



The ICE & Faculty of Actuaries – ERM Series:

Benefits of complex systems approach to ERM

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<http://www.systemicconsult.com>

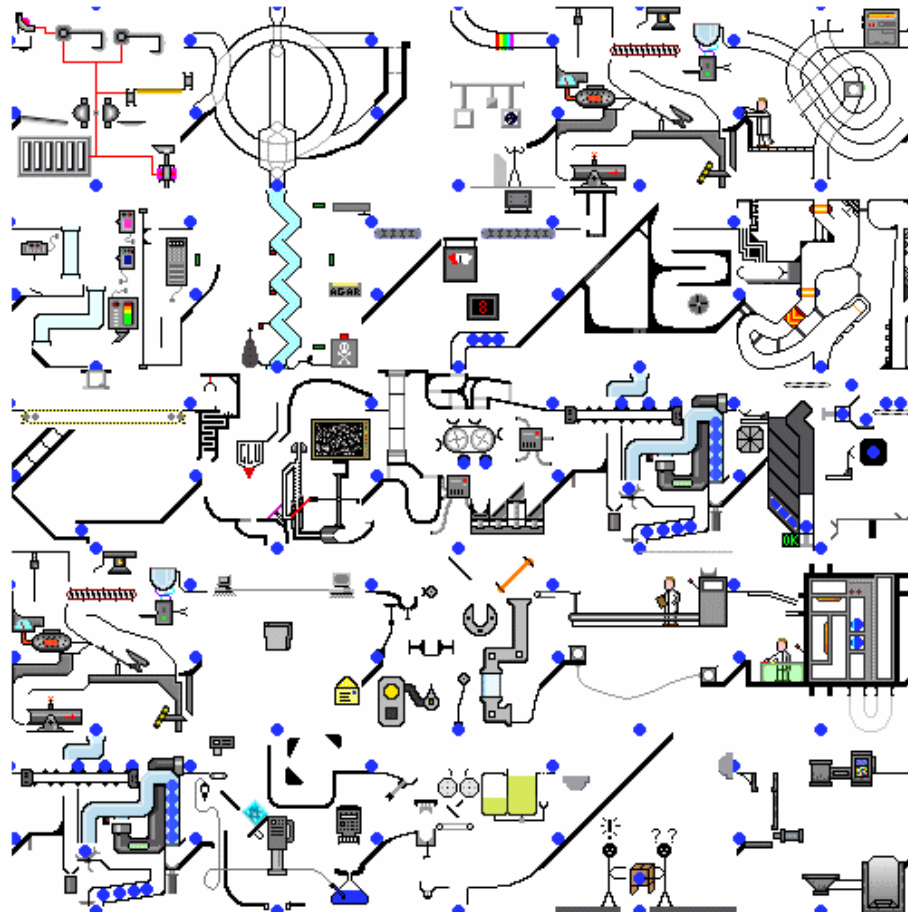
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Benefits of complex systems approach to ERM



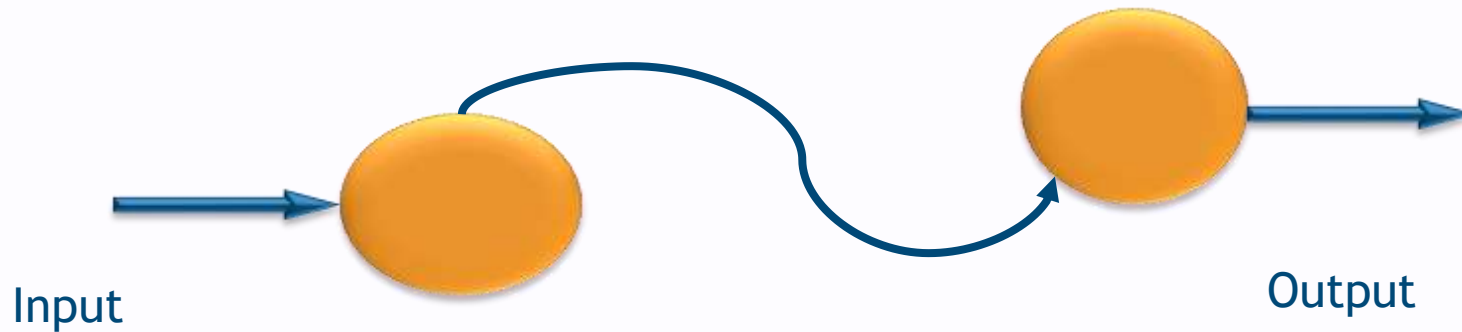
Enterprise Risk Management



Objectives of this session

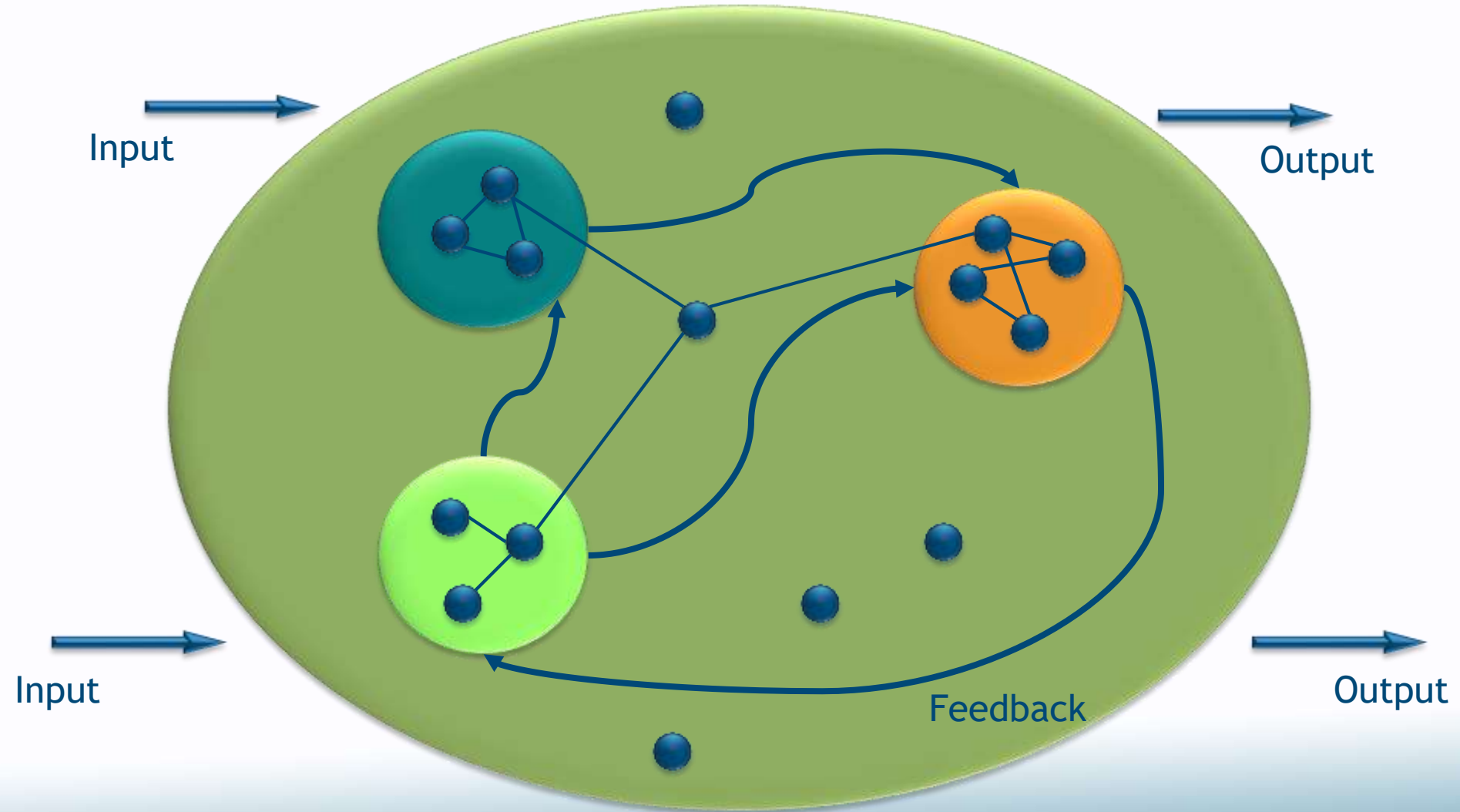
- Introduction to “systems” concepts
- Understand how this is applicable to ERM
- Review of practical methods and tools, with examples

What is a system ?

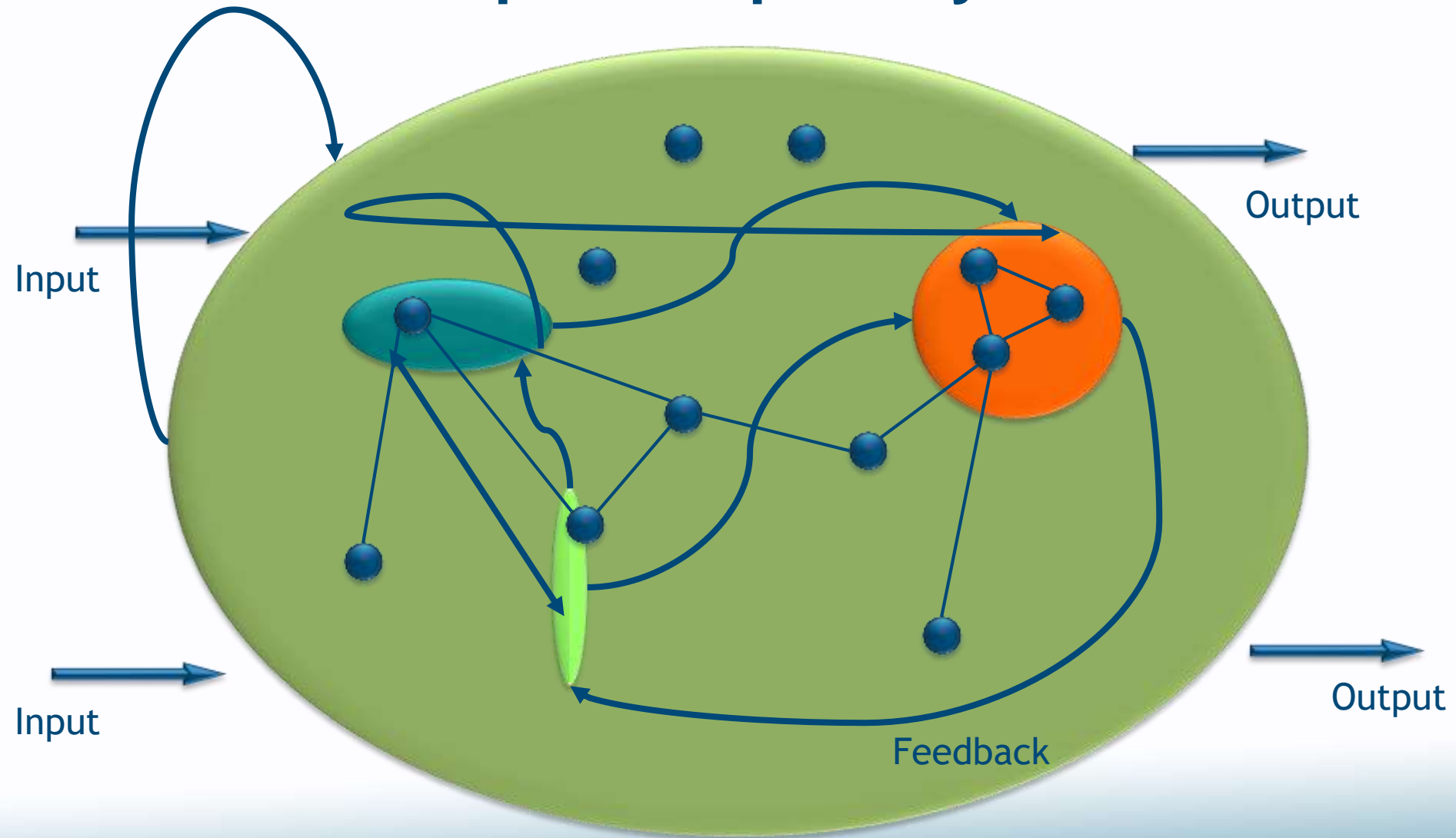


“a set of components interconnected for a purpose.”

What is a complex system ?

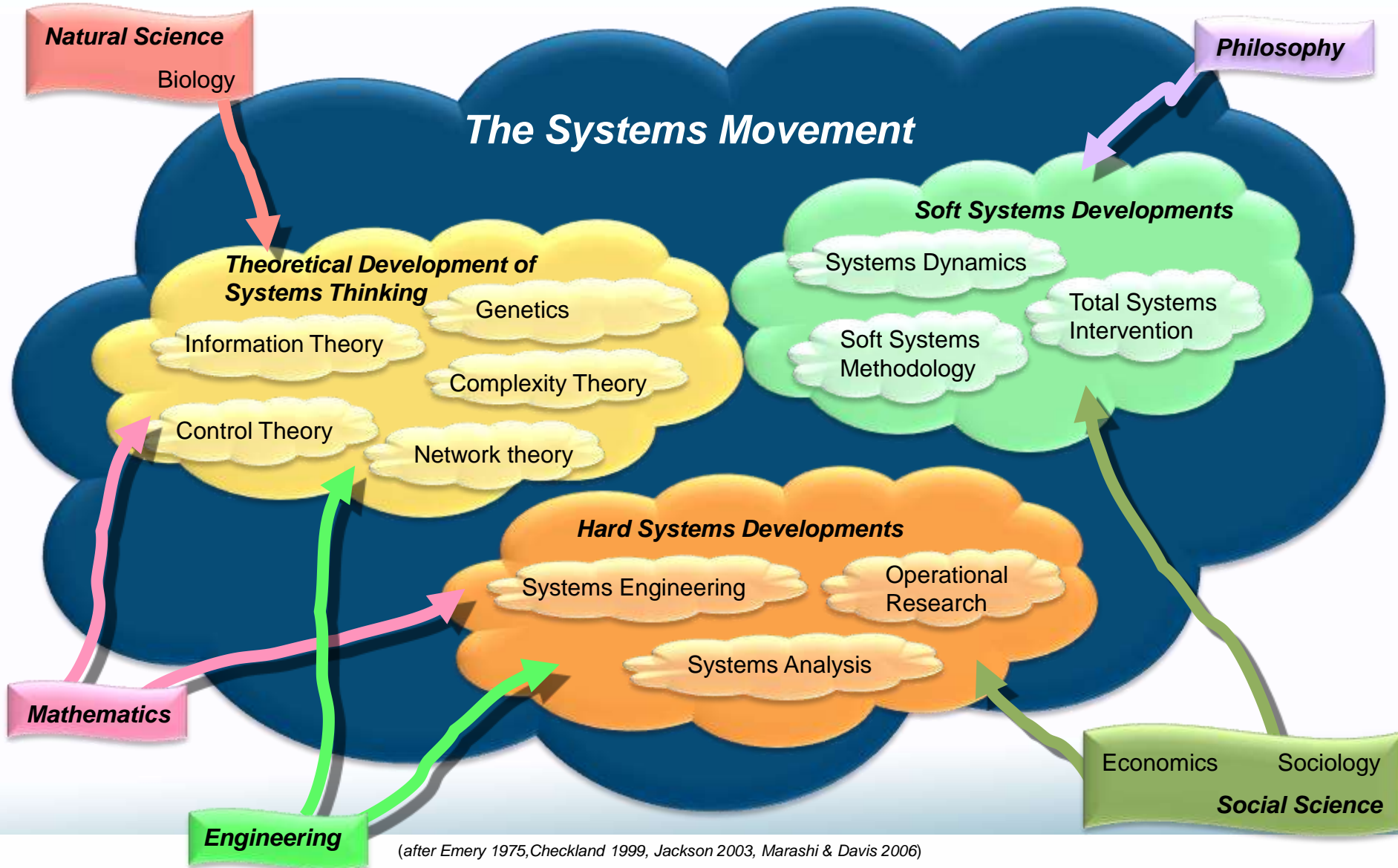


What is a complex adaptive system ?



Elements can change

Systems Movement – not a fad but a holistic approach



Complex Adaptive Systems - Some Properties

- Has a purpose
- Emergence – the whole has properties not held by sub components
- Holism – Boundary and Elements
- Connectivity - Relationships, Rules, Influences and Networks
- Self Organisation – structure and hierarchy but few leverage points
- Interacting feedback loops – causing highly non-linear behaviour
- Counter-intuitive and non-intended consequences
- Has tipping point or critical complexity limit before collapse
- Evolution and history is important
- Cause and symptom separated in time and space

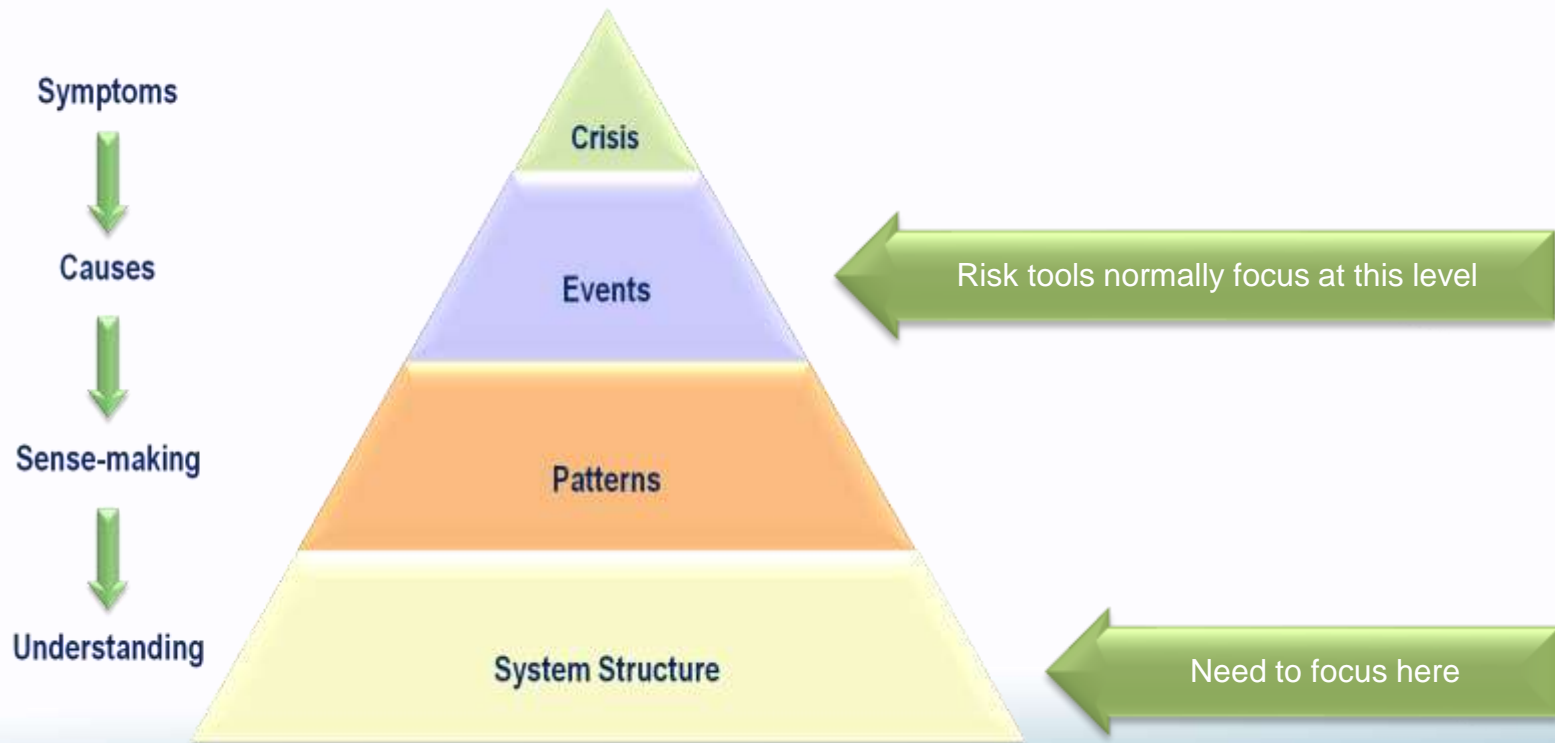
Enterprise Risk Management: Complex System



- They have multiple characteristics, causes and consequences.
- They can combine to produce “new” outcomes.
- Poor understanding about how people influence the process
- Cause often highly separated from symptom
- They can spiral rapidly out of control – non-linear and chaotic

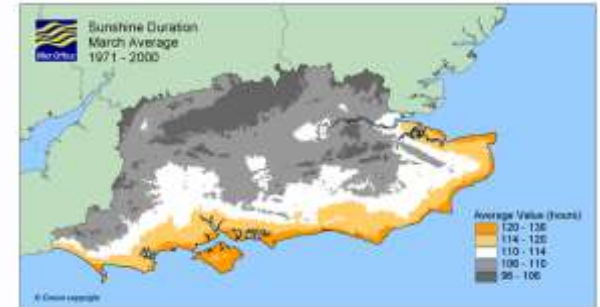
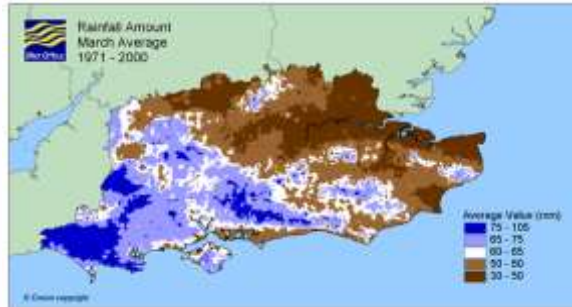
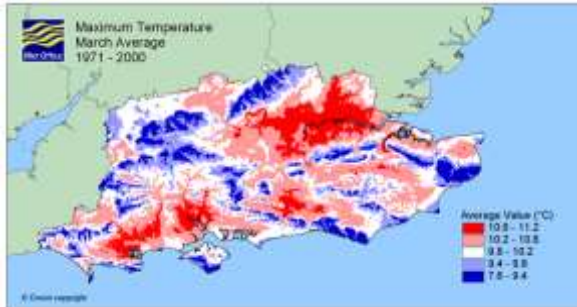
Why Understand the ERM system

- Studying the “factors” *cannot* tell you about the final behaviour.
- Enterprise Risk is the emergent property of a complex system



The weather as an example

- Deciding whether to wear coat to this meeting
- Method 1:



- Look at historical information to make estimate of likely conditions today
- Method 2:
 - Look at the clouds, wind levels etc. and take a view
 - Needs an understanding of the fundamentals of the weather system

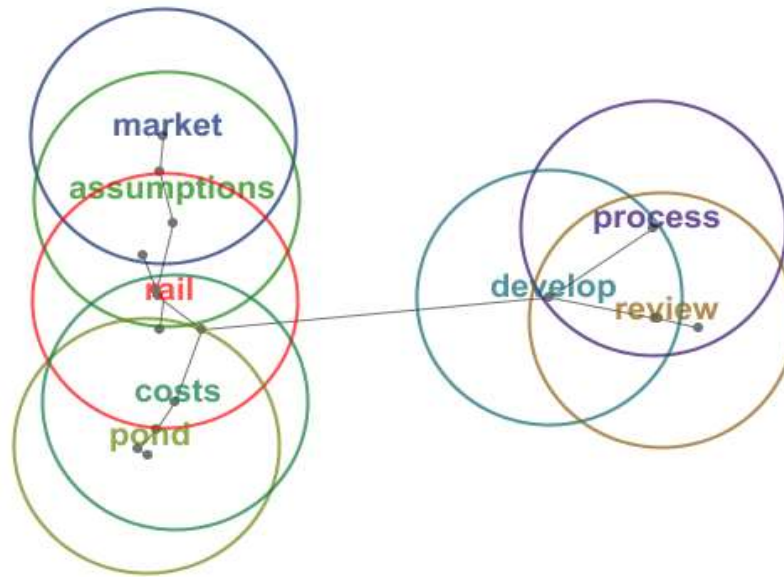
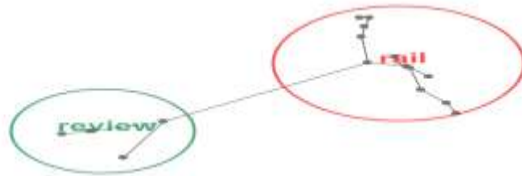
Emergence – E.g. Flocking/shoaling



TOOLS FOR COMPLEX RISKS - PRACTICAL EXAMPLES

“If you only have a hammer you treat everything as though it was a nail”, Maslow

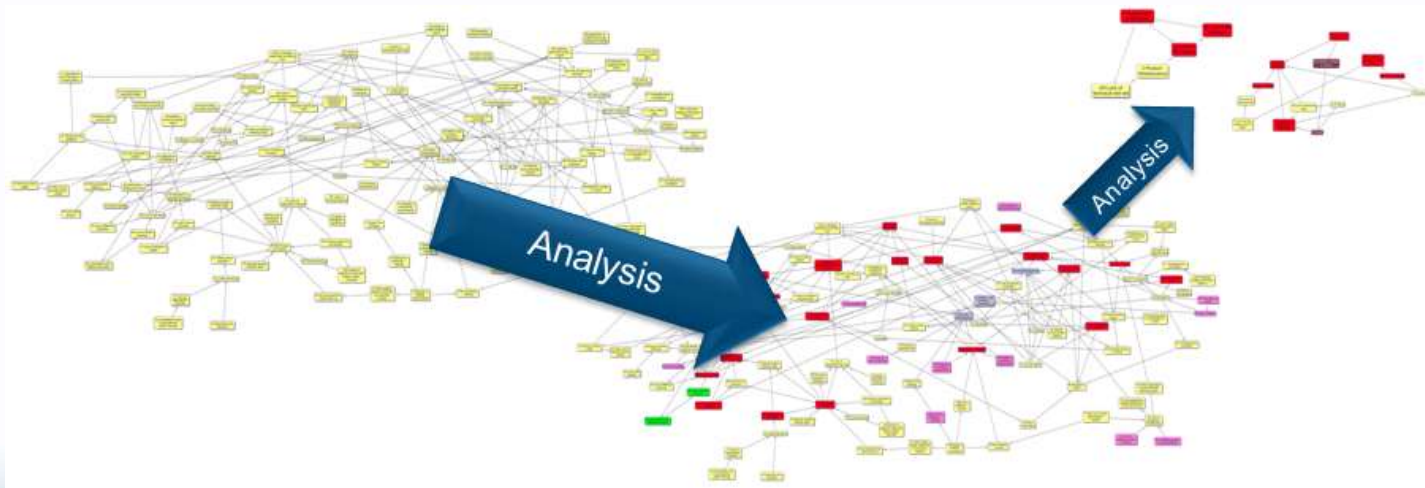
Concept analysis using automated word association



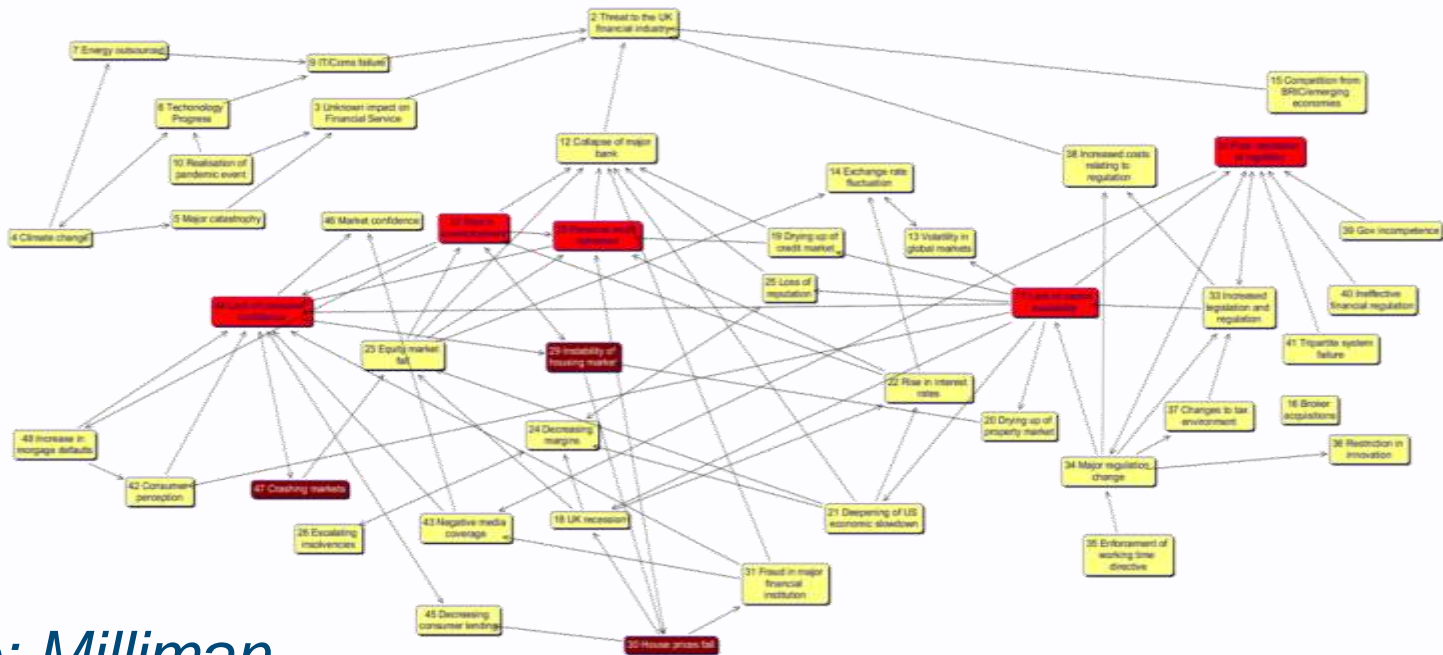
Word-Like	Count	Relevance
rail	24	100%
road	23	96%
assumptions	20	83%
pond	20	83%
market	20	83%
port	19	79%
price	19	79%
costs	18	75%
process	17	71%
design	14	58%
results	14	58%
water	10	42%
schedule	9	38%
review	7	29%
develop	7	29%
head	6	25%
identified	2	08%
risk	1	04%

Understanding The System

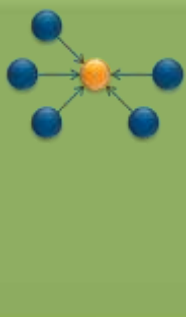
- Describing the risk exposure (i.e. the system) is essential
- Techniques developed to construct initial understanding of risk exposure in terms of:
 - Key risk concepts
 - Key risk drivers
 - Key dynamic areas of the exposure



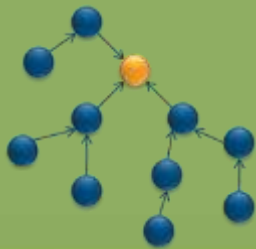
It's all in your head



Source: Milliman



Key Nodes

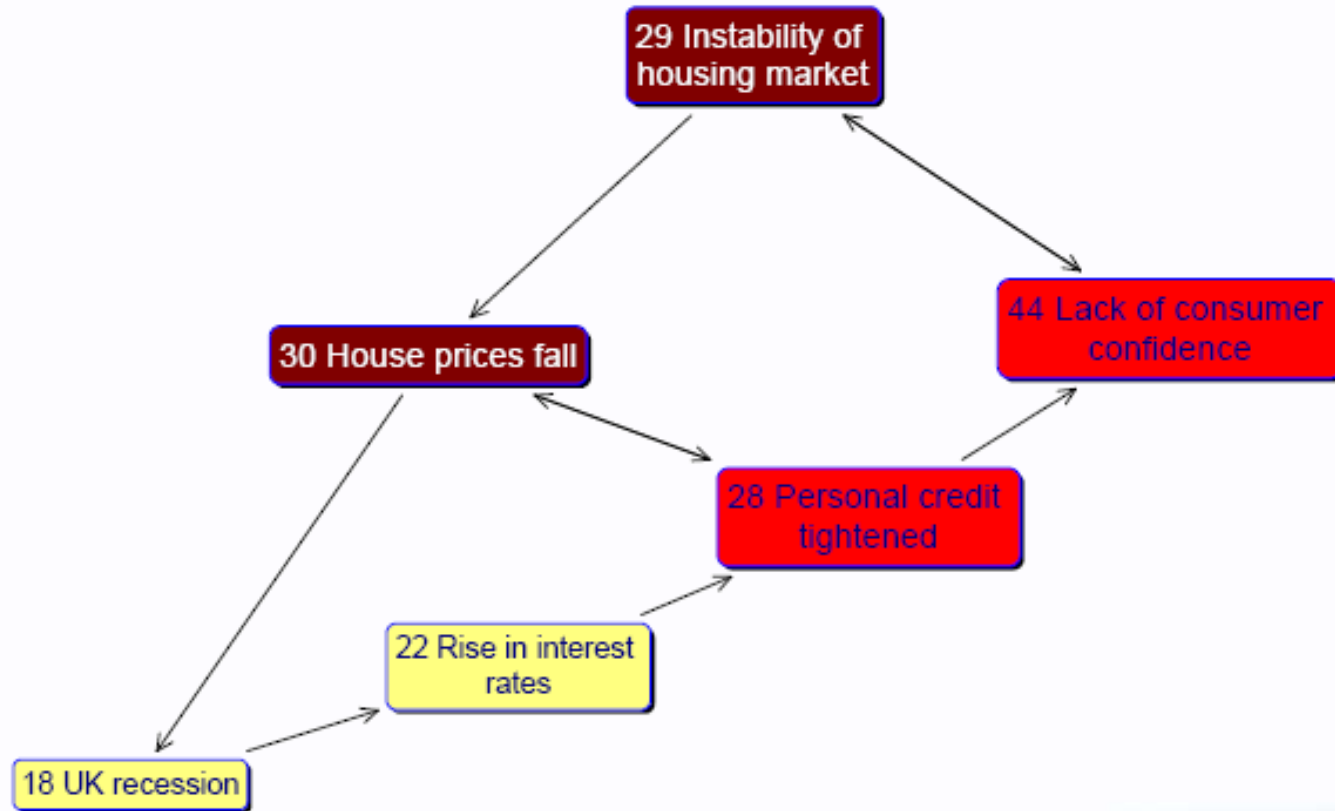


Key Drivers

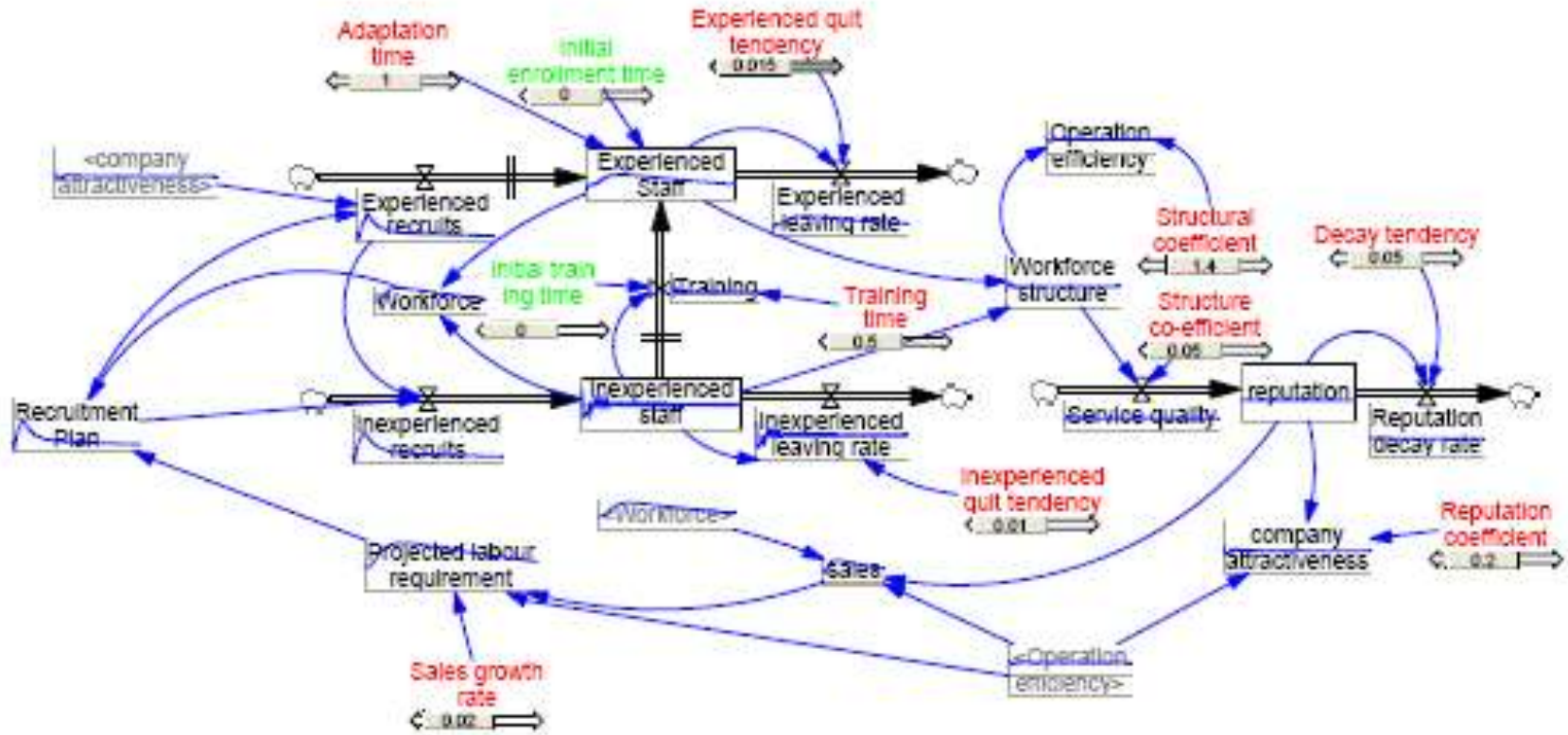


Gaps

Positive feedback loops– *Example*



Can Be Modelled With Systems Dynamics



Evolution is a signature of a complex system

RISK DNA ANALYSIS & EXAMPLE

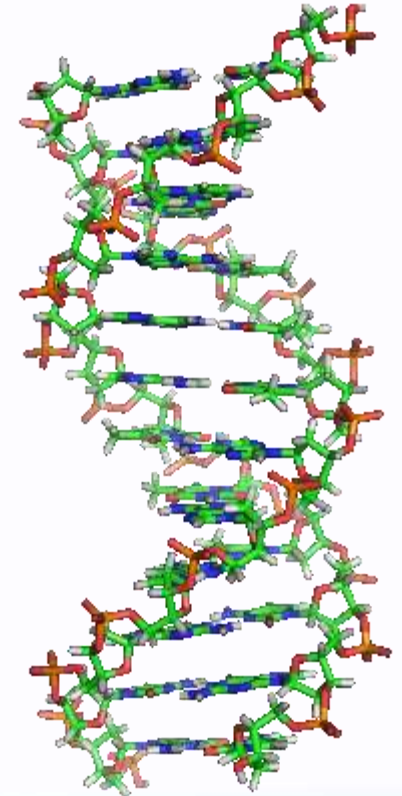
Overview

Evolutionary forces

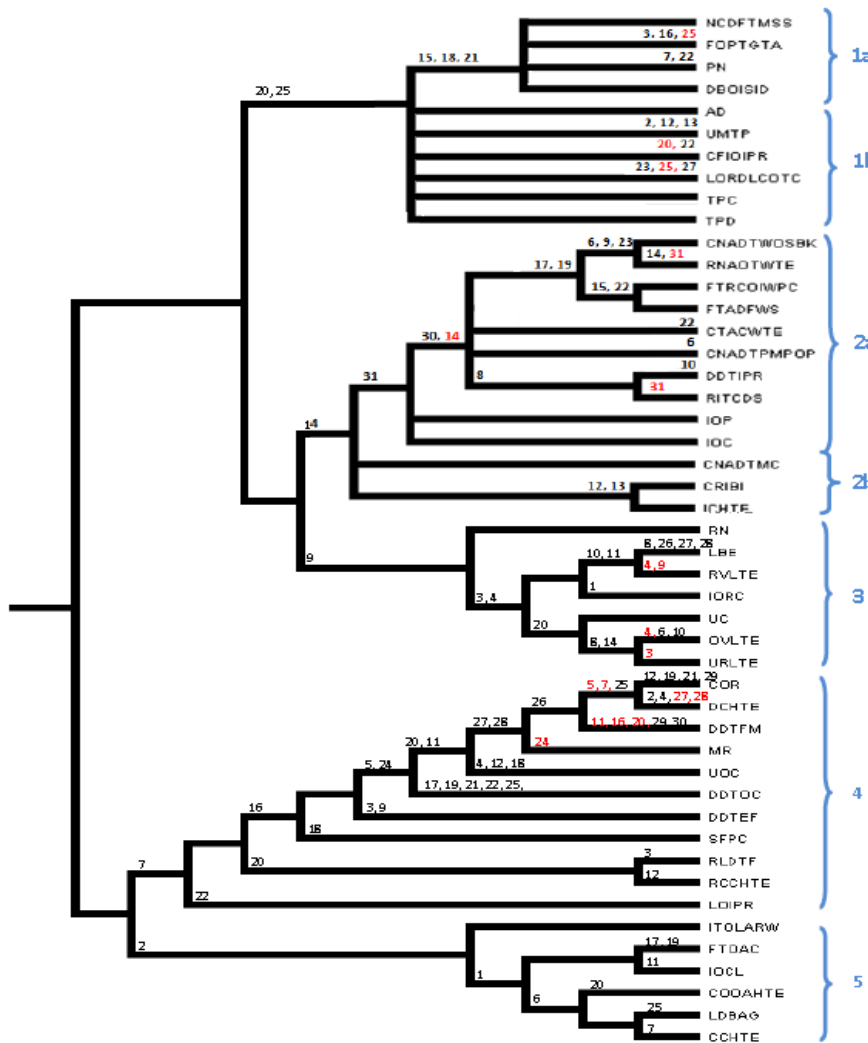
- History matters for complex adaptive systems
- Monitor their evolution
- Their “DNA” gives clues about the future
 - What are the common characteristics
 - Which characteristics combine easily
 - What might appear next



Use richer descriptions
of scenarios



Evolution of downside risks matrix (Ramp Appendix 3)



Defining characters: Poor Planning & control, Human error and incompetence

Risk: Failure to gain technical acceptance
Cost overruns

Defining characters: Extreme economic conditions

Risk: Capital not available
Emerging risk: Risk combines inadequate margins **and** unbalanced sharing of risks

Defining characters: Competition

Risk: Reduction in revenue
Emerging risk: Legislation **and** Terrorism

Defining characters: Crime, technical innovation

Risk: Labour relations, war & terrorism
Emerging risk : Professional negligence and compensation costs

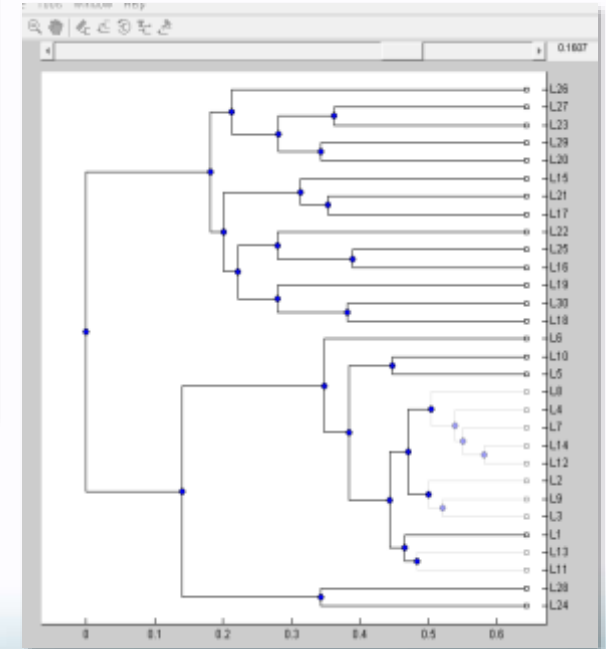
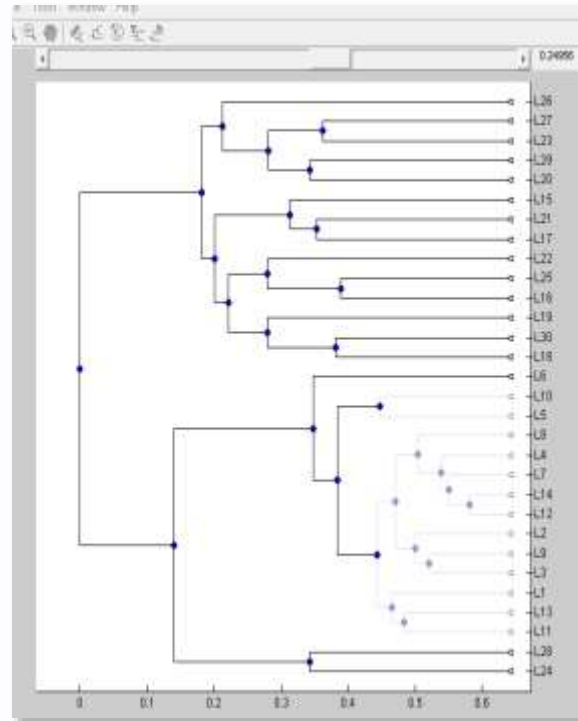
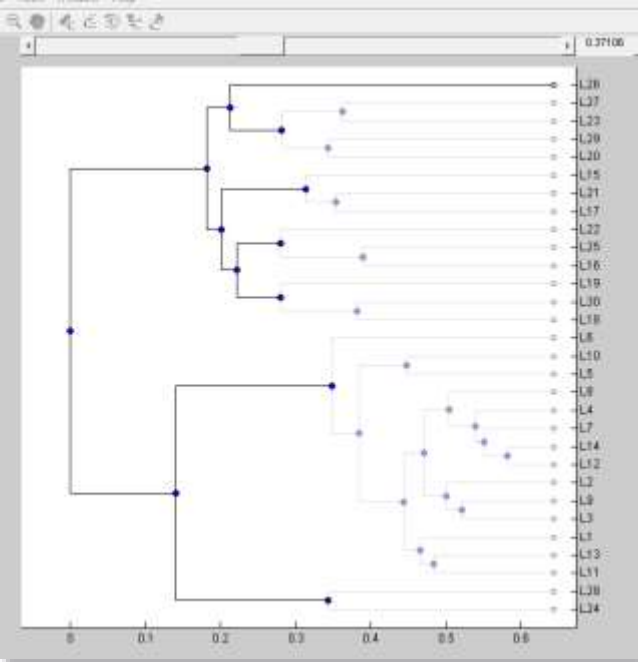
Defining characters: Public opinion & Gov.

Risk: Failure to obtain approvals/consents
Emerging risk : Addition of Gov to risk

Ramp Appendix 3 Downside risk matrix

	a) Government	b) Public opinion	c) Environmental change	d) Legislation	e) Wars, terrorism, riots	f) Poor public relations	g) Crime	a) Demand failure	b) Competition	c) Premature obsolescence	d) Safety standards	a) Cost inflation/interest rates	b) Currency fluctuations	c) Extreme economic conditions	a) Lack of definition	b) Technical innovation	c) Lack of leadership	d) Lack of technical competence	e) Lack of commitment	f) Poor planning and control	g) Inadequate resourcing of project	h) Inadequate legal framework	i) Inadequate progress on project	j) Labour relations	k) Human error or incompetence	l) Earthquake/volcanic eruption	m) Fire or explosion	n) Adverse ground conditions	o) Inadequate financial margins	p) Imbalanced sharing of risk	
Promotion of concept																															
loss of intellectual property rights							1																1								
claims for infringement of intellectual property rights																							1								
Design																															
non compliant design (failure to meet specified standards)																1		1			1	1				1					
design based on inadequate site investigation data																1		1			1	1				1					
professional negligence							1									1		1			1	1				1					
Contract negotiations																															
failure to agree development framework with sponsor																1		1			1	1								1	
failure to resolve conflicts of interest within promoting consortium																1		1			1	1								1	
contractual terms and conditions worse than expected																							1								
Project approval																															
failure to obtain approval/consents	1	1																1			1										
long delay before approval granted	1	1				1																									
unforeseen modifications to project													1	1								1				1					
cost of obtaining approval higher than expected																															
inclusion of contingent liabilities (e.g. environmental clean up)																							1								
introduction of regulatory controls (fares, competition policy)	1	1	1	1						1																					
4. Asset creation																															
Raising of capital																															
capital requirements increased by inflation													1	1	1																
interest costs higher than expected													1	1	1																
capital not available due to market conditions																1															
capital not available due to poor market perceptions of project									1																						
capital not available due to withdrawal of support by key organisations																		1						1						1	
refinancing not available or terms worse than expected																		1						1						1	
default due to insufficient project revenue																		1												1	
default due to external factors			1		1			1	1								1														
Construction																															
inability to obtain land, access right, wayleaves			1																												
compensation costs higher than expected	1	1					1																								
delays due to force majeure						1																									
delays due to other causes (e.g. unforeseen ground conditions)							1																								
cost over-runs												1	1																		
insolvency of promoter																															
insolvency of contractor																															
third party damages																															
failure of project to gain technical acceptance				1																											
structural failure post completion																															
5. Operation																															
Expenses and maintenance																															
unforeseen operating costs																															
major repairs																															
third party claims																															
accident damage																															
Revenue																															
operating volume less than expected																															
unit revenues lower than expected																															
unforeseen competition																															
revenue collection costs higher than expected																															
revenues negotiable (influence of large customers)																															
loss of revenue due to late completion or temporary closure																															
revenue insufficient to cover debt servicing																															
revenue loss due to fraud																															
6. Close-down																															
lifetime below expectations																															
residual value less than expected																															
dismantling costs higher than expected																															

Evolution of risk over time



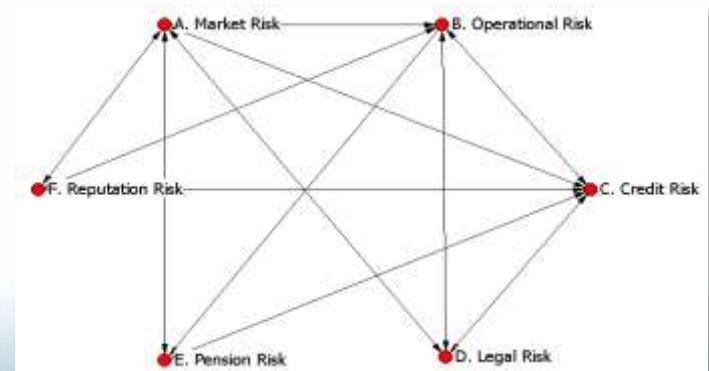
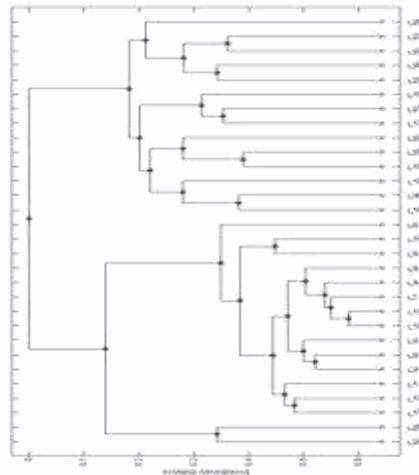
Connectivity Matrix

Connectivity derived from

Risk Factor	Impact (I)	Likelihood (L)	Expectation (I×L)
A. Market Risk	0.80	0.80	0.64
B. Operational Risk	0.50	0.40	0.20
C. Credit Risk	0.80	0.50	0.40
D. Legal Risk	0.20	0.10	0.02
E. Pension Risk	0.20	0.10	0.02
F. Reputation Risk	0.80	0.05	0.04



	A	B	C	D	E	F
A	1	1	0.8	0.8	0.2	0.8
B	0.5	1	0.5	0.8	0.5	1
C	0.8	0.8	1	0.8	0.5	0.2
D	0.2	0.2	0.5	1	0.05	0.8
E	0.05	0.2	0.1	0.1	1	0.2
F	0.5	0.05	0.2	0.05	0.05	1





Welcome: Admin

Last login time:14/06/2010 14:08:18

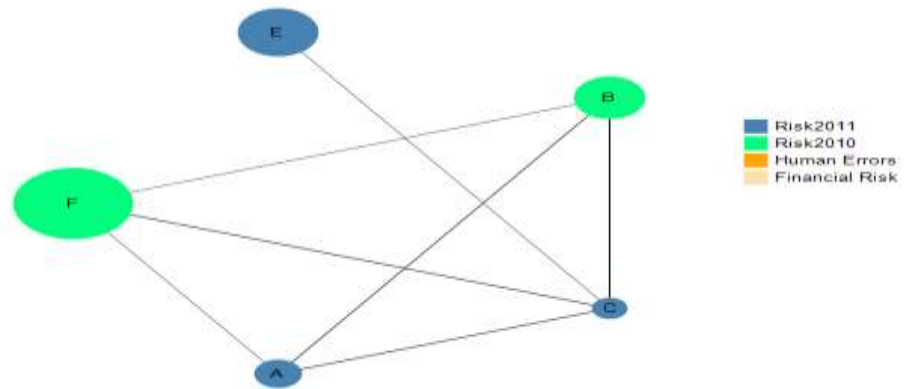
[Logout](#)

- ▶ General Information
- ▶ Risk Information
- ▶ Assessment
- ▶ Connectivity Evaluation
- ▶ Potency Assessment
Evaluates the strength of influence of key risks!
- ▶ Risk Analysis
- ▶ Query
- ▶ Generate Report
- ▶ Basic Information
- ▶ System Administration

Potency Analysis (Normalisation Value)

Name	F	E	B	C	A
F	0.0705	0.0580	0.1249	0.1443	0.0939
E	0.0816	0.0491	0.1160	0.1354	0.0850
B	0.1492	0.1367	0.2036	0.2230	0.1726
C	0.2070	0.1945	0.2614	0.2808	0.2304
A	0.1428	0.1303	0.1972	0.2166	0.1662

Save

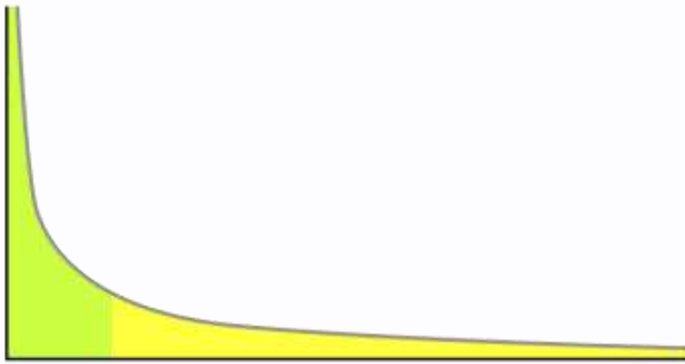


Risk = Likelihood x Consequence x Connectivity

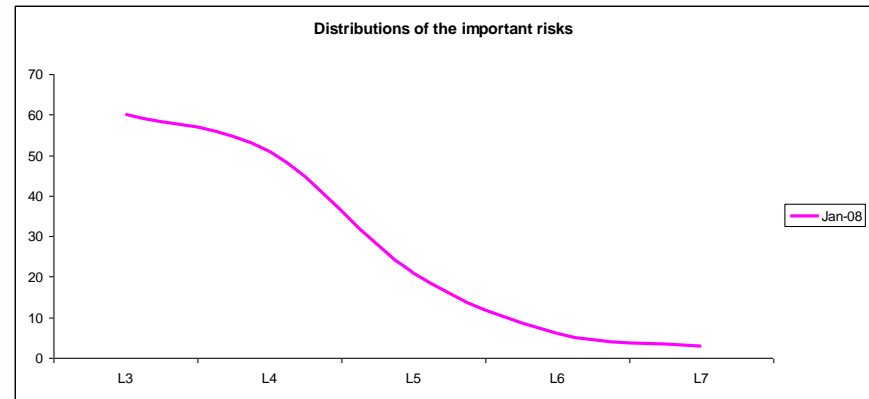
C9.3	█ is unable to cope with the increase in procurement once the decision is made to commence drilling.	Probability	(E) Ramp-up Delay	Level 5	↑↑	7
C9.4	The ability to purchase any non-standard equipment is limited by procurement process.	Probability	(N) Reputation	Level 5	↑↑	7
D5.6	A rail contract is not finalised in time for approval in May 08.	Probability	(E) Pre-appro Delay	Level 6	↑	7
D5.7	█ fails to agree a contract with █ because of a perceived need to have all operational details agreed in advance.		(E) Pre-appro Delay	Level 6	↑	7
E1.10	█ fails to secure its total gas needs under acceptable contracts before █	Probability	(E) Pre-appro Delay	Level 6	↑	7
E1.11	Delays in securing a gas supply delays negotiations with the gas transport entities.	Probability	(E) Pre-appro Delay	Level 6	↑	7
E5.3	The passing of a provincial law required for the use of the █ on a public road takes longer than anticipated.	Probability	(E) Pre-appro Delay	Level 6	↑	7

Power Laws

- Power law can be widely found in both social and natural settings. In principle, the power law indicates an exponential relationship between two variables. Or in other words, the two variables are log-linearly related.
- After observing the number of important risks (L3 and onwards), it has been found that these numbers are not normally distributed. Instead, a power law distribution can better describe the phenomenon. Here is the evidence.



A plot of typical power law distribution



A distribution of risks in a risk register

Recap

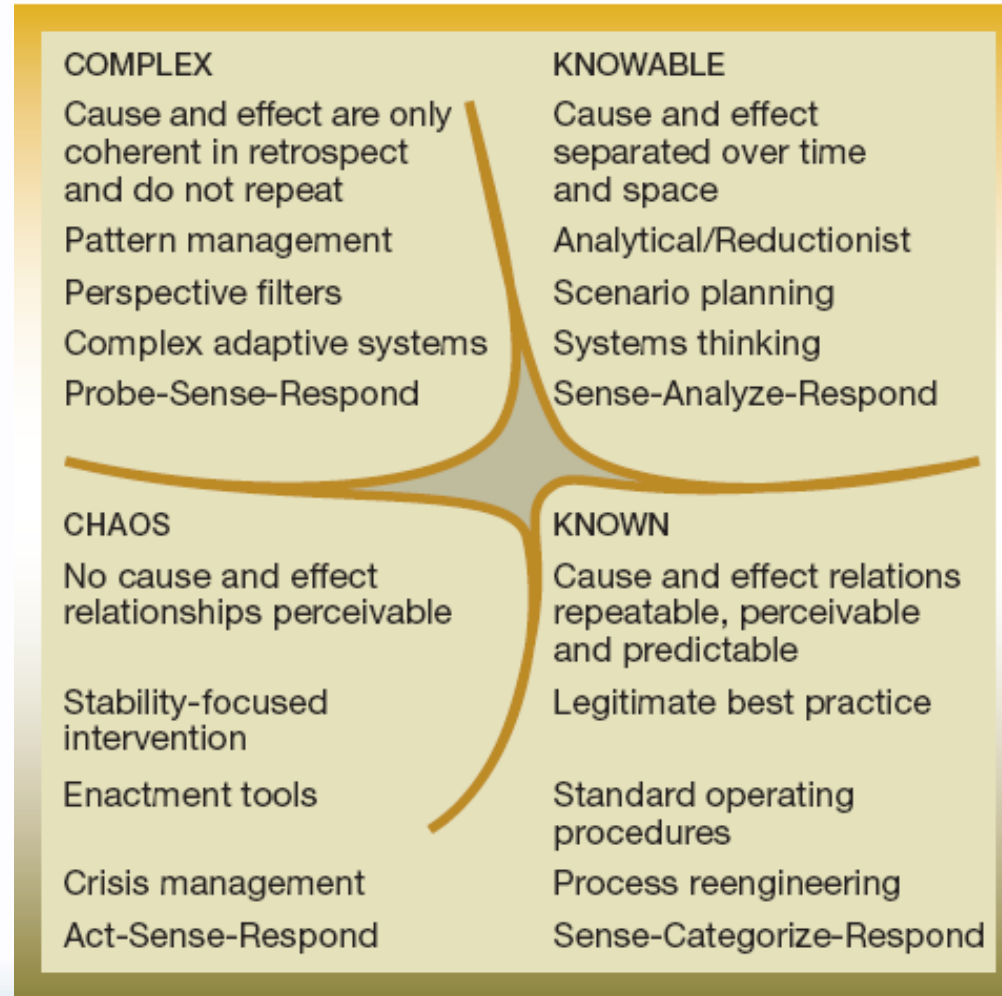
- Complex adaptive systems give out early warning signals
- Using the right tools you can spot them
- Interactions are the important part
- Early warnings are possible
- Don't throw away information – look for patterns
- Try not to guess what is going on before you look at the data
- Evolution is informative

Discussion / Questions



Cynefin framework

- What Rumsfeld meant...
- Consider different domains
- Typical methods OK for “known” and “knowable”
- Very poor at “complex”
- “Chaos” is about crisis management – survival!



Kurtz and Snowden 2003