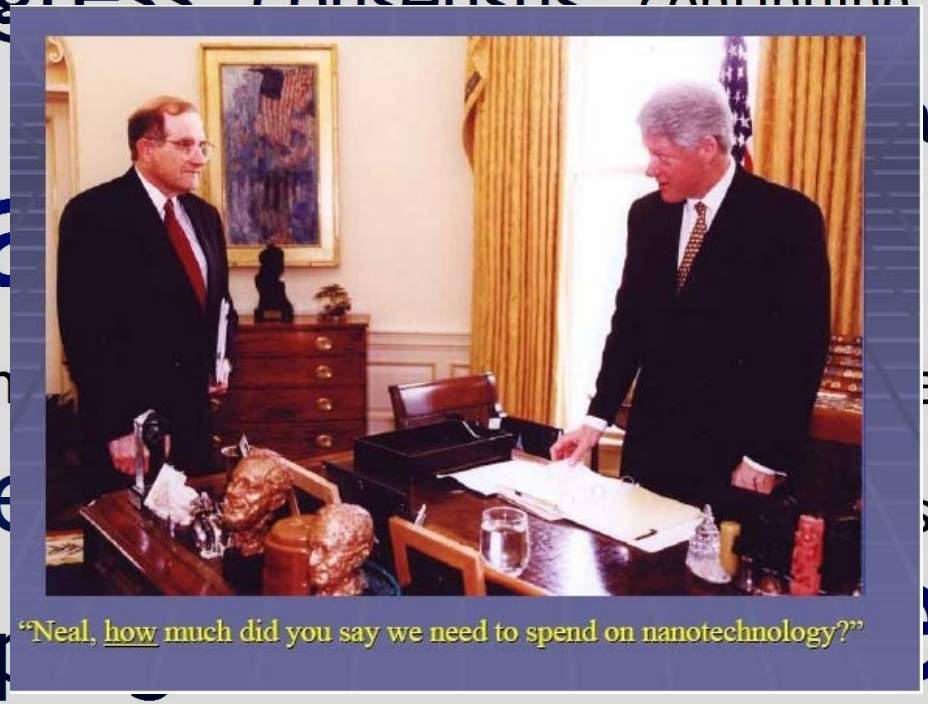
Science of Science & Innovation Policy

Julia Lane
National Science Foundation

aci activities address administration agencies basic believe bills budget capacity change competitiveness concern congress consensus continuing doubling economic nded fact federa fyi generation impact im ent issues marburge policy private product p earch resources science share sustained term university year



Graphic Source: 2005 Presentation by Neal Lane on the Future of U.S. Science and Technology
Tag Cloud Source: Generated from 2007 Presentation by John Marburger on Science Policy and Budget Issues

Scientists Can Provide a ‘Black Box’ Answer

ROMAN AUGURS: Roman augurs foretell the future by observing the behavior of hens

Or, since science and innovation are fundamentally human and social activities, we could use science to answer these questions

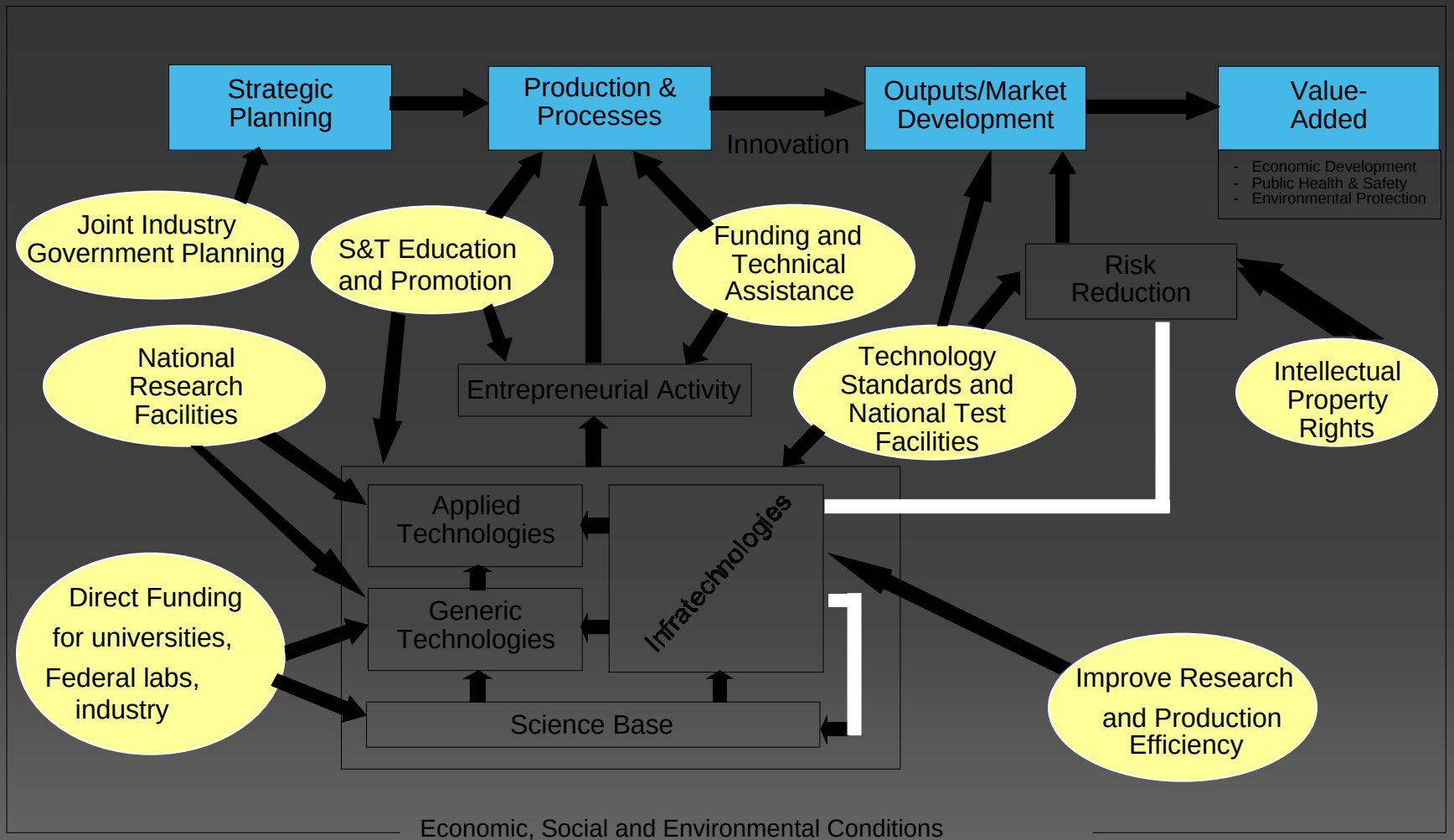
Change in economic activity

- Food
- Goods
- Ideas
  - R&D only one component
  - Complex interrelationships of human beings and social organizations

Existing Views of Systems of Innovation

Compilation by G. Jordan
2007

Showing Government Policy Interventions in the Innovation System



Derived from G. Tassey, National Institute of Standards and Technology, U.S.A. 1991

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Key Indicators in an Innovation Systems Evaluation Framework

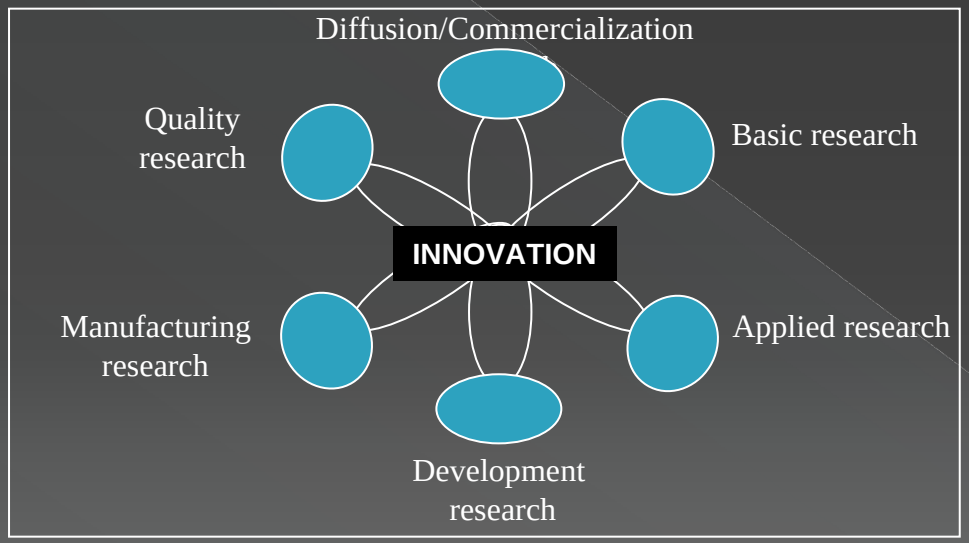
High risk capital – available where

Capabilities – Level, mix, availability

Modes of coordination effective?

Policy Objectives
-Structural
-Technical

Macro- Institutional Rules as they affect the sector



Meso - Performance by Tech sector and arena

Socio economic outcomes

Technical progress

Network connectedness

Micro - funds allocation by arena and profile

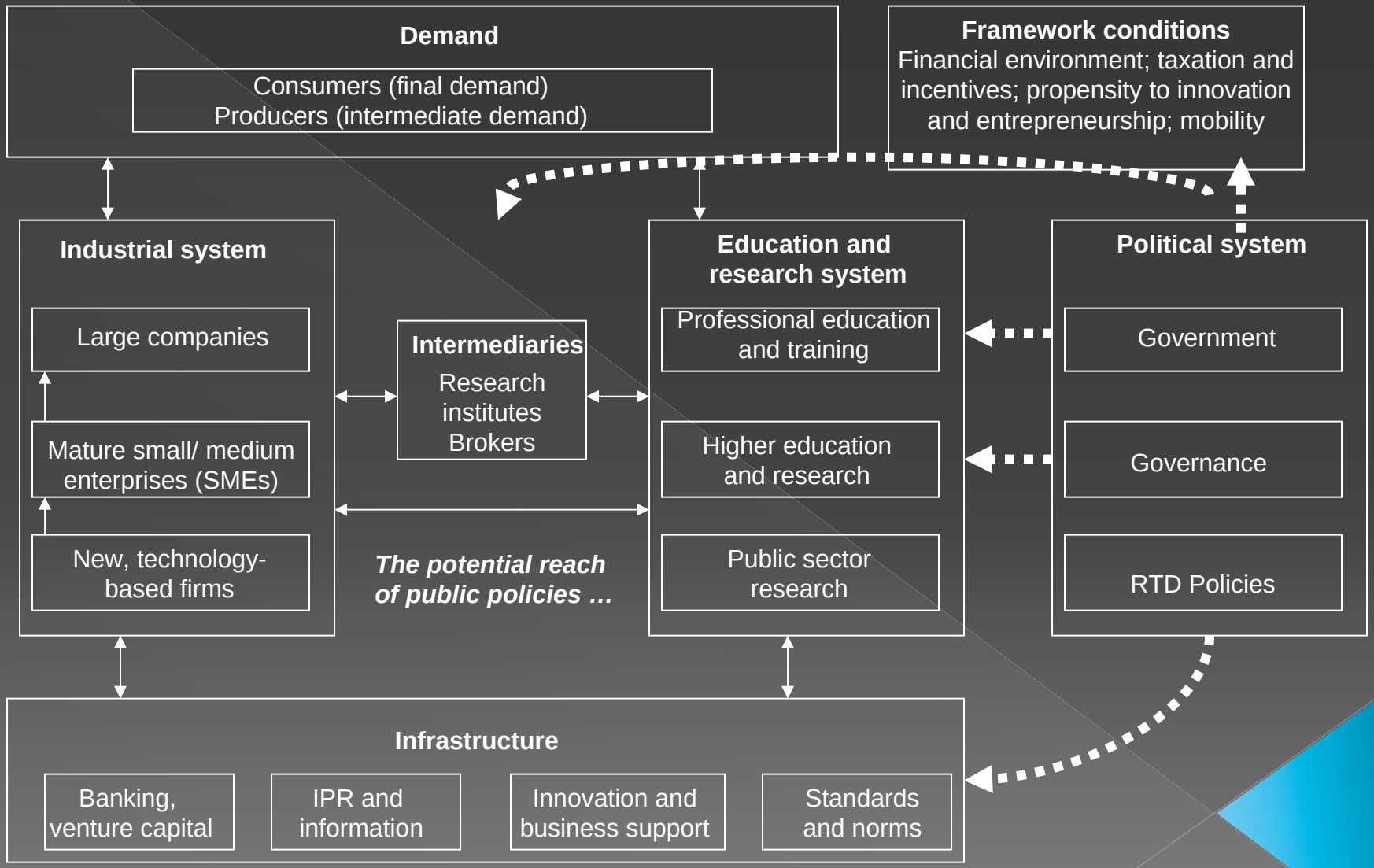
RTD arenas – are there sufficient funds?

Portfolios - need more/ less radical, large scope?

Organizational profiles – do attributes match the profile?

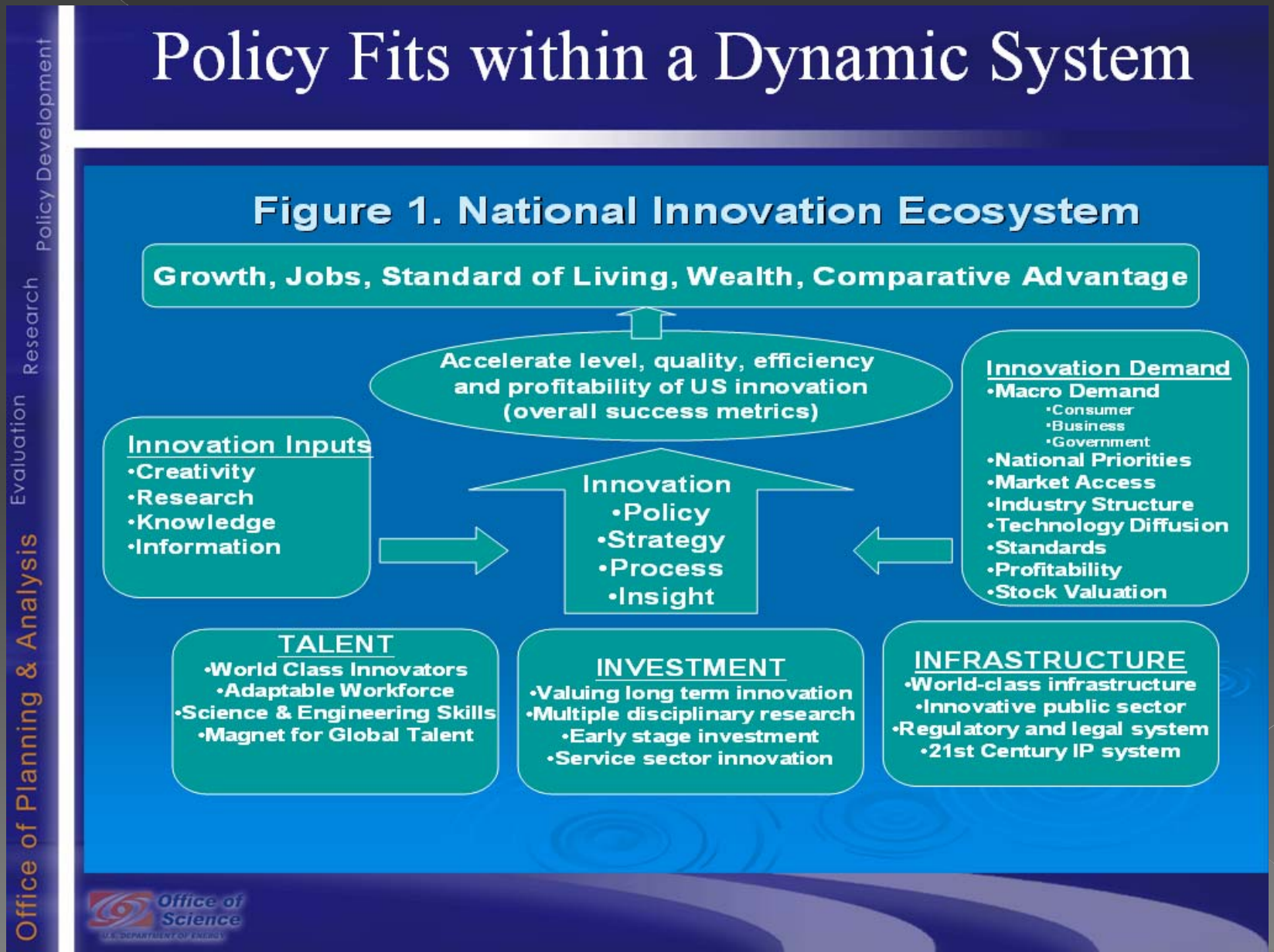
Source: Jordan, Hage and Mote, 2006, 2007

A National Innovation System Model



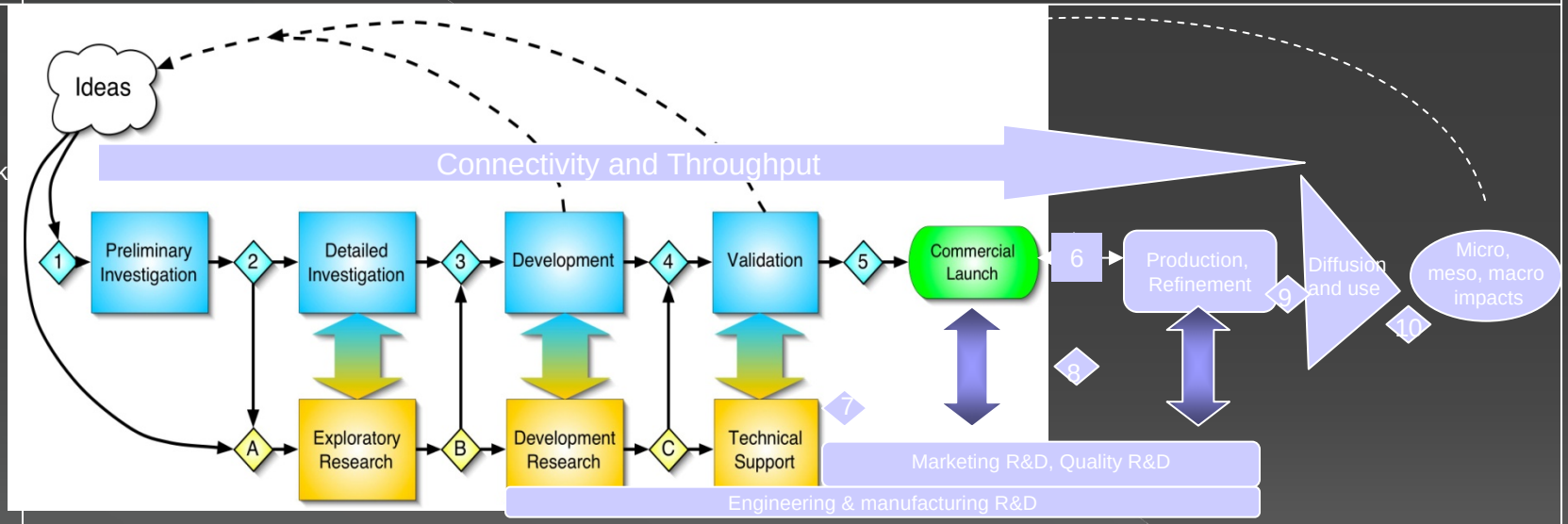
Source: Arnold and Kuhlman, 2001

U.S Council on Competitiveness, 2004



Multiple levels of influence and assessment within an emergent RTD system

Draft 10/20/2005
G. Jordan

Macro (nation, State) IMPACT	**Ideas, Tools, People, Transitions to application**	**New product development** & diffusion	**Public goods, policy**	**Private goods, competitiveness**	**Socio-economic Institutional change**
	Resources, Management, Relationships, Incentives, Institutional Blocks, Influence				
Meso (Sector, RTD Area)	**Science research & education**	**Technology & product development** & diffusion	**Governmental Institutions**	**Business Infrastructure**	**Socio-economic Institutions, Norms**
	Resources, Management, Relationships, Incentives, Institutional Blocks, Influence				
Micro (Orgn., network level)					
INPUTS External Influences	Resources, Management, Relationships, Incentives, Institutional Blocks, Influences				
	Science research & education (General & specific) - Macro -Meso (discipline, problem area -Micro (org., lab, individual)	**Technology & product development** & diffusion (Industrial & public) - laboratory & operational) - Supporting technologies (infra-technologies, generic, & specific)	**Governmental Institutions, Policies** - multi-national - national - regional, state, local	**Business Infrastructure** -Sector level (meso) -Firm (micro)	**Institutions, Norms** -Economic -Socio-cultural

Pieces borrowed from R. Cooper/ Exxon, E. Rogers, Arnold & Kuhlmann, Hage & Hollingsworth, G. Tassey

Science of Science Policy

- Interagency group
  - Roadmap
  - Workshop
  - Wiki
  - Ongoing Activities
- NSF's SciSIP program
  - Investigator initiated research
  - Statistical program (SRS)

The Science of Science Policy: A Federal Research Roadmap

Report on the Science of Science Policy to the

Subcommittee on Social, Behavioral and Economic Sciences
Committee on Science
National Science and Technology Council
Office of Science and Technology Policy

November 2008

The Road to the Roadmap

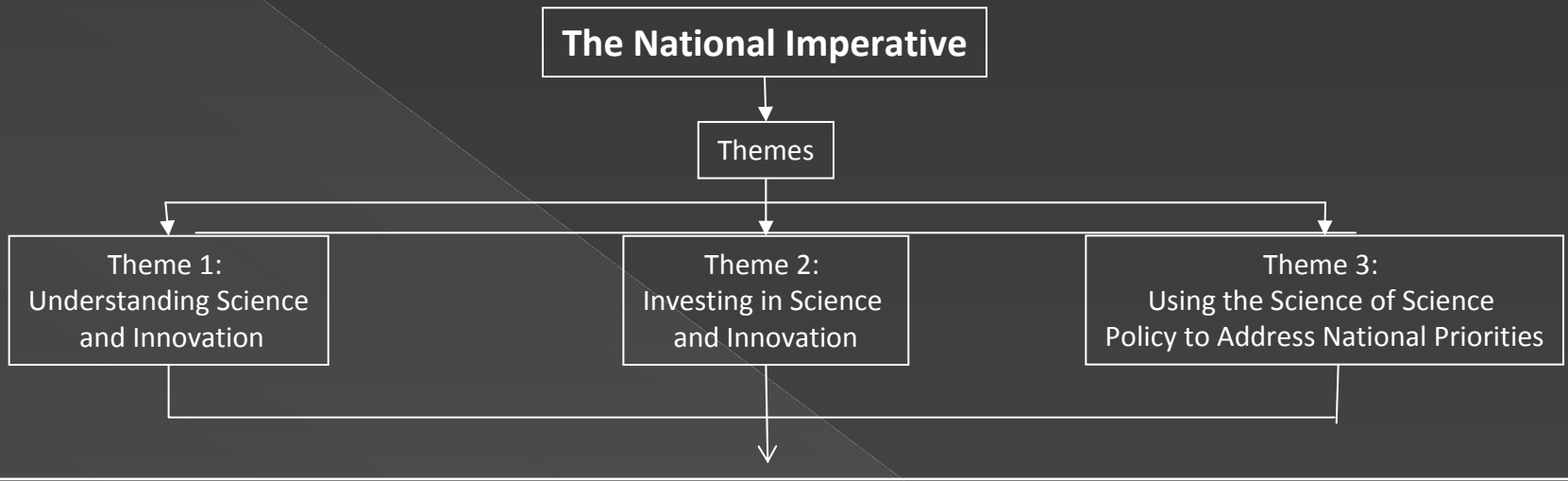
- Two years of effort by 17 Federal Agencies
- Literature Review, Questionnaire, Data Investigations, and NSF's SciSIP Program Provided the Data and Analysis
- Presentations at AAAS, AEA, WREN and Elsewhere Provided Context and Critiques
- Extensive interagency concurrence process
- This workshop to solicit community advice

SoSP Roadmap

- Defines the national imperative for SoSP
- Three Key Themes respond to the imperative:
  - Understanding Science and Innovation
  - Investing in the Innovation Process
  - Using the Science of Science Policy to Address National Priorities

Primary Conclusion: "Expert judgment" remains the best available decision support tool for science policy makers, but a nascent community of practice is emerging in the science policy arena that holds enormous potential to provide rigorous and quantitative decision support tools in the near future. Support and development of this emerging community of practice can provide the Federal government with these much-needed decision tools.

Structure of The Roadmap



Science Questions

1. What Are The Behavioral Foundations Of Innovation?
2. What Explains Technology Development, Adoption And Diffusion?
3. How And Why Do Communities Of Science And Innovation Form And Evolve?
4. What Is The Value Of The Nation's Public Investment In Science?
5. Is It Possible To "Predict Discovery"?
6. Is It Possible To Describe The Impact Of Discovery On Innovation?
7. What Are The Determinants Of Investment Effectiveness?
8. What Impact Does Science Have On Innovation And Competitiveness?
9. How Competitive Is The U.S. Scientific Workforce?
10. What Is The Relative Importance Of Different Policy Instruments In Science Policy?

Findings

Recommendations

SciSIP Program

SciSIP Goals

Understanding

develop usable knowledge and theories

Measurement

improve and expand science metrics, datasets and analytical models and tools

Community of Practice

cultivate a community of practice focusing on SciSIP across the academy, the public sector and industry

The Challenge:
Understanding innovation and the scientific enterprise

- Data Issues
  - Units of analysis?
  - Massive data from heterogeneous sources
- Conceptual issues
  - Creation and transmission of knowledge
  - Complex interactions of actors
- Analytical issues
  - Outcome measures?
  - Counterfactuals?
- Empirical issues
  - Role of standard statistics?

Awards from Solicitation I

- **Human capital development and the collaborative enterprise:**
- **Returns to international knowledge flows**
- **Creativity and innovation:**
- **Knowledge production system:**
- **Science policy implications:**

Awards from Solicitation II

- Describing the Role of Firms in Innovation
- Measuring and Tracking Innovation
- Measuring and Evaluating Scientific Progress
- Advancing Understanding of Collaboration and Creativity
- Knowledge sharing and creativity
- Implementing Science Policy

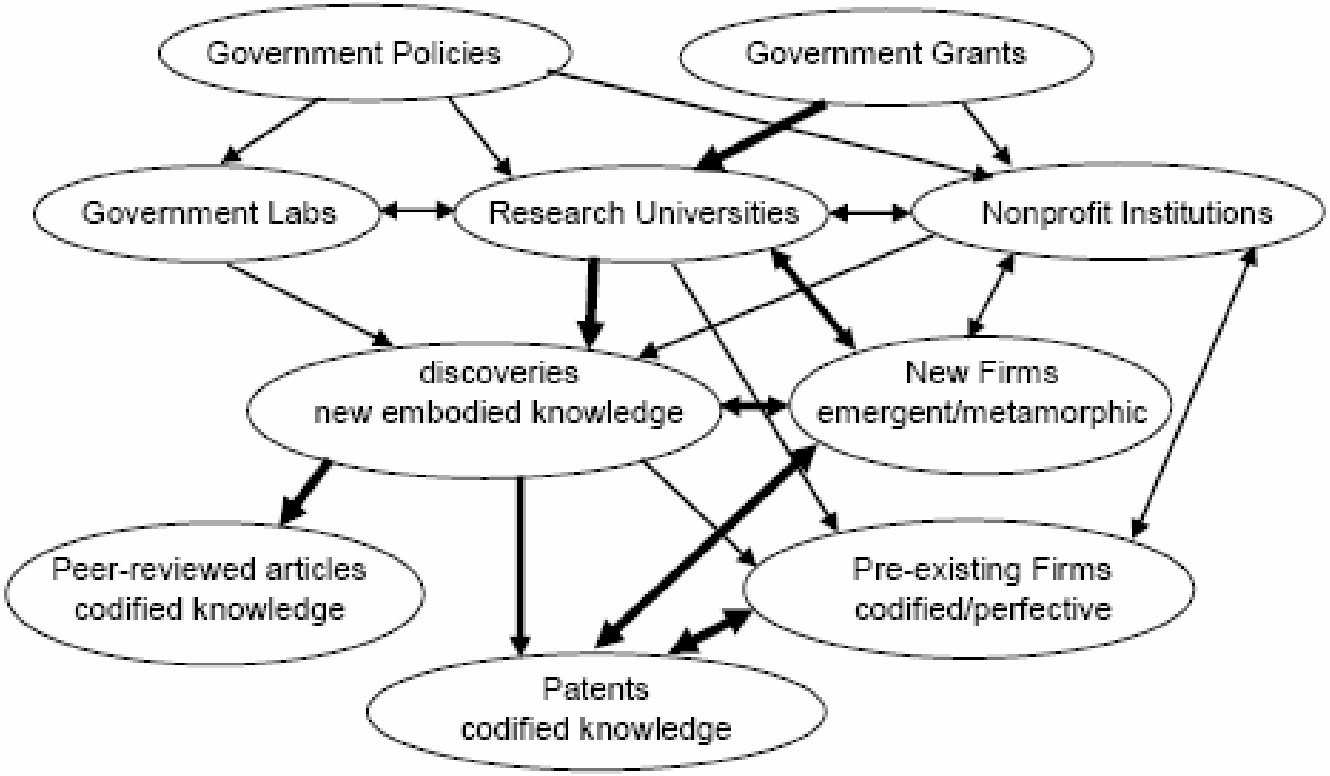
Solicitation III

- Testbeds on Organizations and Innovation
- Visualization (drawing particularly on visual analytics)
- International Collaborations

Selected awards of interest

- Linking Government R&D Investment, Science, Technology, Firms and Employment: Science & Technology Agents of Revolution (Star) Database (Lynne Zucker and Michael Darby, University of California, Los Angeles)
  - Data creation with links from government investment in R&D through the path of knowledge creation, its transmission and codification; then commercialization
    - NSF, NIH, DoD and DoE grants,
    - All journal articles and citations, high-impact articles, highly-cited authors, UMI ProQuest Digital Dissertations
    - US utility patents (complete/parsed/cleaned),
    - Venture capital, IPOs, web-based firm data, and links to major public firm databases via ticker symbols and/or CUSIP numbers.
    - Concordance linking STAR IDs to the IDs in the Census Bureau's Integrated Longitudinal Business Database (ILBD) and Longitudinal Employer-Household Dynamics (LEHD) program, Census data, for use within the Census Research Data Centers.
  - Dissemination
    - a public graphics-based site primarily oriented toward policymakers and the media,
    - a public site providing access to researchers for downloads and database queries limited to the public constituent databases or aggregates derived from the licensed commercial databases, and
    - on-site access at the National Bureau of Economic Research providing researchers access to the complete STAR Database

Figure 1 – Major Features of the U.S. National Innovation System in the STAR Database: Policy, Innovation, Institutional Processes, and Economic Growth



Selected Awards

- Modeling Productive Climates for Virtual Research Collaborations (Sara Kiesler, Carnegie Mellon University and Jonathon Cummings, Duke University)
  - Unit of analysis is project-based research collaboration involving researchers from different institutions
  - Studies the institutional environments of a sample of projects that were supported by the National Science Foundation.
  - Examines importance of a productive climate for distributed research collaboration,
  - Traces the linkages among productive climate and the institutional environments of these collaborations.
  - => better metrics for measuring and predicting performance and innovation in collaborations.

Index	Items
Knowledge outcomes ('ideas')	Started new field or area of research; developed new model or approach in field; came up with new grant or spin-off project; submitted patent application; presented at conference or workshop; published article(s), book(s), or proceeding(s); recognized with award(s) for contribution to field(s). Alpha = .63 (7 items)
Tools outcomes ('tools')	Developed new methodology; created new software; created new hardware; generated new dataset; generated new materials; created data repository; created website to share data; created collaboratory; created national survey; developed new kind of instrument; created online experiment site. Alpha = .65 (11 items)
Training outcomes ('people')	Grad student finished thesis or dissertation; grad student/post-doc got academic job; grad student/post-doc got industry job; undergrad/grad student(s) received training; undergrad(s) went to grad school. Alpha = .70 (5 items)
Outreach outcomes ('people')	Formed partnership with industry; formed community relationship through research; formed collaboration with researchers; established collaboration with high school or elementary school students; established collaboration with museum or community institution; established collaboration with healthcare institution. Alpha = .45 (6 items)

Table 1. Project outcomes studied in Cummings & Kiesler, 2007.

Selected Initial Findings

- Importance of Star Scientists (Azoulay/Graff-Zivin; Zucker/Darby)
  - POLICY – Pioneer Scientists?
- Importance of Infrastructure (Furman/Stern/Murray)
  - POLICY – Institutions, not individuals?
- Importance of Organizational Structure
  - Kiesler/Cummings
  - POLICY – Interventions?

Next steps – and possible cooperation

- Development of theory
- Development of microdata infrastructure
- Research foci
  - Measuring and describing innovation within organizations
    - POLICY – R&D? workforce? IT? IP?
  - Connecting funding with outcomes at micro level
    - POLICY - Timing of discovery; portfolio management
  - Quantifying impact of social networks

SRS and SciSIP

- SRS is the federal statistical agency with responsibility for data and analysis on the science and engineering (S&E) enterprise.
- SRS conducts 11 ongoing, large scale statistical surveys covering the education of scientists and engineers, the S&E workforce, and research and development and also gathers data on public attitudes toward S&E.
- SRS has been a partner in the SciSIP initiative with responsibility for improving several of its benchmark surveys of R&D and the S&E workforce and beginning development of new surveys and databases.

Survey Redesign Activities

1. The complete redesign of the **Business Research & Development and Innovation Survey**
   - Intensive involvement from users in several workshops
   - Business expert panel providing advice over the last two years
   - Over 100 recordkeeping and cognitive visits to industry as part of the survey development
   - A full scale pilot of 40,000 companies goes into the field in early January
   - New data areas include:
     - R&D Financial Measures
     - Management and Strategy
     - R&D Funded or Paid for by Others
     - R&D Human Resources
     - Intellectual Property, Technology Transfer and Innovation

Analytical Activities

- Development and maintenance of an R&D satellite account to the National Accounts
- Exploration of new bibliometrics databases
- Support for the development of an international database on bibliometrics
- Support for workshops on innovation data
- Providing input to the OECD Innovation Strategy through SRS's membership on the National Experts in Science and Technology Indicators (NESTI) working group

For more information please contact:

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