SYSTEMS THINKERS THINK ABOUT SYSTEMS EDUCATION UNDER THE APRIL 2010 (ASH) CLOUDS OF AUSTRIA

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EXECUTIVE SUMMARY

The fragmented nature of systems education with multiple traditions expressed in very different ways at different institutions with ultimate confusing effects on the community of learners (students, managers, policy makers, etc), led to a group of Systems Thinkers to discuss and create generic curricula for education and learning about systems for the generalist and specialist tracks. An active network of systems educators and stakeholders who can benefit from enhanced systems education in having to deal with complex issues, was also explored. In this presentation some guidelines for designing introductory and advanced courses will be discussed. The Introduction to Systemic Thinking and Practice course is intended as an introductory course for students from all disciplines. The Advanced Systemic Thinking and Practice course is intended as a more advanced course for students who are faced with complex issues that require a trans-disciplinary and integrated approach. The designs contain a set of key systems concepts and frameworks relevant to the appropriate level, along with some indicative tools and methods which will enable students to explore the concepts. The value of a Global Network of Systems Educators will also be discussed and how this network could help to fulfil the needs of managers, policy makers and society in general. An example will be given of how the integration of this network with the UQ-UNESCO/MAB Global Learning Laboratories NET could lead to more people (decision-and policy makers in Governments, managers, businesses, etc.) having the ability to practice systems thinking – all of these contributing to Systems Thinking becoming a more mainstream part of a sustainable society.

1. CREATING SYSTEMS EDUCATION CURRICULA

In April 2010 a group of systems thinkers met at the IFSR Conversation at Pernegg, Austria for an in depth conversation about systems education. The goals of Pernegg Team 1 were to create generic curricula for education and learning about systems for the generalist and specialist tracks, and to explore an active network of systems educators and stakeholders who can benefit from enhanced systems education for dealing with complex issues. We discussed the fragmented nature of systems education with multiple traditions expressed in very different ways at different institutions, and developed guidelines for designing two systems courses. The first, ST101 *Introduction to Systemic Thinking and Practice*, is intended as an introductory course for students from all disciplines. The second, ST301, *Advanced Systemic Thinking and Practice*, is intended as a more advanced course for students who are faced with complex issues that require a trans-disciplinary approach. Each course design is intended as an aid to educators, and we expect that educators from different disciplines and systems traditions would adapt it to meet the needs of different students. The designs contain a set of key systems concepts and frameworks relevant to the appropriate level, along with tools and methods which enable students to explore each concept.

The list of tools is partial and indicative, and we fully expect educators to expand the list. We also worked to develop the requirements and benefits of a global network for systems education and systems educators, which could be integrated, for example, with the UNESCO/MAB Global Network of Learning Laboratories for dealing with complex issues. Such a network and its integration with communities of practice could help to fulfil the needs of managers, policy makers and society in general. It could lead to the ability of more people to practice systems thinking, which will also have a ripple effect on others in society – all of these contributing to systems thinking becoming a more mainstream part of a sustainable society. Problem based learning needs to underpin the learning process to support two-way learning spanning staff, students and the community.

[1] *Bosch and Maani are based at the University of Queensland , Australia; McIntyre-Mills is based at Flinders University, Ossimitz is based at the University of Klagenfurt, Austria, Ramage is based at the Open University in the UK and Vesterby is an independent philosopher of science from Seattle, Washington.*

We discussed the application of systemic approaches to enhance learning to address areas of concern by applying appropriate theoretical and methodological approaches.

Our aims were to

- Create generic curricula for education and learning about systems for the generalist and specialist tracks
- Explore an active network of systems educators and stakeholders who can benefit from enhanced systems education in having to deal with complex issues
- Explore how we can contribute to fulfilling the needs of managers, policy makers and society in general
- Enable more people to practice systems thinking and to have a ripple effect on others in society, to contribute to systems thinking becoming more mainstream by, for example, linking a Global Network of Systems Educators to the Global Learning Laboratories Network.

The challenge is how to develop systems education curricula that will be of value to different types of students across conceptual boundaries (cultural, political and professional) and spatial boundaries, organisational, community, regional, international). To this end, the discussions included:

- The fact that participation in the use of various methods in problem solving enhances the students learning of concepts and methodology.
- Brain storming in which the group explained why the various components included in the two courses were relevant to systems education.
- The distinction between systems concepts and systems methods.
- The amount of teaching time allocated to concepts, or tools, or examples.

It is important to note that these discussions were very much based on the sources of literature that the team members would regard as important in their own teaching. To mention a few: Bosch et al 2003; Maani & Cavana, 2007.; McIntyre, 2006; Smith et al 2007; Ossimitz, 1996, Ramage, 2010 and Vesterby, 2008. The following lists of concepts and tools that resulted from the brain storming session (not in any particular order) could easily be added to by others involved in systems education. :

Concepts important in systems education

1. Holism
2. Context
3. Interdependency
4. Flexibility/Adaptability
5. Resilience and robustness
6. System boundaries
7. Complexity
8. Relationship
9. Feedback
10. Controls
11. Concepts/models of time
12. Paradoxes
13. Granularity
14. Non linearity
15. Delay
16. Equifinality
17. Unintended consequences
18. Requisite variety
19. Levels of learning single, double and triple loop
20. Limitations of models
21. Environment
22. Emergence
23. Multiple causality
24. Traps and messes
25. Self organization
26. Communities of practice
27. Root causes
28. Ethics and values
29. Stakeholders
30. Open system
31. Throughflow
32. Equilibrium, steady state, and homeostasis
33. Dynamic behaviour
34. System
35. Feed forward
36. Edge of chaos

Tools that can be of use in systems education (not in any particular order):

1. Participatory design
2. Metaphors
3. Participatory Systems Analysis
4. Mental models
5. Causal loop modeling
6. Bayesian networks
7. Stocks and flows
8. Examples
9. FMA
10. Critical Systemic approaches based on matching the domains of knowledge to area of concern
11. Scenario planning
12. Stakeholder mapping
13. Systemic evaluation
14. Socio technical systems design
15. Team syntegrity
16. Total systems intervention
17. Boundaries of exclusion or inclusion
18. Exploring perceptions of world views
19. Behaviour over time

The members of the group explored the amount of time they spent on concepts, tools and examples /practice. This is summarised below:

	Bosch /Maani	McIntyre-Mills	Ramage	Ossimitz
1.Concepts	15	33	55	25
2.Tools	30	33	25	20
3 Examples/practice	55	33	20	45

2. FORMAL TEACHING AND LEARNING PROGRAMS
2.1 Outline for an introductory course on systems thinking and practice

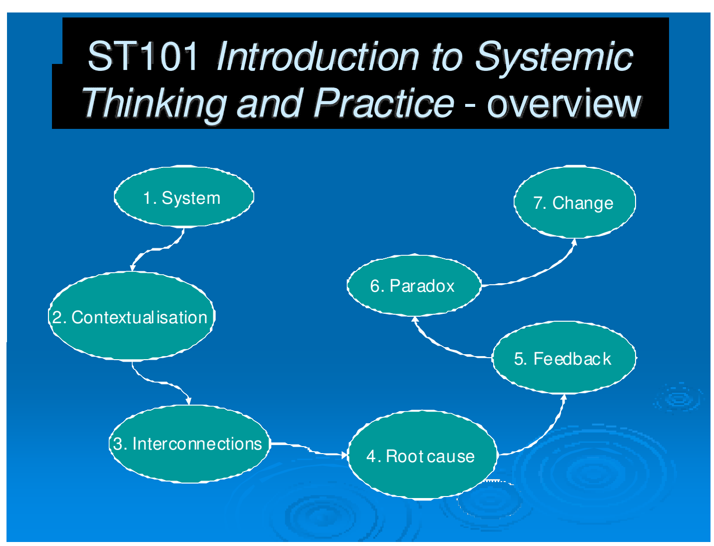
The Systems education Matrix developed during the 2008 IFSR Fuschl discussions was shared with the group.

The Systems Education Matrix (Adapted from Jones et al 2009)

	1. Sense-Making *Having the ability to use basic systems concepts to make sense of phenomena, objects and processes in the world.*	***2.1. Practical Understanding*** *Having the ability to competently apply systems concepts for research or practice. The ability to expound upon or teach systems concepts to others and add to knowledge.*	***2.2. Theoretical Understanding*** *In a position to add competently to the body of systems knowledge (viz., philosophy, theory, metho-dology, and praxis), as well as areas of practical application in specific contexts.*
A. Discipline-Integrated *Having the ability to integrate systems approa-ches into one or more areas of application.*	*e.g. horticulturalist, accountant*	*e.g. systemic horticulturalist*	*e.g. creator of knowledge within systemic horticulture*
B. Generic *Having the ability to understand, apply, and relate systems concepts in multiple contexts and/or to add to the systems knowledge base.*	*systems student mastery*	*systems practitioner*	*creator of Systems knowledge*

The SEM was developed to serve as a tool for systems educators charged with designing new university-level curricula that effectively integrate systems concepts and/or teach those concepts explicitly. During the 2010 Conversation we characterised the main issues of systems education (within the above framework) as follows:

- Highly fragmented, both intellectually and pedagogically.
- A need for a first year introductory course that will be applicable to all disciplines to create "*the ability to use basic systems concepts to make sense of phenomena, objects and processes in the world* - (Sense Making)..



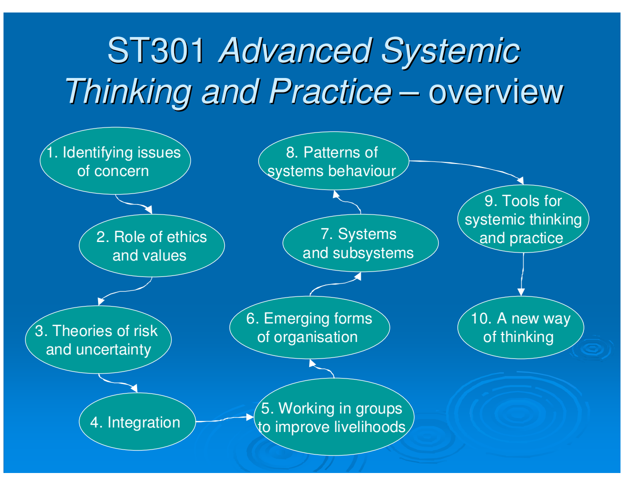
- What contents/concepts should be covered in developing a more advanced course for students who are interested in "*Having the ability to competently use or apply systems concepts for research or practice* - (Practical Understanding/Mastery).

The group started to address these two needs by exploring which of the concepts and systems tools earlier mentioned would apply to the introductory and advanced courses. This has been proven a difficult task, as there are far too many concepts (and tools) that students can be introduced to (those mentioned above were only concepts that came to mind during the brain storming session of our small group of educators). The group decided to "cluster" the concepts into broad modules/categories that will need to be addressed to serve as aids to educators. It is important to note these could only be seen as broad guidelines and each educator would adapt them to meet the needs of different students, disciplines etc.

The introductory course (ST101) consists of a set of concepts & indicative tools. The notes are intended only as some principles for developing a first year course/subject that could be used to guide the development of the learning materials within a particular context. We acknowledge the importance for the materials to be matched to the various contexts in which the course will be delivered.

Learning outcomes will ensure that students understand that:
- The issues facing the world are complex, because **systems** straddle many different factors and involve diverse stakeholders. System's view is predicated on understanding the content and the context (environment) of the problem. This can be explored through participatory processes with the stakeholders using techniques such as Critical Heuristic, Rich Pictures, and many others.
- They will learn about **contextualisation**, by identifying areas of concern within the larger context of their field of study. Contextualization can be explained using mind maps, represented by rich pictures, stories and pictures.
- **Interconnections** across different disciplines need to be understood in order to make sense of the convergent social, economic and environmental challenges that we face as stewards for the next generation. Students need to understand, for example, that poverty and pollution are the result of interconnected social, economic and environmental challenges.
- **Root causes** are based on learning to address the underlying causes rather than seeing and addressing only the symptoms of a problem. This can be explained by means of Causal Loop Diagrams, leverage points and multiple cause diagrams.
- **Feedback** is based on learning to identify positive and negative feedback across components of a system. These can be explained using Causal Loop Diagrams, Influence Diagrams and the paper based computer.
- **Paradoxes** are portals for addressing problems that appear to be intractable by applying systemic theory and practice.
- **Changing systems** (System Dynamics) need to be understood as a core concept that needs to be addressed by applying tools.

2.2 Outline for an advanced course on thinking and practice



The course was designed to serve as a guideline to help students to learn about concepts that will help them towards "mastery of systems practice" and using integrative approaches to work across disciplines:

❖ **Identifying issues of concern**

Learn how to frame issues as problems, to consider what a problem is, and to distinguish between problems and symptoms, by examining interrelationships across multiple areas of concern, such as poverty and tourism.

❖ **Role of ethics and values**

Learn about the importance of ethics and values in relation to contemporary issues such as poverty, pollution, children's rights, climate change, women's rights, conflict, family life, resources shortages (such as water and energy), nutrition, the financial crisis, and corruption.

❖ **Theories of risk and uncertainty**

Learn about how the changing nature of the world impacts upon the way in which people and organisations make decisions.

❖ **Integration**

- Learn how complex problems cannot be solved in isolation within single disciplinary boundaries; learn how to use tools to integrate knowledge and to involve and value the knowledge of all stakeholders.
- Working in groups to improve effectiveness, by learning how to communicate and work in teams towards the common good and enable groups to work together to design better futures.

❖ **Emerging forms of organisation**

Learn that traditional forms of organisation are inadequate in dealing with increasing complexity and interdependency in the emerging global society. This has implications for organisations of all kinds (public, private and voluntary sectors), from the smallest working group to the largest corporation.

❖ **Systems and subsystems**

Learn that systems are composed of subsystems, and how to map out relations across subsystems.

❖ **Systems Archetypes (Generic Patterns of systems behaviour)**

Learn about generic patterns of systems structure and behaviour, such as the 'tragedy of the commons', 'shifting the burden' and 'fixes that fail'.
Tools for systemic thinking and practice

Learn about tools which can be used for decision making and building consensus.

❖ **A new way of thinking (Mental Models)**

At the end of this course students would have learned a new way of thinking which enables them to become an agent for change.

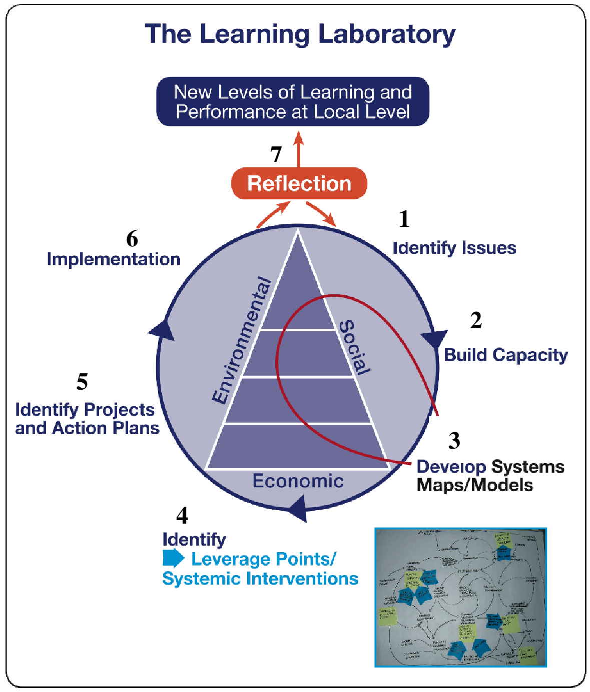
A typical semester course may be delivered as follows

- Week 1: Appreciation of the pitfalls involved in framing issues. Consider the purpose of the interventions.
- Week 2: Theories of risk and uncertainty
- Week 3-5: Integration and synthesis based on knowledge management
- Week 6 -7: Communities of practice, participatory design
- Week 8-9 Open system, emergence and self-organisation
- Week 10: Scale (granularity) and hierarchy; putting logic into organizations, simple examples, Viable Systems Model.

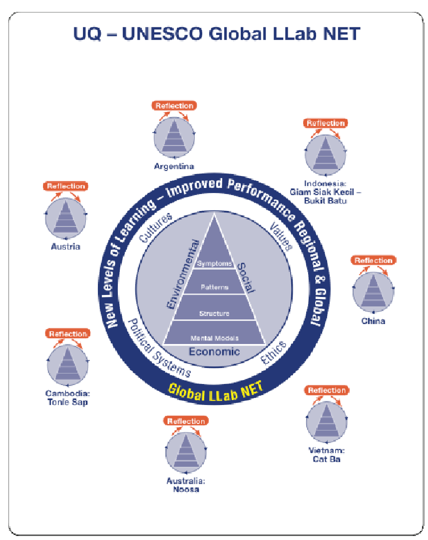
- Week 11: Nature of systems behaviour and systems archetypes.
- Week 12: Representation and accountability
- Week 13: Fundamental personal mind shift

3. INFORMAL LEARNING THROUGH COMMUNITIES OF PRACTICE

The Learning Laboratories for Managing Complex Issues have been discussed as one way of informal learning that could help to make systems thinking more main stream. Bosch explained the Learning Laboratories as a unique process and methodology for integrated cross-sectoral decision making, planning and collaboration in dealing with complex multi-stakeholder problems. The LLab comprises 7 steps[2] whereby all decision makers and stakeholders come together to develop a shared understanding of complex issues and to create innovative and sustainable solutions. The Learning Lab methodology is a generic process which can be applied to solve complex problems and to create consensus in a variety of domains and contexts, social, economic, environmental and cultural. The wide range and diversity of the LLabs is both a challenge as well as a rich source of mutual learning and progress. Not only do LLabs serve the purpose to achieve a particular goal (for the area or issue under consideration) but also improve cross-sectoral collaboration and sharing of knowledge.



The Global Network of Learning Labs (LLab Net) has been a logical next stage in the evolution of the Learning Labs for managing complex issues. The network links culturally and geographically diverse Learning Labs (e.g., UNESCO Biosphere Reserves around the globe), and LLabs being used as management tools for complex problems in a particular State, Province or Country in a virtual network and serves as their 'nucleus'. This provides an unprecedented opportunity as a *global forum for social change*.



While each learning lab operates at a local level in dealing with its own complex issues and challenges (e.g. sustainable tourism, environmental degradation, poverty, access to education, maintaining lifestyle, economic growth, etc), the Global LLab Net provides a platform for all the learning labs from around the world to share knowledge, experience and insights in different cultural and political contexts to generate further regional and global learning and ever-increasing levels of performance. The NET also provides LLabs with opportunities to share their systems models and identified leverage points for systemic interventions

[2] Maani, K & Bosch, O.J.H. Learning Labs For Sustainability © 2010

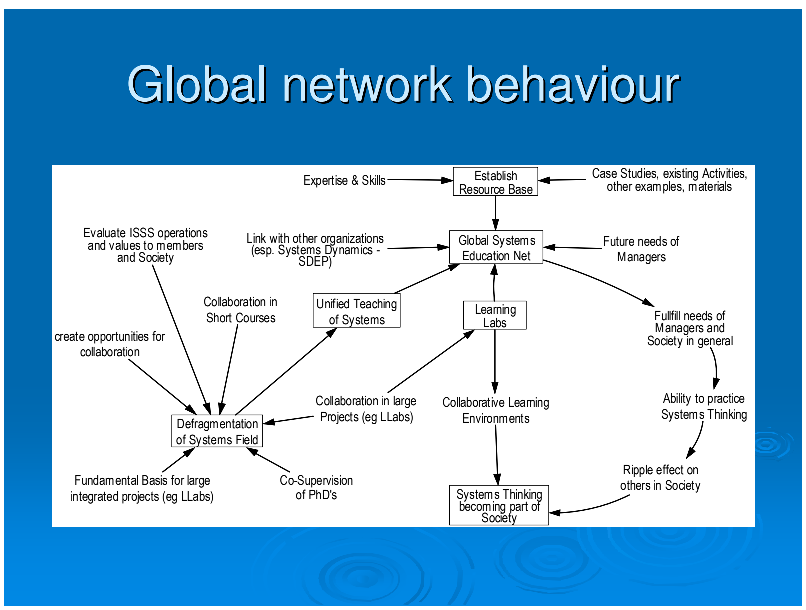
(including potential research projects) with Universities and other research organisations – in this way providing research platforms for collaboration with the individual LLabs.

The Global LLab Net operates since 2009 from its base at the University of Queensland and provides and facilitates a variety of services and synergies. These include acting as a clearinghouse for knowledge dissemination, training workshops, coordinating regional LLab conferences, Decision Labs, executive education, sustainability retreats, research projects, student fellowships, sustainability games, international field trips, and more. The Global LLab NET also provides a collaborative learning environment for sharing ideas and knowledge through different cultural and political lenses that will help achieving new levels of learning and improved management performance at regional, global and local level.

A Community of Learning

LLabs from around the world are brought in direct contact with a wide variety of existing scientific networks around the world. For example, by integrating the Network of Systems Educators (that is starting to form through the IFSR Conversations (Fuschl 2008 and Pernegg 2010), ISSS conferences and activities of the ISSS's Special Integration Group (SIG) for Designing Systems Education) with the Global LLab a world community of learning could evolve. Bringing the Global LLab, ANZSYS (Australia and New Zealand Systems Group) and ISSS together at respectively annual and biennial reflection meetings will not only bring systems theorists and practitioners in direct contact with each other, but will also have the benefit to serve as one way in which informal learning could help to make systems thinking more main stream

The following diagram has been created in discussing the processes and components that could lead to "Systems Thinking becoming part of society". Linking a Global Network of Systems Educators with the Global LLab NET could play an important part in such a vision.



4. General Systems Essentials: An Introduction to a Universal Generalist Curriculum – *By Vincent Vesterby*

The curriculum described here is not an outcome of the Team's discussions. The author has some specific ideas and philosophies about a universal generalist curriculum and we include his views in our report as he was a member of the team. The following briefly outlines a proposed eight year Modern Generalist Curriculum leading to a doctoral degree.

In the modern world there are two levels of generalist understanding. The first level occurs as discipline generalist understanding, wherein a person achieves broad knowledge within a particular discipline, a systems science generalist for example, or a general practitioner in medicine. The second, higher level uses the intrinsic nature of the infinite universe as its paradigm. This level occurs as universal generalist understanding, wherein a person achieves the ability to develop understanding of anything in any discipline by using modern generalist methods. This proposed curriculum is for training universal generalists. General Systems Essentials, the introductory course for this curriculum, can be used by anyone interested in systems science to broaden and deepen their systems understanding.

The curriculum is designed to create discipline-independent general systems scientists (a) who can generate new systems knowledge throughout the disciplines, and (b) who can provide holistic overview of multidisciplinary research and complex issues. Modern generalist understanding will play a supporting role for systems science and systems practice by contributing to quality, rigor, and effectiveness.

The modern generalist mode is based on quality and extent of understanding, which general systems has now made possible, rather than on quantity and extent of knowledge as in the traditional mode, which the ongoing deluge of new knowledge produced by science has made impossible to achieve.
Three universal, omnipresent aspects of the intrinsic nature of all that exists provide the modern generalist mode its ability to achieve discipline-independent breadth and depth of understanding.

- **General factors**—A developed understanding of general systems principles and isomorphies. A general factor is anything that exists and plays a role in the intrinsic nature of reality in two to many different situations.
- **Structural logic**—The manner in which the intrinsic qualities of something that exists determine the kinds of relations that something can have with other things that exist, which determines the patterns of organization of all that exists.
- **Development**—The sequential order of relations between all that exists, throughout space and structure, throughout time and process. It occurs as a consequence of structural logic.

Because these three are intrinsic aspects of that which exists, they orient the mind to realistic objective understanding, and away from the misconceptions derived from the subjectivity of all forms of anthropomorphism and anthropocentrism.

General factors, structural logic, and development exist as patterns of material structure and process. A modern generalist thinks in the mode of these patterns of organization, that is, in the intrinsic mode-of-being of that which is thought about. When doing so, the boundaries of the disciplines fade away. The modern generalist is then working in a discipline-independent manner. Discipline-independent understanding results in the emergence within the mind of another component of the modern generalist intellectual tool kit.

- **The modern generalist universal conceptual model**—is a universally holistic, three-dimensional mental model of structure and process that orders all knowledge according to the natural interrelationships of the reality referents of that knowledge.

There are three further components of the modern generalist tool kit that orient the mind to realistic objective understanding.

- **Biological epistemology**—The recognition that experiencing, knowing, and understanding are biological in nature, the emergent products of biological evolution, and have been honed for hundreds of millions of years to be tools of particular effectiveness in detecting, analyzing, and interrelating with the biotic and abiotic ecological conditions in which our ancestors lived.
- **Realist philosophy**—Realist philosophy is about achieving understanding of that which exists. A modern generalist is a scientific philosopher who uses existing intrinsic aspects of reality to explore, analyze, understand, and describe that which exists.
- **Prime imperative of analysis**—Look to the subject of investigation itself. Let the intrinsic nature of reality dictate the nature of the understanding of reality. Analyse the reality referents of concepts, rather than the concepts themselves.

This generalist mode does not simplify complexity, but instead accepts it for what it is, enters the complexity by way of known general factors playing roles therein, observes what else is there playing roles of structure and process, and thereby achieves understanding of the intrinsic nature of the complexity.

General Systems Essentials introduces the student to this mode of developing understanding through practical, hands-on use of these tools, opening the way to deeper generalist understanding. The full Modern Generalist Curriculum provides a longer term developmental path to provide the student with a modern generalist skillset, a skillset largely absent in modern science—that of the discipline-independent universal generalist.

5. References

Bosch, O. J. H., King, C. A., Herbohn, J. L., Russell, I. W. & Smith, C. S. (2007). Getting the big picture in natural resource management - systems thinking as 'method' for scientists, policy makers and other stakeholders. *Systems Research and Behavioral Science* 24 (2), 217-232.

Jones, J., Bosch, O., Drack, M., Horiuchi, Y. & Ramage, M. (2009). On the Design of Systems-Oriented University Curricula (Report on the International Federation for Systems Research Fuschl Conversation held at Fuschl-am-See in Austria 2008). *Research Reports of Shibaura Institute of Technology: Social Sciences and Humanities (Bulletin of Universities and Institutes,* 43 /1, 121-130, 2009) Japan.

Maani, K. and Cavana, R. (2007). *Systems Thinking System Dynamics – Managing Change and Complexity.,* Prentice Hall, Pearson Education, 2nd Edition...

McIntyre-Mills, J. (2006). 'Systemic Governance and Accountability: working and re-working the conceptual and spatial boundaries of international relations and governance'. Volume 3 , 'C. West Churchman and Related Works Series', Springer, London.

Ossimitz, G. (1996). The Development Of Systems Thinking Skills Using System Dynamics Modeling Tools. http://www.fmd.uni-osnabrueck.de/e_books/GDM/annual_1996.html

Ramage, M. (2010) *Systems Thinkers*. Springer. ISBN: 9781848825246

Vesterby, Vincent. 2008. *Origins of Self-Organization, Emergence and Cause*. Goodyear, Arizona: ISCE Publishing, ISBN 0-9817032-0-8.

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