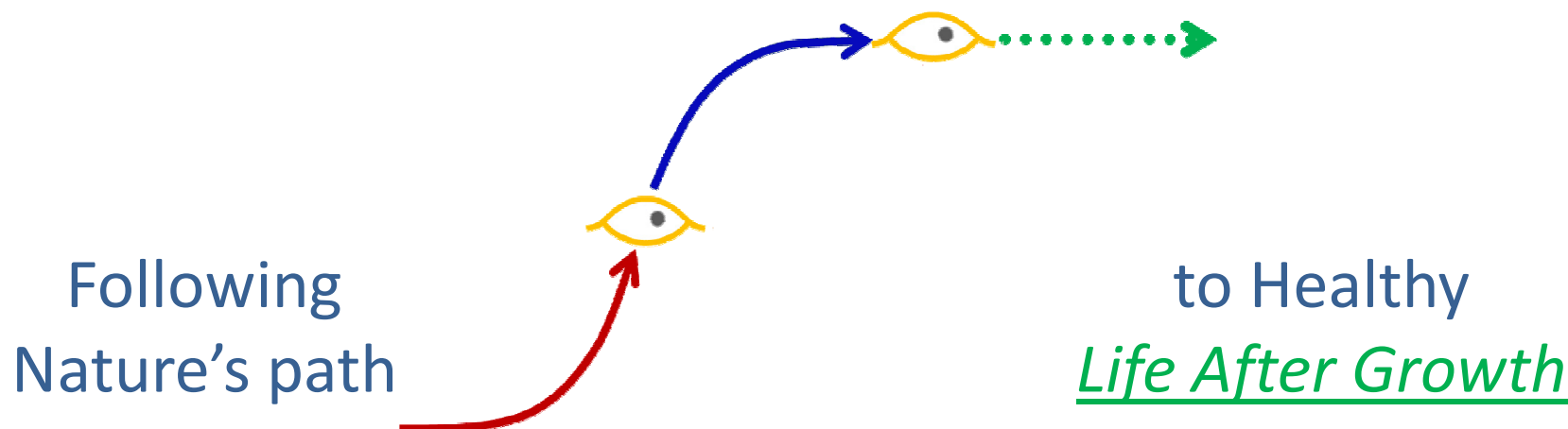
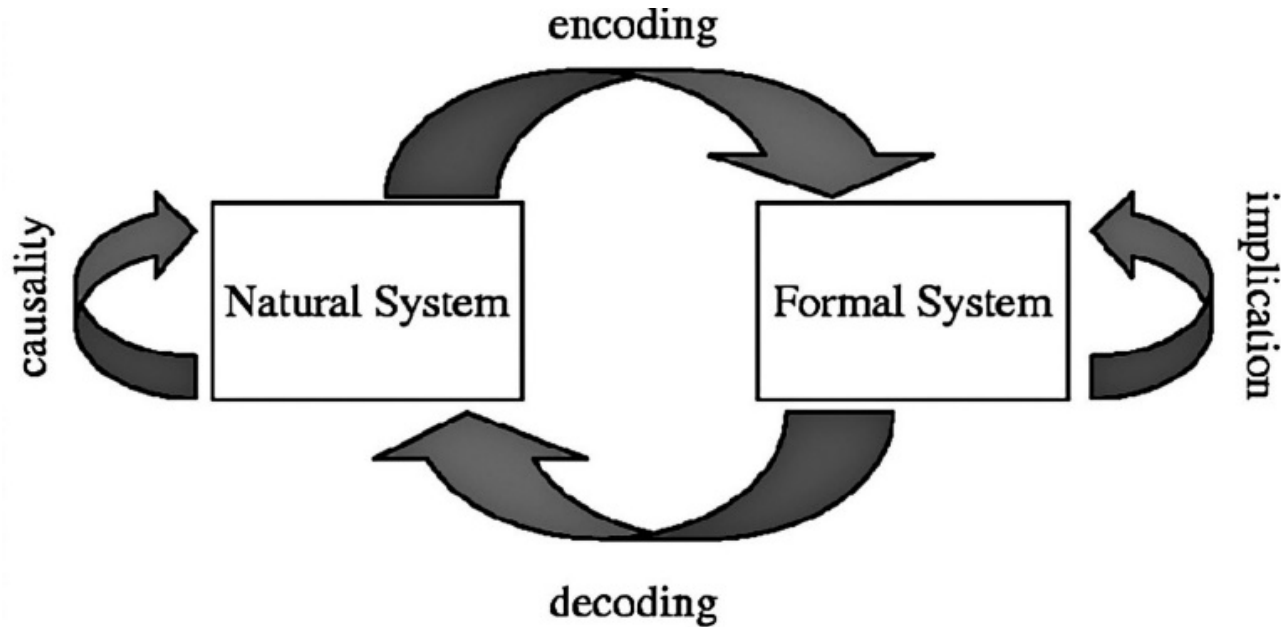


# An Ecological Economics of Growth: Learning from nature when to turn

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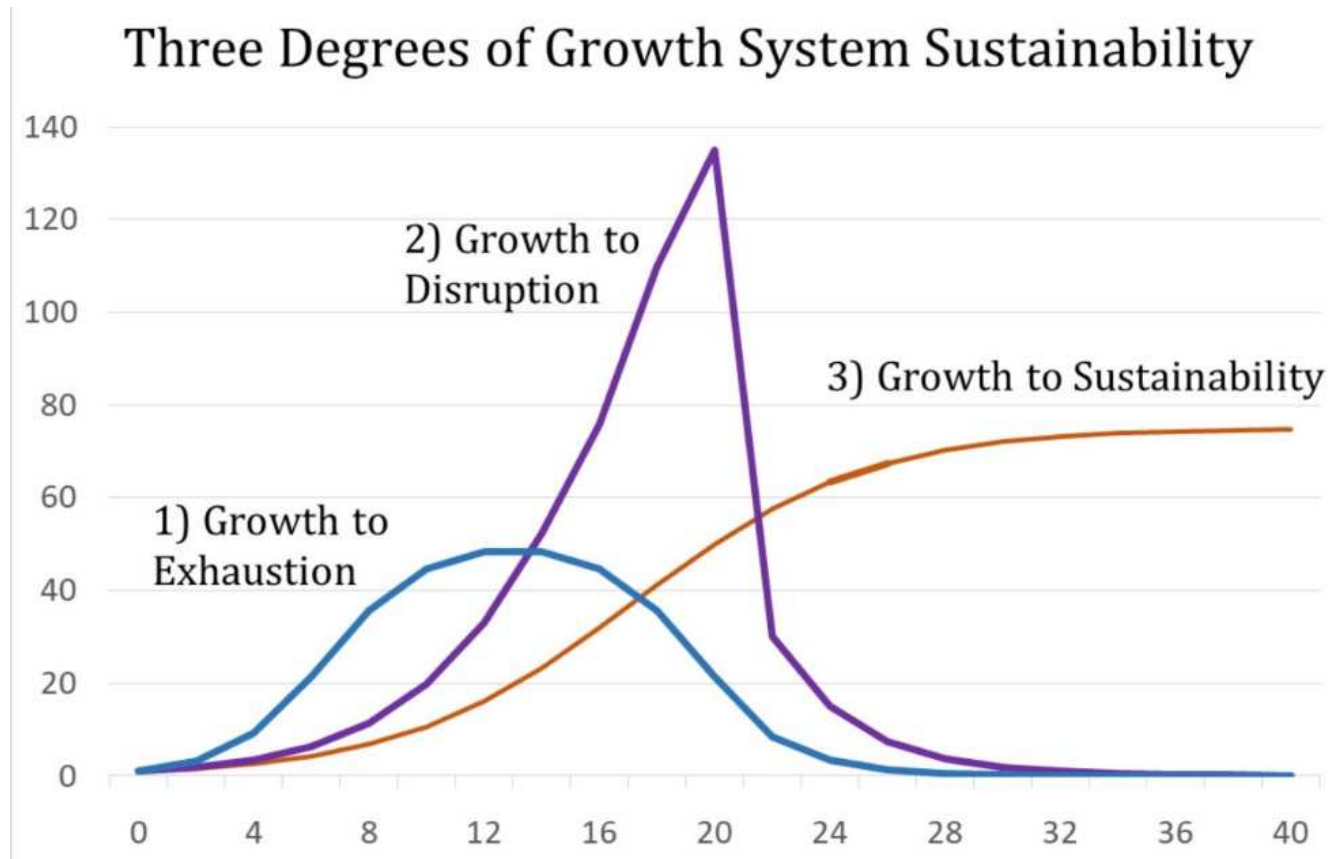


1.



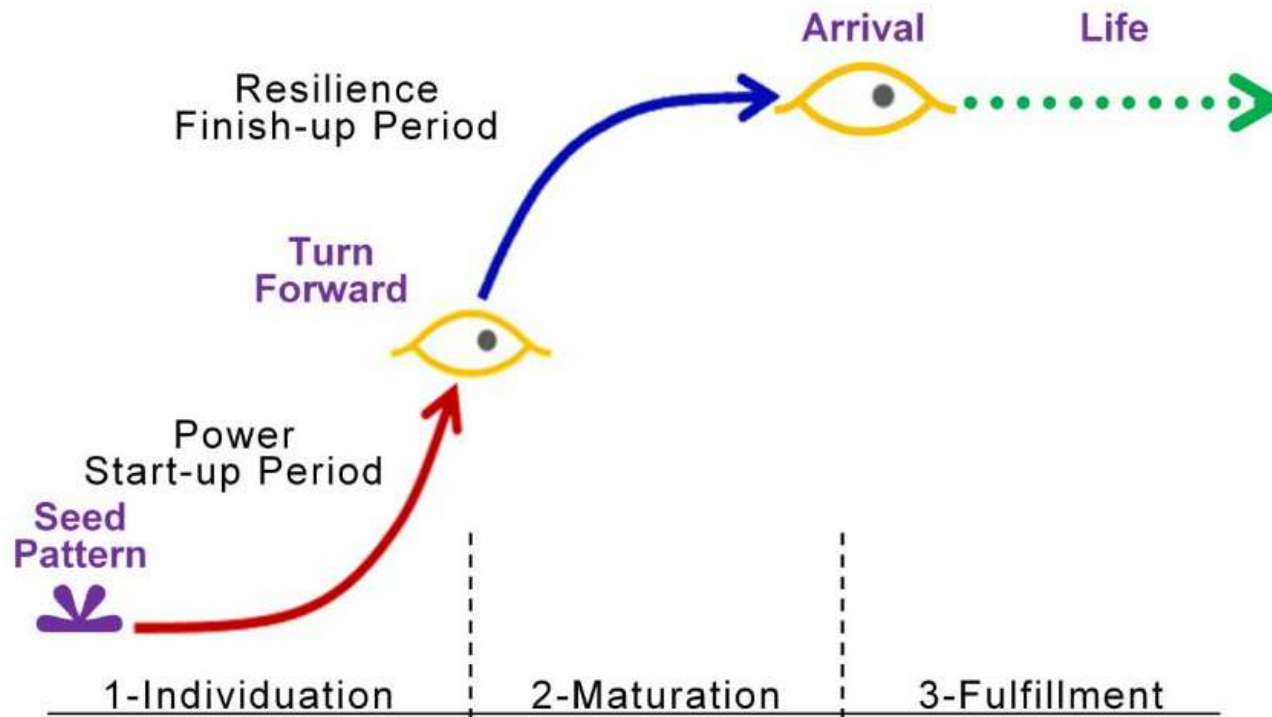
Robert Rosen's Heuristic Model of Scientific Learning: A cycle of first *observing causality* in nature for *encoding* into the scientific language of *implications*, to be used for *decoding* into test applications, and repeated with further *observation and testing*.

2.






Three degrees of endurance: 1) Consuming available resources without a system for finding more. 2) Building a system while ignoring its limits of internal coordination. 3) Using the start-up period to build a system to then stabilize for long life.

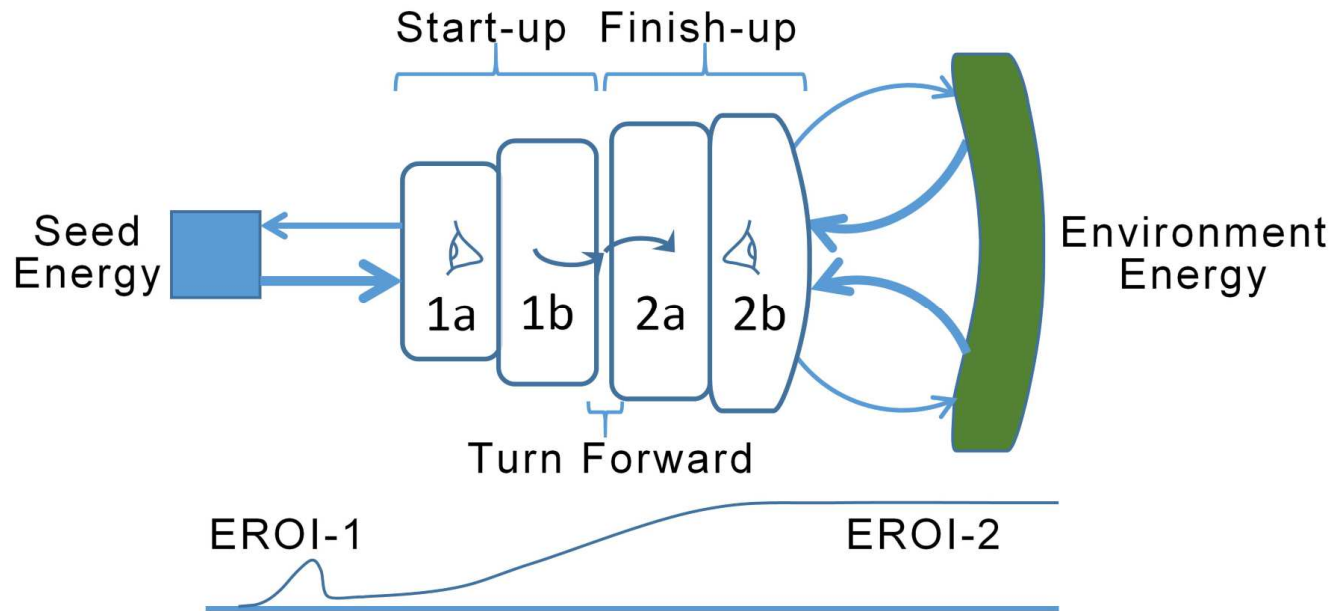
3.



The six stages of natural growth alternate between events of reorganization and periods of development with the new organization.<sup>5</sup>

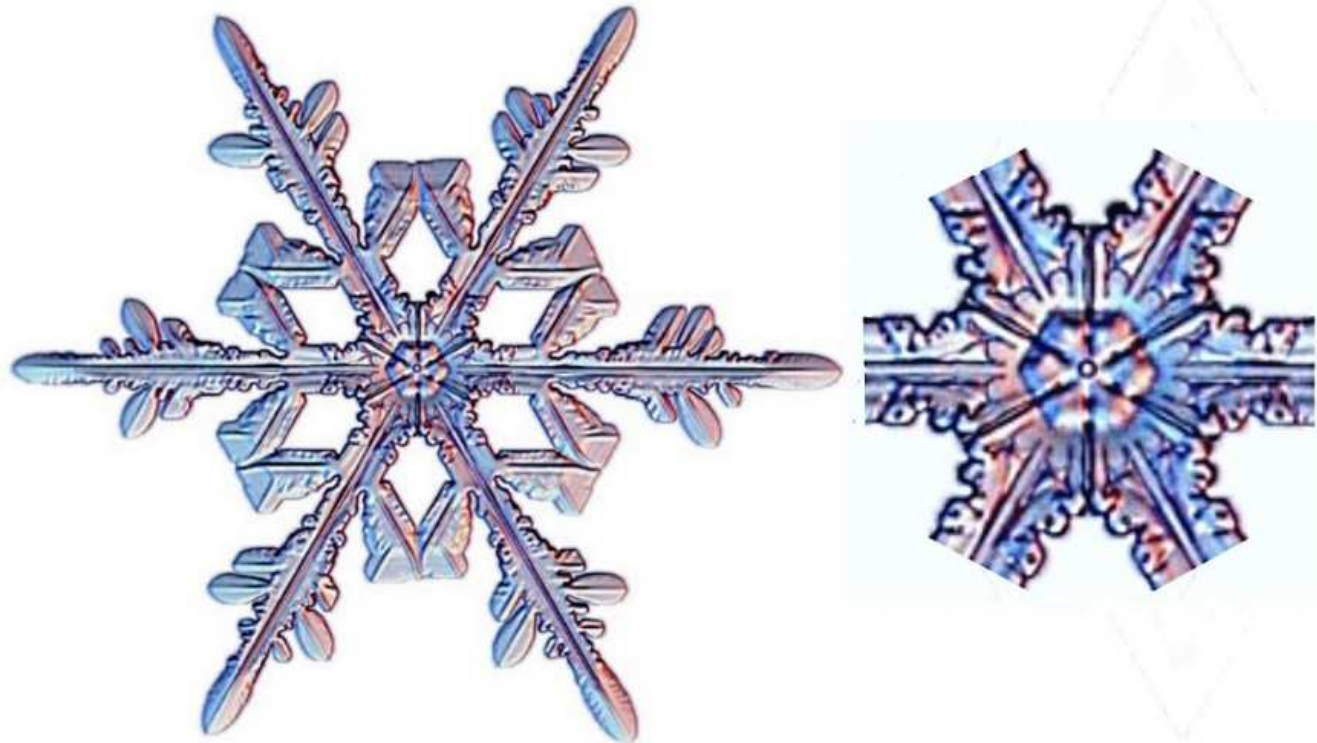
- 1) the **seed event**, , followed by 2) **start-up growth period** (red) ]-*Individuation*
- 2) the **turn forward event**, , and **finish-up growth period** (blue) ]-*Maturation*
- 3) the **arrival event**, , and **Climax life period** (green) ]-*Fulfillment*

## 4.



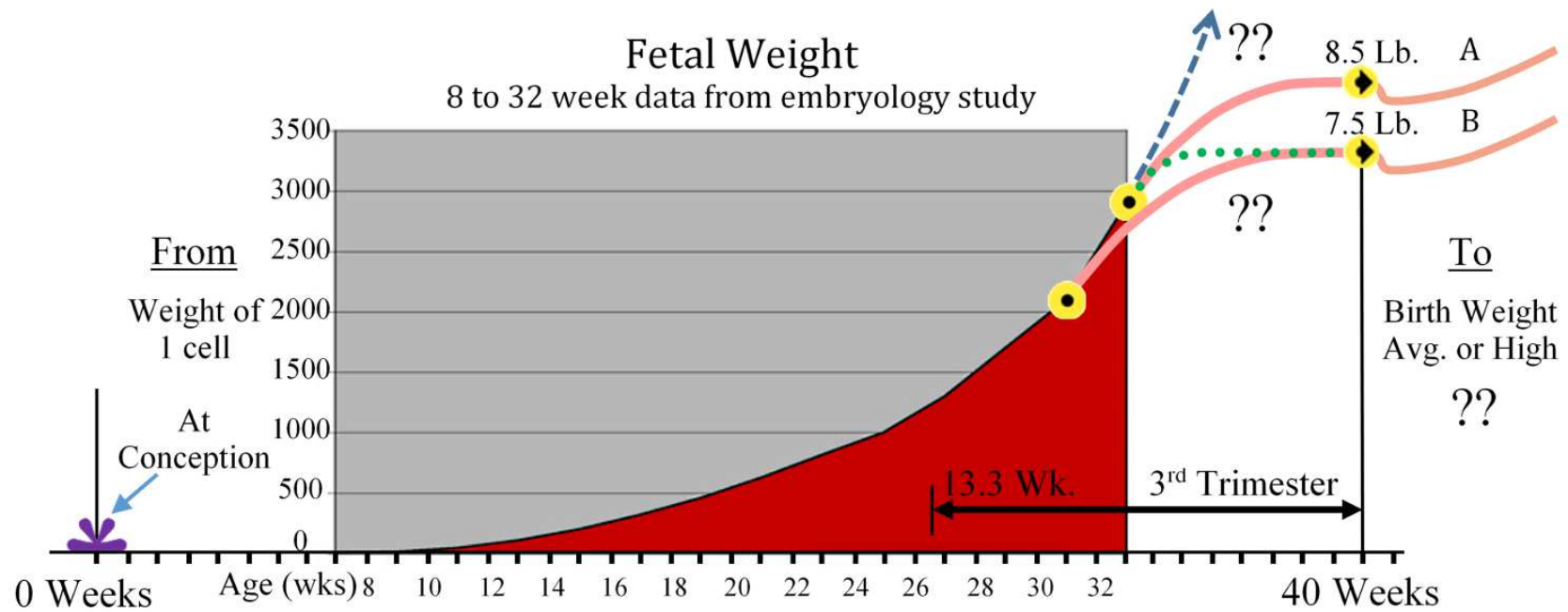
An economic system needs energy supplies greater than its operating energy costs to balance its energy budget. Its first energy source, EROI-1, is usually consumed as the system develops more lasting energy resources, EROI-2.

## 5.



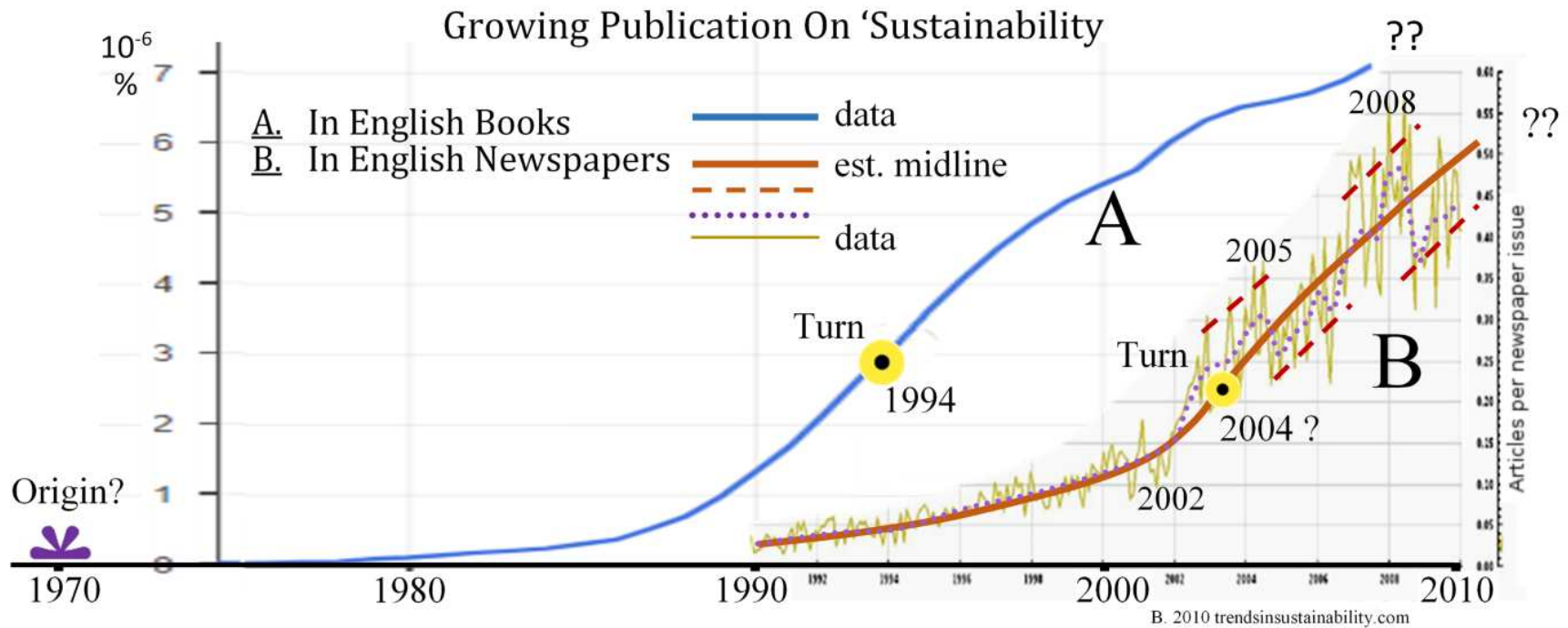
A Snowflake and its Central Kernel: The crystal design builds up from a tiny central dot. The smallest visible hexagonal shape is still quite simple, and next rings increasingly complex, as if the filigree design was “entangled” within that crystal core.

6.



Case Study I. Human Gestation based on partial data on fetal weight.

## 7.

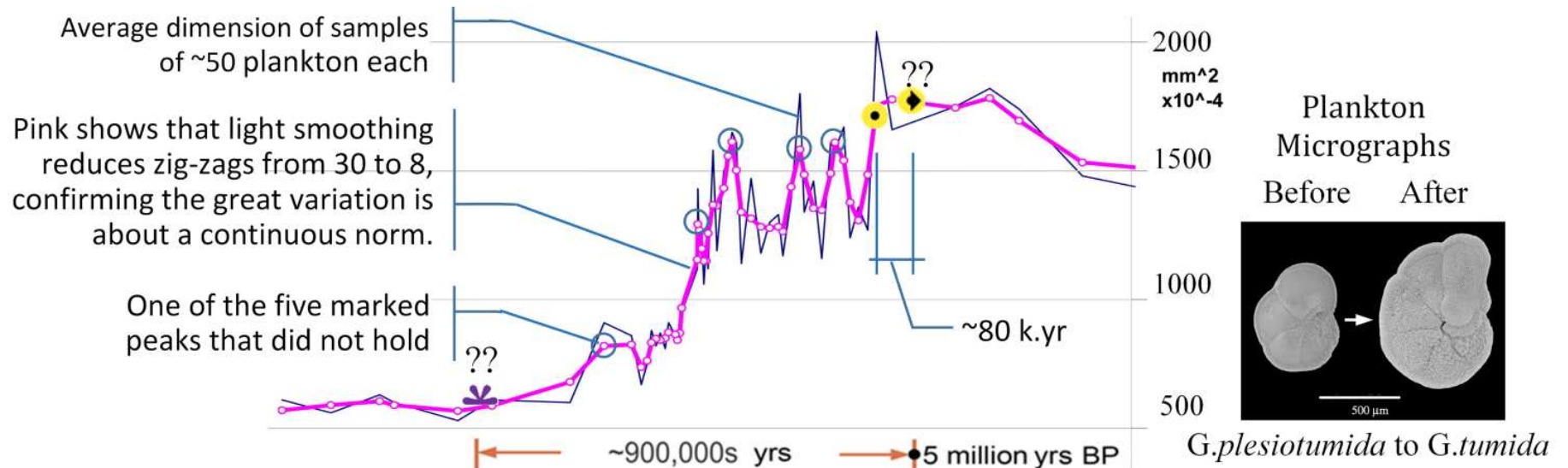


Case Study II. Data on book and newspaper publishing on 'sustainability.'



7.

The Developmental Speciation of *G. tumida* Plankton



*G.tumida* plankton punctuated evolution over 900 k.yrs, showing repeated bursts of increase in species size, that then fall back until finally, one holds.

9.

**Organizations**

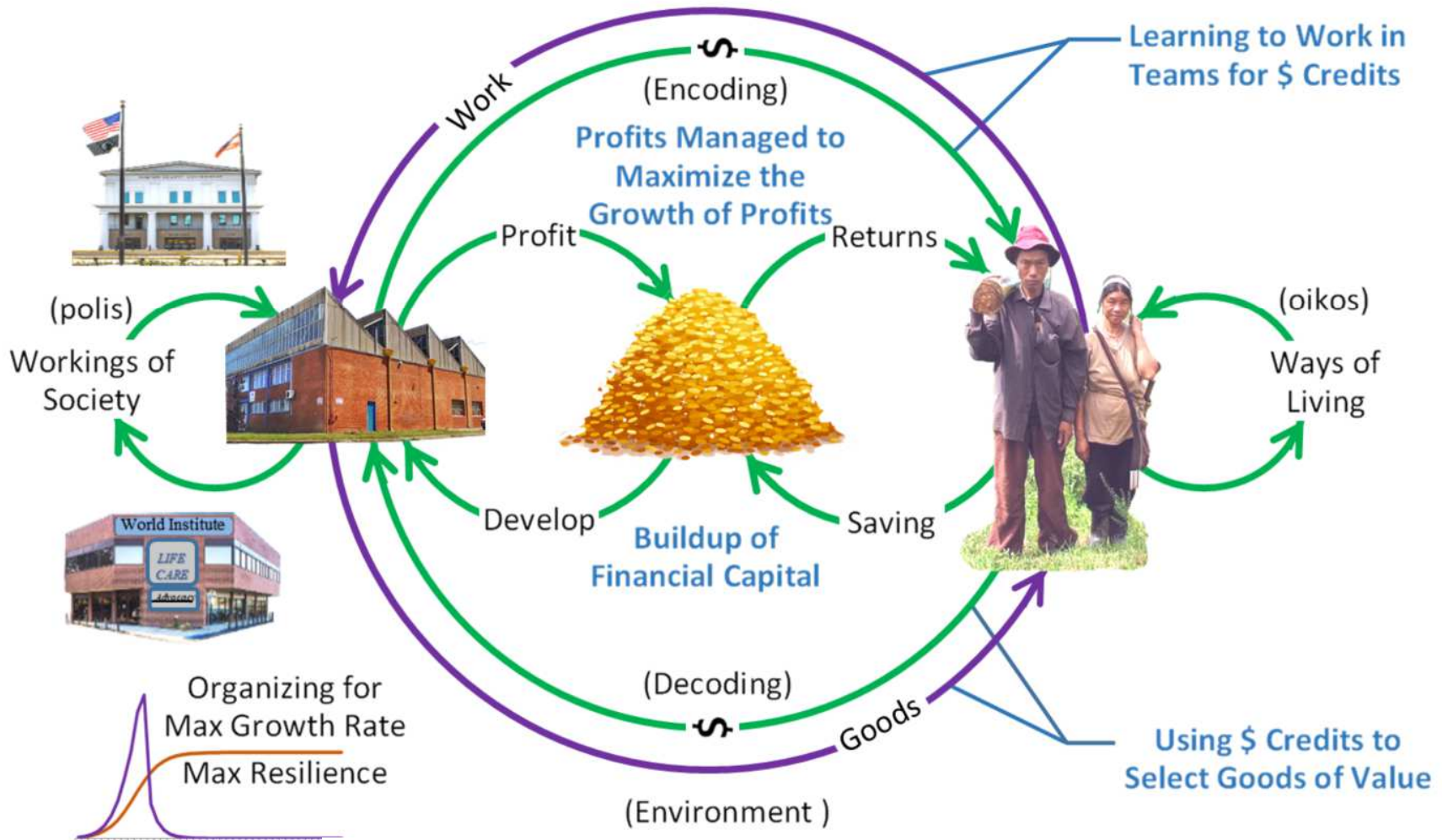
- Government
- Business
- Non-Profits

**Finance**

- Banking
- Investing
- Trading

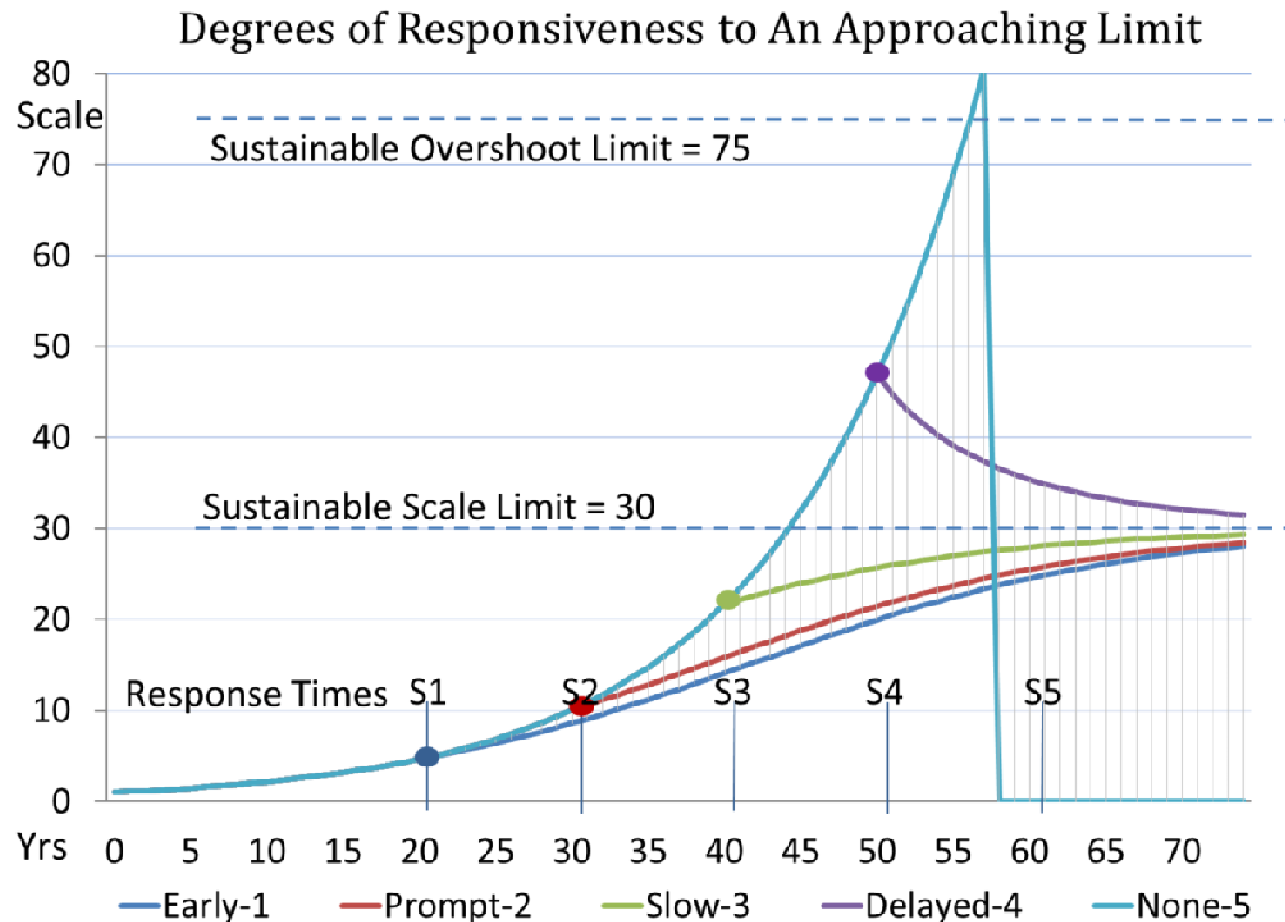
**Organizers**

- Populations
- Families
- Individuals



Decision-Making in a Finance Guided Eco-Economy: Business and Investor choices set future directions of development to maximize their growing profits. Consumer choices reward the most attractive products. Government and Non-Profit choices respond to societal values and needs, with the most costly “externalities” of growth not counted.

10.



Early and Delayed Responses to Sustainable Limits: Increasing delay in response results in increasingly disruptive responses. The growth rate of all five curves is +7 %/yr. After each response, its rate of approach to the limit is -7 %/yr. Both reflect the assumed maximum reorganization rate of the growth system. (Henshaw 2008).

