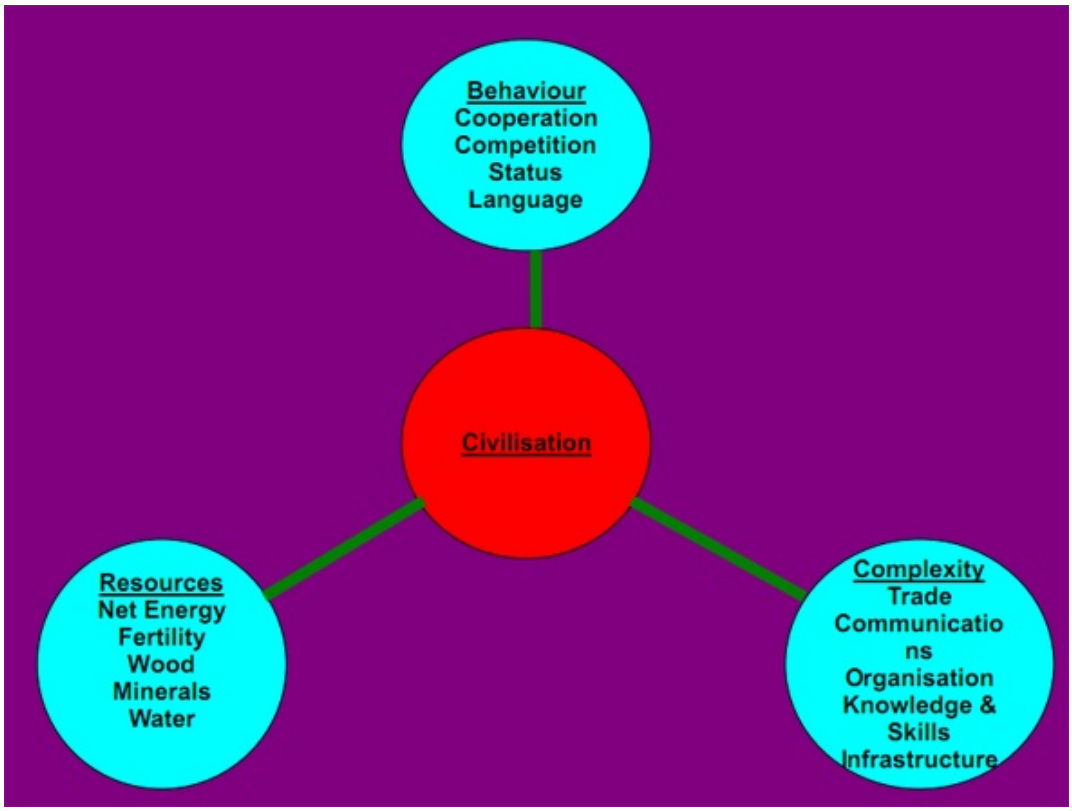
The Oil Drum: Europe
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Turning and turning in the widening gyre
The falcon cannot hear the falconer:
Things fall apart: the centre cannot hold:
Mere anarchy is loosed upon the world

from The Second Comming
W B Yeats

16 Thousand Years: What's Changed?

Lascaux cave complex SW France


Behaviour
Cooperation
Competition
Status
Language
Civilisation
Resources
Net Energy
Fertility
Wood
Minerals
Water
Complexity
Trade
Communicatio
ns
Organisation
Knowledge &
Skills
Infrastructure

Thermodynamics of Civilisation

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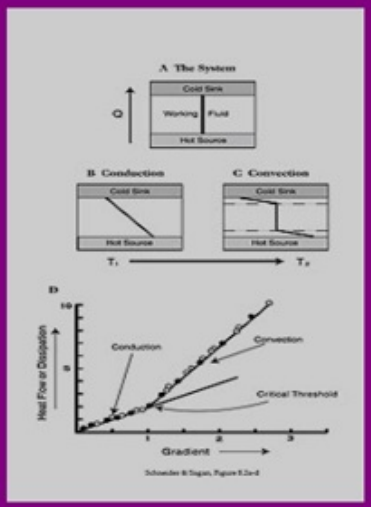
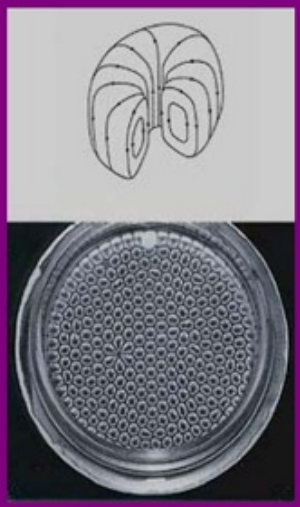
Far from equilibrium thermodynamics & Bernard cells

- Flow of free energy allows structure to form.
- Locally, entropy is reduced. Globally entropy increases.
- Thermodynamic properties: phase transitions; MEP; sensitive dependence on initial conditions

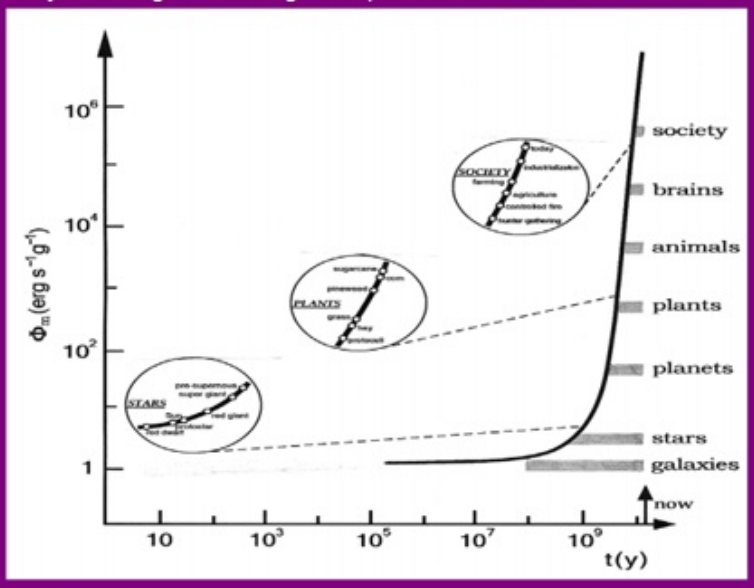




(Pictures: www.intothecool.com)

Energy Rate Density: A Cosmic View

- Trend of greater complexity with evolving sources of free energy
- Complexity is not a goal- teleological explanations not valid



(Chaisson, Eric. *Cosmic Evolution: The rise of Complexity in Nature*, 2002)

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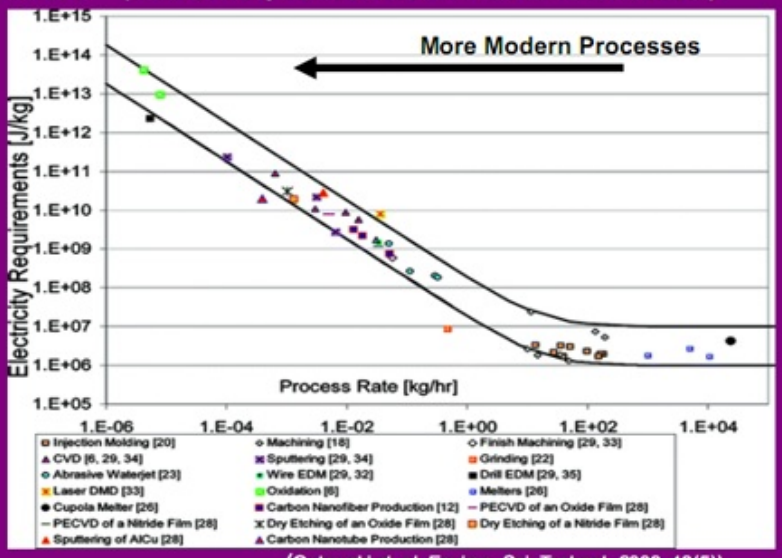
Resources used in manufacturing process

- Growing complexity of modern processes.
- Semiconductor technologies most obvious example.
- 2g 32MB DRAM chip requires 1700 g input. Silicon wafers from quartz uses 160 times energy for normal silicon. (Williams, E.D., Ayres, R.U., Heller, M. *Environ. Sci. Technol.* 2002, 36)



(Gutowski *et. al. Environ. Sci. Technol.*, 2009, 43(5))

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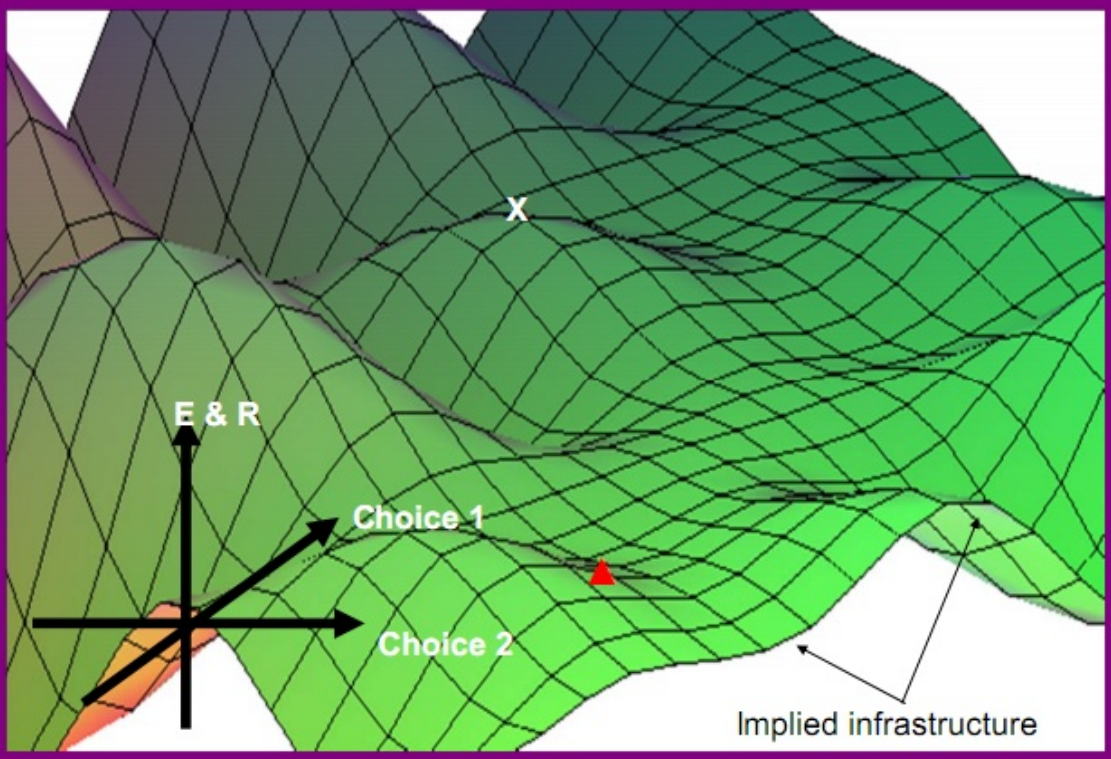
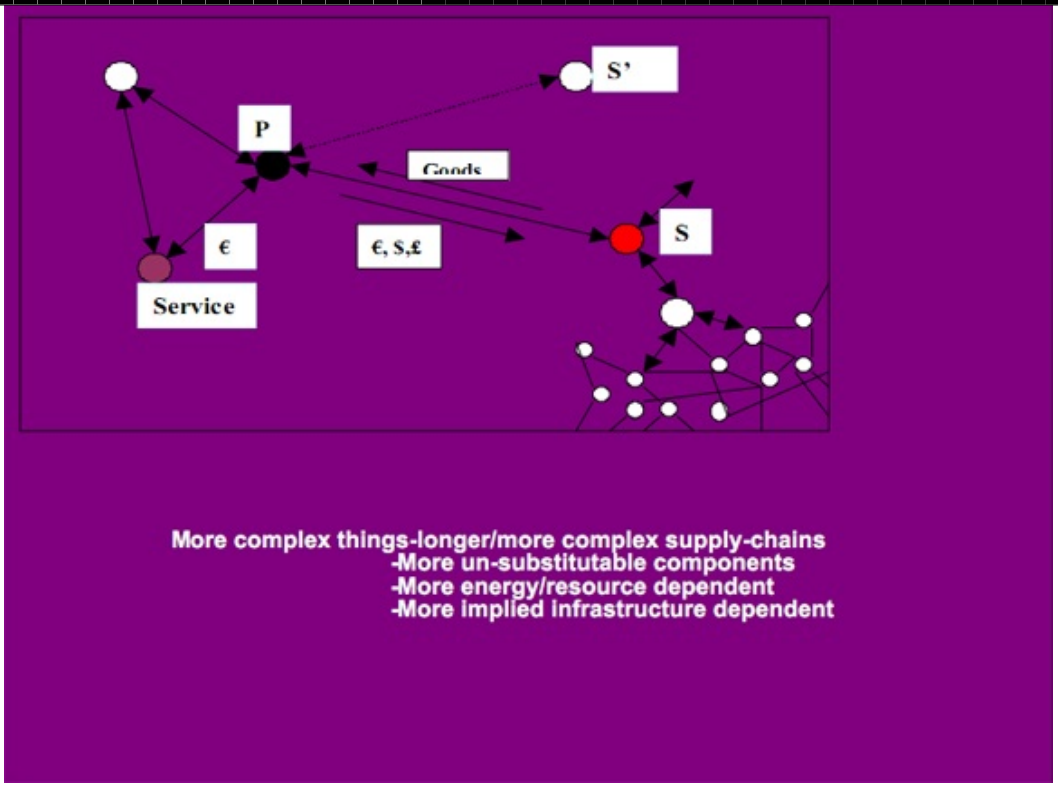
Evolution of Complexity

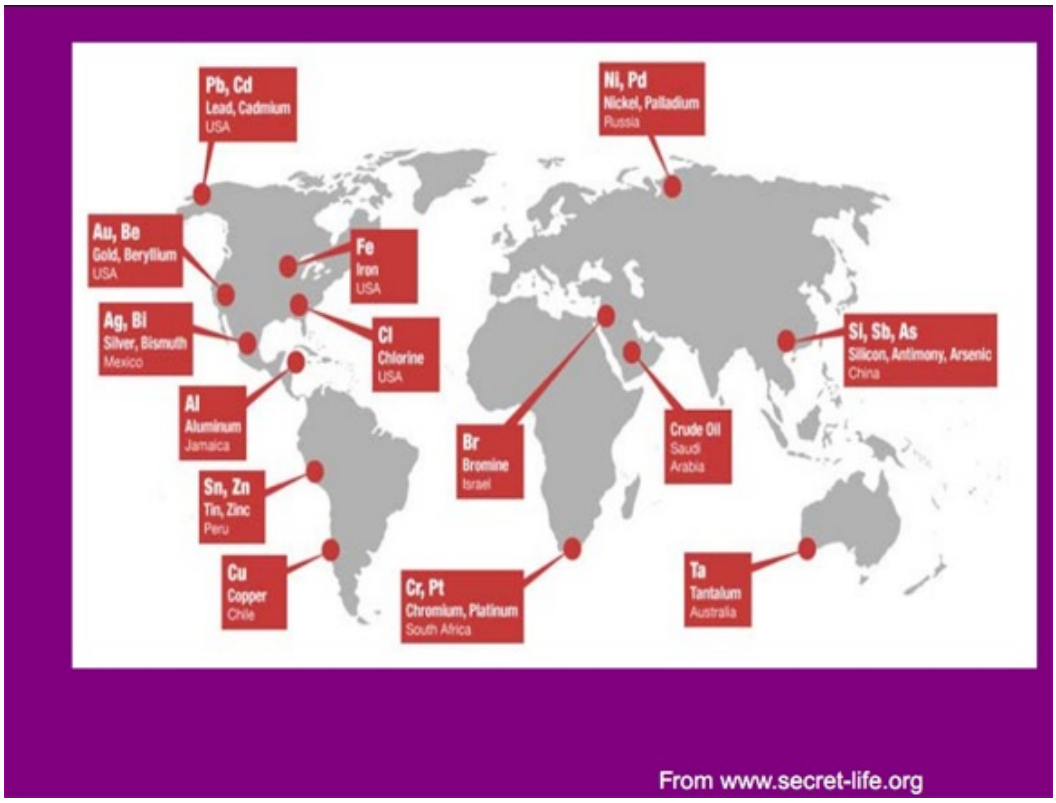
- Problem solving-constrained by social, cultural attitudes & structures, implied infrastructure, and resource availability
- Easiest problems/ lowest cost first
- Sub-systems become more interdependent: Can help to manage risk
- As new technologies/ business models emerge, adoption and spread through wider networks dependent upon efficiencies they provide, lower costs, new markets
- New technology and system to which it is introduced co-adapt & co-evolve
- Efficiency gain by letting individual parts of system share transaction costs by integrating common platforms such as IT networks, financial systems, and supply chains
- Growing complexity provides basis for solving more complex problems
- Declining Marginal Returns: Civilisation; EROEI; Material Resources; R&D;Agricultural Productivity
- Lost resilience, can no longer adapt to perturbations (Tainter)

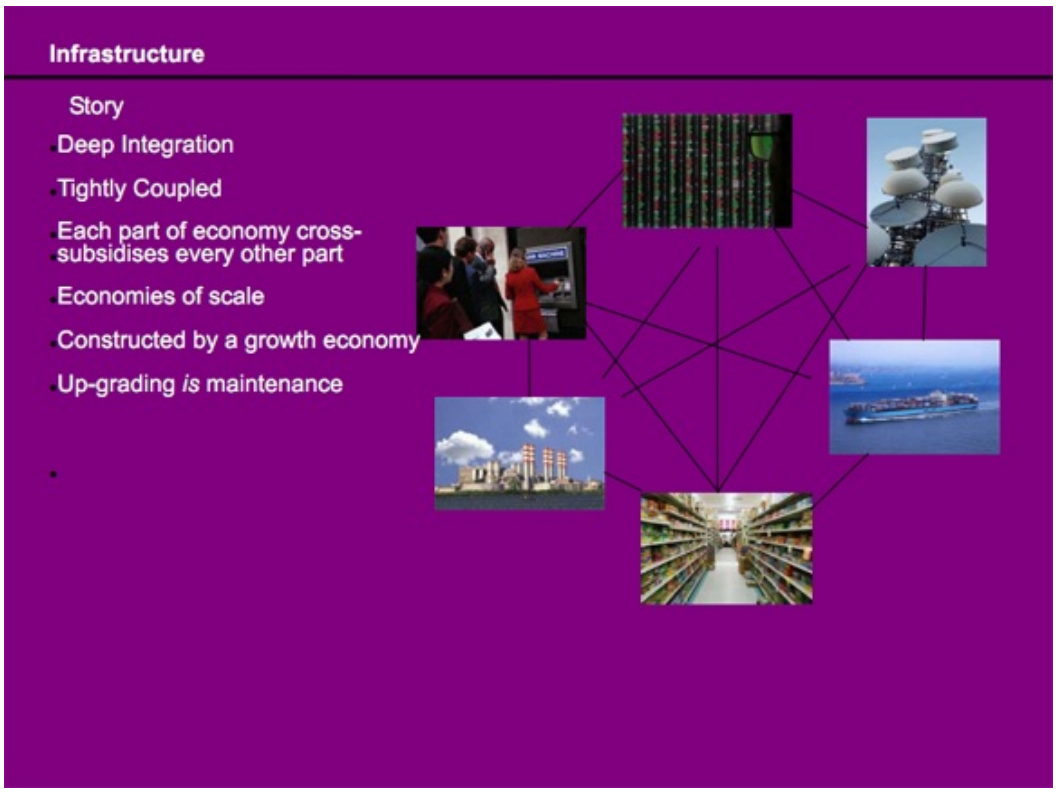
Analogy: An adaptive landscape for a choice, at a time




Supply-Chains & Infrastructure


S'
P
Goods
€
€, $,£
S
Service
More complex things-longer/more complex supply-chains
-More un-substitutable components
-More energy/resource dependent
-More implied infrastructure dependent


Pb, Cd
Lead, Cadmium
USA
Ni, Pd
Nickel, Palladium
Russia
Au, Be
Gold, Beryllium
USA
Fe
Iron
USA
Ag, Bi
Silver, Bismuth
Mexico
Cl
Chlorine
USA
Si, Sb, As
Silicon, Antimony, Arsenic
China
Al
Aluminum
Jamaica
Br
Bromine
Israel
Crude Oil
Saudi
Arabia
Sn, Zn
Tin, Zinc
Peru
Cu
Copper
Chile
Cr, Pt
Chromium, Platinum
South Africa
Ta
Tantalum
Australia
From www.secret-life.org

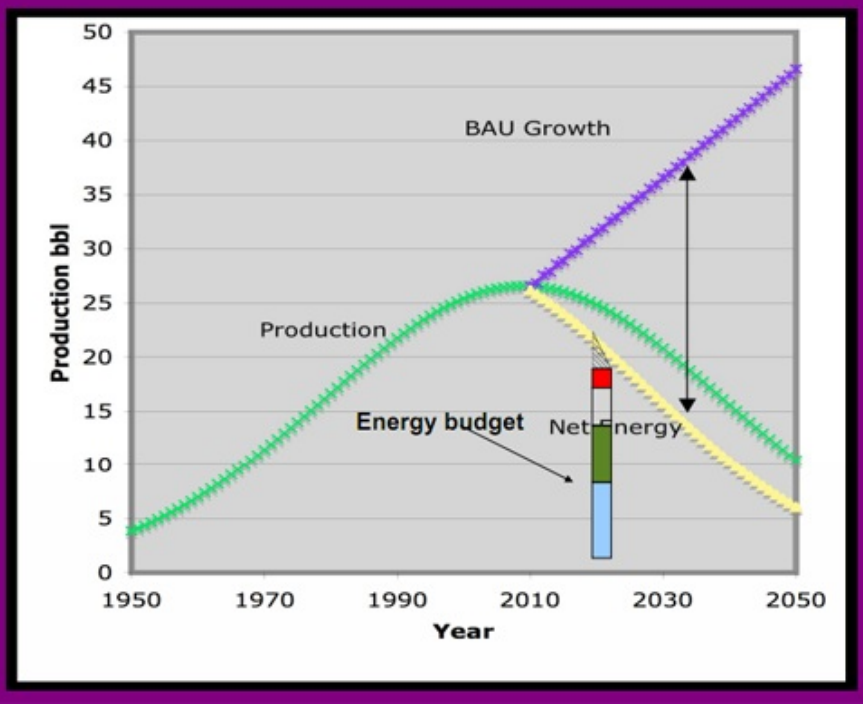

Infrastructure
Story
Deep Integration
Tightly Coupled
Each part of economy cross-subsidises every other part
Economies of scale
Constructed by a growth economy
Up-grading *is* maintenance

Collapse

A sudden decrease in complexity

OR

A phase transition, driven by a series of mutually re-enforcing positive feedbacks


50
45
40
35
30
25
20
15
10
5
0
Production bbl
BAU Growth
Production
Energy budget
Net Energy
1950
1970
1990
2010
2030
2050
Year

[redacted]

[redacted]

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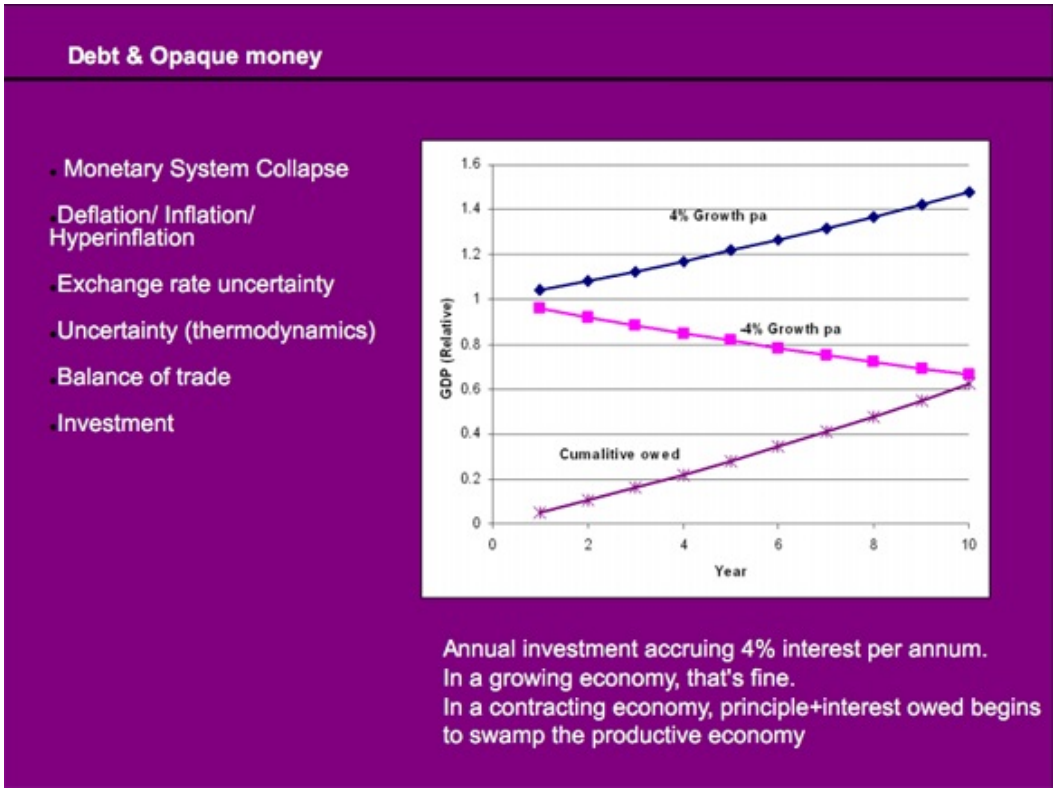

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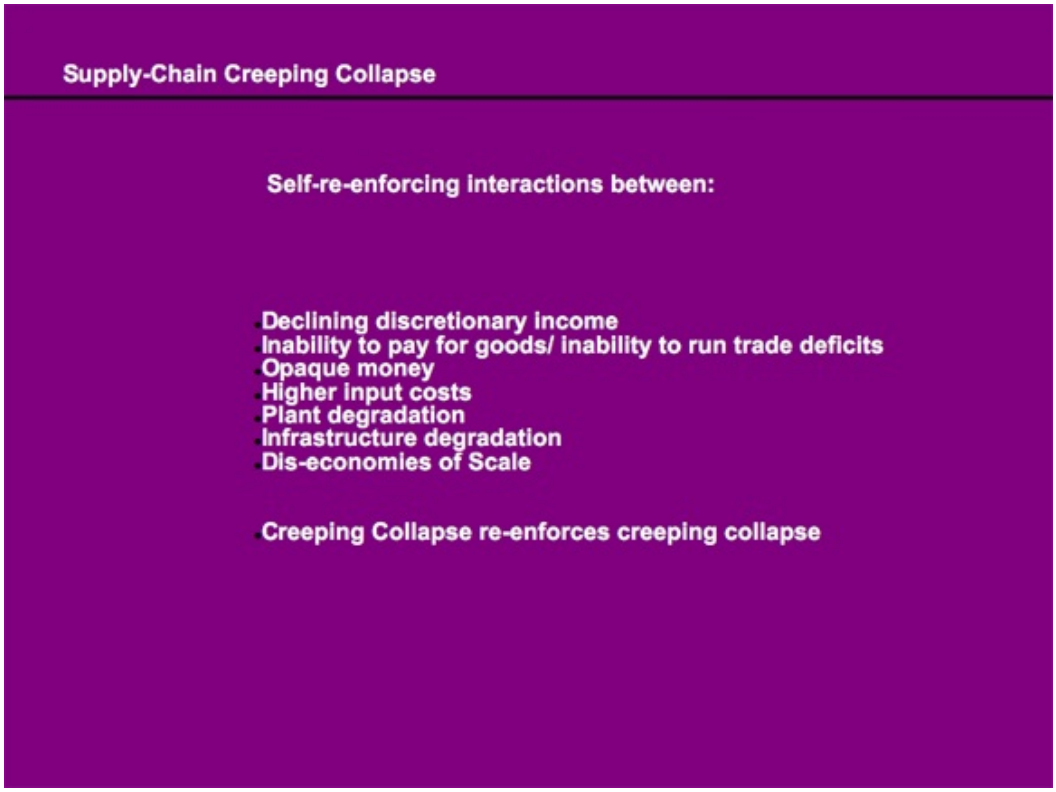
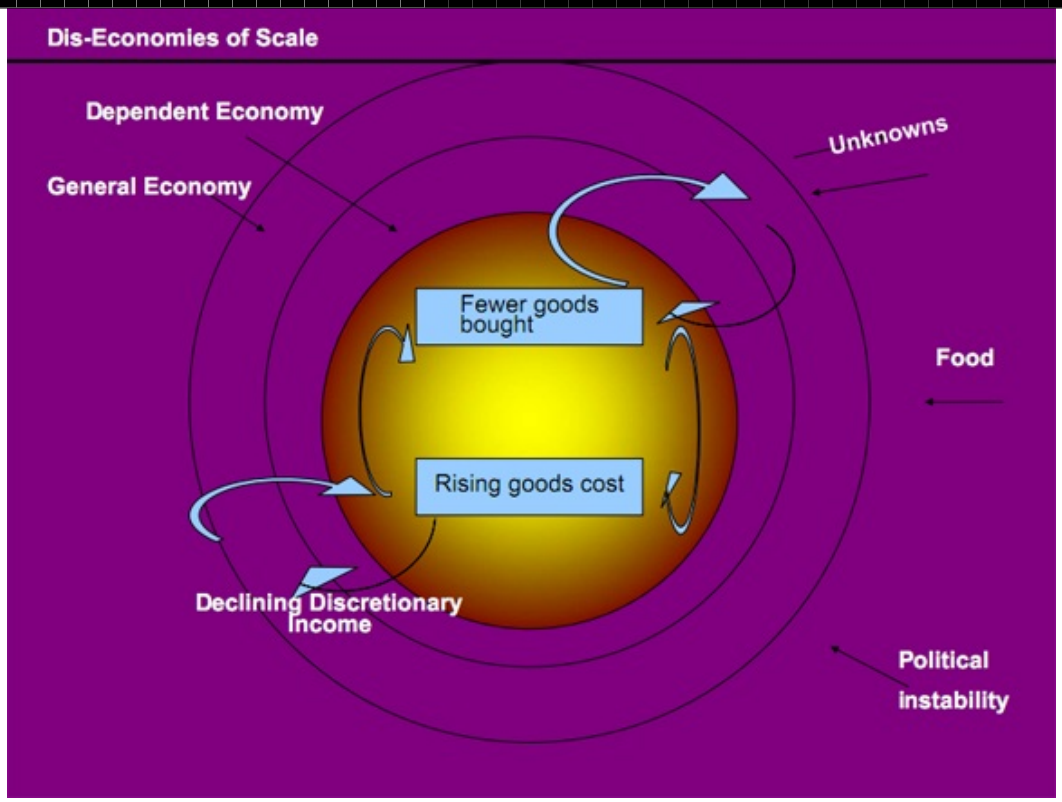

Supply-Chain Creeping Collapse
Self-re-enforcing interactions between:
Declining discretionary income
Inability to pay for goods/ inability to run trade deficits
Opaque money
Higher input costs
Plant degradation
Infrastructure degradation
Dis-economies of Scale
Creeping Collapse re-enforces creeping collapse


Dis-Economies of Scale
Dependent Economy
General Economy
Unknowns
Fewer goods bought
Food
Rising goods cost
Declining Discretionary Income
Political instability

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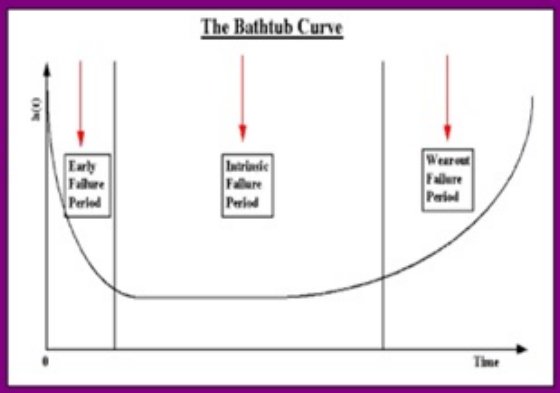
Infrastructure Creeping Collapse

- Tightly Coupled
- Complex resource intensive supply chains
- Expensive to maintain
- Highly cross-subsidised
- Economic stress
- Supply-chain creeping collapse
- Short-component lifetimes
- Complexity and interconnected make cascading failure hard to predict



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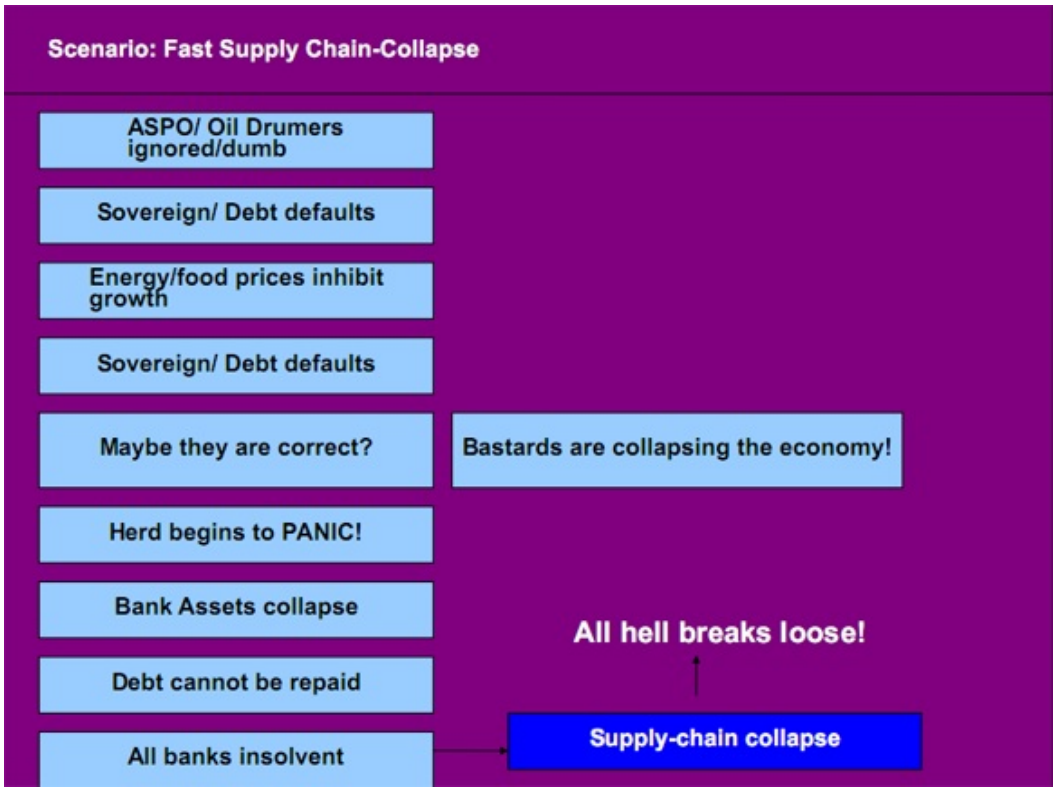
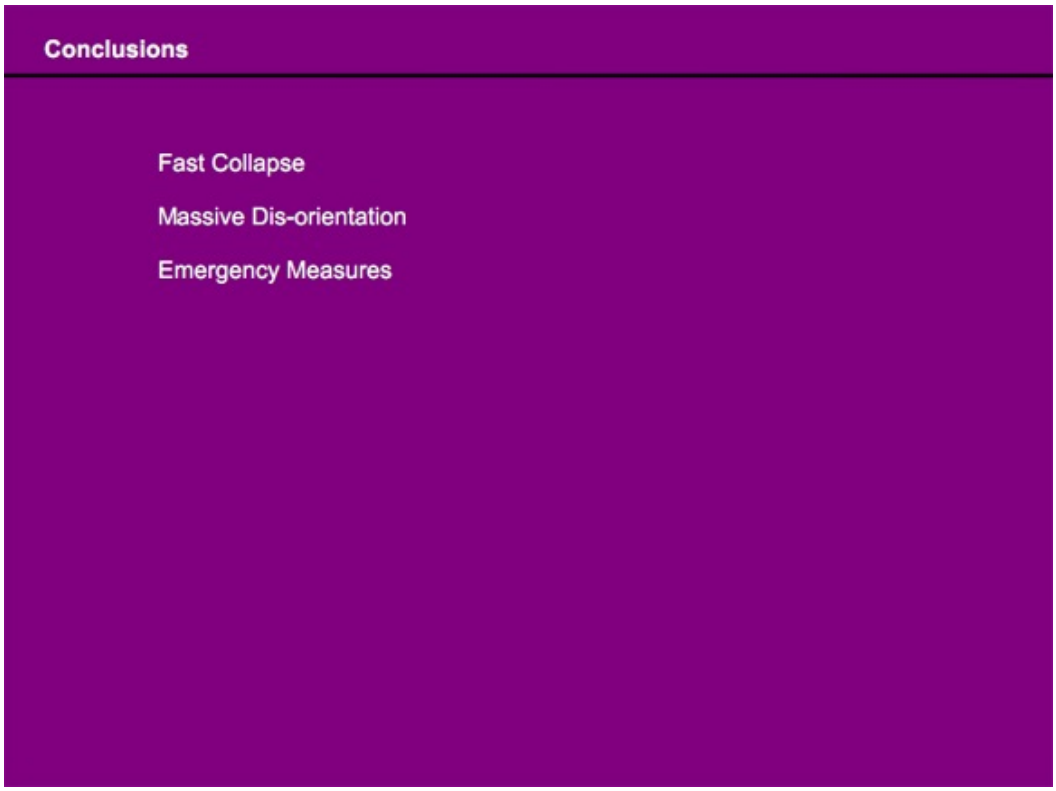

Scenario: Fast Supply Chain-Collapse
ASPO/ Oil Drumers ignored/dumb
Sovereign/ Debt defaults
Energy/food prices inhibit growth
Sovereign/ Debt defaults
Maybe they are correct?
Bastards are collapsing the economy!
Herd begins to PANIC!
Bank Assets collapse
All hell breaks loose!
Debt cannot be repaid
All banks insolvent
Supply-chain collapse


Conclusions
Fast Collapse
Massive Dis-orientation
Emergency Measures