Mary C. Edson, Gary S. Metcalf., Peter Tuddenham, Gerhard Chroust (eds.)

Systems Literacy

Proceedings
of the Eighteenth IFSR Conversation 2016
St. Magdalena Linz, Austria

International Federation for Systems Research - Johannes Kepler

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Welcome by the Vice Rector

JKU
JOHANNES KEPLER UNIVERSITY LINZ

Univ.-Prof. Dr. Alexander Egyed M.Sc.
Vice Rector of Research

Ladies and Gentlemen, dear participants of the IFSR Conversation 2018 here in Linz!

As the Vice Rector for Research of the Johannes Kepler University, it is my pleasure to open this academic event. We are delighted to have you here to participate and share in this event.

System Sciences is a holistic discipline - it unites nearly all areas of science and technology from mechatronics to informatics, from mathematics to cybernetics, from social sciences to philosophy, and beyond. System Sciences is interdisciplinary in its very nature and it thrives from the many people that contribute to it.

In that spirit, I am happy to welcome you back to St. Magdalena in Linz. This is not the first time the IFSR Conversations have been held here and my special thanks go to the organizing committee for once again selecting our city for this prestigious event: the president Gary S. Metcalf, the secretary general Gerhard Chroust, and the vice presidents Mary C. Edson, Stefan Blachfellner, and Nam Nguyen.

The Johannes Kepler University and Linz will do its best to make sure this will be another memorable event and I wish you the very best success for your deliberations in the coming week.

Univ.-Prof. Dr. Alexander Egyed M.Sc., Vice Rector of Research

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Opening:
Mary C. Edson, Gerhard Chroust, Vice Rector Prof. Alexander Egyed, Gary S. Metcalf (l-to-r)

Executive Summaries from the Teams at the Conversation

This past April, three teams of systems scientists gathered for the 18th Biennial IFSR Conversation (formerly Fuschl Conversation) in Linz, Austria. The Conversation was held once again at Bildungshaus Sankt Magdalena, a seminar hotel on the outskirts of Linz, along the River Danube. Johannes Kepler University is just a little over a mile or kilometer away. Systems Literacy, guided by Peter Tuddenham, was the overarching theme for this Conversation. A total of 25 participants dispersed among three teams focused on these topics:

Team 1: Application of Boulding's Skeleton of Science to Inform Transdisciplinarity,
Team 2: Unity in Diversity – Making the Implicit Explicitly, and
Team 3: Exploring the Relationship of Systems Research to Systems Literacy.

Each team was asked to submit soon after the Conversation a short Management Summary. These summaries you find below. Later in the year the 3 teams Peter Tuddenham produced extensive Reports about their

work. A personal reflection on the Conversation was delivered by George Mobus.

Those participants who are new and unfamiliar with the Conversation's design may be daunted by the idea of spending five days in small groups focused on singular topics, especially if they are accustomed to traditional academic conferences in which the formal lecture, unidirectional, rather than interactive and participatory. Feedback from participants tells us that while that unsettling feeling exists on Sunday, it evaporates quickly by mid-week. By Friday, most participants wonder where the week went because there is a sense that there hasn't been enough time to explore all the material that emerged from the week's Conversation. Here are some of the participants' overall impressions from this Conversation:

"...possibly the most important work in the world. Needs acceleration."

"...unsure what to expect. I had a chance to explore questions of interest to me."

"...it was a fruitful week with rich experience."

"...I can't wait until the next one!!!"

"...brainstorming process with creative/critical thinking."

Most of the participants enjoyed the collegiality and diversity of the teams. They also expressed that there is neither time nor the conditions for deep development of these subjects discussed in day-to -day academic - professional - career - work environments. The quality of interactions at this level received high marks for generativity and innovation, especially for collaboration and "co-creating knowledge," as one participant remarked. As most social interactions continue to evolve into the 21st century globally, so must the Conversation. Several participants remarked about leveraging technology and social media to enrich the discussions. We will research

these options, along with several other suggestions for improvements, in the months preceding the 19th Biennial Conversation. In the meantime, we ask our member societies to encourage their members to start thinking about topic proposals and to develop ideas with colleagues who may be interested in joining the Conversation in 2018.

Systems Literacy - The Focal Theme for the IFSR Conversation (Peter Tuddenham)

In November 2015, the 2016 IFSR Conversation team leaders met to discuss the possibility of developing an overarching theme for the 2016 Conversation. Because the teams had been articulating systemic concepts and principles, several ideas for a central theme were considered. Among these ideas was the topic of Systems Literacy introduced by Peter Tuddenham at the International Society for the Systems Sciences (ISSS) Annual Meeting in Berlin, Germany in August 2015. As team leaders developed their topics with their teams, they kept a focal theme of Systems Literacy in mind. The intention was that participants in the Conversation integrate the work of the teams into a body of knowledge to be developed into modes for educating those new to systems thinking, the systems sciences, and systems research, as a coordinated and coherent whole system initiative to define and achieve Systems Literacy.

Systems Literacy could be defined as understanding your model or models of Systems, how it is the same and different from others' models of Systems, and how our individual and collective actions influence Systems behaviors and how Systems behaviors influence us. An agreed definition will be an outcome of the Systems Literacy Initiative process.

The Systems Literacy Initiative is a process of an ongoing international, coordinated effort to create a greater awareness and understanding about “Systems” and to develop a comprehensive set of big ideas, supporting concepts and learning progressions that have broad agreement. At present, this Systems Literacy Initiative is now being developed by a working group of members from IFSR, ISSS, the International Council for Systems Engineers (INCOSE), and the American Society for Cybernetics (ASC).

At the 2016 IFSR Conversation welcome reception on Sunday evening, 3 April 2016, a brief introduction to the background, structure and process of other literacy efforts for the ocean, earth science, atmosphere, climate, and other subjects that can serve as models for Systems Literacy was presented by Peter Tuddenham. An invitation was extended to the participants to consider how their conversations during the week contribute to Systems Literacy in general, both content and process, and to engage for an hour at the end of each day to contribute to the content and participative design process for the Systems Literacy Initiative.

At the end of each day’s conversations all teams assembled as one group to contribute to the Systems Literacy Initiative. On Monday the group answered the question “How would we know when we have a systems literate society?” Tuesday the group addressed issues of different representations of “Systems” in different languages and cultures. Another area of discussion was the Next Generation Science Standards in the USA that have cross-cutting concepts that are very close to a set of seven systems principles or considerations. The Wednesday contribution by the group was suggestions for other groups and parties who could be included in the broad Systems Literacy Initiative.

The IFSR 2016 Conversation overall theme of Systems Literacy was a helpful contribution to the overall multi organization Systems Literacy Initiative. Furthermore, the overall theme provided a way for some emergent properties of coherence and convergence to occur within each group's conversation.

Team 1: Exploring Transdisciplinarity using Hierarchy Theory, Boulding's Skeleton of Science, and General Systems Theory

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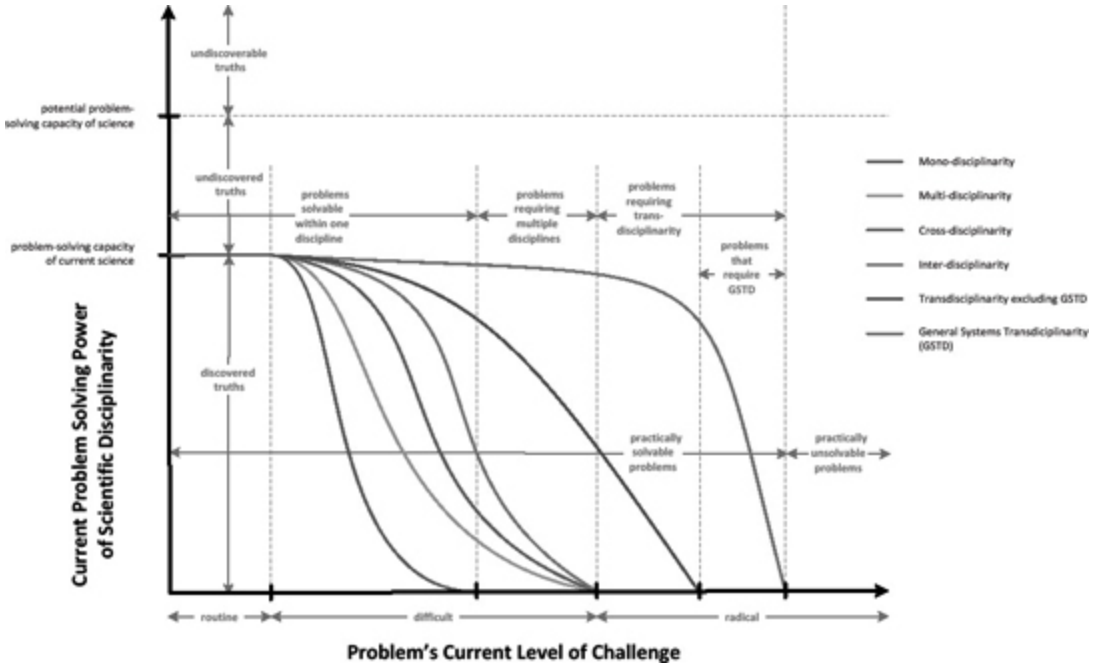

Figure 1. The application areas of kinds of disciplinarity (Rousseau, et al, 2016c)

The purpose of our Conversation at Linz was to discuss the hierarchy of systems complexity that Kenneth E. Boulding proposed in "General Systems Theory: The Skeleton of Science" (1956), drawing on his earlier work *The Image* (1956). We sought to explore the possibilities for informing a process of intentionally holistic transdisciplinarity. Members of this team have been involved with research that would feed into the transdisciplinarity conversation during the week-long meeting in Linz (Singer, et al. 2012; Rousseau et al, 2014, 2016 a,b,c). This work builds on von Bertalanffy's (1968) GST and the overarching unity, and Laszlo's (1972) systems philosophy as the underpinning unity. Throughout the week, we also discussed Sue Gabriele's framework for building relative Inclusive, Continuing, and Emancipatory (rICE) social systems starting from Boulding (1956), Checkland (1991), Scott (1992), and Gabriele (1997). Examples drew from her experience and research in schools and workplaces

(see the conference proceedings for detailed discussion of this innovative framework).

Transdisciplinarity in practice requires more than simply bringing different disciplines into an intervention (Wilby, 2011a,b; Madni, 2007, 2010). Rousseau and Wilby (2014) argued that it will arise in practice from what could be called a General Systems Epistemology (GSE), and that development will be based on a radical change and design of practice coming from a unified single ontology. An initial ordering of increasing complexity in various forms of working in disciplinary practices, from mono-disciplinary practice towards the goal of transdisciplinary practice.

Figure 1 shows along the x-axis, the increasing level of challenge and increasing complexity in a problem situation, broken into 3 broad categories of routine, difficult, and radical. Known models and theories can be brought to bear on “routine” problems, but as the complexity increases, in a similar pattern displayed in Boulding’s *Skeleton of Science*, then the theories and methods required to address “difficult” and “radical” problem situations are less certain in their application and outcomes.

In the current 2016 IFSR Conversation, the intent was to map specifically chosen systems methodologies in terms of Boulding’s work, to demonstrate the systems principles incorporated (or not) in those methodologies, and where found, how those principles might be used to illuminate a possible form of a new transdisciplinarity in practice. What emerged from this week was a particular methodology (rICE), based on Boulding’s *Skeleton of Science*, and how that may show transdisciplinarity in practice. An underlying theme in Kenneth Boulding’s research and writing was the search for governing principles, rules and system structures. Boulding worked to discover some system of measurement

(a form of gravimeter) applicable to the general field of social systems, similar to those found in the physical sciences. This was a framework that Scott referred to as a typology of system complexity (Scott, 1992). There are additional ways of viewing the Skeleton however, and it is these viewpoints on the content and context of Boulding's Skeleton we explored in our discussions.

Frameworks, clockworks, and control systems or "thermostats" (levels 1-3), are predictable, designable to exteriorly prescribed criteria (e.g., goals determined by a teacher, engineer, or CEO). Open, blueprint, image-aware, and symbol-processing parts (levels 4-7) are not designable. These undesignable systems, organisms, act according to interiorly prescribed criteria—needs (Level 4: e.g., ameba or living cell), abilities (Level 5: e.g., plant), perceptions (Level 6: e.g., animal), and choices (Level 7: human) -- of increasing variability. Level 4-7 system boundaries are mandatory. Level 8-9 system boundaries are fleeting, optional. Social and transcendent levels (Levels 8-9) are thus even more variable. Level 7 systems (humans) can ignore the leader's input and even take opposite action. Thus, Level 7 (individual) goals preempt Level 8 (organization) goals. Individual humans can move from one Level 8 system to another – changing their schools or workplaces. They cannot change their Level 7 system – their physical body.

Boulding's nine-level typology may clarify these two conflicting camps. In other words, top-down old paradigm bureaucratic models assume all parts of a social system are designable. New paradigm laissez-faire models assume no parts are designable. Boulding's typology shows how both paradigms are needed. The first step in the path to a more fully specified new paradigm for social system behavior is this shift in agency-from teacher to learner, from CEO to

employee. Whether behavioral laws and causes relate to gravity or human agency, both paradigm shifts here are proposed as hard science--a result of extensive empirical observation, rather than speculation. A shift at such a grand level requires reconceptualization and recalculation at all levels of system. Thus, development and applications are to be wide (across disciplines: cf. transdisciplinarity) and deep (at all levels of organization: cf. hierarchy theory).

Links to Hierarchy Theory and Transdisciplinarity

Gabriele's Figure 2 illustrates more specific areas for linking insights from Boulding's Typology to Hierarchy Theory and Transdisciplinarity. Left are examples of eight disciplines. There are the hard technical systems, where material agency dominates (Levels 1-3 in Boulding's Typology), and there are the soft social systems, where human agency dominates. Informed by transdisciplinarity, knowledge and concepts are to be meaningful, to make sense, across all the disciplines.

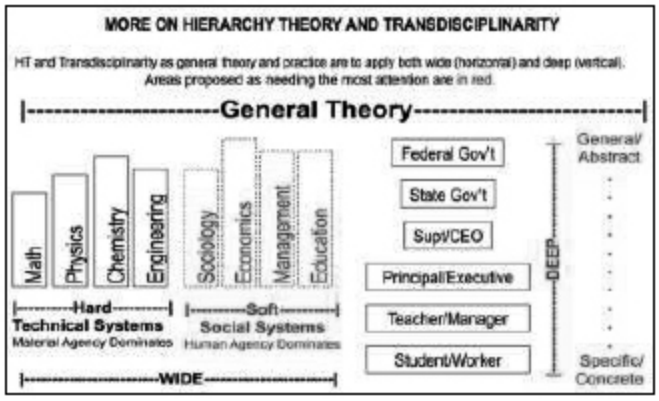

Figure 2. Illustrations of Hierarchy Theory and Transdisciplinarity

Far right is another dimension and continuum, from general and abstract to specific and concrete. Boulding affirmed that "Somewhere however between the specific that has no meaning and the general that has no content

there must be, for each purpose and at each level of abstraction, an optimum degree of generality" (1956, 197). Thus, specific concepts and vocabulary are to be appropriately general or specific to be most meaningful at each level of organization and within each discipline.

Conclusions of the Conversation and Further Development of this Work

Given the complexity and scope of our topics, as well as our different images and viewpoints, there are many possibilities. We do anticipate further exploration and development of the core principles identified in Gabriele's elaboration of Boulding's typology, not yet developed during our work. We propose to explore them and link them to Hierarchy Theory and Transdisciplinarity in an intentionally holistic approach. Further conversation within the Team is ongoing to explore the relationships between Boulding's typology and the search for the evidence of transdisciplinary systemicity and some measurement of that concept in specific systems methodologies. Methodologies such as Soft Systems Methodology (SSM), the Viable System Model (VSM), System Dynamics (SD), and Complex Adaptive Systems (CAS) have yet to be evaluated for systemic principles incorporated (or not) in those methodologies, and where found, how those principles might be used to illuminate a new form of transdisciplinary practice, e.g. in Gabriele's rICE methodology.

Acknowledgements

The authors would like to thank Peter Tuddenham, Debora Hammond and David Rousseau for their thoughtful contributions to the team discussions during the week and in the writing of this report.

Team 1: Janet Singer, Allenna Leonard, guest contributor Peter Tuddenham, Sue Gabriele, Michael Singer, Stefan Blachfellner. (Team Leader Jennifer Wilby not pictured)

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Team 2: Unity in Diversity – Making the Implicit Explicit

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The origin for this conversation is that we put forth the case that it is in this time of crisis that we must break down the barriers to communication across disciplines, organizations, societies, beliefs and cultures in order to promote collective understanding for a common good.

Before the conversation, as a framework for communication we distributed the “Systems tree” which is a conceptual model of the “systems thinker’s attitudes” and the key “systems concepts” that facilitate system understanding. The idea was explore these concepts, to develop a common understanding of their meaning and to have some experience in using them to consider different real world complex problems. This would allow us to develop a prototype game for teaching, exercising and developing systems thinking skills for all, which could be tuned to the diversity of potential players.

The journey started with the team a few weeks before the conversation itself in Linz: some e-mails were exchanged, some "exercises" done by the team, contributed papers were received to generate some ideas. We had a long video call with one member of the team and a short one with most of the other members.

Before the IFSR, we laid out a framework for the days in terms of team experience that we wanted to achieve:

- Sharing, playing and visualizing the system concepts
- Using the system concepts to analyze stories
- Building the framework for the game
- Using the game to analyze a real world problem

This was intended to facilitate the capture of the diversity of the team in the development of the toolbox for the prototype game.

Our first meeting with the team did not go so well. One of the team members did not want to review the objectives for why we were there and to engage in a conversation on the way forward. After what seemed to be an impasse, one team member suggested to use a story called “The Baron and Baroness” as a way to exercise systems thinking. This we did and it promoted a better atmosphere for conversation and to get to know each other a little better.

After the story and lunch, we all produced some drawings of concepts which helped a little in sharing the idea that we can express concepts not just in words but also through art. For example when we played with the concept of boundary there were several different representations which highlighted different features of personal perspective.

One day two, we started with a systems thinking roundtable. This gave the opportunity for everyone to speak and to express what were their hopes and expectations for the conversation. The questions asked were: “What is Systems thinking? What are the challenges and what are your hopes? What situations have your left behind and what