S Y S T E M S

http://cba.unomaha.edu/faculty/mohara/web/LEAf10-SYSTEMS-handout.pdf

"*For every complex problem*
there is an answer that is clear, simple, and wrong."
H. L. Mencken

"*Any intelligent fool can make things bigger and more complex.*
It takes a touch of genius - and a lot of courage to move in the opposite direction."
Albert Einstein

"*As far as the laws of mathematics refer to reality,*
they are not certain, and as far as they are certain, they do not refer to reality."
Albert Einstein

"*Not everything that counts can be counted,*
and not everything that can be counted counts."
Albert Einstein

"*Two things are infinite: the universe and human stupidity;*
and I'm not sure about the universe."
Albert Einstein

"*Technological progress is like an axe in the hands of a pathological criminal.*"
Albert Einstein

"*Imagination is more important than knowledge.*"
Albert Einstein

Many, but far from all, of the items outlined below can be found discussed in:
Hayden, F. Gregory. *Policymaking for a Good Society: The Social Fabric Matrix Approach to Policy Analysis and Program Evaluation*. Springer: New York, 2006. ISBN-13: 978-0387-29369-1.

I. All excellent analysis focuses upon systems.
- A. Profit necessarily requires ***at least two systems*** (π = TR - TC).
- B. Ethics always involves ***at least a multitude*** of systems.
- C. Complex socio-ecological systems necessarily engage complex socio-technological systems.
- D. One tool for managing such analysis is the Social Fabric Matrix.

II. Systems analysis requires a **paradigm shift** away from **isolated transactions** and towards **interrelated processes**.
- A. Point of view is dependent upon a system of beliefs; and, that system of beliefs rarely is inventoried or acknowledged by the viewer.
  - 1. Context.
    An isolated zero sum transaction
    versus a linear flow versus a system.
  - 2. Criteria.
    - a. What are the metrics of "good" and of "bad"?
      - i. For example,
        does "good" always increase when GDP increases?
      - ii. See also II.A.7.
    - b. Systems necessarily have competiting arrays of explicit goals and arrays of implicit goals.
    - c. EXAMPLE: Sustainability.
      - i. **Strong sustainability**.
        Infinitely repeatable
        until an exogenous force alters the system.
        Does not require the assertion,
        but is totally consistent with the assertion, that human technology
        can not be a close substitute for natural processes.
        (e.g., formula *can not* equal mother's breast milk)
      - ii. **Weak sustainability**.
        A short long term (i.e., not long run) repeatable.
        Weak sustainability does require the assertion that human technology
        can be *at least* a close substitute for natural processes
        (e.g., formula *does* equal mother's breast milk).
      - iii. **Profitable**.
        For period of firm's planning horizon
        TR received exceeds TC paid.
  - 3. Consequences.
    - a. Feasible.
      - i. Reality.
      - ii. Reasonable expectations.
      - iii. Actually expected.
      - iv. Known knowns versus known unknowns versus unknown knowns versus **unknown unknowns**.

II. A. 3. a. iv. [I.] If
the set of
unknown unknowns is not a null set,
then
is the set of
known knowns a null set?

b. Countable.

c. Counts.

4. Social: is it "us" versus "them"; or is it "us" and "them"?

a. Who are "us" and who are "them"?

i. Are "them" necessary for "us"?

b. When are "us" and when are "them"?

i. Intra-generational transfers.

ii. Inter-generational transfers.

[I.] Rule of 72: see, II.B.2.

c. What are "us" and what are "them"?

i. Prioritization of life forms.

d. Where are "us" and where are "them"?

i. Are "us" three dimensional beings in a
four dimensional time/space; and "them"?

e. Be here now. ≈ 11! * 20! * 13! ≈ 6.0 x 10^36 versions.

5. Technological.

a. Combination of idea(s) and physical embodiment(s).

b. Feasible combination of inputs.

i. Knowledge.

ii. Skills.

iii. Tools.

c. Implicit blinders (e.g., See {literally} *My Diner with Andre*).

i. Can not see (e.g., II.A.3.a.iv.; especially [I.].)

ii. Acutely see.

iii. Criteria of appraisal changed by change itself.

[I.] Unpredictable consequences.

[A.] Good idea
experienced as bad consequence.

iv. Coherent (i.e., stable across contexts) criteria are
superior criteria for appraisal.

[I.] Money is objective rather than coherent.

[II.] As scope of consequence increases
both
the coherence of objective criteria decreases
and
social urge to use objective criteria increases.

d. Implicit value structure.

i. When is a technological change an "advance"?

[I.] Schumpeter: creative destruction.

[A.] Shut down rule *ala* $AVC_{old} > ATC_{new}$.

II. A. 5. d. i. [II.] Schumacher: contextual appraisal.
[A.] Bigger is not always cheaper (e.g., *Small is Beautiful*).
[III.] Veblen: conspicuous consumption.
ii. Which tool for change appraisal is correct?
[I.] Static versus dynamic.
[II.] Mechanical versus biological.
[III.] Equilibrium versus chaotic.
e. Law can not anticipate.
i. Reasonable expectations by definition are historical.
f. Due to the relatively minimal constraints attributable to the physical embodiment component of technology, technology is an economically distinctive input.
i. *Within bounds that are far less bounded than is ordinary, technological change often* ***in****correctly is viewed as allowing economies of scale to be feasible.*
[I.] Economies of **scale** = proportional increase in <u>*all inputs*</u> generates a disproportionate decrease in ATC of output.
[II.] Economies of **size** = proportional increase in <u>*most inputs*</u> generates a disproportionate decrease in ATC of output.
[III.] Economies of **scope** (a.k.a., **network effect**) = proportional increase in the <u>*market(s) generating and/or receiving the inputs and/or the outputs*</u> generates a disproportionate decrease in ATC of output.
[A.] Within a process and across processes are linkages for obtaining inputs and sending outputs
[1.] A **feedback loop** connects past outputs back to future inputs.
[B.] Feedback loops accentuate other processes.
[IV.] But, recall II.A.2.c.; especially II.A.2.c.i. versus II.A.2.c.ii.
[V.] In these estimations of ATC how broadly (e.g., II.A.2.c.i.) is "total" estimated?

6. Ecological.
a. What is the priority ranking of every life form?
i. Which life forms on Earth are *sine qua non* for human life?
ii. Recall II.A.4. and II.A.5.f.i.

II. A. 6. b. Can rape be stewardship?
- i. **Private goods**, generically, are notable for their characteristics of rivalry of consumption and exclusivity of possession.
- ii. **Public goods**, generically, are notable for their characteristics of externalities springing from muted rivalry and exclusivity.
- iii. Waste (i.e., real property law) is breach of duty.
  - [I.] **Waste** is misappropriation of the ownership rights of either concurrent or subsequent owners.

c. What are the minimum feasible number of generations for an evolutionary consequence in a life form (i.e., what is minimally necessary fraction of total population that must carry gene; as well as what is the relevant average fecundity)?
- i. Is it the "seventh generation of the seventh generation"?
  - [I.] E.g., approximately 266 years if assuming Thomas Jefferson's generational estimate of 19 years times 14 generations.
    - [A.] See, II.B.2.a.iv.[I.].
- ii. How does the metric "generation" vary across life forms?
  - [I.] Which existing technologies have generated an evolutionary consequence in some life form (e.g., antibiotic resistance)?
  - [II.] Which technologies have done so in humans (e.g., speech; but not graphs)?
  - [III.] Given how you answered II.A.6.c. and II.A.6.c.ii, relative to which other life forms on Earth, moving into the future, do humans have and do humans not have an advantage over most other life forms for gaining beneficial evolutionary consequence?

7. Positive versus Normative.
   a. Recall Einstein counting.
   b. Science strives to be positive and science strives to minimize being normative.
   c. **Positivism** (a.k.a., scientific method) seeks to avoid values (e.g., observer bias) and instead seeks to solely focus on facts.

II. A. 7. d. **Normative**
explicitly recognizes and seeks to inventory
the values explicit and implicit in all "facts".
i. Normative asserts
it is impossible to extinguish observer bias.
ii. Normative asserts
that the <u>*choice*</u> of the "facts" is inherently normative.
[I.] But note, New York Senator Daniel Patrick Moynihan, former U.S.A. Ambassador to the U.N., was fond of observing that "*Everyone is entitled to his own opinion, but not his own facts*.".

B. Conceptions of time influence what is perceived.
1. Stream of time.
a. Unidirectional causation (i.e., past then present then future).
b. Clock time is an artificial human abstraction created to foster positivist objective perceptions. See below, V.K.
i. Infinitely divisible and aggregatable units of clock time.
ii. Risk of specifying use of a time unit (e.g., large) and thus precluding ability to perceive a process that is completed relative to a vastly different unit of time (e.g. study days when process takes place in seconds; or, *visa versa*;
study days when process takes place in decades).
2. Discounting of time.
a. Value varies with magnitude of temporal separation.
i. E.g., **Rule of 72**:
72 / i = periods to double or to halve a quantity.
ii. Helps answer II.A.4.b.
iii. Typically ignores both II.B.3. and III.A.B.C.
iv. Discounted present value
routinely requires an implicit assumption that rarely is accurate.
[I.] At 7.2% simple annual interest, $1 borrowed today and payable at the end of 10 years is doubled by the debt's interest payment of $1; similarly, in this way, at 7.2% interest a $1.0 x 10^6 cost imposed 276 years in the future is today worth but $1.0 x. 10^-2.
[A.] When a future externality is currently estimated and discounted, <u>*rarely*</u> is a sinking fund currently created and that penny deposited so in that future 276 years hence that future million dollar harm is compensated (e.g., II.A.4.b.ii.).

II. B. 2. b. Time preference.
- i. Discounting
  implicitly prefers the present over the future
- ii. Adequate deposits into a
  II.B.2.a.iv.[I.][A.] sinking fund
  might reflect a balanced time preference
  rather than a biased time preference.
- iii. Given II.A.3.a.iv.[I.],
  use of II.B.4.b.i. might be required to demonstrate a
  balanced rather than a biased time preference.

3. **Synchronicity**.
   a. Sequencing of process inputs and outputs.
      - i. Time is certain to be:
        - [I.] Linear;
        - [II.] Cyclical
          (e.g., feedback loop); **and/or**
        - [III.] Alternating
          (e.g., contextually defined directionality
          for a feedback loop).

   b. Punctuality of process inputs and outputs.
   c. Duration of process inputs and outputs.
   d. Coordination of process inputs and outputs.
4. Preferences for Risk.
   a. Speaking technically,
   "uncertainty" does not equal "probability";
   nor equals "risk".
      - i. "**Risk**" =
        probabilities mathematically coupled with
        reward and loss distributions
        (e.g., Bayesian decision tree weighted average).
      - ii. Rarely will you encounter a human who
        consistently speaks technically about
        risk, hazard, reward, probability, and/or uncertainty.

   b. **Risk Averse** =
   decision maker prioritizes avoidance of large hazards;
   thus, voluntary acceptance of large risks requires
   rewards to be disproportionately larger
   (since probabilities are assumed not alterable).
      - i. **Precautionary Principle** =
        for major risks shared broadly (e.g., externalities) the
        decision maker ought prioritize
        avoidance of worst case outcomes even if
        probabilistic assessment forecasts
        profitable risk taking.

II. B. 4. c. **Risk Neutral** =
voluntary acceptance of all risks as long as
hazards and rewards track proportionally with the risk.
i. Economics, seeking to be positivist,
assumes a rational person and then
assumes all rational persons are risk neutral.
[I.] Based upon the flip of fair coin,
what reward do you require
to voluntarily accept your slavery as a hazard?

d. **Risk Seeking** =
decision maker prioritizes
large rewards over smaller rewards,
thus voluntary acceptance of large risks
does not
require rewards to be grow proportionately with risks.

e. What is a "**Black Swan**"?
i. What are the differences in consequences between a
positive "Black Swan" and a *negative* "Black Swan"?

f. When is a characteristic:
i. "random"?
ii. "chaotic" (e.g., **Butterfly Effect**)?
iii. "unpredictable"?
iv. Recall II.A.3.a.iv.[I.].

III. A network as a context for consequence alters the array of feasible consequences.
A. Size.
1. Maximum size of an individual unit
is exceeded by aggregation of units.
a. Across multiple dimensions,
the whole is greater than the mere sum of the parts.
2. Recall relative consequences discussed in
II.B.2.a.iv.[I.] as well as in II.B.4.b.i.

B. Scale.
1. Proportional increase in output with
proportional increase in all inputs
is more feasible and more likely with aggregations of units versus
with individual units.

C. Scope.
1. Classic definition of "network effect" springs from scope.
2. Proximately caused consequences
both on distant processes and in distant systems
via alteration of synchronicity across feedback loops.
3. Scope consequences alter:
a. parts,
b. subunits,
c. aggregations of parts and of subunits, and/or
d. the whole.

III. C. 4. Scope, with no change in technology, can be
similar in consequence to a change in technology
(i.e., change in the *feasible* combination of inputs).
a. Feedback loops
can alter positively and can alter negatively what is feasible.

D. Optimization.
1. Whose utils are to be maximized?
a. Recall II.A.4.
2. Benefit / Cost Analysis.
a. What are the implicit values expressed when the ratio is phrased as "cost/benefit"?
3. *Pareto Optimality*:
change only is "good" if improve one without harm any.
a. Contrast with *Pareto Principle*:
20% of inputs yield 80% of outputs.
4. *Coase Theorem*:
if few transactions
and if small transaction costs individually and in aggregate,
then (but not so if either of the above ifs is not satisfied)
initial allocation does not preclude efficient end allocation
via market transactions.
a. Coase Theorem helps define the efficient boundary between the firm and the market.
b. Coase Theorem is routinely *mis*applied
to justify gross inequalities coupled with
governmental non-response (e.g., externalities).

III. D. 5. Cobb-Douglas function:
$Y = A L^{\alpha} K^{\beta}$
where
Y = total production; A = total factor productivity;
L = labor; α = elasticity; K = capital; and β = elasticity.
a. These elasticities are used to define economies of scale.
6. Subunit optimization at the expense of the whole becomes a discrete source of subunit "profit".
a. Also known as the **principle / agent problem**.
b. Can be explored from the perspective of **rent seeking**.

IV. General Systems Analysis (GSA) prioritizes a focus on
relationships, structure, and interdependency
rather than a focus on constant attributes of objects.
A. Openness, complexity, wholeness, hierarchy, and regulation
set up those relationships, structure, and interdependence.
B. Within a dynamic whole
a part functions differently than when the part is examined in isolation.

V. Twelve Principles of Systems.
- A. A system is a set of objects
  together with relationships between objects and their attributes.
  1. Objects are elements.
  2. Attributes are properties.
  3. Relationships connect with iterations.
     a. Due to our Bounded Rationality
        we are prone to tell ourselves the lie of uni-dimensionality.
- B All systems are open.
  1. Openness is a flow (i.e., inputs and outputs)
     between the system being examined and the environment.
  2. State of system influenced by flows.
  3. Environment routinely viewed as a black box that is source of:
     a. Natural good production (e.g., forest);
     b. Natural resources (e.g., oil);
     c. Living Systems
        (a.k.a., Life Support Services [e.g., atmosphere]);
     d. Sink Function (e.g., absorb and process pollution).
- C. Systems are nonisomorphic (i.e., whole is greater than sum of parts).
  1. a.k.a., holistic.
  2. Rejects reductionist thinking of objects viewed in isolation.
- D. Systems stress equifinality.
  1. Posits multiple feasible paths rather than focus on equilibrium.
     a. Forecasting the future
        (e.g., start with an ice cube and end with ?)
        is far easier than
        forecasting the past
        (e.g., now a puddle of water having started with ?).
  2. Recall *can* versus *may* versus *should* (i.e., power v. law v. ethics)
- E. System components interact.
  1. Cultural values (e.g., golden rule versus invisible hand).
  2. Social beliefs (e.g., free will versus fate).
  3. Personal attitudes (e.g., risk preference).
  4. Technology: recall II.A.5.
  5. Natural Environment (e.g., wild versus depleted).
- F. Systems operate within constraints imposed by
  system controls and system regulations.
  1. Magnitude of constraints vary.
     a. Necessary.
     b. Sufficient.
     c. Adequate.
     d. Viable.
  2. Subsystem linkages provide venues for control and regulation.
  3. Rules of control and regulation are both alterable and interactive.

V. F. 4. Technology
interacts with control and regulation in a multitude of ways
(e.g., *mechanism* for control versus *alters* controls).
5. Social beliefs
interact with control and regulation in a multitude of ways
(e.g., view of what is feasible
[e.g., USA racism prior to Martin Luther King]).

G. Systems contain hierarchies.
1. Outputs of some subsystems provide inputs to other subsystems.
2. Hierarchies increase scope of reasonably foreseeable consequences.

H. A system can be viewed via its flows, deliveries, and sequences.
1. Threshold levels trigger reaction.
2. Tolerance levels exceeded trigger transformation.

I. Feedback loops can be positive or negative.
1. Positive feedback is self reinforcing.
a. If both above threshold and below tolerance levels,
then fosters growth.
i. But, tendency towards instability and/or decay
b. Positive feedback often serves as
both intra-system and inter-system communication.
2. Negative feedback is self-regulating and fosters goal direction.

J. Systems foster differentiation and elaboration.
1. Evolution towards complexity.

K. Systems use real time rather than classical time.
1. Newtonian time relies upon strict deterministic causality.
a. Contrast with equifinality, above at item V.D.
2. Time is a social construct rather than a natural phenomena.
a. Focus on process synchronicity; not clock time.
i. Recall II.B.3.

L. Evaluation of a system's objects, attributes, and relationships requires prior specification of values.
1. Recall II.A.2.
2. System viability typically requires both
sufficiency and redundancy.