Introduce Metaphor? Engine ☆ Metabolism ☆
Organism ☆
Garden

Part I — material flows

PERKS Red, Blue, Kg
~~KRMPS~~ diagrams, like figs 7.1, 7.2

The metabolic Economy!
A model for material and energy flows ⚡️

Blue notes from 7 Aug 2013

Intro material flows

Some don't accumulate, some do.

classification based upon use! Context is everything.

Do for Examples A—C
Link to KLEMS database?

Issues:

- Oil and coal: $\dot{S}$, $\dot{R}$, or $\dot{E}$? I think $\dot{R}$, at this point
  Switch to $\dot{E}$ later!

- Include $\dot{Q}$ (waste heat)? No → not a material flow
  $CO_2 \rightarrow \dot{S}$ flow to environment
  $\dot{S}$ into sector from env. (free O_2)

- Write material balance eqns? No. Not helpful.
  Says masses balance.   Maybe 1 or 2.

- What about $\dot{E}_{34}$ (and others)? Bundle into $\dot{R}_{34}$ or $\dot{S}_{34}$

lead with single-sector diagrams. Then A, B, C Examples

Why include?
- Economy is material
- Introduce examples A, B, C
- Introduce Auto industry production as a case study.

Part II — Energy Flows [J] or [BTU]   Green
- Energy diags like Fig 5.1, 6.1, etc.
- Extract energy flows from matl diagrams.

Energy becomes the focus. Direct Energy assoc. w/ all of matl. flows. Only some is numerically significant.
- FF
- Elec.
- waste heat

- Add $\dot{Q}$ ← from part I
- Some $\dot{S}$, $\dot{R}$ are $\dot{E}$ flows.
  derive
- 1st Law, Total Energy, embodied energy eqns

- Don't link to X yet
- Link to ~~BEA~~ KLEMS data from Becky?
- Do for Examples A, B, and C.
- Include Society (z) in the eqns.

Part III   Currency and value flows. [$]   Red, Blue, Black, ~~Green~~

- Leverage MKH notes from 24 July 2013

- Do for Examples A, B, C

- Link to BEA and Becky's work

- Address · value creation (value add)
    · Inflation (Fed) and need for ~~infl.~~-adjusted currency flows

- Include both $\dot{x}$ and $\dot{c}$ diagrams.
  exposes assumptions

- Issue:
    - If BEA already accounts for upstream inputs, is that compatible with matrix inversion approach?   No problem here!

~~AA~~

Part IV — Energy Intensity ~~~~~~~~

→ link Part II (energy) with Part III (currency and value) to derive energy intensity formulation (ε_s)

compare w/ how normally defined in Energy I-O w/out accumulation terms.

~~Issue~~ Accumulation of embodied energy vs. ε. Can't distinguish

Part I - Implications

- Accumulation of embodied energy vs. ε.
  Can't distinguish.
- dB/dt is an error term
- Energy Quantification (thermal, exergy,
  useful work)

- Boundaries
- etc.

- Use Example of auto production throughout
  - Relevant to M ε
- What of Knowledge?
  - increase efficiency?   - Energy I-O literature
  - decrease waste?   - Barry and Falk
    - Economist article
- reduce material in P to accomplish same ends?
  and energy

- thermodynamic limits

- substitutibility of factors of production?
  Auto industry as an example.