Systems Thinking
A New Language for a New Age

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Professor Kambiz Maani is the holder of UQ Chair in Systems Thinking and Practice at the University of Queensland. Dr. Maani’s academic and consulting career spans over 25 years in the USA, Asia, Australasia, and South America. He is an internationally acknowledged expert in systems thinking, organizational learning and leadership.

Kambiz has lectured internationally and has held visiting positions at a number of universities including MIT, London Business School (LBS), Boston University, Cornell and Helsinki School of Economics. At MIT he has collaborated with Dr. Peter Senge, the best selling author of The Fifth Discipline.

Kambiz’s executive courses on systems thinking and organisational learning have been offered internationally to universities, government agencies and corporations. Kambiz is co-author of the leading book: Systems thinking, Systems Dynamics - Managing Change and Complexity (2nd ed. 2007). The book, now in second edition, is used widely at universities and corporations around the world.

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Need for new thinking

The unleashed power of the atom has changed everything save our modes of *thinking*, and we thus drift toward unparalleled catastrophes. We cannot solve problems with the same mindset that created them.

*Albert Einstein*
Headline Issues

- Climate Change
- Energy Crisis
- Food Crisis
- Environment
- Carbon Emission
- Water Shortage
- Land use
- Biodiversity

- Economic Growth
- Social dislocation
- Poverty
- Human Health
- Animal Health
- Food Safety
- Globalisation
- Sustainability

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Key Questions

• What happens when all of these threats start to interact?
• How can we know their combined effect?
• Who is managing the interaction of these threats?
Characteristics of our age

- Complexity
- Division/Fragmentation
- Change
- Uncertainty
- Ambiguity
- Paradox
- Lack of Moral Leadership ‘just do it’
- Unintended consequences
Need for Paradigm Shift

Puzzle Metaphor: The Mechanistic Mindset of the Industrial Age

Molecule Metaphor: The Organismic Mindset of the Systems Age

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Organisations are living systems
Origins of modern thinking

- Isaac Newton (1642-1727)
- Adam Smith (1723-1790)
- Charles Darwin (1809-1882)
- Frederick Taylor (1856-1915)
Systems Thinking

The ability to see the world as a complex system

Systems Thinking unravels complexity through non-linear feedback over time

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Reductionist vs Systems Thinking

- Sum of the Parts
- Analysis
- Linear
- Data driven
- Forecast (past)
- Specialist knowledge

- Interaction of parts
- Cause and effect
- Circular (feedback)
- Patterns
- Scenarios
- Integrated Knowledge

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“We have to understand the whole before we can understand the parts - what matters is their interaction.”

“You can never understand anything by analysing it.”

Russell Ackoff
The systems approach begins when first you see the world through the eyes of another

West Churchman
The Iceberg model
Four levels of Thinking

- Events
- Patterns
- Systemic Structures
- Mental Models

Reactive
Adaptive
Generative
Creative

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Climate Change and Mental model
Mental Models – pre industrial revolution

The only difference between man pre industrial revolution and post was the power to control the environment

Machines will deliver mankind “power over nature”, and would free him from the need to be working constantly for the bare necessities of life.

Francis Bacon
Mental Models – the revolution begins

“The whole industry of human life is employed not in procuring the supply of our three humble necessities, food, clothes and lodging, but in procuring the conveniences of it according to the nicety and delicacy of our tastes.”

Adam Smith Lectures on Justice, Policy, Revenue and Arms

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Our Prevailing Mental Models

• More is better
• Life is about me
• Technology will solve our problems
• There is enough in nature for everyone
• We can control things
The average American ecological footprint

Each person’s fair Earthshare in 2003

= 4.4 acres
(1.8 ha.)

The average footprint of US citizens in 2003

= 24 acres
(9.6 ha.)

Human economies will only survive over the long term if they are able to function within the carrying capacity of planet Earth.

The resources of 4 more planets would be needed for everyone in the world to live like Americans. The globalization of the American consumer society is not possible.

© BEST Futures 2004, www.bestfutures.org
The Green Paradigm Shift…

• **Gaia** – the planet exists with all the elements working together as a giant control system, keeping all things in balance
Gaia

"The entire range of living matter on Earth from whales to viruses and from oaks to algae could be regarded as constituting a single living entity capable of maintaining the Earth's atmosphere to suit its overall needs and endowed with faculties and powers far beyond those of its constituent parts...[Gaia can be defined] as a complex entity involving the Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback of cybernetic systems which seeks an optimal physical and chemical environment for life on this planet."

James Lovelock – Gaia, a New Look at Life On Earth

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Endo-symbiosis

“The planet is a super organismic system and evolution is the result of co-operative not competitive processes that life did not take over the world by combat but by networking

“Darwin’s grand vision is not wrong, only incomplete”

Lyn Margulis
Evolutionary Biologist

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systemic thinking & complexity

Systemic thinking is a cognitive process which connects decision maker’s mental models to understanding of complexity
2008/09 in perspective...

“food, fuel and finance are simply the three canaries in the mine. These are the early warning signals that our current economic system is simply not sustainable”

Summit on the Global Agenda, WEF, Davos Jan 2009
Gatton Carbon Footprint

• 10,000 tonnes
• 7,000 tonnes (70%) is due the piggery alone!

Student audit of UQ Gatton Campus, 2009
Systems Thinking and Sustainability

1. Mankind is facing unprecedented challenges in dealing with critical issues related to sustainability.

2. Sustainability is impacted by many stake-holders and has multiple drivers and dimensions: freshwater, oceans, atmosphere, land, energy, and biodiversity.

3. These issues, while distant in time and space, are interconnected and systemic. Conventional single-dimensional (silo) approaches cannot deliver the right answers.
Systems Thinking and Sustainability (2)

4. Interventions in sustainability embed complex feedback loops, non-linear cause and effect and long delays. Thus outcomes are largely unpredictable - emergent property.

5. New challenges require matching responses. We cannot solve new problems with old tools.

6. Narrow, short term and isolated solutions will invariably lead to “unintended consequences”.
Systems Thinking and Sustainability (3)

7. We need to balance short term solutions with long term sustainable interventions. They are not incompatible.

8. To create resilience, collaborative integrated and systemic approaches are required.

9. But, fundamentally and foremost, we need a new way of thinking and mental models that allow us to test and challenge age-old assumptions. This is the key Challenge!

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Where is the Life we have lost in living? Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?"

T.S. Eliott, in Choruses from the Rock (1934)
What is a System?

A system is not the sum of its parts – it is the product of their interactions.

We have to understand the whole before we can understand the parts - what matters is their interaction.

Professor Russell Ackoff
Wharton Business School

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Examples of systems

- solar systems

- mechanical systems (thermostat, cruise control, float valve, guided missile, etc.)

- biological systems (digestive system, body temperature, thirst/hunger, balance, growth and aging, etc.)

- ecological systems (population/food, predator/prey, etc.)

- social-economic systems (judicial, political, management, production, inflation, etc.)

Maani & Cavana, 2nd edition 2007
Systems Thinking

Is a scientific methodology for understanding and managing complexity

1. Theory and Principles
2. Qualitative Modelling (CLD, BOT, Systems Archetypes)
3. Dynamic Modelling (System Dynamics, Agent Based Modelling)
4. Learning/Strategy Labs
Systems Thinking in daily language

- What goes around comes around
- The solution is part of the problem
- Cyclical pattern
- We’re in this together
- Fluctuating pattern
- Vicious/virtuous cycle
- Domino effect
- She is on a roll
- Ripple effect
- Chronic behaviour
- Downward/upward spiral
- Self-fulfilling prophecy
- Closing the loop
- Snowballing
- There is more to it than meets the eye
- The cure can be worse than the disease
Why do we need Systems Thinking?

The increasing interdependence and complexity in the World raises the

1. Need to understand the interconnections and combined effects of decisions and polices
2. Need for greater partnership and collaboration of all stakeholders
3. Need to integrate policy and strategy
4. Need for shared vision and alignment of mental models
5. Need for new leadership and decision-making - at all levels
6. Need for a common language for understanding complexity and uncertainty

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I'm sure glad the hole isn't in our end...
Origins of the ‘Systems Thinking’

- 1923 - Werner Heisenberg: Uncertainty Principle
- 1947 - Norbert Weiner: Cybernetics
- 1954 - Von Bertalanffy: General Systems Theory
- 1960 - Jay Forrester: System Dynamics
- 1990 - Peter Senge: Systems Thinking
  (The Fifth Discipline)
Dimensions of Systems Thinking

- **PARADIGM** - a holistic way of thinking about the world and relationships
- **LANGUAGE** - a tool for describing interrelationships that shape the behavior of systems
- **METHODOLOGY** – a computer simulation technology for understanding and predicting dynamic behavior of complex systems
ST as a Paradigm
Barry Richmond

• **Dynamic Thinking**: How things change over time?
• **Closed-Loop Thinking**: cause and effect often work in circles.
• **System-as-Cause Thinking**: problems are often generated from within the system.
• **Operational Thinking**: How different elements within a system impact each other?
Systems Thinking
Developing a systems model for Cat Ba Biosphere Reserve

Dr Nam Nguyen

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Biosphere Reserve: Cat Ba Archipelago
Geological Values

Out-standing geological formations
Traditional Cultural Values

Cat Ba has unique traditional values of a sea-island community

Fishing Village Anniversary on April 04

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Environmental issues – floating farms
No waste treatment
Symptoms of past international approaches to projects in the CBBR
A Systems Approach

- $$$ for alleviating poverty
- $$$ for an environmental problem
- $$$ for improving tourism

The Iceberg Approach

$$$ for fundamental problems to achieve sustainable systems
The Cat Ba System (2007)

Outcome of two days Systems Thinking workshop at UQ Gatton Campus in March, 2007

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SYSTEMS (HIGH LEVEL) MAP OF MAIN SECTORS IN CBBR MODEL

- Environmental sector
- Social sector
- Economic sector
- Tourism sector

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The ‘big’ picture of CBBR system

The system is influenced by:

- NGOs
- Governance structure
- Policies

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Economic Development Loop

- GDP per capita
- Livelihood of Commoner
- Misuse of NR
- Tourist revenue
- Other income sources
- Agriculture revenue
- Investment in agriculture
- Access to market
- Temporary immigrants
- Agricultural/environmental pollution
- Attraction of Cat Ba Island
- Information and communication

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Social Development Loop

Migration → Population

Population → Student population

Student population → Educated population

Educated population → Social evils/crime

Social evils/crime → People's awareness

People's awareness → Tourism development

Tourism development → Economy

Economy → Health

Health → Livelihood of Commoner

Livelihood of Commoner → Poverty

Poverty → Important: the relationship between poverty and social evils?

Important: the relationship between poverty and social evils? → Cultural values

Cultural values → Social development

Social development → Migration

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Tourism Development Loop

- Number of tourists
- Tourism revenue
- Social evils
- Infrastructure
- Link to Social Dev loop
- Link to Eco Dev loop
- Government's investment
- New investment
- Use of underground water
- Available underground water
- Ecosystem
- Tourism pollution
- Attraction of CB island
- Waste
- Hotels and Restaurants
- Services

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A PhD student is working on the topic of conservation, people, and policies.

The system is influenced by:
- NGOs
- Governance structure
- Policies

A prospective PhD student will be working on the Agriculture Loop.

A prospective PhD student will be working on the topic of water management and policies.

The system is influenced by:
- Policies
- Cultural values
- Education
- People's awareness
- Social evils/crime
- Immigration
- Population
- Student population
- Tourism development

The system is influenced by:
- Information and communication
- Access to market
- Other income sources
- Health
- Food safety
- Life expectancy
- Population
- Immigration

A PhD student is working on the Tourism Loop.

Ecosystem

Use of underground water

Scarcity of NR

Law enforcement

Mise of NR

Health

Population

Food safety

Life expectancy

Immigration

Population

Student population

Tourism development

People's awareness

Social evils/crime

Education

Cultural values

Governance structure

Policies
TMP Case
What is the Relationship Between Staff T/O & Market Share?

Marketing Ability (Individual) → R5 (External Market) → Client Relationship → Staff T/O → R3 (Employee) → Performance → R4 → Internal Communication

Company Profile → R1 (Profitability) → Competitiveness → Staff T/O

Price → Quality of Service → Market Share → Revenue

R2 (Investment) → Training Spending → Motivation → Staff T/O

R2 (Investment) → Revenue → R1 (Profitability)

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