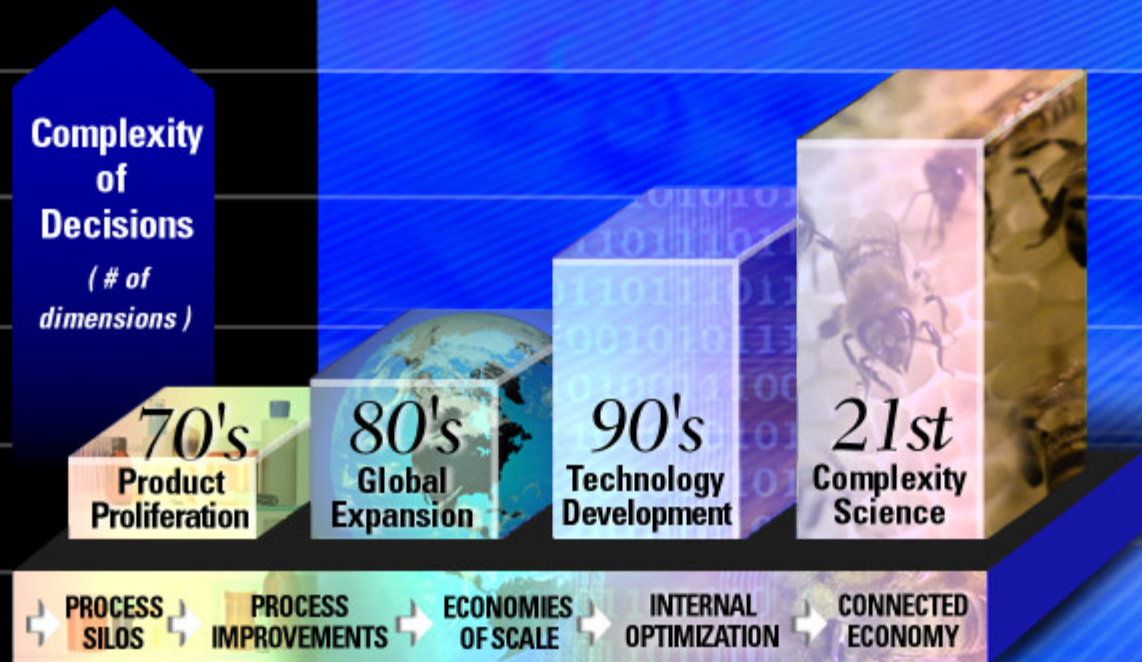




The Business World Continues to Become More Complex

A Historical Perspective

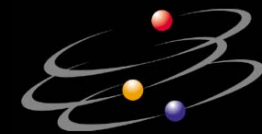




Complex Business Networks are Very Similar to Natural Ecosystems

Complex operating networks require an understanding of each component's effects on its internal and extended partners





Business Conditions Dictate a Need For New Metaphors and New Solutions

*“The laws of the mechanical
are never the laws of the
organic.”*

Sir Isaac Newton

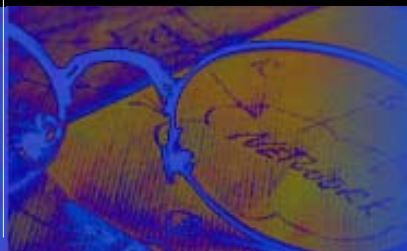
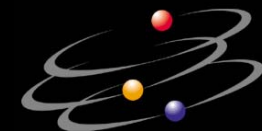
*“The world of our making has
become so complicated that we
must turn to the world of the
born to understand how to
manage it.”*

Kevin Kelly

Executive Editor, *Wired Magazine*;
Author, *Out of Control*

Technology, innovations and
the connected economy have
created business systems that
behave like living organisms

Advances in Complexity
Science provide tools for
understanding the behaviors of
complex business systems and
for controlling or influencing
these behaviors



Scientific Approach:

Complexity science is the study of “non-linear ” or “complex adaptive” systems.

Such systems are common in nature and business and cannot be controlled by outside means.

But they can be under the control of their own self-organizing properties.

Complexity science applies our understanding of these complex natural systems.



Complexity Science-

“when the whole is greater than the sum of the parts”

- New science that uncovers the underlying principles of *complex adaptive systems*.
- Complex adaptive system have *independent components* (agents) that interact with each other and the environment.
- *Emergent properties* result from complex interactions and cannot be predicted from properties of individual agents.
- Complexity science applies these ideas *across disciplines* from economics to business.



Conceptual Tools of Complexity Science

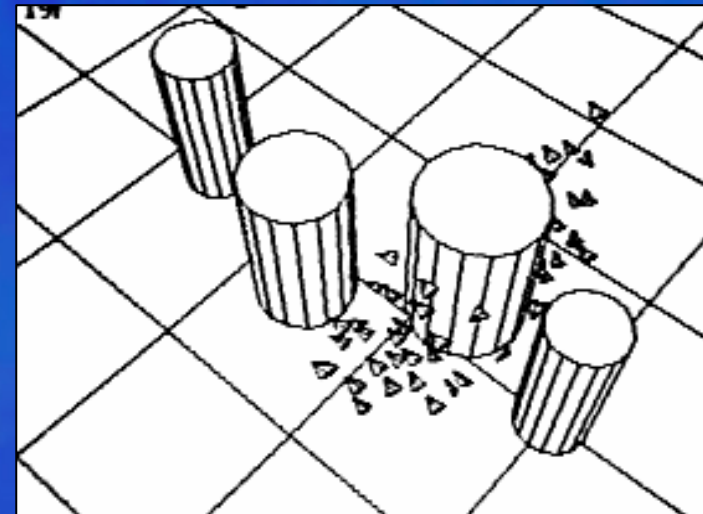
- Emergent behavior
 - self-organization and adaptation
- Phase transitions
 - high leverage opportunities
- Fitness landscapes
 - visualizing problem difficulty



Emergent Behavior – Self-Organization and Adaptation

- Bird agents obey four simple rules:
 - *Separation*: steer to avoid crowding local flockmates
 - *Alignment*: steer towards the average heading of local flockmates
 - *Cohesion*: steer to move toward the average position of local flockmates
 - *Avoidance*: steer to move away from oncoming obstacles

Flocking:
Emergent, Complex Behavior





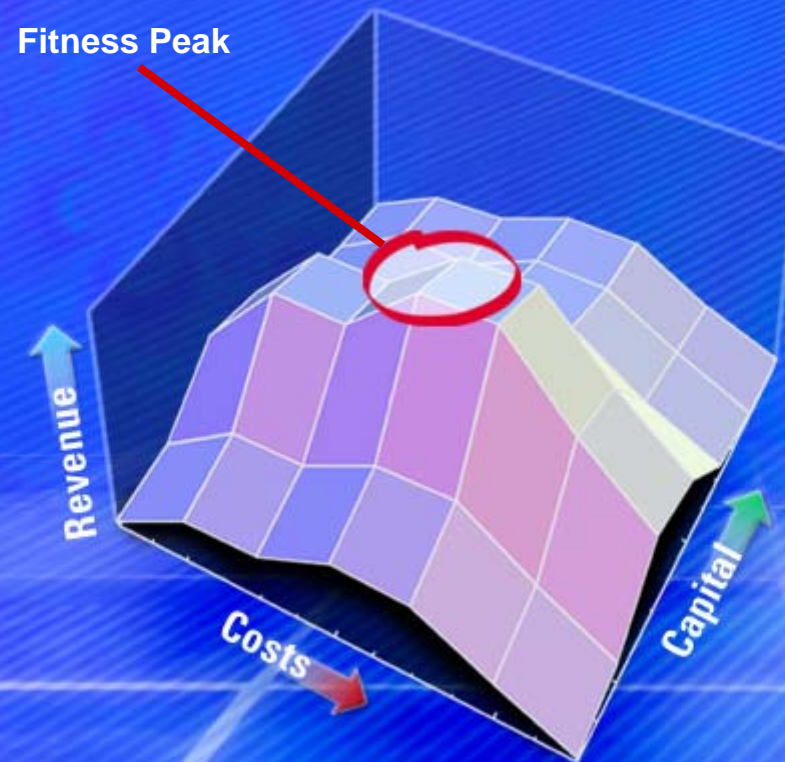
Complexity Science Themes

- **Multiple Objectives**
No single right answer exists; instead, trade-offs rule the day
- **Co-Evolution**
Every change in strategy causes competitors to change strategy, and vice versa...
- **Adaptive**
When the environment changes, solutions change
- **Distributed**
Simple local rules can have powerful global results
- **Self Organizing**
Structures and solutions can organize themselves
- **Distributions over averages**
Averages are often over-simplifications; probability distributions tell the whole story
- **Exploration vs. Exploitation**
A fundamental trade-off between optimality and adaptation exists



Multi-dimensional View of Business Impact

Moving away from 20th century systemic approach dictates the need to look at results through a new lens that provides an opportunity to look inside the dimensions that influence business value.





Summary: The Complexity Science Opportunity

The Upstream Oil & Gas business, as well as the modern economy, is an increasingly complex place

Traditional approaches are breaking down

- current functions become more difficult
- new opportunities go unnoticed

Complexity science gives us tools to deal with complex problems

A wealth of business and operational solutions, opportunities, and improvements are now possible