

Science of Science Policy: The Vision & Reality

Bill Valdez

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Original Vision of SoSP

Jack Marburger asked 2 simple questions:



“If I had \$10 of extra budget,
how much do I allocate to biology?
Physics? Chemistry?”

“How do I explain that
decision to the President?”

The Context

Jack was faced with a difficult environment:

- Aftermath of 9/11
- Creation of DHS & Focus on Terrorism
- Climate Skepticism

And he wanted help from social and economic sciences to create a Supplement for **Expert Judgement**:

- Data-Driven Decision Support Tools
 - “How Much?”
- Data-Driven Resource Allocation Justifications
 - “Why?”



Models Already Are Core Agency Decision Support Tools

At this conference we've seen models for:

- Climate Change
- Urban Studies
- Infectious Diseases
- Physics
- Biology
- Innovation

*So What's the Problem
We're Trying to Solve?*

The Reality:

Resistance to Use of Models and Decision Support Tools For Internal Agency Processes

Jack was on the right track, but was only attacking a subset of the larger problem:

The Federal government is the largest, most complex organization in the world...

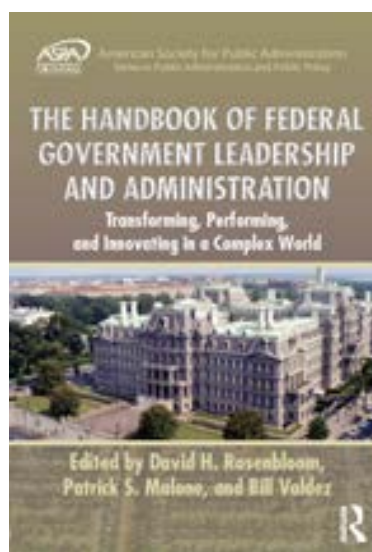
...but continues to use outdated decision support tools/processes for all of its business processes.

Some Key Facts

- Federal R&D funding is \$140 Billion concentrated in 17 agencies.
- Federal government has:
 - \$3.8 trillion budget
 - 2.8 million employees & 17 million contract employees
 - 1,400 business units

And touches the lives of every American on a daily basis...

...and, yet, remains one of the most poorly understood and studied organizations of its kind.



Models & Decision Support Tools Currently Are Not Used For:

- Budget Formulation/Execution
- Workforce Analyses
- Resource Allocation Decisions
- Risk Analysis
- Project Management
- Procurement Decisions
- Portfolio Balancing

***All of These Functional Areas Are
Guided by Expert Judgement***

What Drives Policy Makers?

Three Primary Drivers:

- Budget
 - Annual budget cycle dominates planning and decision making in the bureaucracy.
- Proximity to Power
 - Politicals, by law, are the ultimate decision makers.
- Mission Accomplishment
 - Congress & the President determine and guide Agency missions.

How Would Models Help?

- Resource Allocation Decisions
 - Budget Formulation/Execution
 - Workforce Analyses
 - Risk Analyses

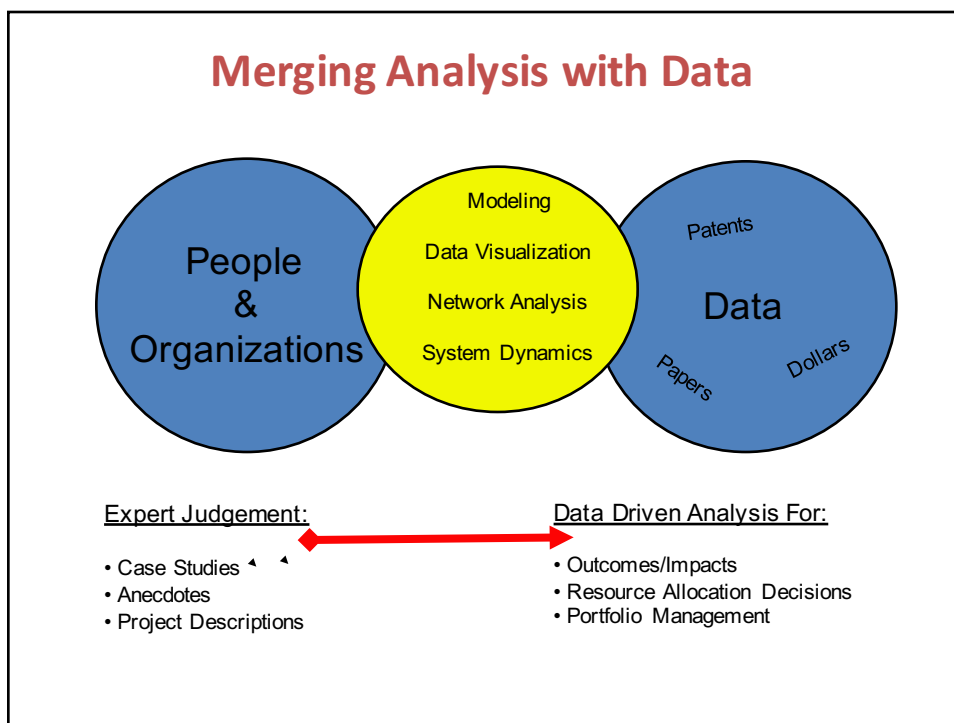
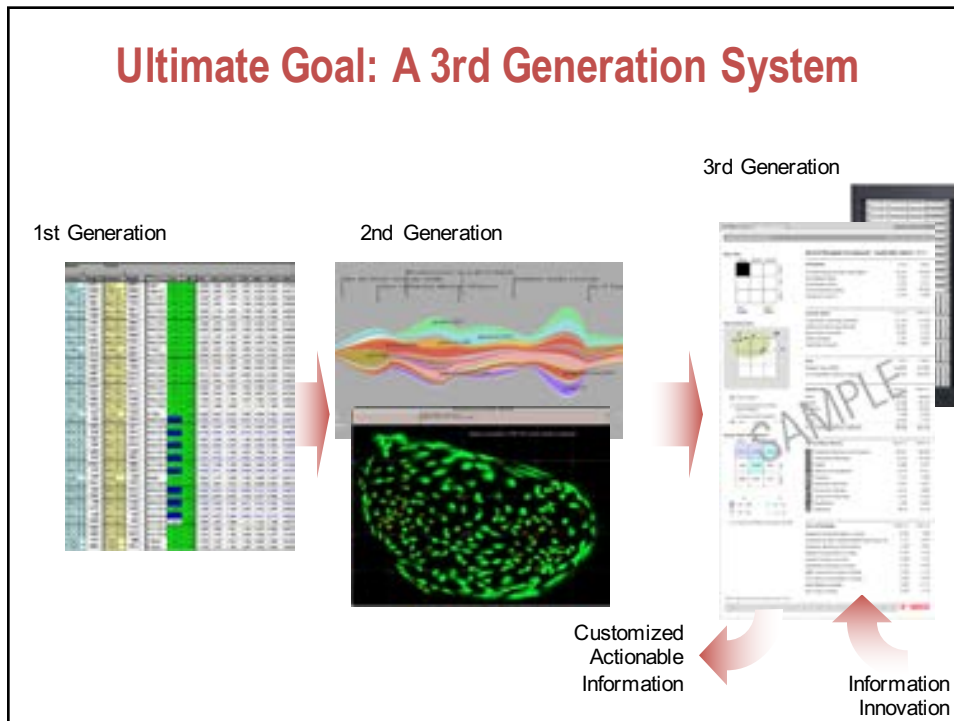
 - Defense/Promotion of Agency Mission
 - Clean Energy Economy
 - Homeland Defense

 - Crisis Management
 - Zika
 - Hurricane Katrina
 - 2007 Recession
- Currently, however, all of these decisions are made through expert judgement and in a highly fragmented operating environment.*
- Systems thinking is rarely a part of the decision making process.*

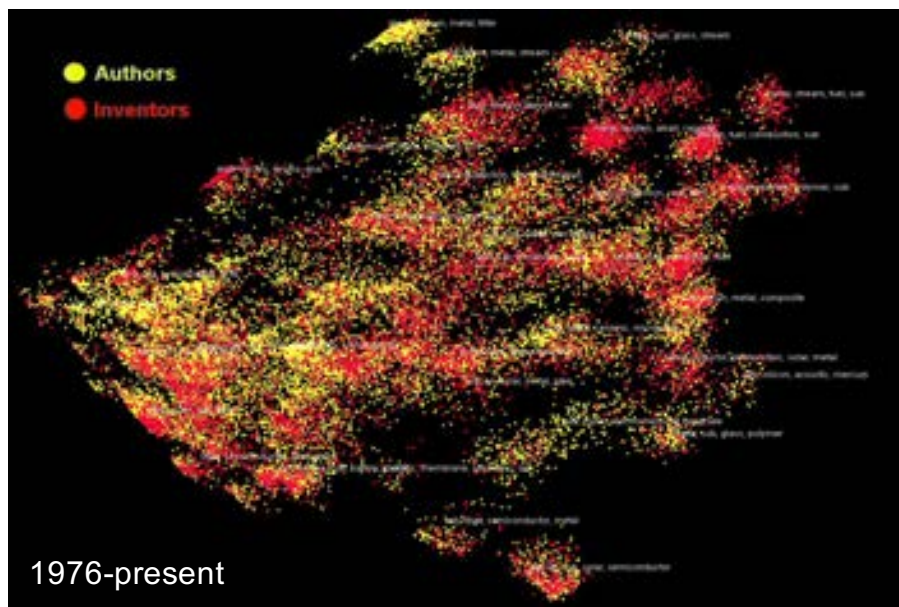
What is Needed

Jack's vision of data-driven decision support tools will come to fruition if:

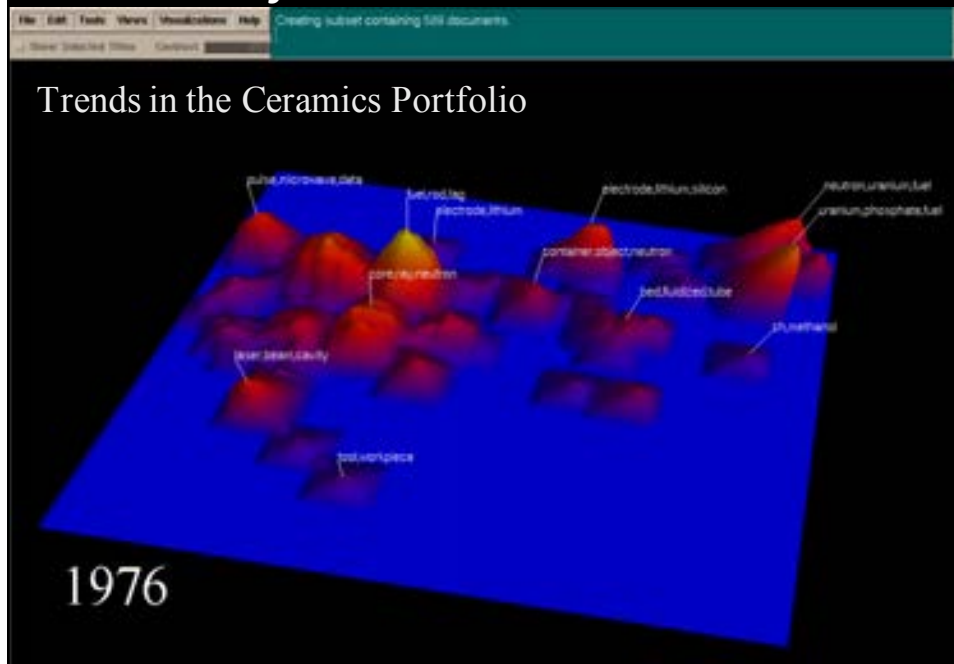
- Dan Mote's views on culture take hold (cultural accelerants and barriers).
- Sandy Petland's innovative uses of big data can drive policy/budget decisions.
- Basic agency business processes utilize models on a routine basis.

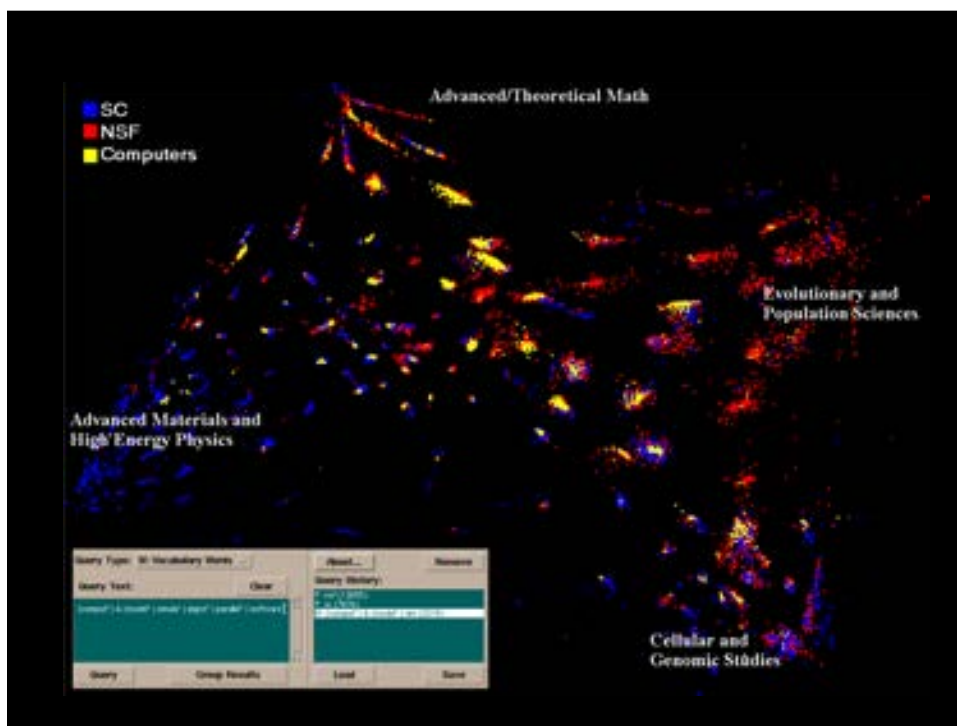
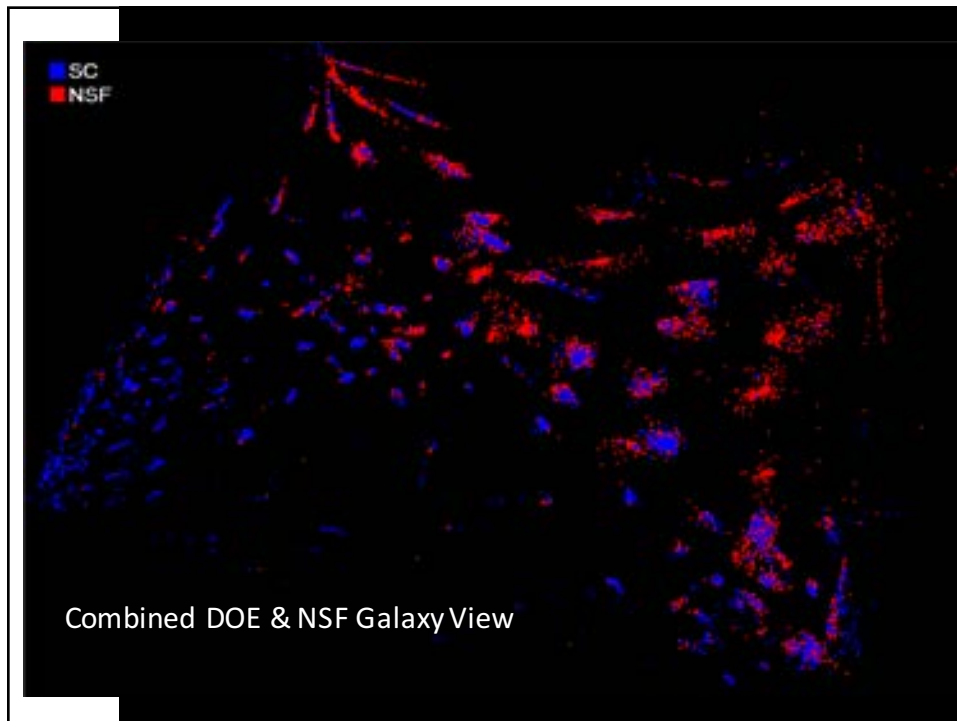


“Galaxy View” of 52,000 Researchers



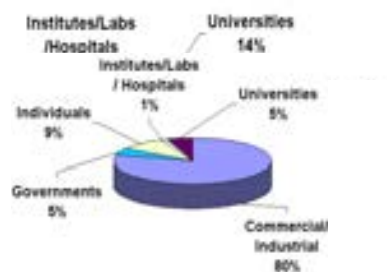
Portfolio-Level Views with SPIRE





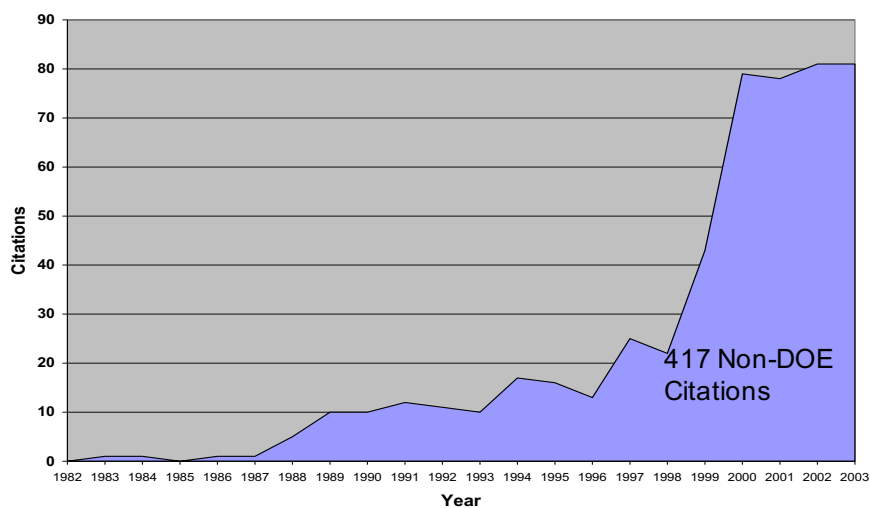
DOE Patent Analysis Tool - Data

- Abstracts and background data from 12,869 patents originating from work sponsored by DOE
- Abstracts and background data from 50,263 patents that cite DOE patents as prior art representing 82,737 citations
- 1,231 Distinct organizations have attributed one or more of their patents to work sponsored by DOE

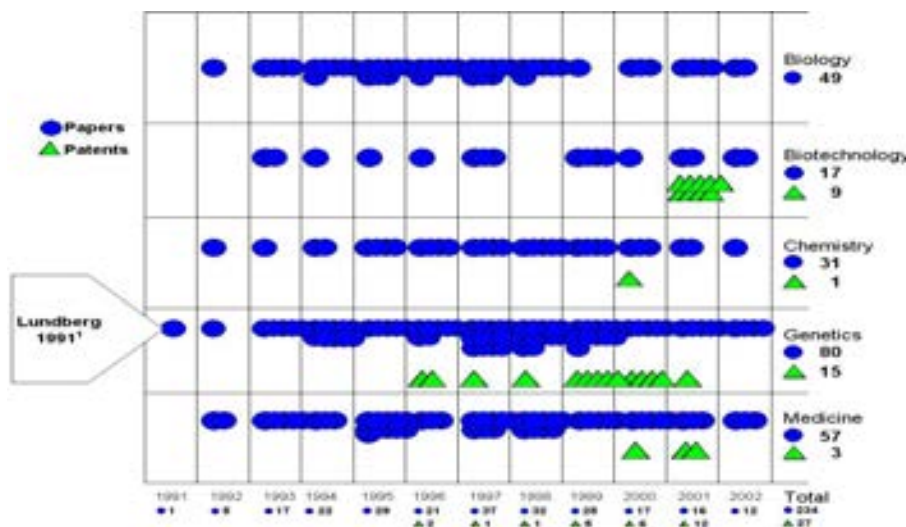


13,345 Distinct organizations have cited one or more of DOE patents as prior art.

Citations of DOE Patents in Surgical Application of Pulsed Laser Technology



Knowledge Amplification Effect



¹Lundberg, KS, et al. (1991) "High-fidelity Amplification Using a Thermostable DNA-polymerase Isolated from Pyrococcus-futuosus", Gene, vol 108, p. 1.

Surgical Application of Pulsed Laser Technology

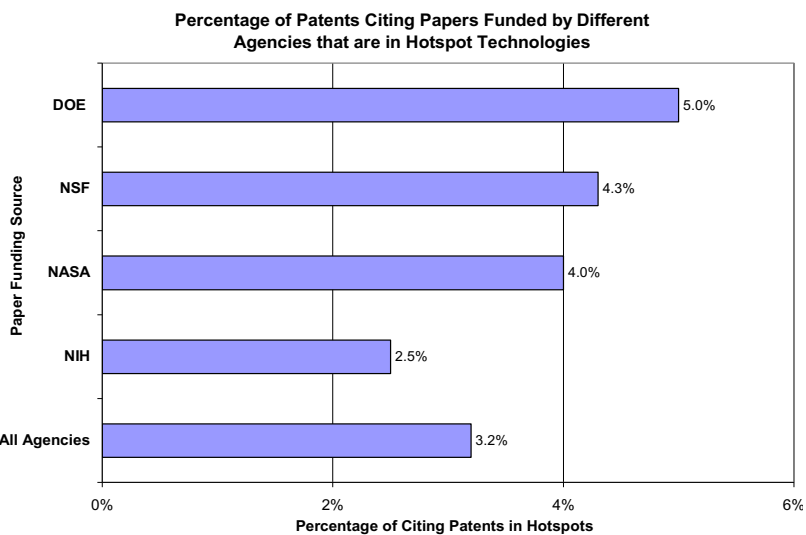
DOE holds 5 patents related to the surgical application of pulsed laser technology:

- 4,381,007, Multipolar corneal-shaping electrode with flexible removable skirt.
- 4,326,529, Corneal-shaping electrode.
- 4,686,979, Excimer laser phototherapy for the dissolution of abnormal growth.
- 4,349,907, Broadly tunable picosecond IR source.
- 5,720,894, Ultrashort pulse high repetition rate laser system for biological tissue processing.

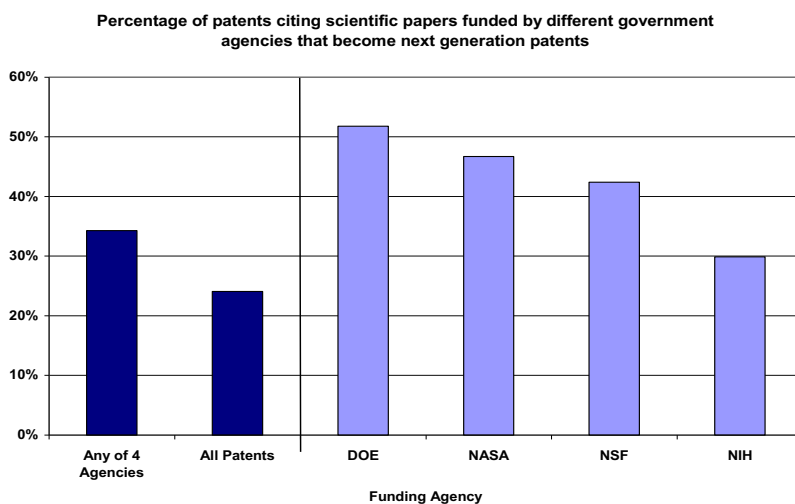
Although most of the underlying research was originally conducted in the early to mid 1980's, these patents continue to generate broad interest within the medical community.

To date, these patents have been cited in over 350 patents from some of the world's leading innovators in surgical equipment and techniques.

Patents that cite papers funded by DOE are more likely to be in Technology Hotspots than patents that cite papers funded by other agencies



Patents citing public science are also more likely to become next generation successor patents

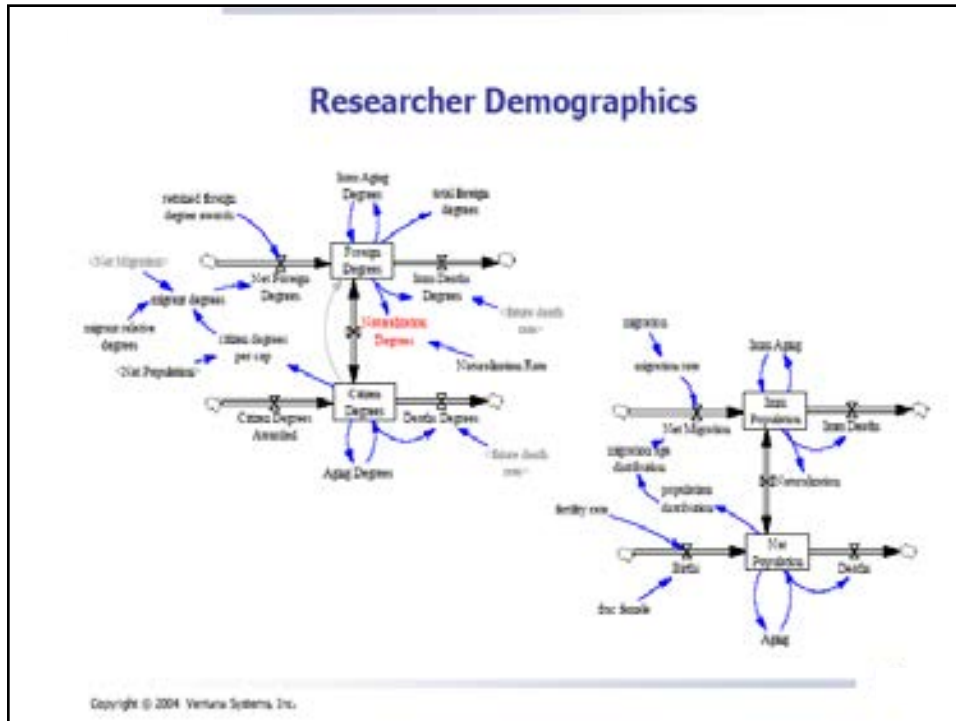


System Dynamics Modeling for a Dynamic System

What would the models look like and what will they tell us?

- System Dynamics Modeling is an alternative to Optimization/Econometric Modeling.
- Builds on work done by Jay Forrester, MIT, over past 45 years.
- Uses “soft data” and “system attributes” to model non-linear systems, such as R&D and knowledge.
- Results are “scalable” and can go from project to organization to system.





S&E Workforce Model

- Connects funding to health of science disciplines
- Assesses supply-demand balance and wage effects
- Facilitates lab-university resource allocation

What are the Barriers to Use of Models for Decision Support?

- Absence of Funding for Data Collection/Modeling
- Lack of Career Staff Expertise with Models
- Complexity of Use
- Short Attention Span of Political Leadership
- Institutional Inertia
 - Expert Judgement
 - Budget/Procurement Processes
- Fear of Transparency
- Deep Distrust of Social/Economic Sciences

Don't Underestimate the Impact Of Deep Distrust

Physical phenomenon can be measured against objective criteria and theories developed over millennium, while organizational/human behavior has only been studied for two centuries:

- Weather Forecasting vs. Psychology
- Physics vs. Economics
- Seismology vs. Organizational Dynamics