




Professor George Rzevski

# Designing Complexity into Products and Processes

Professor George Rzevski

Founder and Chief Scientist, Magenta Corporation, London  
Professor of Intelligent Systems, Brunel University, London

Professor George Rzevski

# *Complex is Beautiful*








Professor George Rzevski

## Complex Systems




- Ecology
- A human being
- Global economy
- Road traffic
- Epidemics
- Global terrorist networks
- A virtual enterprise
- The Internet
- The next generation of products and processes

Professor George Rzevski

## What is Complexity?




- A system is complex if it consists of autonomous units (Actors, Players, Agents) each pursuing own goal in a strong interaction with each other
- The interaction can be competitive, cooperative or a combination of the two
- Goals of individual players may or may not be disclosed to other players

Professor George Rzevski




## Useful Features of Complexity

- **Autonomy of constituent agents** – they can act (within given constraints) without being instructed or controlled
- **Emergence** – the overall behaviour of the system emerges from the interaction of constituent players; certain properties of a system do not necessarily reside in its components, which means that components can be simple as long as their interaction is rich
- **Selforganisation** – they change their own behaviour in response to the occurrence of unpredictable events and therefore can achieve their tasks in spite of undesirable or even hostile internal or external changes
- **Evolution** – with time, they irreversibly change their behaviour in response to changes in their environments and therefore have a longer useful life

Professor George Rzevski


# In contrast to .....

Professor George Ravski

## Deterministic Systems

- Software based on algorithms
- Conventional cars, aircraft, engines
- Conventional car production lines
- Corporations based on rigid hierarchies
- A pendulum
- A clock



Emerging Design Research 3  
**MORE IS MORE**  
Embracing Complexity in Design


ECID Finale  
Royal College of Art  
16th/17th December 2005

Professor George Ravski

## Complexity versus Determinism

There are two philosophical theses:

- **The World is predictable (deterministic)**
  - based on the "grand design"
  - any uncertainty is due to our inability to understand it
  - the future is given
  - **Aristotle, Kant, Newton, Einstein**
- **The world is inherently unpredictable (complex)**
  - evolves with time due to autocatalytic properties of some of its elements
  - evolution is irreversible and leads to an increase in complexity
  - the future is under perpetual construction
  - **Buddha, Maxwell, Darwin, Popper, Prigogine**




Emerging Design Research 3  
**MORE IS MORE**  
Embracing Complexity in Design

ECID Finale  
Royal College of Art  
16th/17th December 2005

Professor George Ravski

## Two Paradigms

DETERMINISTIC SYSTEMS	COMPLEX SYSTEMS
Control hierarchies	Networks
Sequential processing	Parallel processing
Centralized decisions	Distributed decisions
Instructions	Negotiation
Data-driven	Knowledge-driven
Predictability	Self-organization
Stability	Evolution
Pre-programmed behaviour	Emergent behaviour



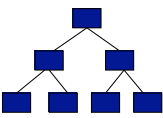
Emerging Design Research 3  
**MORE IS MORE**  
Embracing Complexity in Design

ECID Finale  
Royal College of Art  
16th/17th December 2005

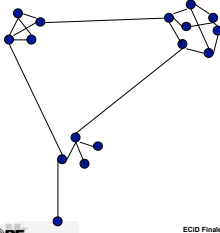
Professor George Ravski


## Two Paradigms

DETERMINISTIC SYSTEMS



COMPLEX SYSTEMS





Emerging Design Research 3  
**MORE IS MORE**  
Embracing Complexity in Design

ECID Finale  
Royal College of Art  
16th/17th December 2005

Professor George Ravski


## Why is Complexity Beautiful?

Complexity is a prerequisite for

- **Adaptation** (complex system adapt to any external or internal unexpected change that disrupts its operation)
- **Resilience** (complex systems are resilient to attacks that represent a treat for their survival, eg, viruses, bombs)

Global Internet-based economy is unpredictable and volatile therefore we need organisations, systems and artefacts that can rapidly adapt to perpetually changing operational conditions and resist attacks

**To solve complex problems one needs complex tools (Ashby's law of requisite variety)**

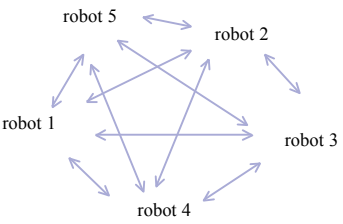



Emerging Design Research 3  
**MORE IS MORE**  
Embracing Complexity in Design

ECID Finale  
Royal College of Art  
16th/17th December 2005

Professor George Ravski

## A Family of Space Robots





Emerging Design Research 3  
**MORE IS MORE**  
Embracing Complexity in Design

ECID Finale  
Royal College of Art  
16th/17th December 2005

