Paths Forward for Sustainability Science?
Inter-dependence of the parts... (Pingali)

Framework

Analysis/Model results
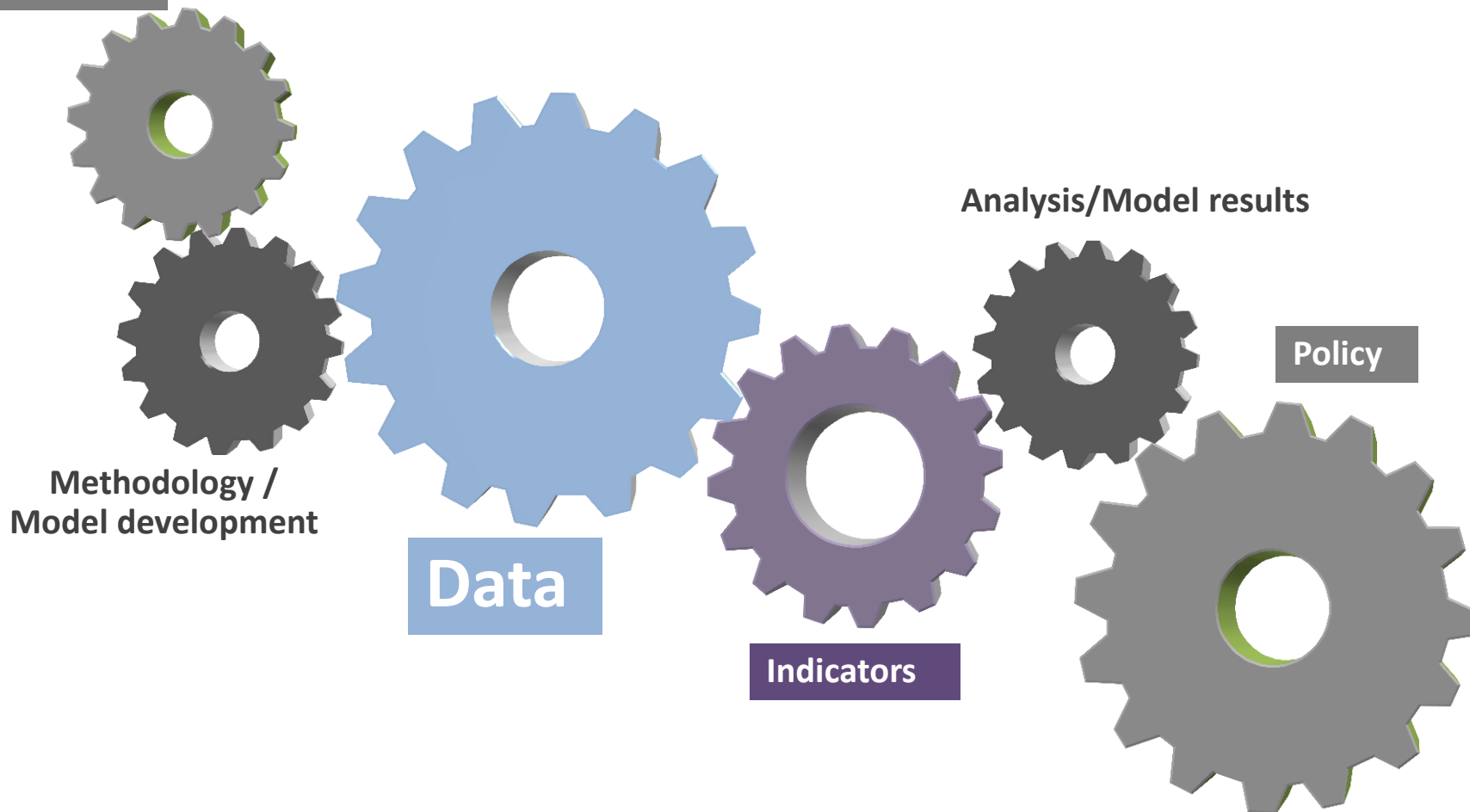
Policy

Methodology / Model development

Data

Indicators

Paths forward?: Frameworks

- Forgotten since Brundtland: *Sustainability* frameworks need to be about people, equity and the long run
- Progress since OCJ has involved disentangling…
  - Ends
    - Theory justified focus: human *wellbeing* aggregated X-space, time
  - Means
    - Capital asset stocks / state variables (C_n, C_m, C_h, C_s, C_k)
    - Production-Consumption systems (sectoral, place-based, or both) by which people access, use assets to create well-being
    - Actors (individuals, firms, governments) with agency / power they deploy to bend P-C systems to advance their views of well-being
- Gaps
  - Most research addresses 1 or 2 assets, ignores others
  - Agency and power relations remain understudied

Paths forward? Data & Indicators

- Progress since OCJ:
  - Strategically(How are we doing re SD?)
    - Need to track *all* asset stocks in chosen Framework... (eg. IWR)
  - Tactically (What to do next?)
    - *Particular* indicators in each asset "basket" chosen to reflect particular User/Policy needs
    - Additional indicators needed for use in social learning, adaptive management, avoidance of "bad places,"....
- Gaps
  - DATA so models, indicators reflect reality, not imagination
  - Tracking spillover impacts on other places/times (externalities)
  - Treatment of equity (distribution) in *access* to asset stocks

Paths forward? Models

- Progress since OCJ
  - Basic understanding models of SESs
  - IAMs… (John Weyant, Elena Bennett presentations)
  - Decision support models (lots, + RISAs, etc.)
- Gaps
  - Expert advice: Models are only one component
    - Howden's "hard in soft"; Dietz; role of facts, framing, learning
  - Need IAMs based on state variables of all capital assets
  - Taking seriously that SESs are complex adaptive systems
    - Models need to better handle human innovation re values, technologies, institutions…
    - Under-application of agent-based approaches

Paths forward? Other…

- Need for *sustainable development* puzzles
  - How have the SESs of particular places actually changed over long time scales of sustainability?
    - PNAS SF on Collapse (Butzer), IHOPE, Bennett's Tang challenge, our London…
    - But documenting change in key state variables (assets)
    - If most of key data is with historians, what role NAS?
- Need for community building
  - Lots of great ideas….
  - Training: Snowmass for Sustainability Science
  - The literature: JEL for Sustainability Science; ARER