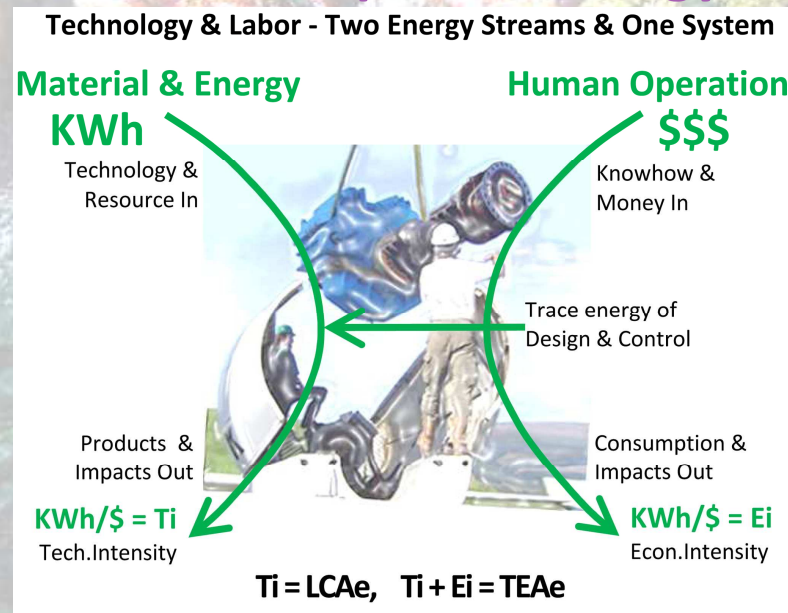


# TEA Total Environmental Assessment

p.f. henshaw  
10/1/09  
ed 1/12/10

- Natural Systems only work as wholes
- Technology & Economic impacts are incurred together.
- Total Footprint = Technology + People
- Technology uses one set of resources, the humans that operate technology do the work for another set of resources - Two separate energy & resource streams.



# TEA Total Environmental Assessment

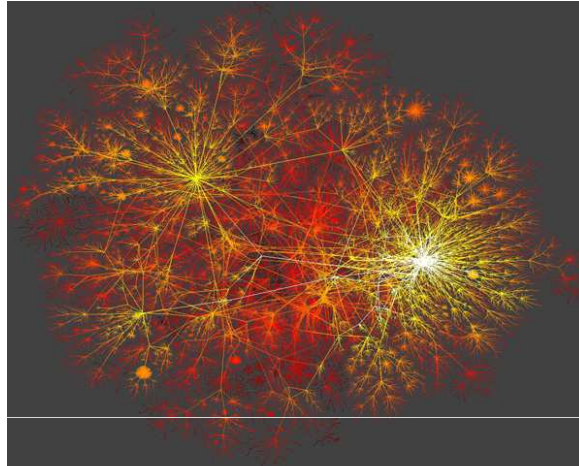
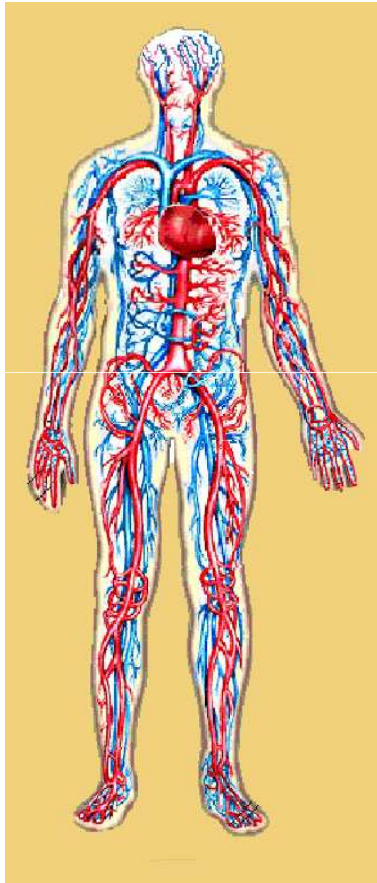
p.f. henshaw  
10/1/09  
ed 1/12/10

- **Macro & Micro Rebound Effects**
  - Business Development - Start-up, Maturation, Break-down
  - Economic - Feedbacks, Dependencies, Opportunity costs
  - Environment - Resource Discovery, Development, Depletion
- **Analytical Methods – “HDS 4Dsustainability”**  
<http://www.synapse9.com/HDS.htm#sd>
  - Whole system measure – set boundaries and find parts
  - Combining measures with different units
- **The Philosophical Problem –**
  - Nature doesn't use variables in equations, but whole systems of mutually essential parts,
  - Networks of complementary parts that act as a whole.



# Accounting systems / Natural systems

- Every system counts on all its parts & is built by them



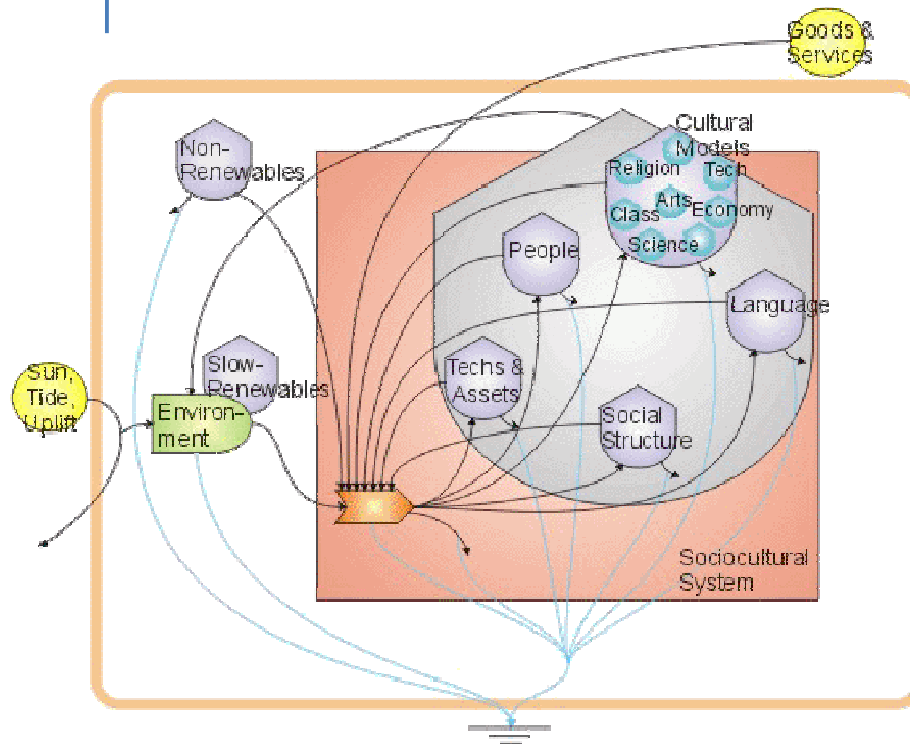
- Every part counts on ALL its systems, the lathe on the operator & the business, the business on the town and community it's finance, culture and networks of supporting industries

## •H.T. Odum Model

Listing Inputs to an equation

Numerical Variables

Defined Relations



## •Whole System Diagram

Pointing to Individual Wholes

Collect-Transform-Distribute

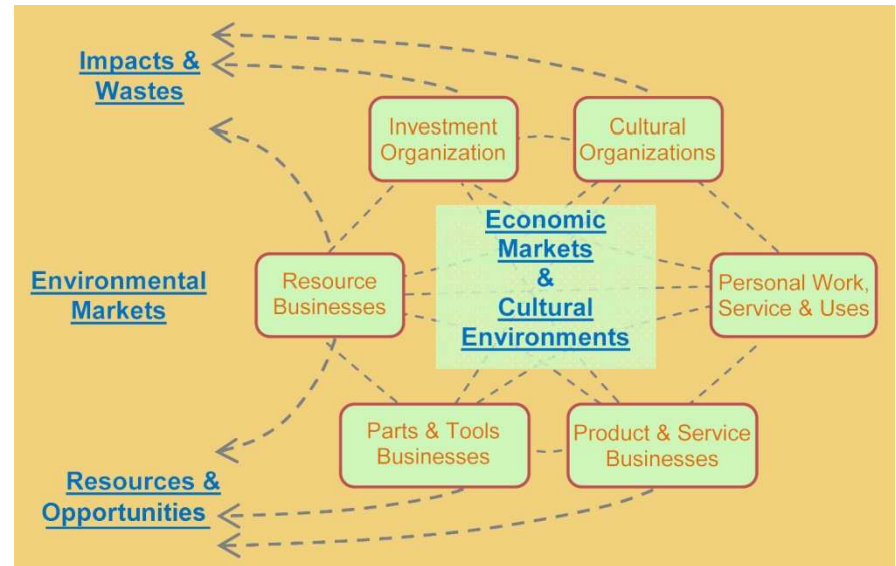
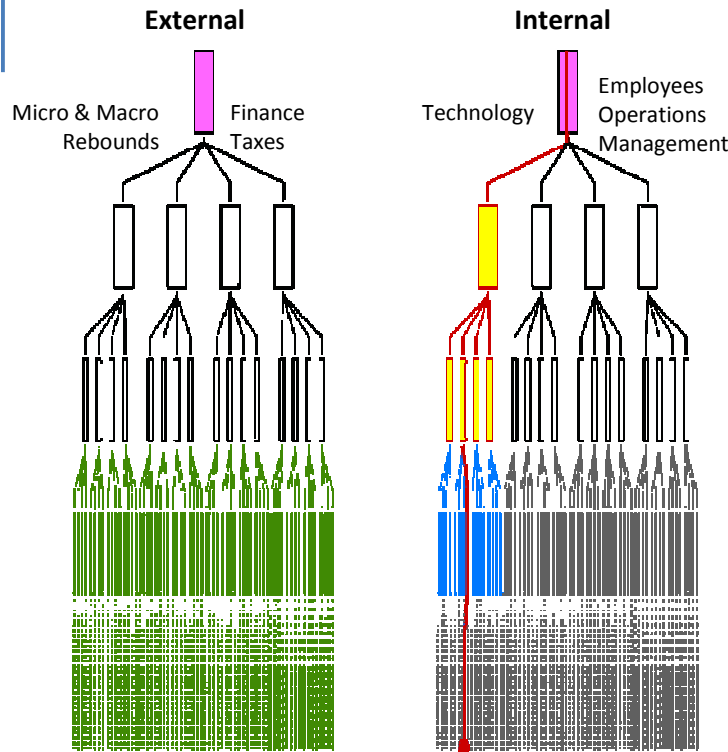
Self-organizing Physical Process



# Accounting systems / Natural systems

- Technology Footprint
- Economic Footprint
- Micro-Economic Rebound Effects
- Macro-Economic Rebound Effects

- Business Service Network
- Labor Resources
- Cultural Resources
- Financial Resources



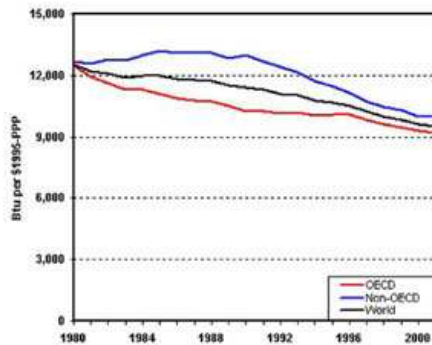
What they have in common also sets the boundary of their impacts, their value in \$ as a share of the system's total

# Measure from the world as a whole

• Why efficiency improvement inevitably grows economic impacts

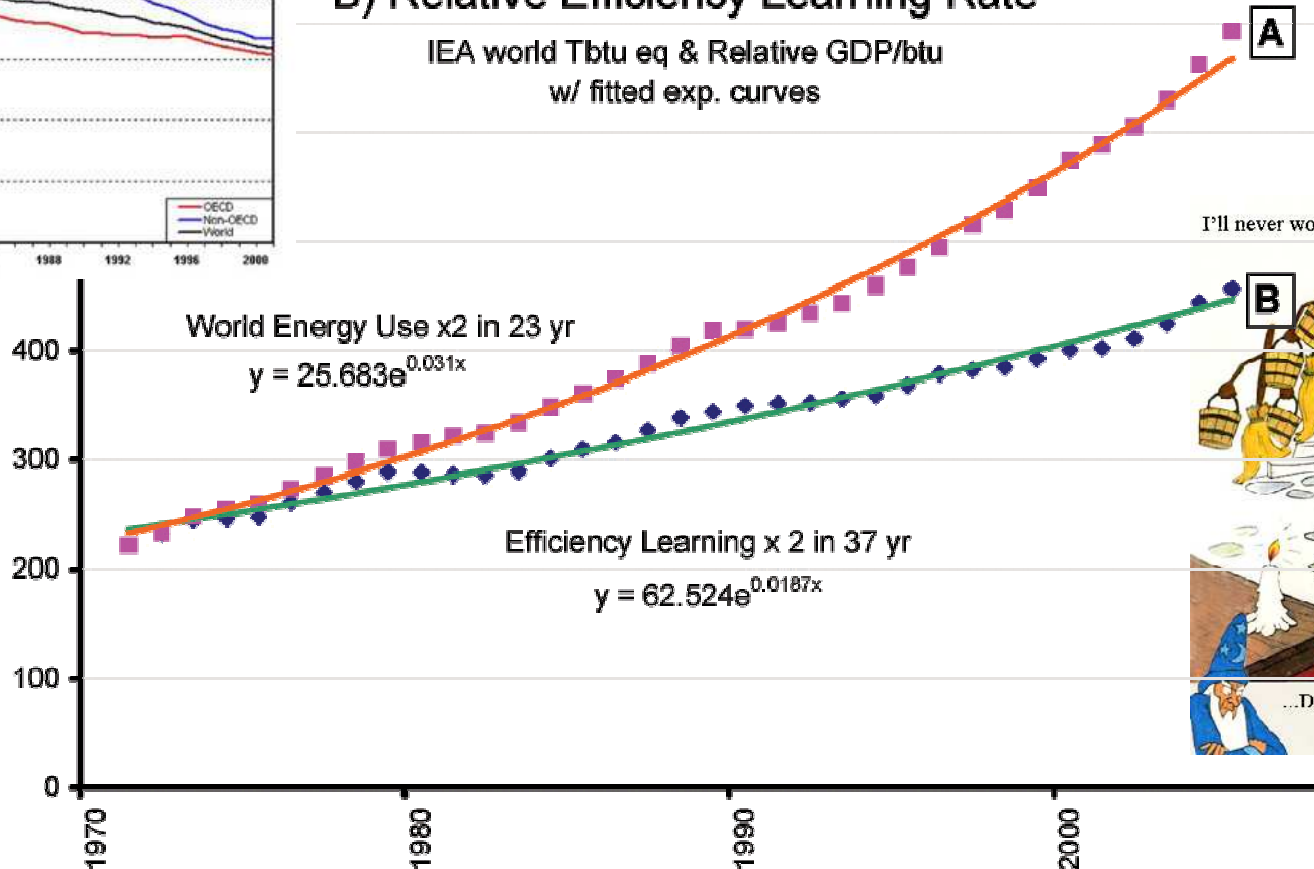
• Why “average” growing impact is a good estimate to start with

Development and Energy Intensity



A) Energy Use v.  
B) Relative Efficiency Learning Rate

IEA world Tbtu eq & Relative GDP/btu  
w/ fitted exp. curves



# Whole system accounting

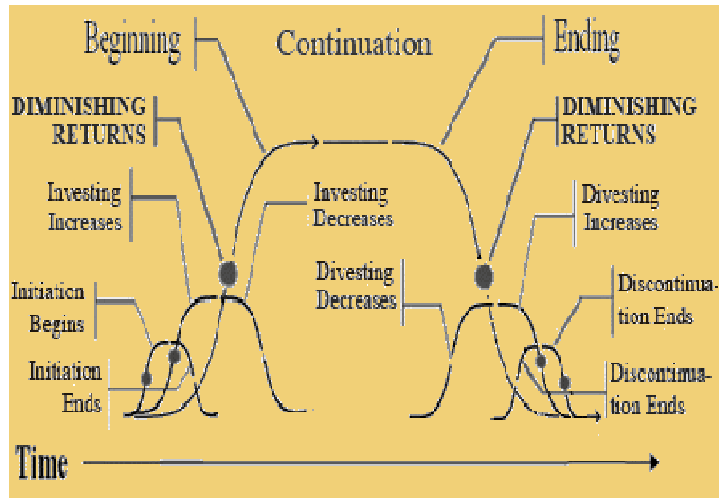
**Direct impacts** – how the product uses its environment  
both for deterministic & opportunistic causes

- Add estimated average Economic Footprint =  $\sim 6000\text{btu}/\$$  (2008\$)
- + Technological footprint within two degrees of separation  
(two steps of spending on 1000 things = 1 million degrees of distribution)
- + Unique impacts, – Unique compensations = “first pass total”
- Combining “apples & oranges”, measures with dissimilar units



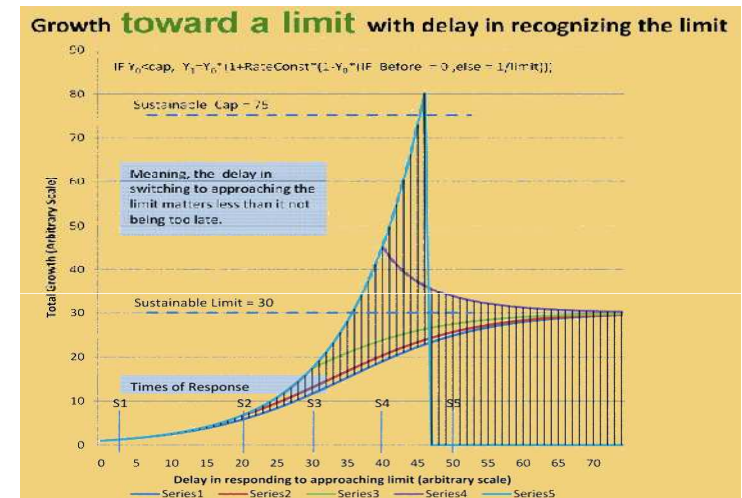
## Time Impacts – how the business changes its environment

- Business development stages beginning & ending



- Costs of beginning & ending
  - Development impacts share
  - Impacts of how profits used (+/-)
  - Dismantling & Restoration share
- Resource impacts
  - Sustainable development (+)
  - Depletion opportunity cost (-)

- Resource development maturation or exhaustion



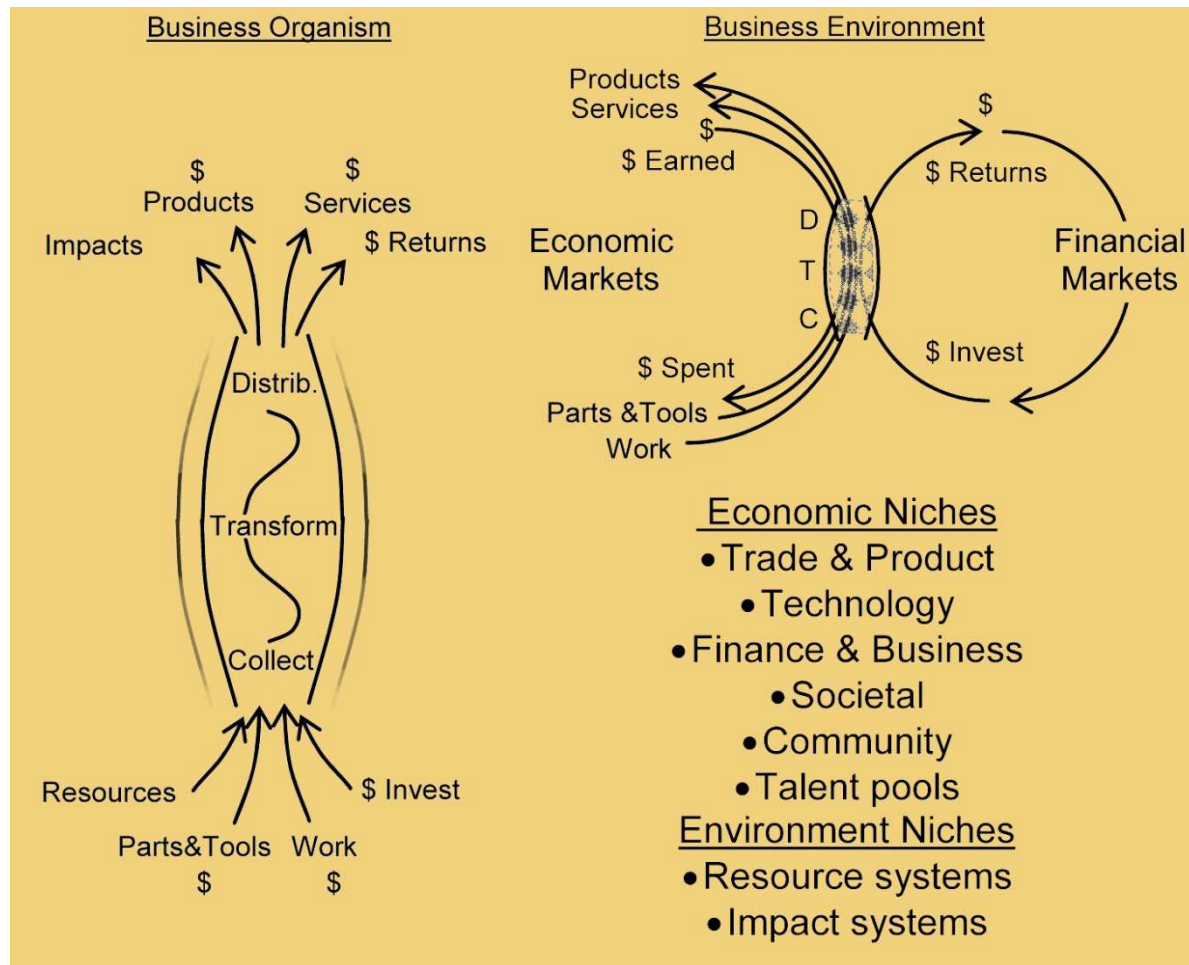
- Virtuous rebound effects
  - Sustainable circles, prompt response
  - Self-limitation & education
  - Maturation & diversity
- Vicious rebound effects
  - Unsustainable dependencies
  - Slow response to limits



# Individual System Accounting Model

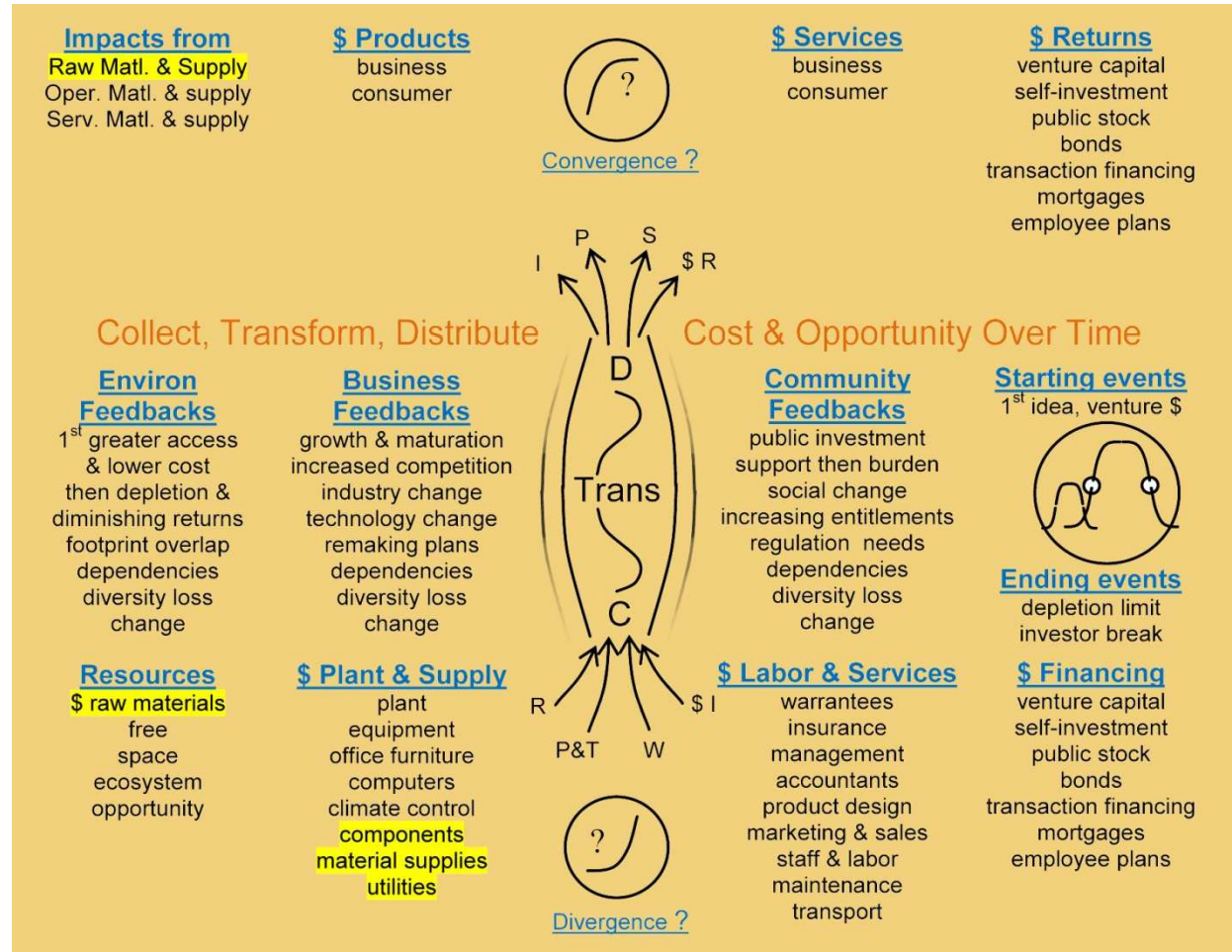
- Individual Whole System
- A product's share of whole

- Economic Niches & Finance
- Environmental Niches



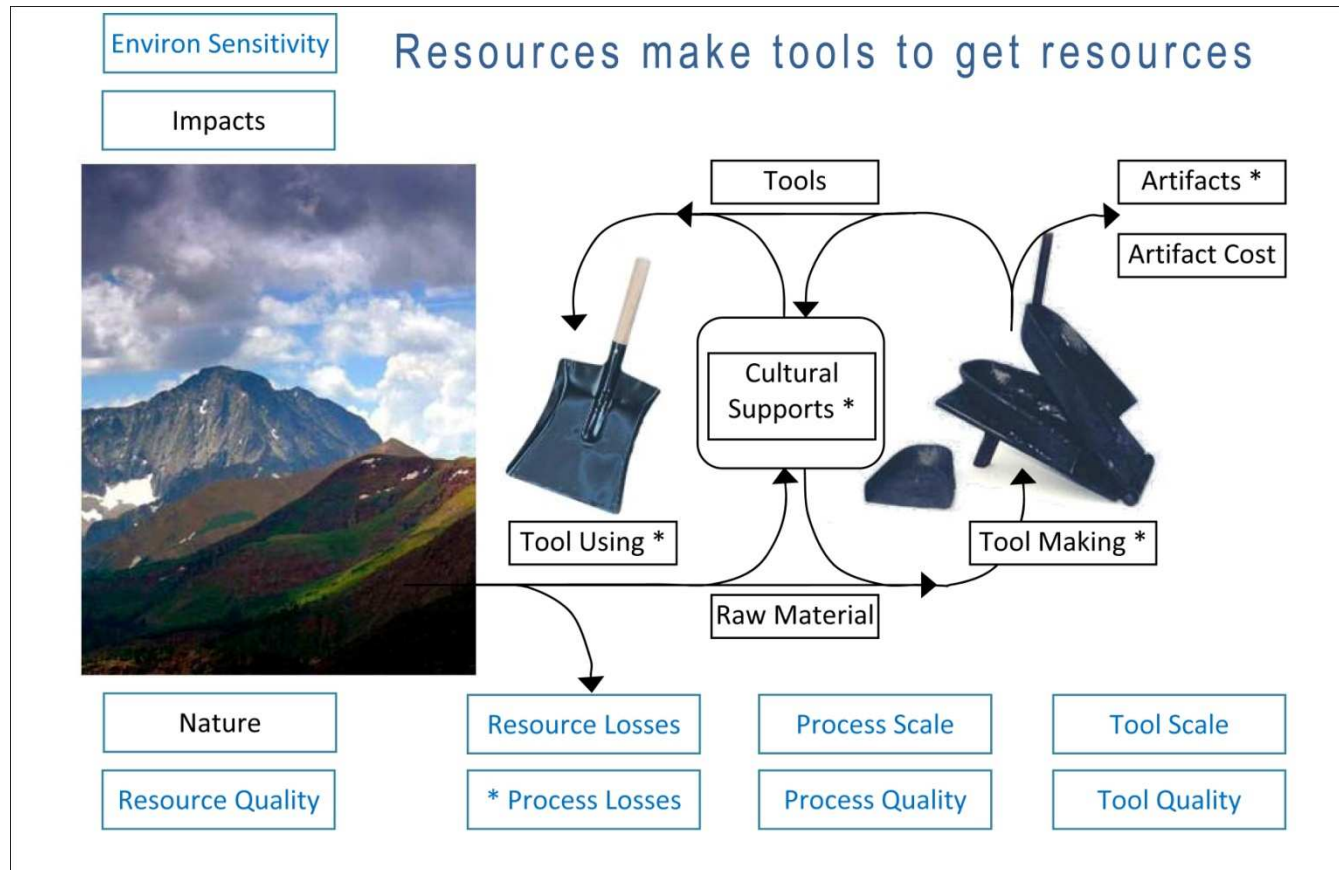
# Outline list of categories

- Technology system
- Economic delivery system



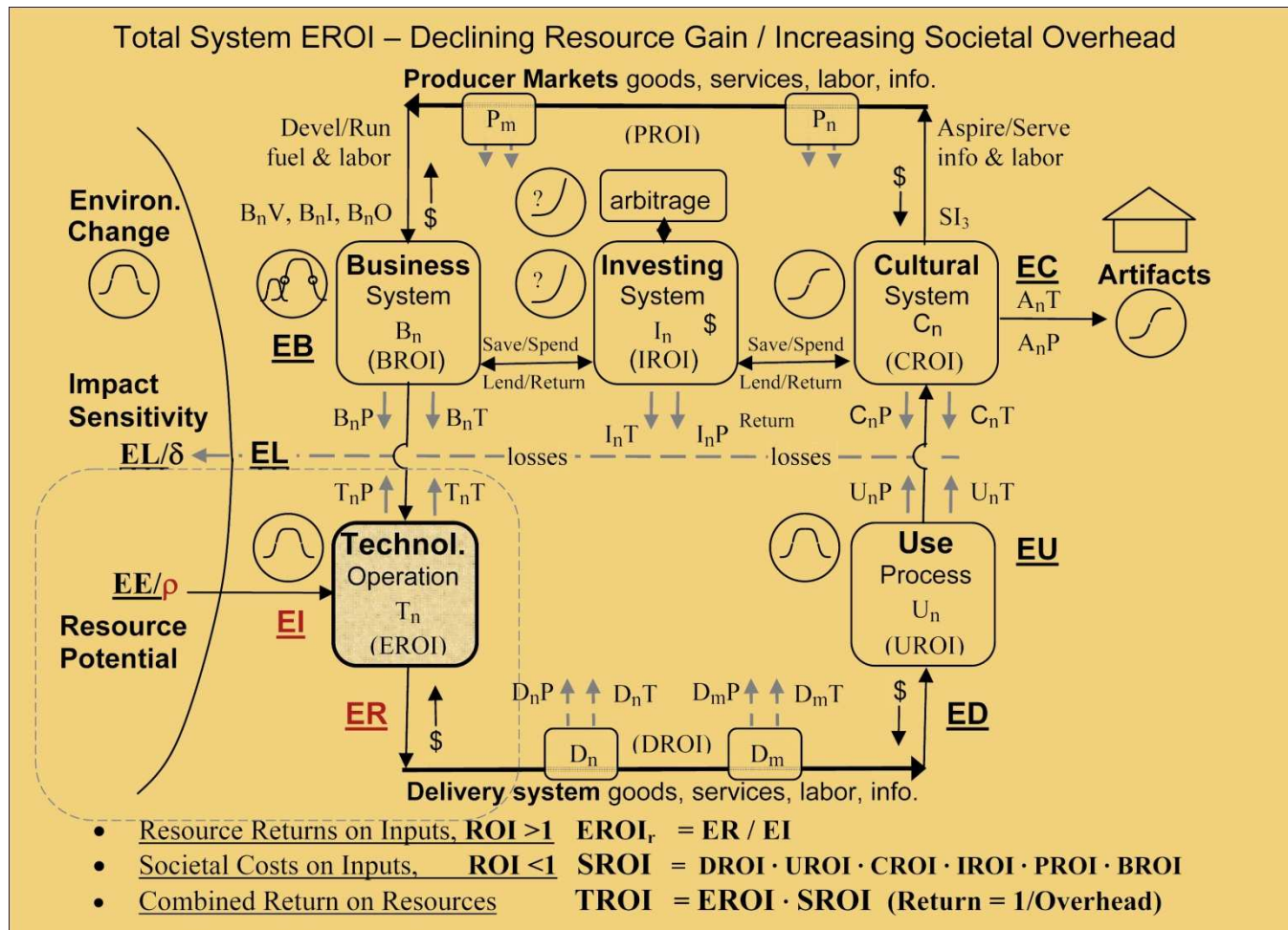
# Whole system EROI methods

## •Life cycle of a resource technology system



•Tools serve a tool making user, changing the tools and the resource over time, to maturity or exhaustion.

# TEA Technology, Entropy, Products & People



• A general accounting of the products needed to drive technology and products needed to drive people



# The Philosophical Problem

- Nature doesn't create impact systems using weighted categories, but as wholes built around complementary parts.
- Nature uses "life", storms of connections that act as a whole, building on complementary opposites somewhat beyond categorization.
- Technology & Econ impacts incurred with the same choices.
- That nature doesn't connect parts the way we think is why we need to watch systems behave as a whole.



TEA