decisions and design problems, Sweeting turns this around and suggests that design may contribute as much to ethical theory as ethics to design. He explores the relationships and structural morphology between design's wicked problems and normative ethical dilemmas as a basis for proposing this symmetry. With design and ethics responsive to each other in mutual terms, ethical design questions might be released from the historical position of external limitations and trade-offs between competing priorities. Sweeting suggests the ways in which designers cope with ethical challenges in socially complex wicked problems can inform action towards complex ethical challenges in other contexts, including those within ethical discourse.

Eloise Taysom and Nathan Crilly analyse resilient systems from a design perspective in their chapter, *On the Resilience of Sociotechnical Systems*. Based on ongoing research by Taysom in Dr. Crilly's University of Cambridge lab, an analysis is developed on the differentials of resilience theory, the applications of resilience, and the possible impacts of these differentials on sociotechnical systems. Sociotechnical systems are constituted within networks of stakeholders and users, who have the most at stake in situations where the continuity and function of complex systems are tested under resilience scenarios. Deconstructing resilience as an umbrella concept, a pragmatist position is taken by drawing out the perspectives of stakeholders across numerous complex system domains. A theoretical framework is proposed addressing resilience in terms of three properties of resilience response: (a) resilience as resisting influences, (b) resilience as recovering from influences, and (c) resilience as changing to accommodate influences. Systems enabling all three responses to exogenous shock or influence can be considered to have higher capacity for resilience than systems based on one or two of the properties, as a higher variety of responses to unforeseen influences would be possible.

University of Waterloo's Perin Ruttonsha closes the section with an epic chapter, *Towards a (Socio-ecological) Science of Settlement*. Ruttonsha's analysis presents a sweeping review of urban systems thinking informed by design, culture and social sciences, and the evolution of systemic planning from the era of Doxiadis' ekistics to current complexity theory. The chapter leads with the proposal for a science of settlement (in essence, bringing Ekistics into the next century) as a study of the full complement of human–environment interactions. A comprehensive analysis of the *sustainability perspective* in urban ecology develops the locations and methods for sociomaterial intervention in the sustainment of cities in natural ecosystems. Ruttonsha further develops a phenomenological analysis of the *dwelling perspec-*

tive of human interaction in the places and experiences of habitation. The chapter closes with an analysis of the complex systems dynamics of habitation in the evolving urban form, connecting multiple theories and ideas in socio-ecological systems thinking. She connects the chapter's message to Humberto Maturana's compelling keynote at RSD5, where he challenged the conference with the many social concerns in a single question, "how do we want to live together?" The chapter aims to build a socio-ecological science of settlement, which might bridge between domains and practices in quality of life, settlement planning, and transition management.

Part III, Method and Practice, opens with Birger Sevaldson's recent development of the Gigamap as methodology. He extends the theory and practice of systemic design mapping with *Visualizing Complex Design: The Evolution of Gigamaps*. Sevaldson recounts the development of Gigamaps in systems-oriented design as an "organic" studio practice for collaborative engagement in complex system design projects. Sevaldson presents a basis for a knowledge framework for the evolution of this core methodology in systemic design. He builds upon Cross' (1999) notion of design praxiology, a philosophy of purposeful practice leading to designerly wisdom and adaptive expertise in complex systems design. Given the emphasis on "myriadic" expression, whereby system relations are expressed in their inherent complexity, Sevaldson endorses several new methods for interrogating this multiplexity that extends the sensemaking aspects of collaboration to "sense-sharing."

Silvia Barbero (Politecnico di Torino) presents studies from the Torino programme of systemic design with *Local Ruralism: Systemic Design for Economic Development*. The potential for regional economic flourishing through rural community development is demonstrated through integrated design research and ground-level projects. Her approach to social innovation aims to improve the quality of life and economic wellbeing of people, evaluating engagements with people to develop local economies in disadvantaged rural regions. Local ruralism takes into account the need to design locally supportive structures for economic and social flourishing, organically co-produced within the regions themselves. Barbero presents three significant case studies in different geographies (Mexico, Italy, and Spain) all facing declining economies. The studies develop evidence for approaches and concrete guidelines, through a systemic design framework, to facilitate systemic improvements in rural regions.

John Cassel and Susan Cousineau, collaborators in the agroecology informatics field, develop a chapter from their advancement of permaculture principles in scaling sustainable agriculture, in *Permaculture as a Systemic Design Practice*. This chapter presents the exciting possibility of relating the ecological design practices and ethics of permaculture to design and systems thinking. The permaculture movement has evolved principles for ecologically sensitive management of farming, land restoration, and the social cultivation of communities. Similar to the domain of science model (Jones' chapter), their permaculture model is extended through specific applications in an arena of practice, with lessons drawn forward into a grounded theory for general application. They suggest that systemic design can significantly enhance permaculture practices, by developing techniques for forming stable objectives, assessing appropriate technology, stakeholder engagement, and launching and

managing viable agroecological projects. Building from across the systems history of permaculture sources, Cassel and Cousineau promote a framework for enabling ecological farming and management practices through designing local and distributed systems of permaculture for agriculture.

The collection that follows includes some of the most definitive and compelling ideas in systemic design, developed in an active discourse community, with peer collaboration, over the course of several years of symposia. Each of these authors discloses not only an intellectual position guided by transdisciplinary study but also their emerging practice areas of new applications that are now being tested in various stakeholder settings.

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