

Research Profiles: How Theory Guides Research Evaluation

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**A Webinar hosted by
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Webinar Focus and Agenda

- Show a proposed theoretical framework about relationships among science and technology (S&T) advances, organizations, and context,
- And what that suggests for evaluating a diverse portfolio of research.
- Brief Q&A
- Discussion

“Where do we start to find/develop the ‘theory’ we need in order to improve evaluation of basic research?”

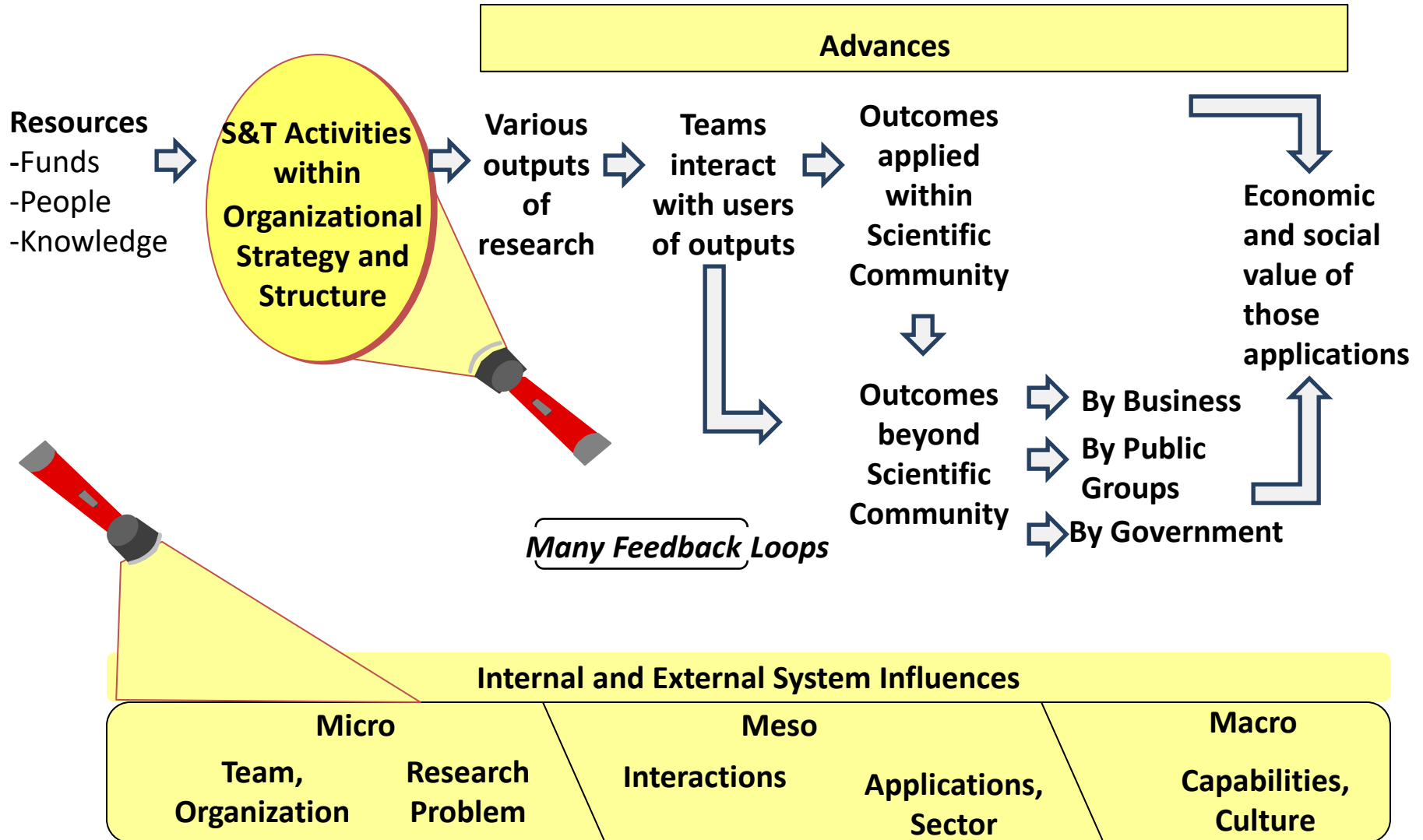
Theory –What and How

A **theory** is (1) a set of interrelated concepts, definitions, and propositions that explains or predicts events or situations by specifying relations among variables; (2) a statement of what causes what, and why, and under what circumstances.

Process of building theory: Iterate three steps

- Observation
- Categorization
- Association (correlation, causation)
- Formed in a body of understanding that researchers build cumulatively

Research Profiles is part of larger framework



An Organization's Research Environment: DOE study observed 42 attributes

Especially important for more radical advances

- Research autonomy
- Cross-fertilization of ideas
- Time to think and explore
- Freedom and resources to pursue new ideas
- External collaborations
- Relevant, mixed portfolio (including basic research)
- Identification of opportunities
- Sense of challenge
- Critical thinking
- Able to take risks

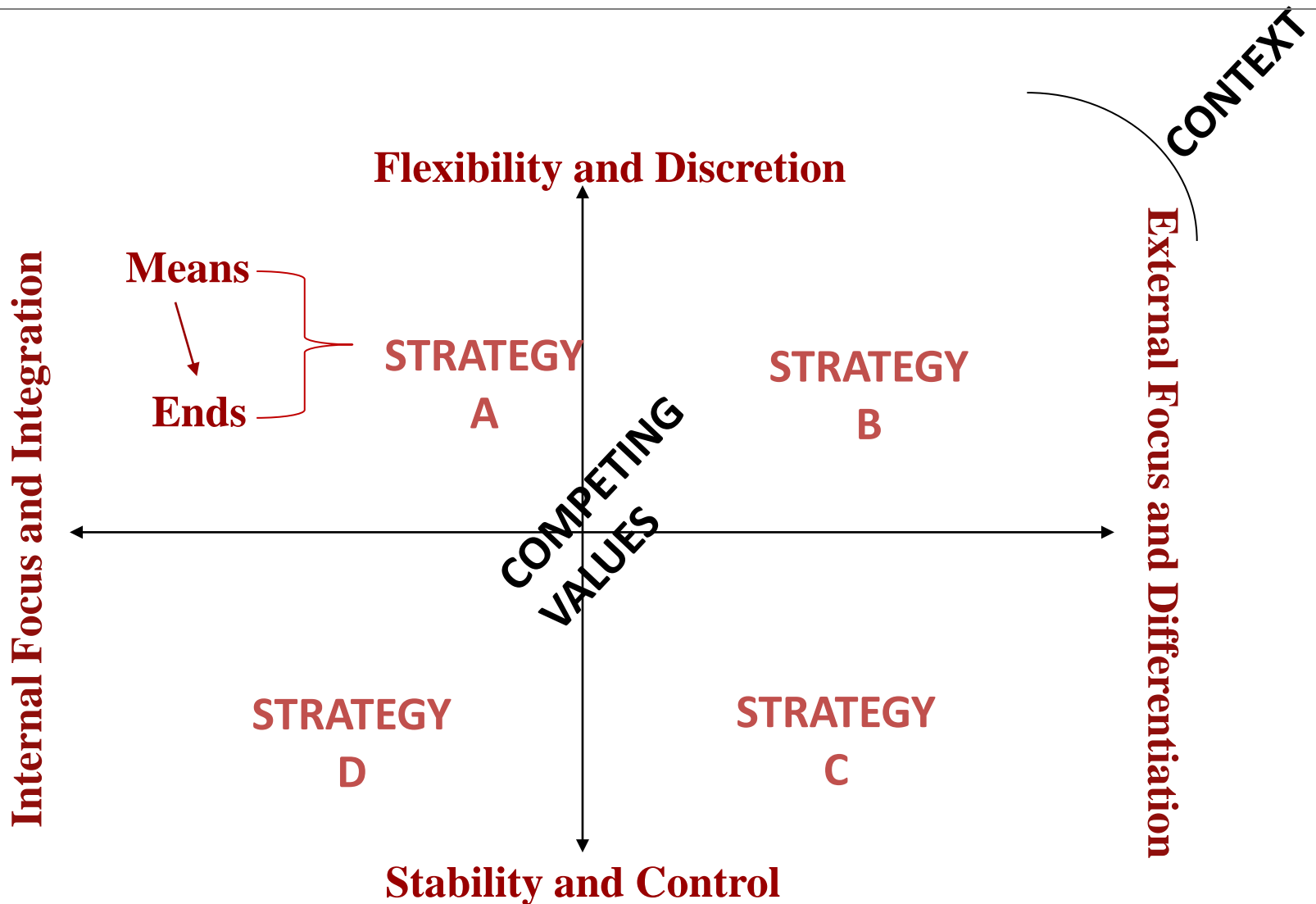
Especially important for broad, large scope advances

- Sufficient, stable funding
- Investment in new opportunities
- Clearly defined goals
- Good project planning and execution
- Good measures of success
- Reputation for excellence
- Coordination via managers
- Champions for basic and applied research

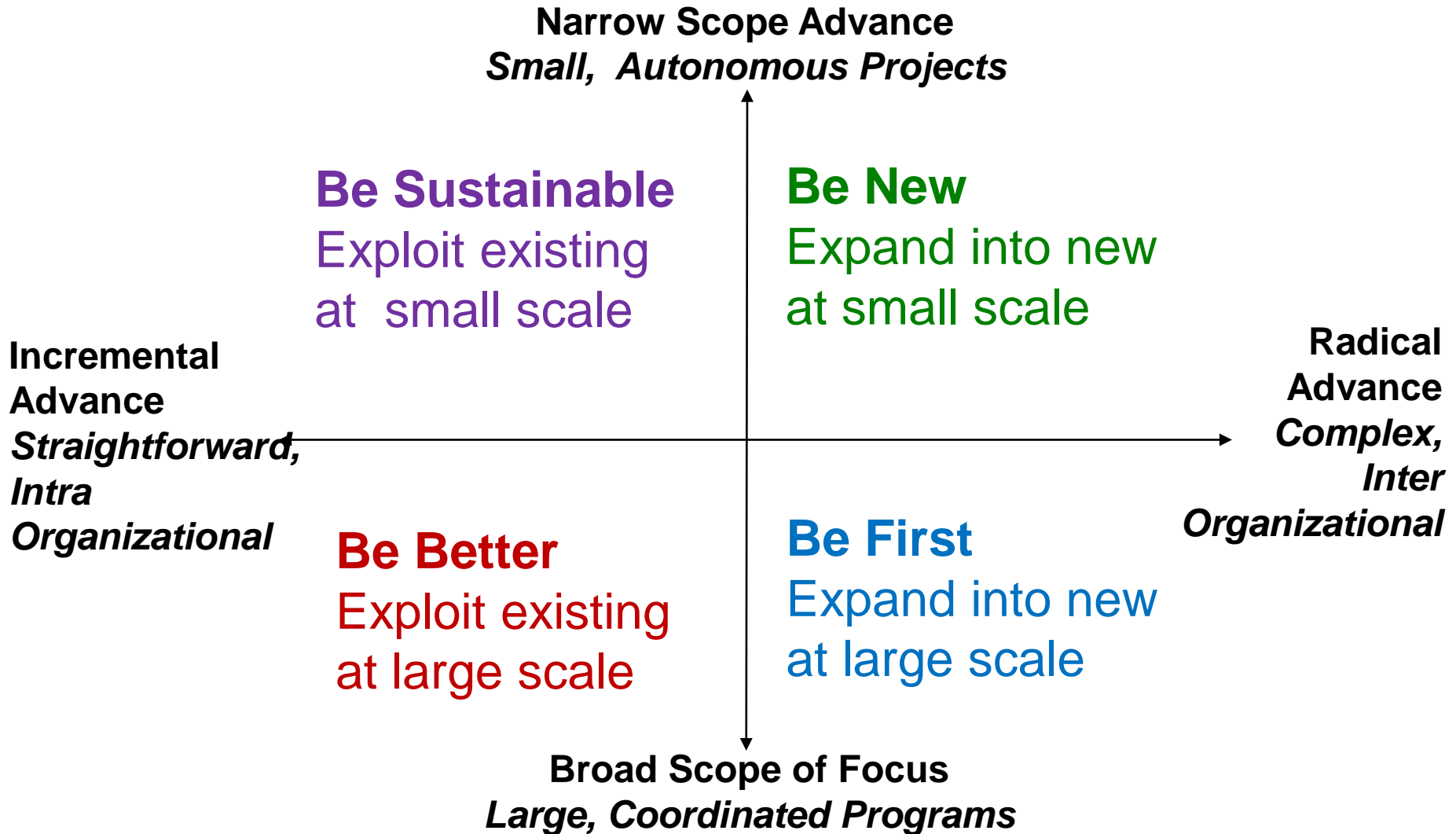
Important for all:

- Quantity and quality of resources (people, equipment)
- Rewards for research/work
- Value of research managers
- Organizational support for research

Noticed categorization and associations in Competing Values Theory applied to S&T



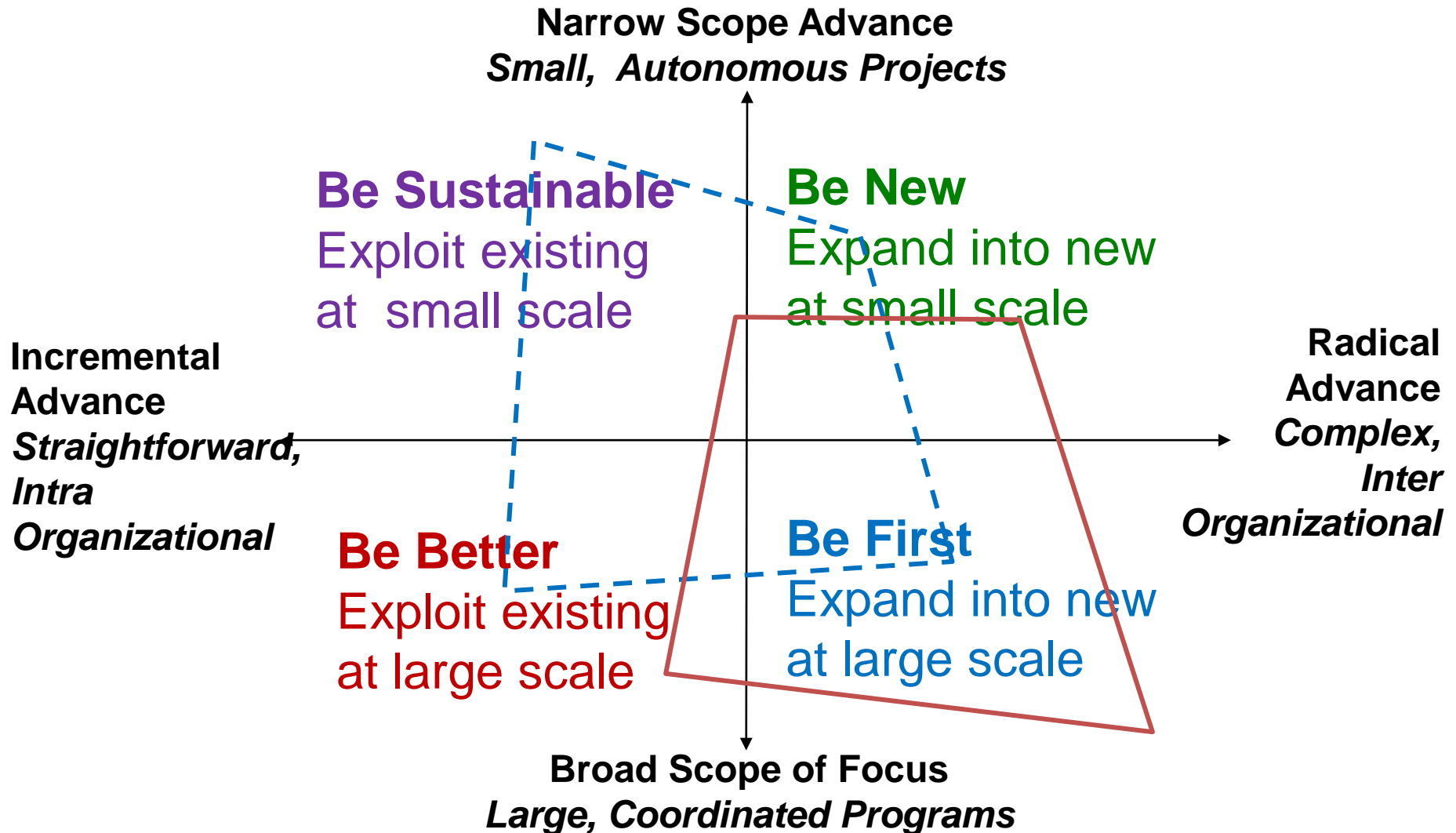
Research Profiles: Modified organizational theory to be specific for S&T



Examples: Competing values (tensions) between organizational structure and strategy

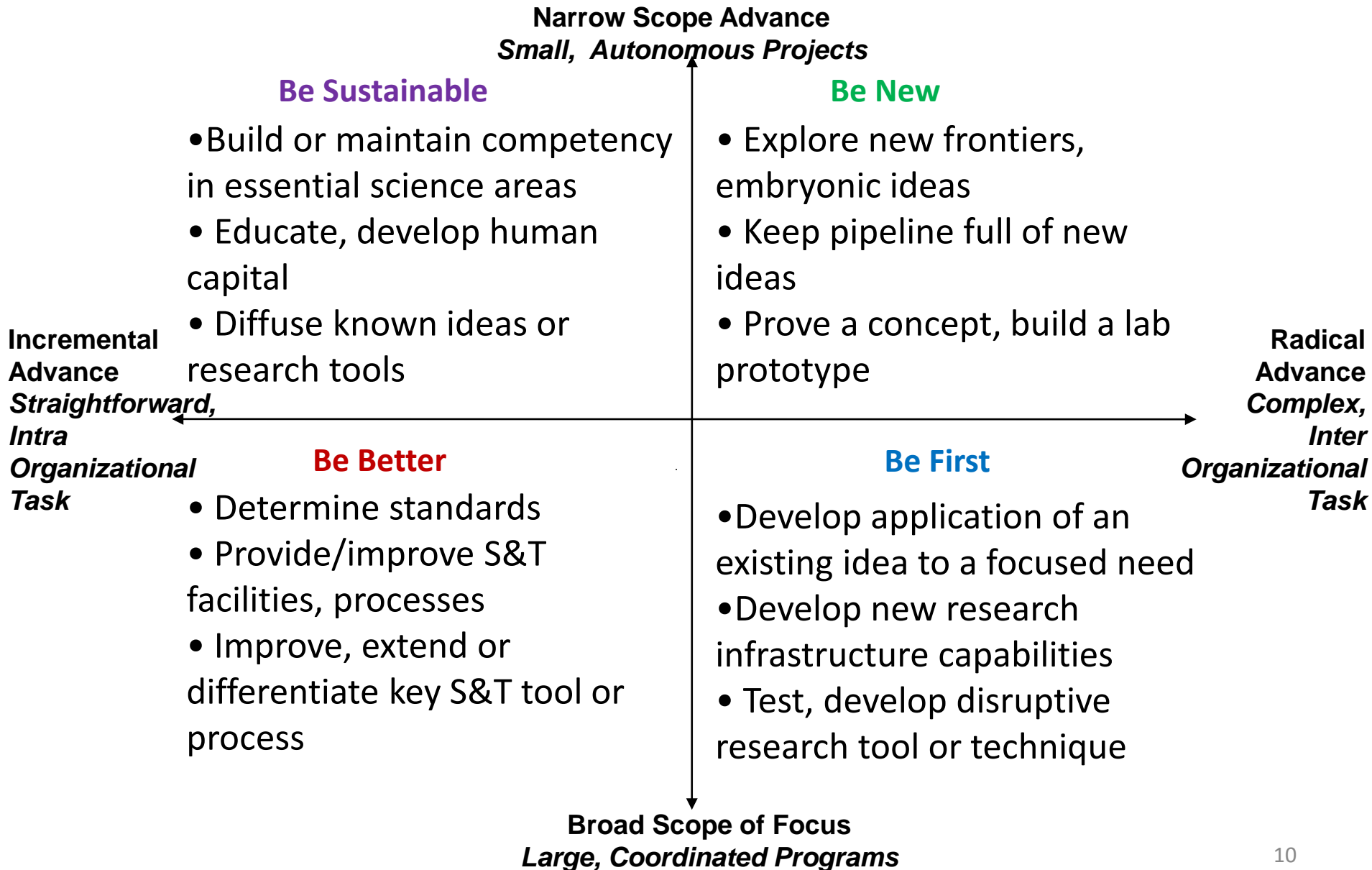
- Tension between autonomy and control/coordination
- Tension between small science and big (expensive) science
- Tension between bifurcation and generalization, differentiation and integration, amount of risk taken
- Tension between external focus and internal focus
- Tension between working across organizational boundaries or not
- Broad scale research requires sustained commitment/control of large resources, while remaining open to change.
- More radical and broad scope requires complex tasks and teams, multiple organizations, making integration more difficult (many parameters, knowledge sets).

Example: Portfolios are often a mix of profiles



Four Research Profiles

have different objectives and outputs



Profiles have different possible outcome indicators

Be Sustainable

Exploit existing at small scale

Narrow Scope Advance
Small, Autonomous Projects

Scientific Impact - Mastering, extending existing ideas, techniques or fields

Performance- Contributors, collaborations, or human networks participating

Research Agility- Develop common terms/language, technical capabilities

Structure of Knowledge: Coordinated activities, revised textbooks

Infrastructure Contribution- Facilitated exchanges within R&D (workshops)

Societal Impact- Ideas seeded, open discourse, social interaction

Be New

Expand into new at small scale

Scientific Impact - Radically new idea, theory, technique, or prototype

Performance- Portfolio of highly unusual projects, creative approaches

Research Agility- Change the way people think, ask questions and do research

Structure of Knowledge- Uncoordinated activities, pursuit of new fields

Infrastructure Contribution- An expanding/changing risky portfolio

Societal Impact- International thought leadership

← **Incremental Advance**
*Straightforward, Intra
Organizational Task*

Expanding on Feller & Gamota, 2003

Radical Advance
*Complex, Inter
Organizational Task* →

Profiles have different possible outcome indicators

Incremental Advance <i>Straightforward, Intra</i> <i>Organizational Task</i>	Radical Advance <i>Complex, Inter</i> <i>Organizational Task</i>
Scientific Impact- Incrementally improved or standardized knowledge set	Scientific Impact- Radically new body of knowledge or research tool or use
Performance- Well organized projects making steady progress	Performance- Projects with expected high yield, speedy completion, or identifiable outcomes
Research Agility- Determined bench-marks, standardized knowledge/tools	Research Agility- Identification of applications for existing/new ideas/techniques
Structure of Knowledge- Correct diagnosis of challenge	Structure of Knowledge- Strategic coalitions, rapidly deploying activities
Infrastructure- Provide accessible R&D facilities, equipment, techniques	Infrastructure- Facilitate consensus or pursuit of theory or project aimed at R&D need
Societal Impact- New standards for scientific inquiry, technical quality	Societal Impact- Development and use of products, processes, applied knowledge

Be Better

Exploit existing at large scale

Be First

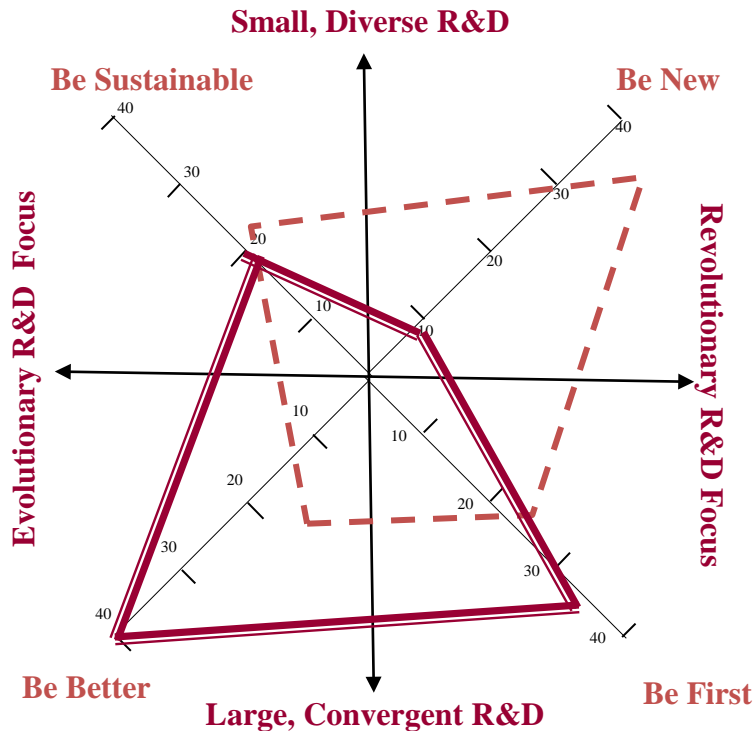
Expand into new at large scale

Expanding on Feller & Gamota, 2003

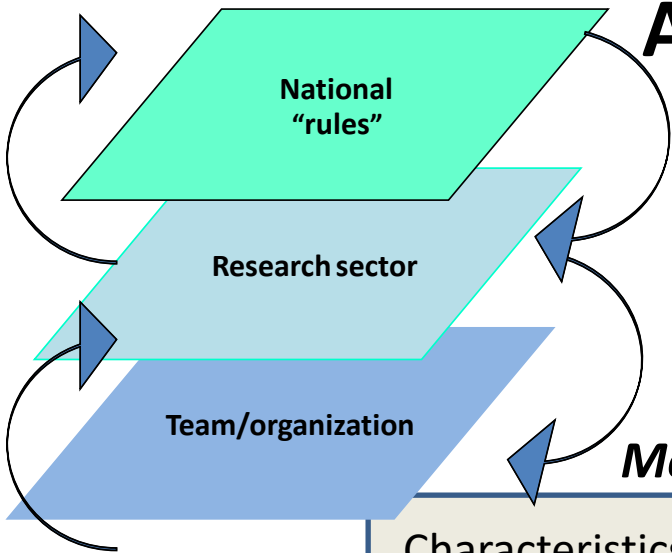
Examples of circumstances driving choice of objectives and strategies

Example Scenarios

- For R&D funding to meet the challenges of cybersecurity, the decision could be to concentrate most new resources on developing and improving existing S&T because short term solutions are needed. (portfolio mix shown by thick red line)
- In emerging areas expected to be of critical importance such as quantum computing, the decision could be to fund exploratory research and broad scope testing of applications to make radical leaps forward in that area. (portfolio mix shown by dotted red line)



A systems view of possible contexts



Macro

- a. Availability of Capital, Capabilities
- b. Ease of coordination
- c. Legal, political, regulatory
- d. Culture, Societal values

Meso/Sector

Characteristics of Interactions:

- a. Diversity
- b. Continuity
- c. Mechanisms
- d. Competition?

Nature of science impact:

- a. Knowledge
- b. Infrastructure
- c. Structure
- d. Agility

Nature of the application:

- a. Breadth, Timing
- b. Radicalness of change
- c. Mission, Application sector
- d. Speed of technical change
- e. Absorptive capacity

Micro

Characteristics of team

- a. Size, diversity
- b. Experience
- c. Organization/management

Nature of the research problem

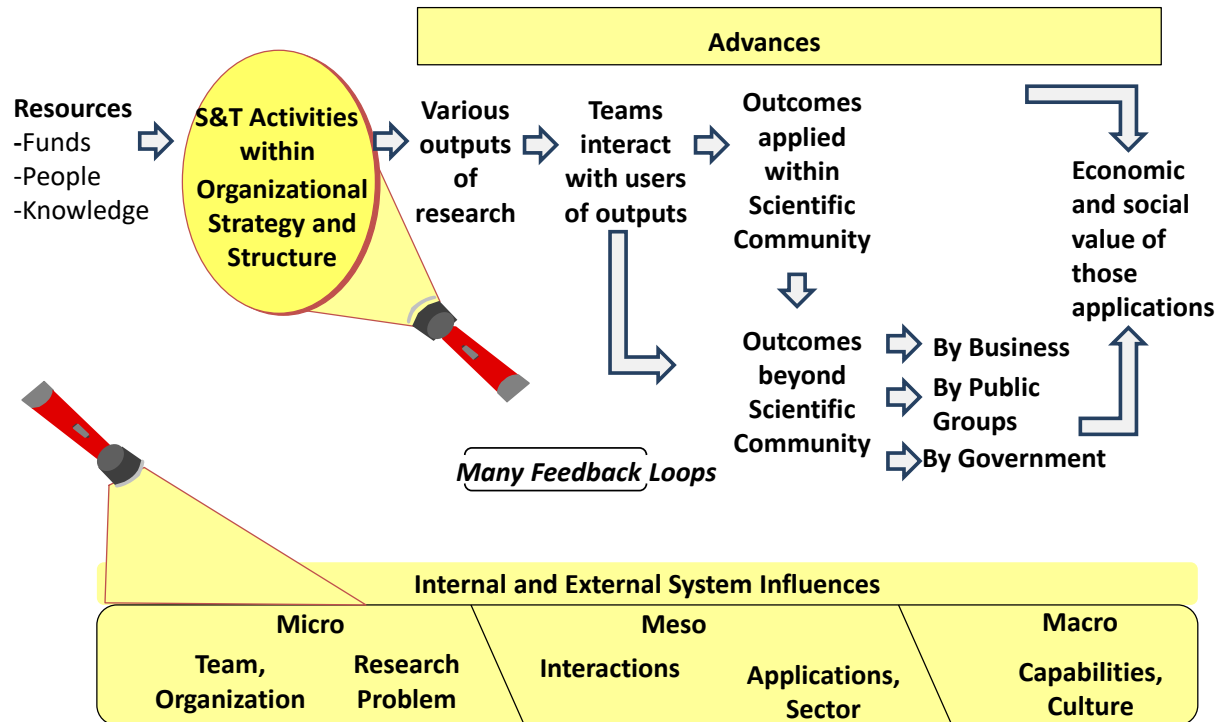
- a. Research type
- b. Profile:** Radicalness and Scope

Nature of the research field

- a. Maturity
- b. Availability of tools
- c. Cost of research

Summary: Research Profiles Framework

characterizes and suggests relationships among S&T advances, organizations, and context



Main hypothesis: There will be more and better S&T advances when an organization (funder, institute, research team) matches its structure to strategy and strategy to the given set of circumstances.

Summary: Research Profiles implications for S&T evaluation

- One size does not fit all. Different Profiles mean different What, Why, and Under what circumstances
- More careful characterization of research strategies (and profiles) would help guard against implicit biases and assumptions
- More careful characterization of context in our evaluations would help us distinguish between signals and noise.

Possible Action Steps

- Generic templates for different profiles in different circumstances can be developed and shared.
- The contextual variables can be operationalized and shared.
- Synthesis across similar evaluations will allow us to build better theory and address more systemic questions.

Thank You

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