Science of Science Management

Evaluation and Assessment Topics

October 2-3, 2008

NIH Campus

Bethesda, MD

Cornell University

Science of Science Management:

Systems Evaluation & Assessment

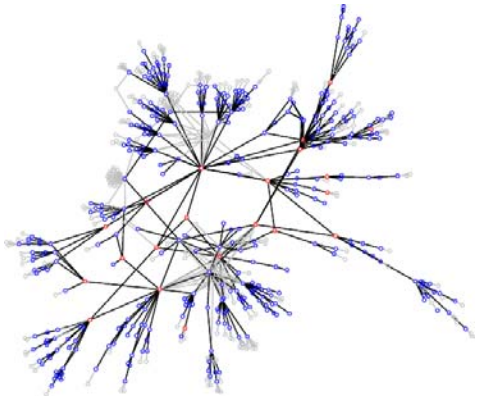
William M. Trochim
Cornell University

Science is organized knowledge.
Wisdom is organized life.

—Attributed to Immanuel Kant (1724–1804)

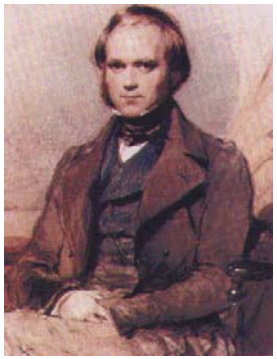
The *Systems* Challenge

- Science's Evolution
  - The rise of "big" science
  - Research & practice – integration and translation
  - Collaboration, specialization and disciplinarity
- Systems Issues
  - Science is a *complex* system
  - Science is a *social* system
- Requires a *science of systems*
  - Systems thinking and systems approaches



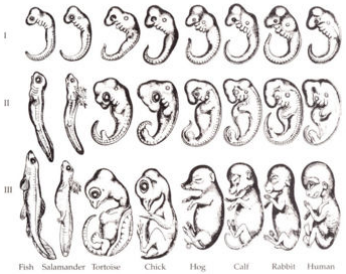
An *Evolutionary* Systems Approach

Evolutionary and systems theories



- Natural selection

- Artificial selection
- Ontogeny and phylogeny

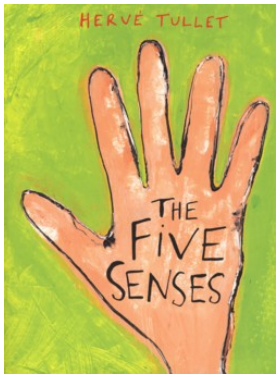


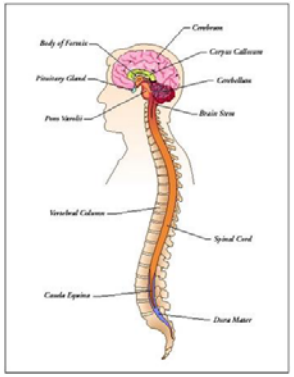
- Symbiosis and co-evolution

- Monoculture

Organizations as Organisms

Organisms have *built in*

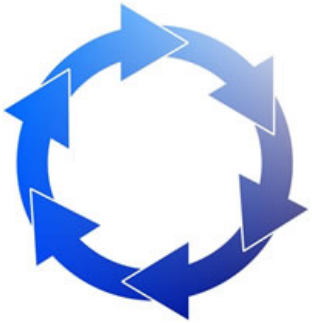




Organizations need to *create* these functions

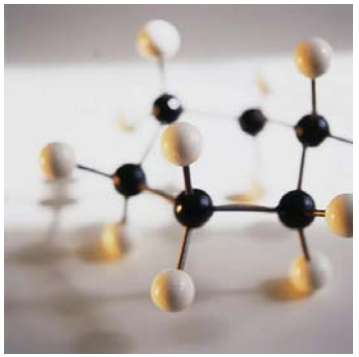
Evaluation in the Systems Context

- Roles of evaluation
  - Variation generation
  - Selective retention
  - Evaluation as *feedback*



- The problem with “traditional” evaluation
  - Traditional approaches not designed for systems contexts
  - The challenge of “control” in a complex dynamic context
  - The “wrong tool” and the potential for harm

- The need for “systems” evaluation
  - A difference of kind, not degree
  - Professional developments
  - Systems evaluation or systemic assessment?



Evaluation & Systemic Assessment Questions
How Can We…

- Develop a Comprehensive Conceptual Model
- Use Participatory and Collaborative Evaluation Approaches
- Incorporate Integrative Mixed Methods
- Integrate Evaluation With Existing Reporting Systems
- Adapt the Evaluation to the Initiative's Stage of Development
- Develop Standardized Cross-Initiative Evaluation Systems
- Utilize Peer Review Approaches
- Address Issues of Causation and Control
- Improve Funding and Organizational Capacity for Evaluation
- Address Management Issues in Large Initiative Evaluation

Trochim. W., Marcus, S.E., Mâsse, L.C., Moser, R.P., Weld, P. (2008). The Evaluation of Large Research Initiatives: A Participatory Integrative Mixed-Methods Approach, *American Journal of Evaluation*, 29, 1, 8-28.

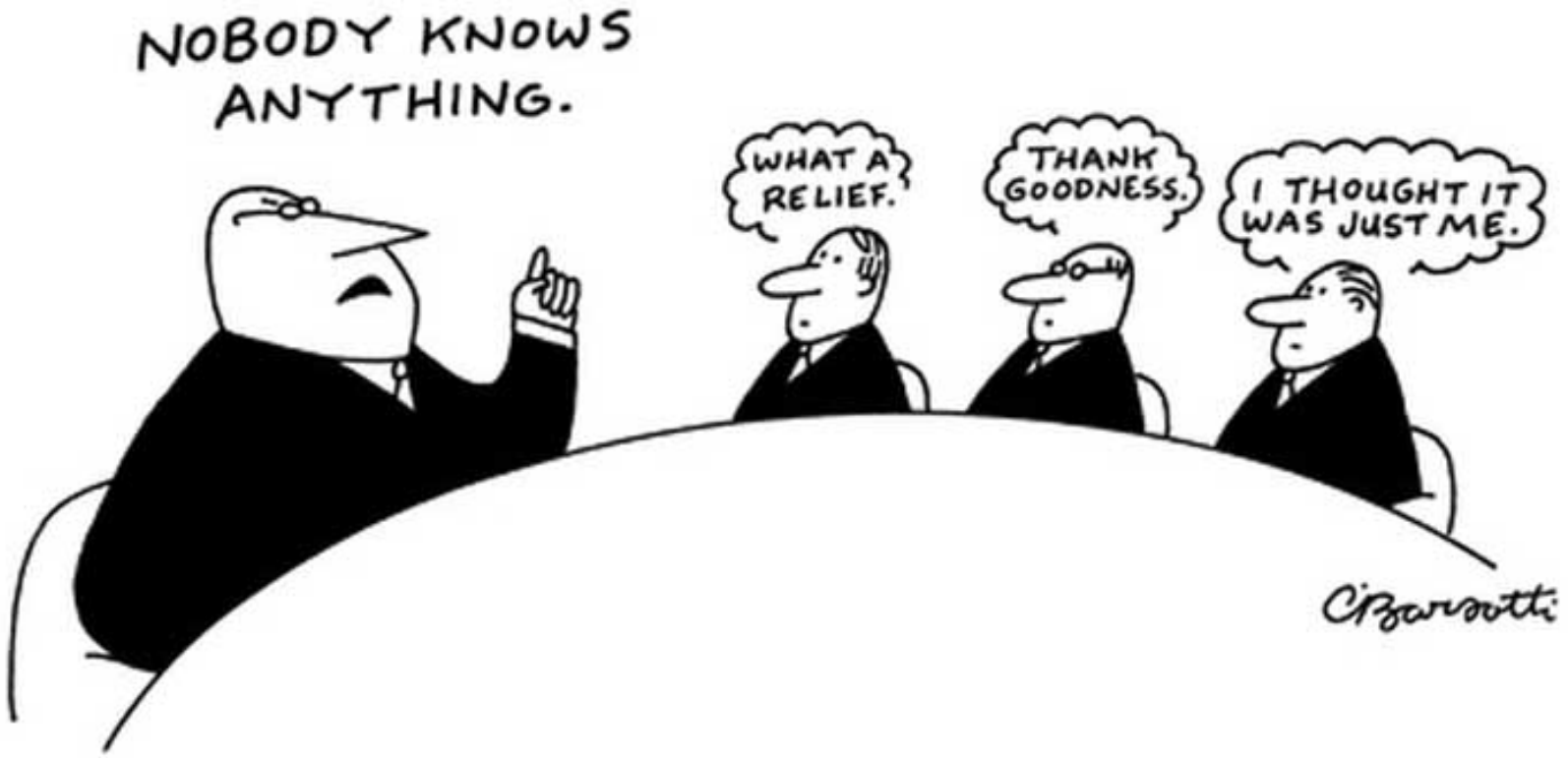
Can Scientists Manage Science?

"Sometimes I wonder if there's more to life than unlocking the mysteries of the universe."

Can We Use Old Methods for New Problems?

"Genetic engineering got us into this mess, and genetic engineering will get us out of it."

What Do We Know About SoSM?



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The Citation Revolution Meets the Identification Revolution:

Opportunities for Science Policy Evaluation and Assessment

Scott Stern
Northwestern University and NBER

NIH Science of Science Management
October 2008

Key Questions for Science Policy Evaluation and Assessment

- How do alternative funding strategies influence scientific research productivity?
  - People versus Projects
  - Investigators versus Teams
- How do alternative institutional settings influence the accumulation and exploitation of scientific knowledge over time?
  - Private sector versus Public sector
  - Open Access versus Restricted Access
- How does investment in fundamental life sciences research impact the development of life sciences technology and, ultimately, clinical outcomes?

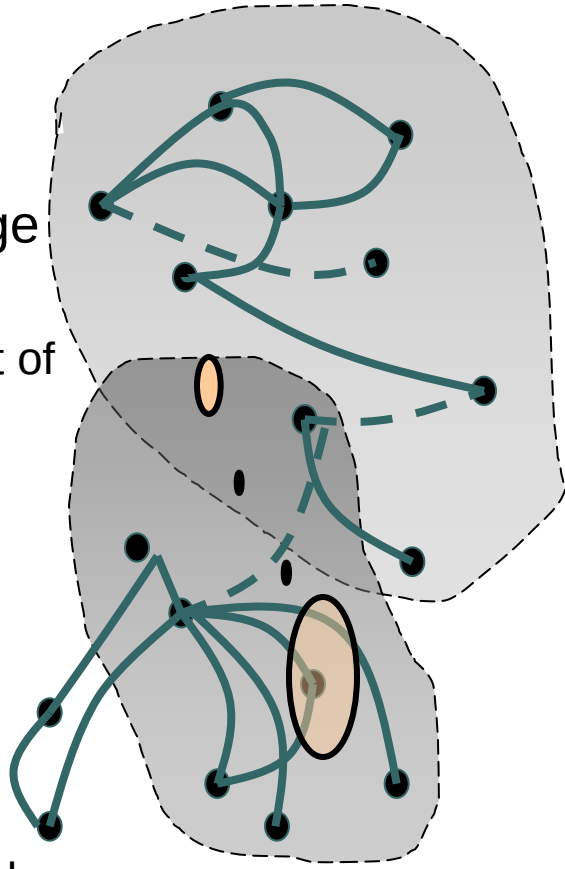
The Identification Challenge

- An Example: Does research developed within a university setting diffuse more quickly or have a higher impact than private sector research?
- Three Alternative Mechanisms…..
  - **The Selection Effect:** The research produced within a university has a higher level of intrinsic quality
  - **The Focus Effect:** The research produced within a university is more "basic" and thus induces more follow-on research (but may be less closely tied to clinical outcomes)
  - **The Marginal Effect:** Even for a given project, the policies and rules governing university research (openness, publication) *amplify* the diffusion and impact of research

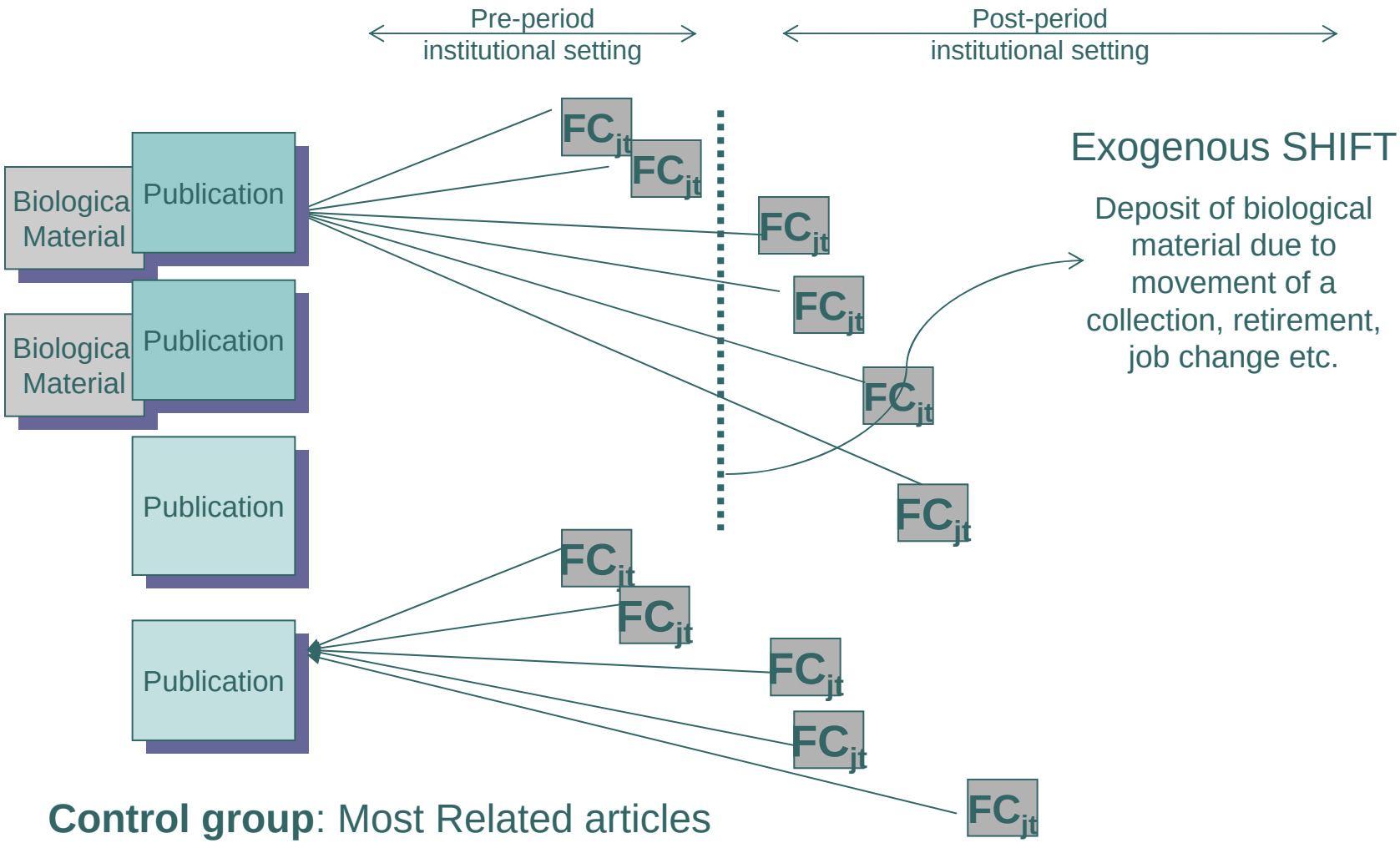
- *The science management implications of each mechanism is dramatically different*
  - *The Identification Revolution in economics and related disciplines focuses on how to use "natural experiments" to disentangle causal mechanisms and so provide direct evidence on the value of alternative "treatments" or policies*

The Citation Revolution

- Citations (or related *referencing information*) as a systematic (albeit imperfect) measure of the linkage among scientific researchers and scientific knowledge over time, space and context
  - The “pieces of knowledge” approach to the measurement of knowledge flows
- Dramatic improvement in our understanding of the *meaning and use* of citation information, in both publications and patents
- Relative to (even) 5 years ago, powerful tools :
  - Detailed statistical characterization of the relationship between cited and citer
  - Construction of co-author, citation, & collaboration networks
  - Identification of “comparable” pieces of knowledge” focuses attention on the impact of policies and institutions on the diffusion of knowledge over time, space and context



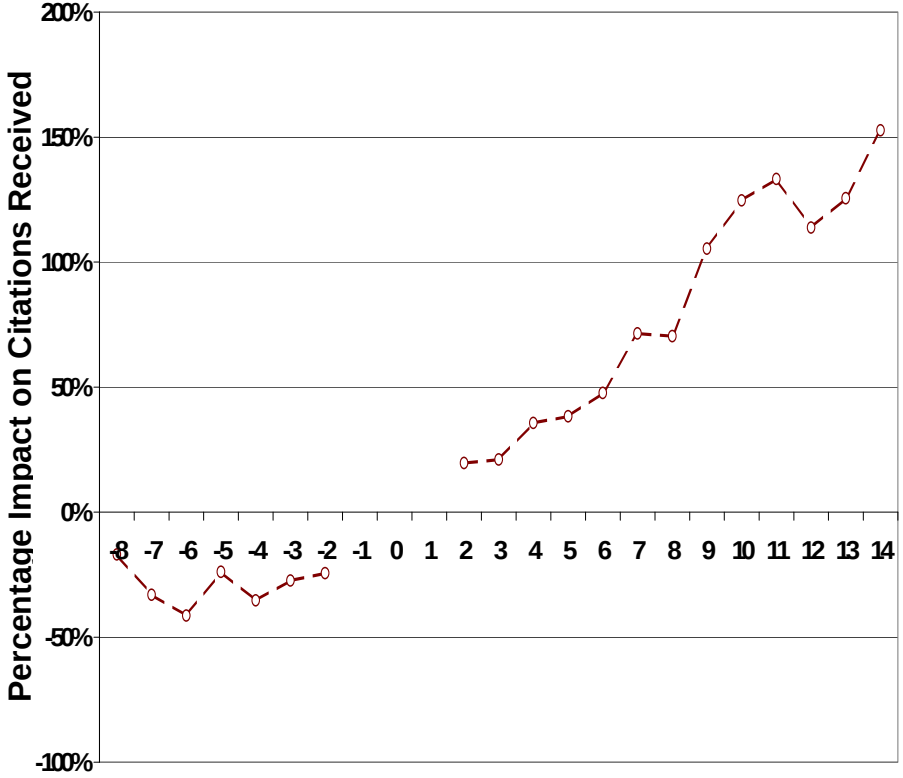
The Citation Revolution Meets the Identification Revolution



Control group: Most Related articles in the same journal & issue

What is the impact of ensuring independent access to certified biological materials?

The Impact of BRC Deposit on Follow-on Citations



A "Natural Experiments" Approach

- Controlling for the quality, age, and timing of each article, Furman and Stern (2008) find that BRC deposit is associated with more than a 70% increase in the rate of citation to a linked research article
  - Lots of robustness and validity checks
- Rate of return calculation suggests that BRC deposit is at least 3X more effective at enhancing research productivity than simply funding additional research projects

Creating a Science of Science Management at the National Institutes of Health

- ***Join the Identification Revolution:*** The scope for *causal* inference regarding alternative science policies and institutional arrangements seems promising
  - Many alternatives and "quirks" in the system (cut-off points, idiosyncratic events) help identify key natural experiments
  - While one must be cautious about potential interpretations, potential for rigorous cost-effectiveness analysis
- ***Lead the Citation Revolution:*** The NIH has the scope not simply to exploit citation data but to substantively change the meaning and precision of citation information
  - The Allocation and Meaning of Scientific Authorship
    - Conceptual contributions versus implementation
  - The Allocation and Meaning of Citations
    - Citation Categories, Citation Checking
  - Impact-Oriented Funding Criteria

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Musings on Meta-analysis and Scientific Progress

David B. Wilson, Ph.D.
George Mason University

October 3, 2008

The Big Picture

- "Chaos in the brickyard" (Bernard Forscher, 1963; Mark Lipsey, 1997)
- Science is about the accumulation of knowledge
- We must take seriously the task of synthesizing findings across studies

Role of Meta-analysis

1. Making sense of existing evidence
2. Establishing gaps in current knowledge-base
3. Credible approach to informing policy

Challenges to Advancement

- Lack of sufficient replications
- Meta-analysis needs core elements across studies or sites
- Scientific culture rewards innovation and uniqueness
- Excitement of science is pursuing one's own ideas

Promising Developments

- Multi-site evaluations and projects
  - Tremendouse potential for the application of meta-analysis
  - Requires (some) core data elements across sites
  - Requires examination of (some) core research questions across sites
- Registries of clinical trials (should be expanded to more than just clinical-trials)
- Increase in data repositories
- Prospective meta-analysis

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Evaluation in the Context of Science Management

Doris M. Rubio, PhD
Director, Center for Research on Health Care:
Data Center
Co-Director, Institute For Clinical Research Education
Associate Professor of Medicine, Biostatistics, Nursing, and
Clinical and Translational Science

University of Pittsburgh | ctsi | CLINICAL + TRANSLATIONAL SCIENCE INSTITUTE

Evaluating Science Challenges

- What is the 'IT' we are evaluating?
- What is the numerator/denominator?
  - How many people does it take to produce a Rembrant?
- Examples of science management issues:
  - Mechanisms - K23 versus K12
  - Policies - Multiple PI versus Single PI
  - Interventions – CTSA versus GCRC, K30, K12
  - Programs – US versus Sweden or Israel

Evaluation Methods

- Tradition – case studies, bibliometric, etc
- Prospective
  - Plan for evaluation
  - Develop web-based data capturing system
  - Foster real time data
  - Analyze current research paybacks
  - Facilitate the exchange of data
  - Investigators submit reports annually→5 years post

Infrastructure for Data Capture

- Database structure
  - Each core develop criteria
    - Knowledge assessment
    - Knowledge generation
    - Knowledge utilization
    - Public Health Impact
  - May need surrogate for criteria
  - Criteria that are feasible, measureable, and have the flexibility of adaptation

Data Capturing System Challenges

- Track success of Investigator, Field, or Institution?
- Mindful of complexities
  - US – most Nobel prize winners, patents
  - One of the worst health care systems
- What other variables impact public health?

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