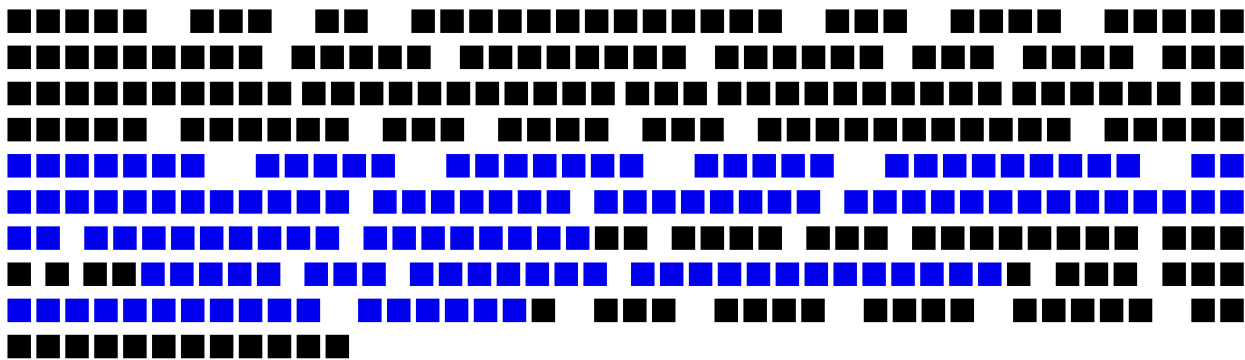
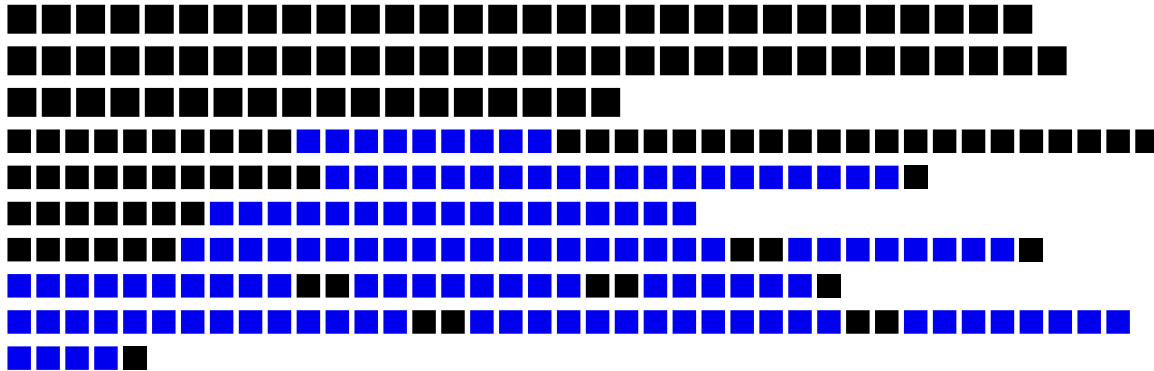


The Oil Drum: Europe

DISCUSSIONS ABOUT ENERGY AND OUR FUTURE



Things Fall Apart

Some thoughts on complexity, supply chains, infrastructure & collapse dynamics

David Korowicz
Feasta
The Foundation for the Economics of Sustainability

ASPO/The Oil Drum Peak Summit
Alcatraz, Italy
28th June 2009



*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 Coming
W B Yeats*

16 Thousand Years: What's Changed?

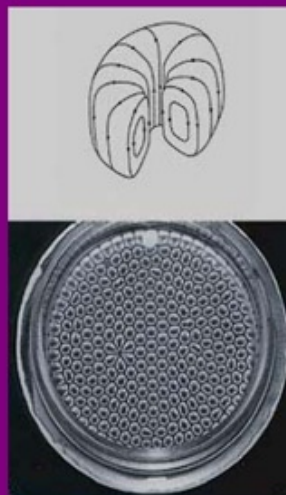
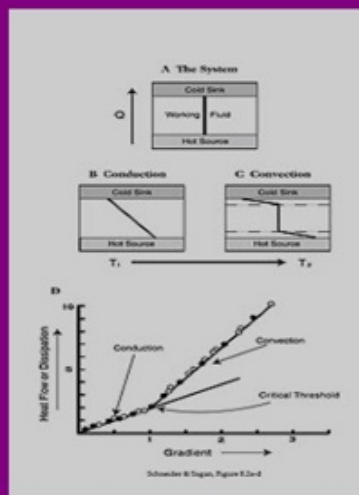


Lascaux cave complex SW France

Thermodynamics of Civilisation

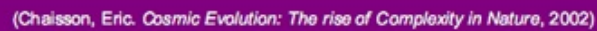
Far from equilibrium thermodynamics & Bernard cells

- 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)

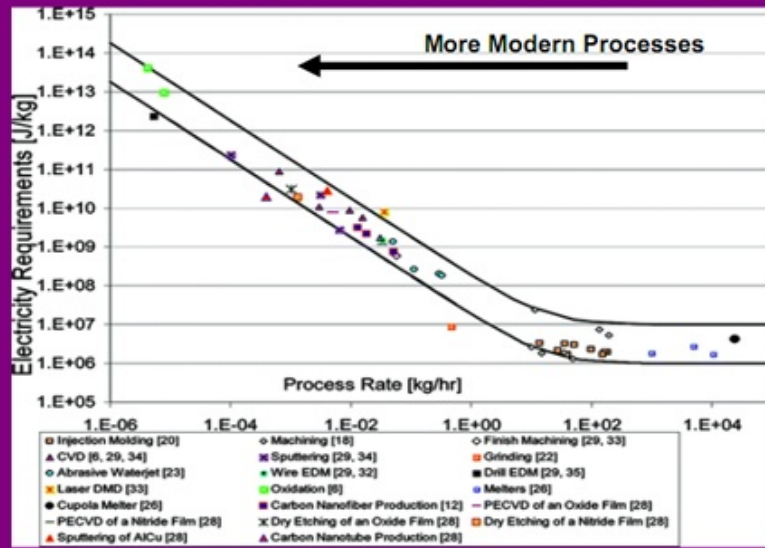
- Trend of greater complexity with evolving sources of free energy
- Complexity is not a goal- teleological explanations not valid

[illegible][illegible]

1. The first step in the process of creating a new product is to identify a market need. This involves conducting market research to understand what customers want and what problems they are facing. Once a need is identified, the next step is to develop a concept that addresses this need. This is often done through brainstorming sessions and the creation of a prototype. The concept is then refined through further research and development, leading to the creation of a detailed design. This design is then used to create a new product, which is then tested and refined before being launched into the market.

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))

Complexity & the Global Economy

Complexity

Number and depth of interactions; product number; product complexity; institutional complexity

Self-Organising

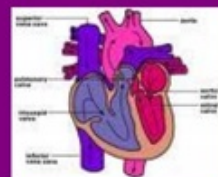
The Blind Watchmaker; local control- globally uncontrollable

Supply-Chains

Resource allocation and distribution; information processing;
& infrastructure maintenance

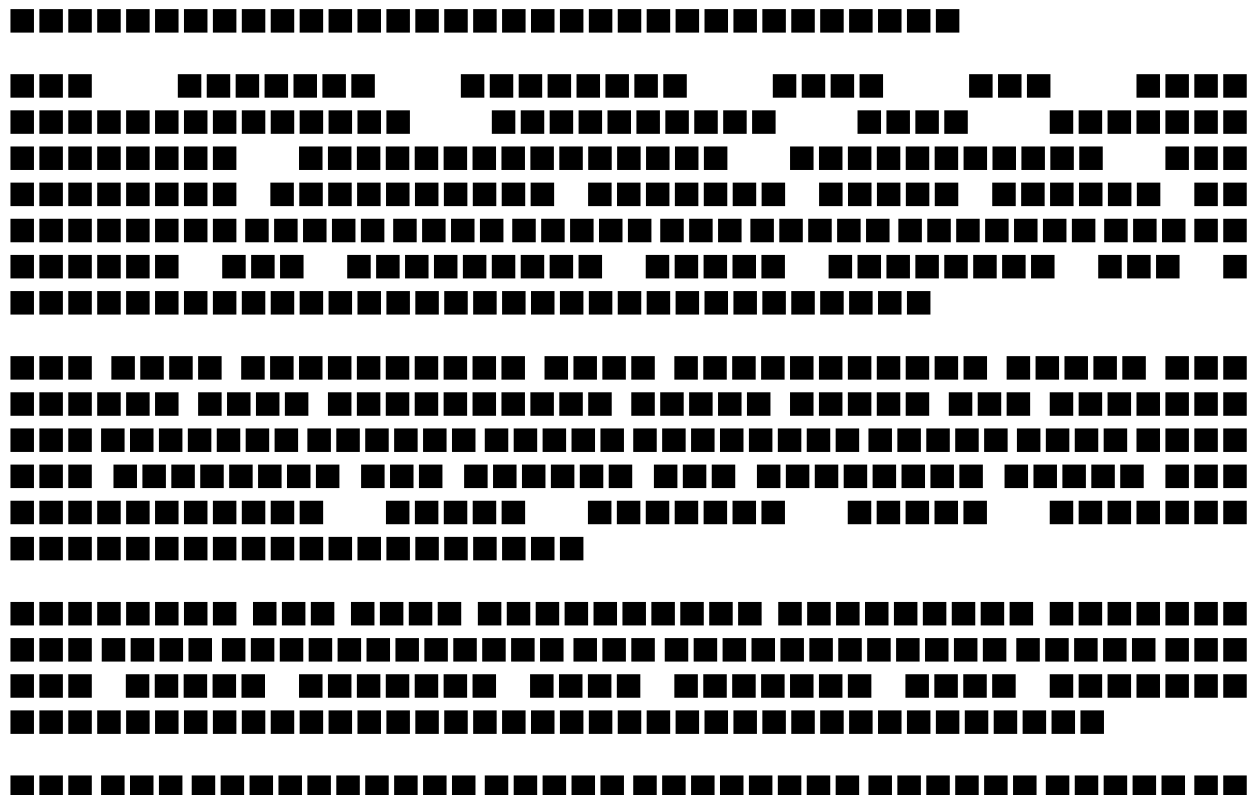
Growth Tendency in a Finite World

Problem solving is resource intensive; $I = P \times A \times T$

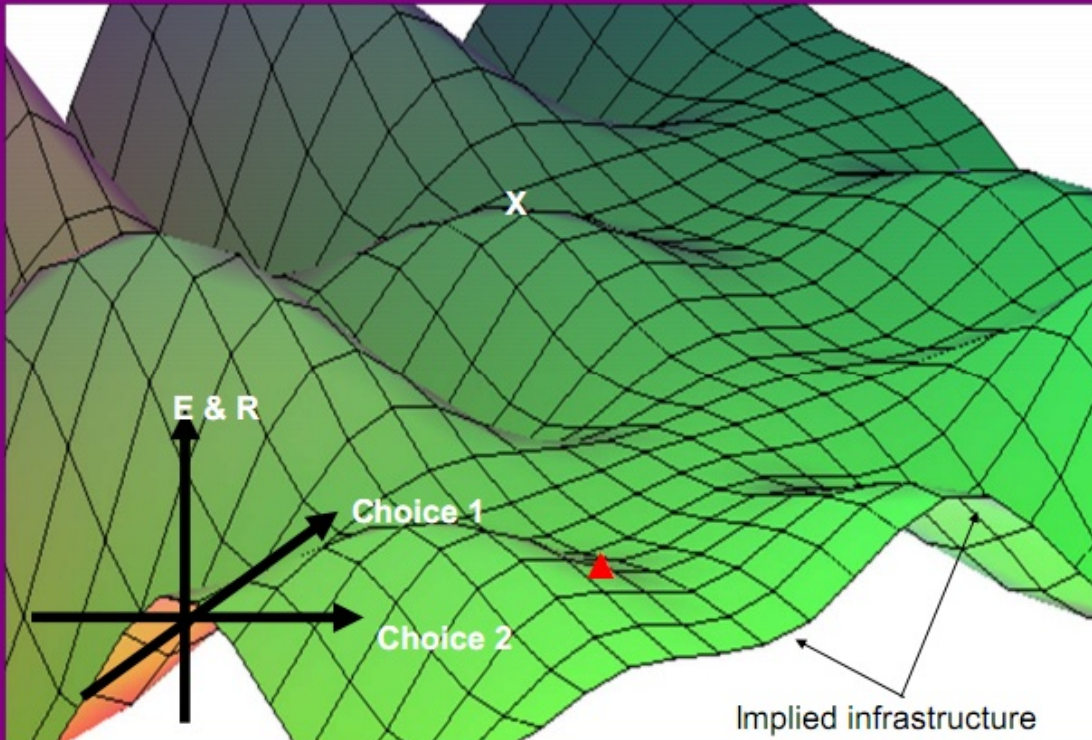


Evolution of Complexity

- 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

[illegible][illegible][illegible]

Supply-chain management is the management of the flow of goods and services, from the raw materials to the final product. It involves the coordination of all activities involved in the production and distribution of goods and services, from the selection of suppliers to the delivery of the final product to the customer. Supply-chain management is a critical function for any organization, as it directly impacts the cost, quality, and delivery of the products and services it offers.

Supply-chain management is a complex process that involves the coordination of all activities involved in the production and distribution of goods and services. It is a critical function for any organization, as it directly impacts the cost, quality, and delivery of the products and services it offers. Supply-chain management is a complex process that involves the coordination of all activities involved in the production and distribution of goods and services.



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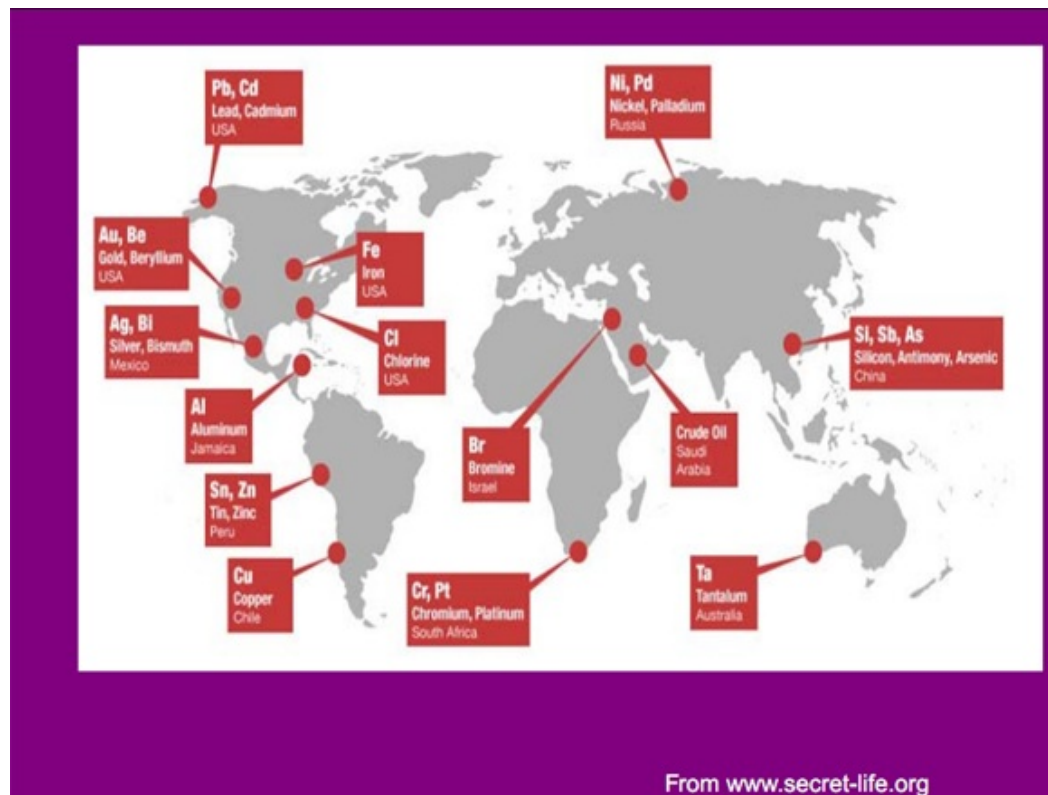
the world's largest producer of lead, cadmium, and zinc. The United States is also a major producer of these metals. The United States is also a major producer of these metals.

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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



[illegible]

1. The first step in the process is to identify the problem or goal. This involves understanding the current situation and determining what needs to be achieved.

2. Once the problem is identified, the next step is to gather information. This can be done through research, interviews, or data analysis.

3. After gathering information, the next step is to develop a plan. This involves determining the best course of action to achieve the goal.

4. The fourth step is to implement the plan. This involves putting the plan into action and monitoring progress.

5. Finally, the last step is to evaluate the results. This involves assessing the outcomes of the process and determining if the goal was achieved.

[illegible]

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6. Finally, the last step is to evaluate the results. This involves assessing the outcomes of the process and determining whether the goal has been achieved.

THE UNIVERSITY OF CHICAGO

Collapse

A sudden decrease in complexity

OR

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

Collapse

A sudden decrease in complexity

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

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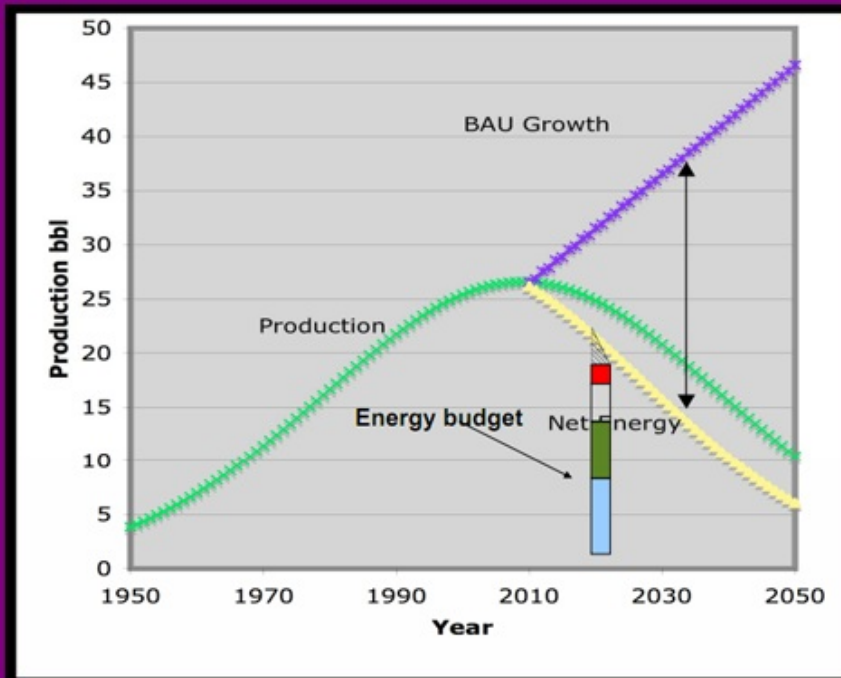
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Energy production and consumption are projected to increase significantly by 2050.

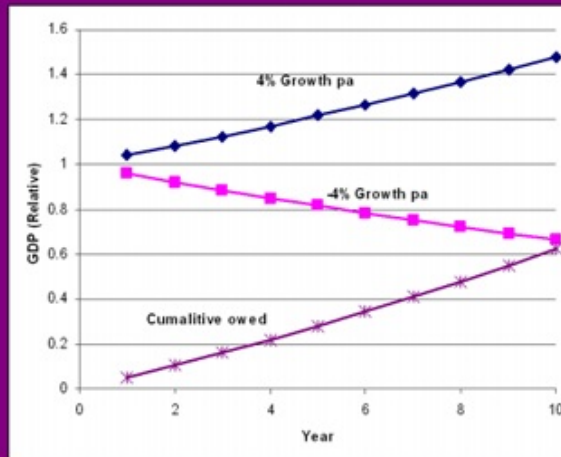
The graph shows that production will peak around 2010 and then decline, while the energy budget will continue to grow. This gap between production and the energy budget will become increasingly significant over time, highlighting the need for alternative energy sources.

The 'Net Energy' curve shows that the energy budget will exceed production around 2010, leading to a net energy deficit. This deficit will grow as production declines and the energy budget continues to rise, posing a significant challenge for global energy security.

The 'BAU Growth' curve represents a business-as-usual scenario, which is not sustainable given the finite nature of fossil fuels. The 'Energy budget' curve shows the required energy input to maintain current levels of production, which is also unsustainable. The 'Net Energy' curve illustrates the energy surplus or deficit, which is crucial for understanding the long-term viability of different energy scenarios.

Debt & Opaque money

- Monetary System Collapse
- Deflation/ Inflation/ Hyperinflation
- Exchange rate uncertainty
- Uncertainty (thermodynamics)
- Balance of trade
- Investment



Annual investment accruing 4% interest per annum.
In a growing economy, that's fine.
In a contracting economy, principle+interest owed begins
to swamp the productive economy

[illegible][illegible]

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**XXXXXXXXXX XX XXXXXXXXXX XXXX XXXXXXX XXXXXXX
XXXXX XXXXXXXXXXXXXXXXXXXX XXXX XXXXXXX XXXXXXX XX
XX**

[illegible]

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

The diagram illustrates the concept of Dis-Economies of Scale through a series of concentric circles and a central feedback loop. The innermost circle is a yellow-to-orange gradient. Within this circle, two light blue rectangular boxes are stacked vertically: the top one contains the text "Fewer goods bought" and the bottom one contains "Rising goods cost". Two curved arrows connect these boxes in a clockwise cycle: one from the top box to the bottom, and another from the bottom box back to the top. Surrounding this central circle are two more concentric circles. The middle circle is labeled "Dependent Economy" with an arrow pointing to it from the top left. The outermost circle is labeled "General Economy" with an arrow pointing to it from the top left. To the right of the circles, the word "Unknowns" is written with an arrow pointing towards the space between the circles. Below the circles, the word "Food" is written with an arrow pointing towards the circles. At the bottom right, "Political instability" is written with an arrow pointing towards the circles. At the bottom left, "Declining Discretionary Income" is written with an arrow pointing towards the circles. The entire diagram is set against a solid black background.

[illegible]

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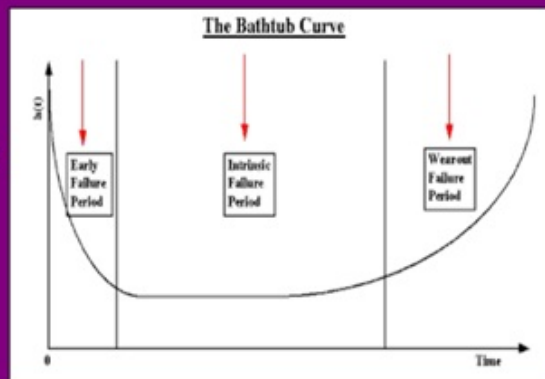
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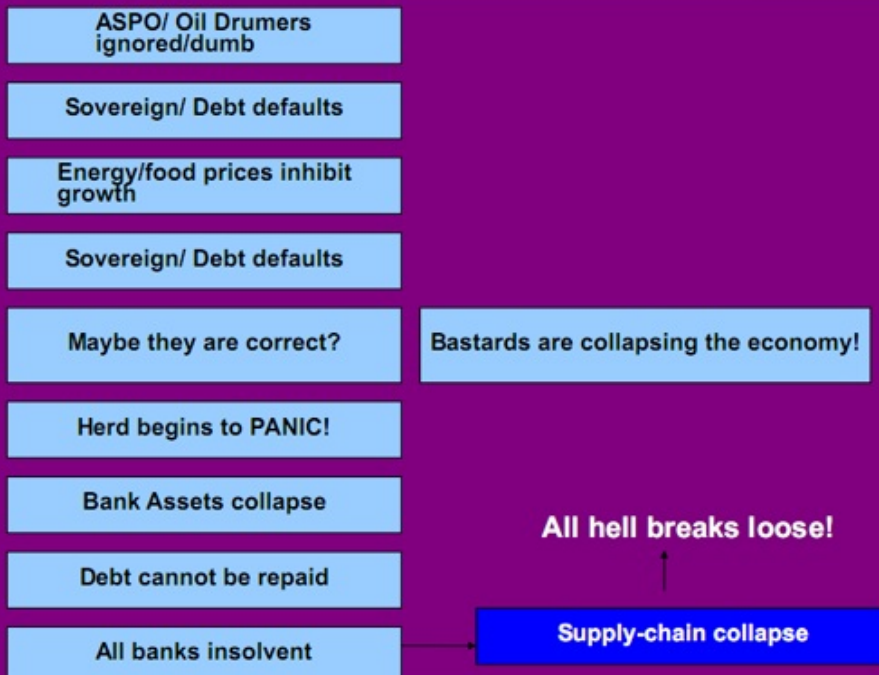
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Infrastructure Creeping Collapse

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



Scenario: Fast Supply Chain-Collapse



The first part of the report discusses the background and objectives of the study. It highlights the importance of understanding the factors that contribute to the collapse of a structure, particularly in the context of seismic activity. The objectives of the study are to identify the key factors influencing the collapse and to develop strategies to mitigate the risk of such events.

The second part of the report presents the methodology used in the study. This includes a detailed description of the experimental setup, the data collection process, and the analytical techniques employed to interpret the results. The methodology is designed to ensure the reliability and validity of the findings.

The third part of the report discusses the results of the study. It presents the data collected during the experiments and analyzes it to identify the key factors that led to the collapse. The results show that the collapse was primarily caused by the combination of seismic activity and structural weaknesses.

The final part of the report provides conclusions and recommendations. It summarizes the findings of the study and offers suggestions for future research and practical applications. The conclusions emphasize the need for improved structural design and seismic safety measures to prevent such collapses in the future.

Conclusions

Fast Collapse
 Massive Dis-orientation
 Emergency Measures

The following table provides a summary of the key findings of the study.

The table shows that the collapse was primarily caused by the combination of seismic activity and structural weaknesses. The results indicate that the structure was not designed to withstand the level of seismic activity that occurred.

