Do Existing Logic Models for Science and Technology Development Programs Build a Theory of Change?

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Program Theory and Theory of Change

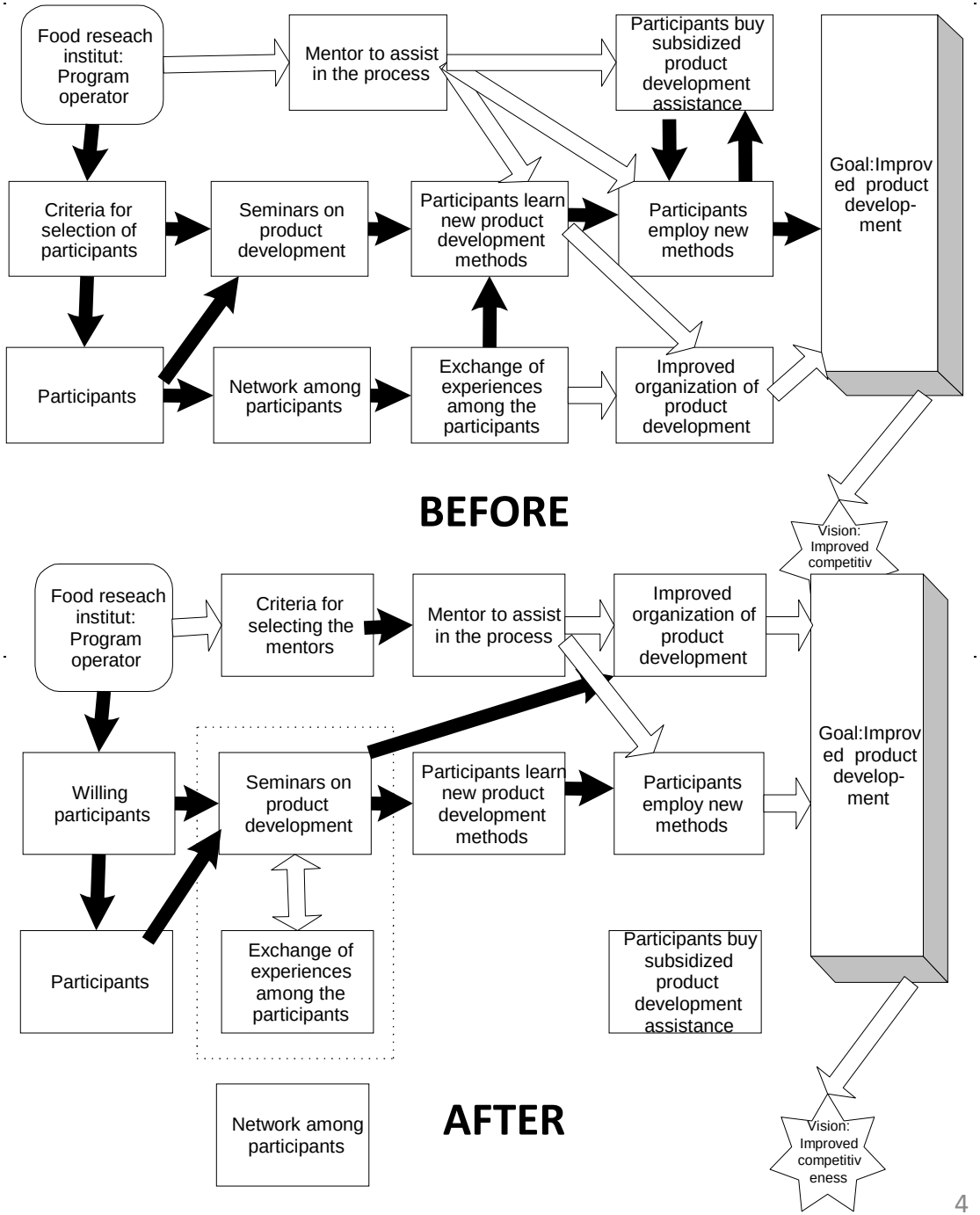
- Program theory is a theory or model that describes the underlying assumptions about how a program is expected to work; how the program causes the intended or observed outcomes.
- A theory of change is both a program theory and an implementation theory -- the expected steps in the implementation of the program, an explanation for why program customers will follow through after the program so that outcomes not totally under the program's control will be achieved. (Weiss)

Why do we care?
- program improvement
- evaluation synthesis
- attribution

Strong linkage

The logic model and the program can be revised to reflect new information.

Source: Torvatn, 1999



A Matrix for Assessing Attribution

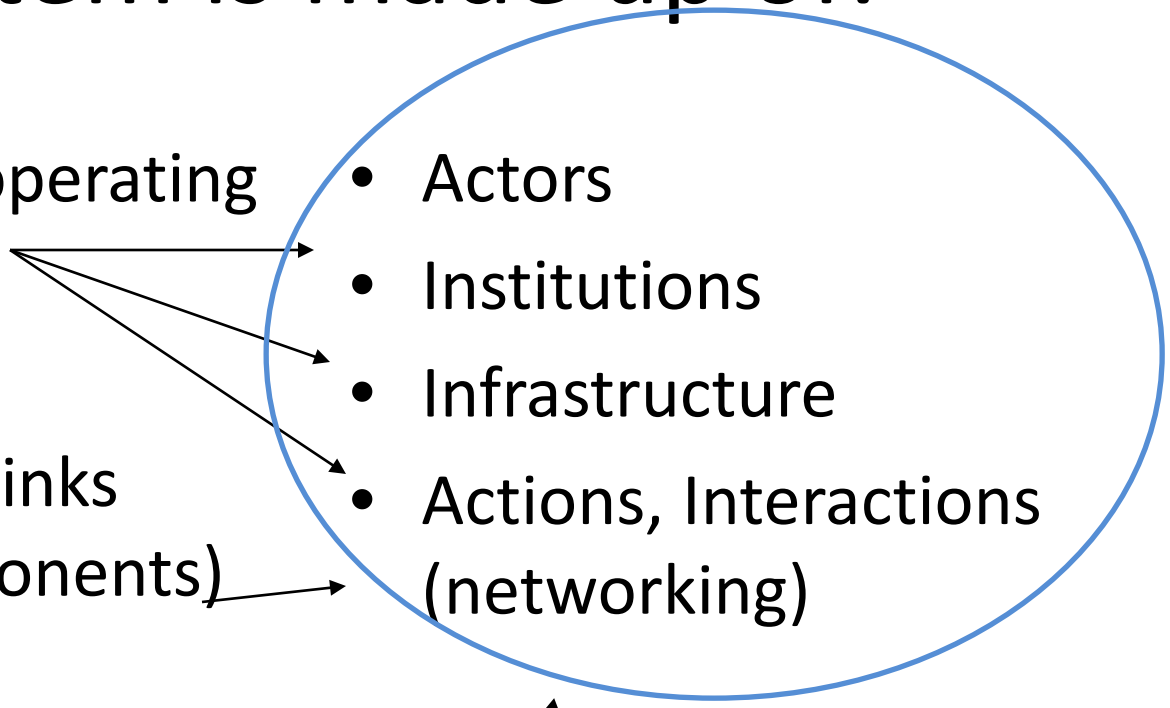
Categories of Information Needed for Additionality Assessment	Technology Timeline (Stage of Research, Development, and Commercialization)→					
	Preliminary & detailed investigation	Develop components	Develop system	Validate/ demonstrate	Commer-cialize	Market Adoption
History of the technology						
What DOE Did						
What Others Did — Private Sector						
What Others Did - Governments						
The DOE Effect, Influence						

Ruegg & Jordan, 2010

What's the challenge?
- complex emergent system
- not well studied
-missing magic in the middle

A system is made up of:

- Components (operating parts)
- Relationships (links between components)



- Attributes (properties of the System's dimensions)

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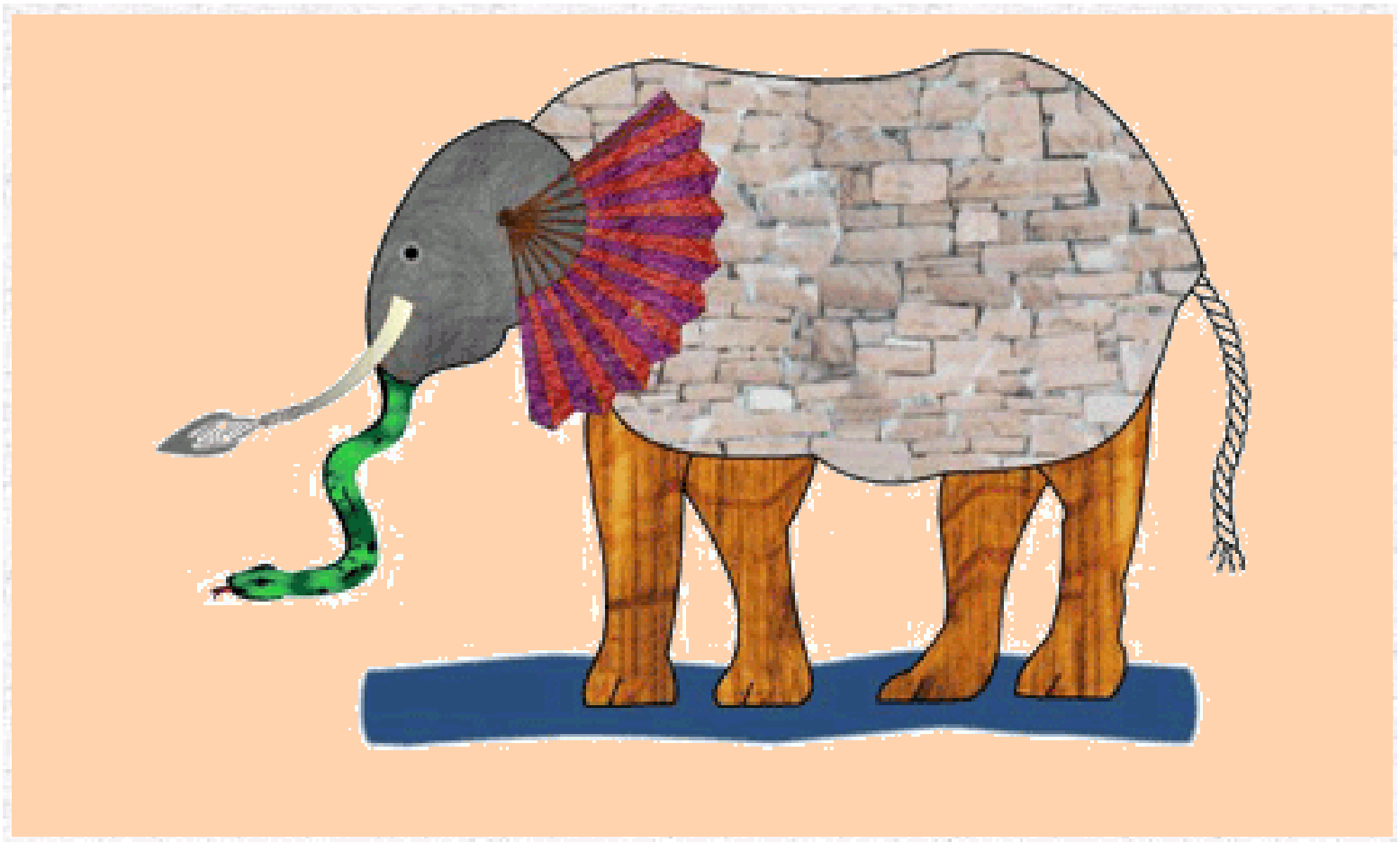
Source: Carlsson et al., 2002
Anna J. Wieczorek, Utrecht University

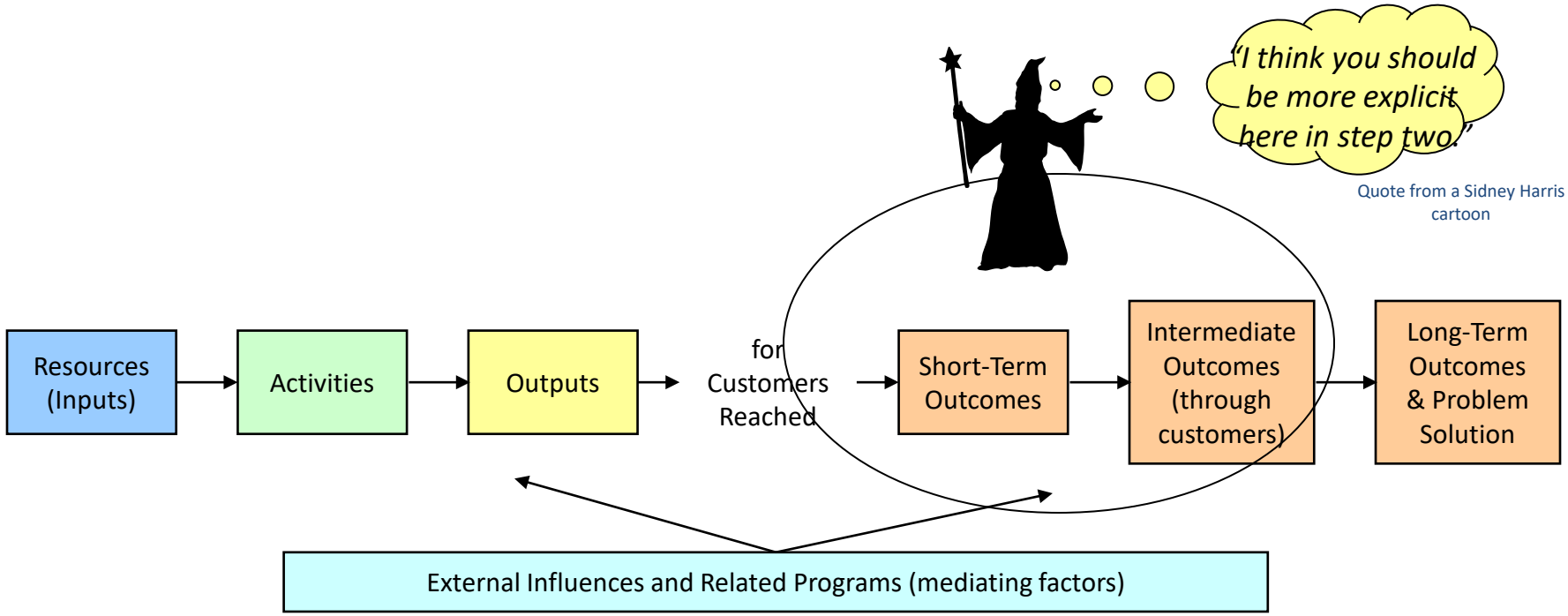
Parts are studied and understood better than the whole!



Source: Bhavya Lal, STPI, at AEA 2006

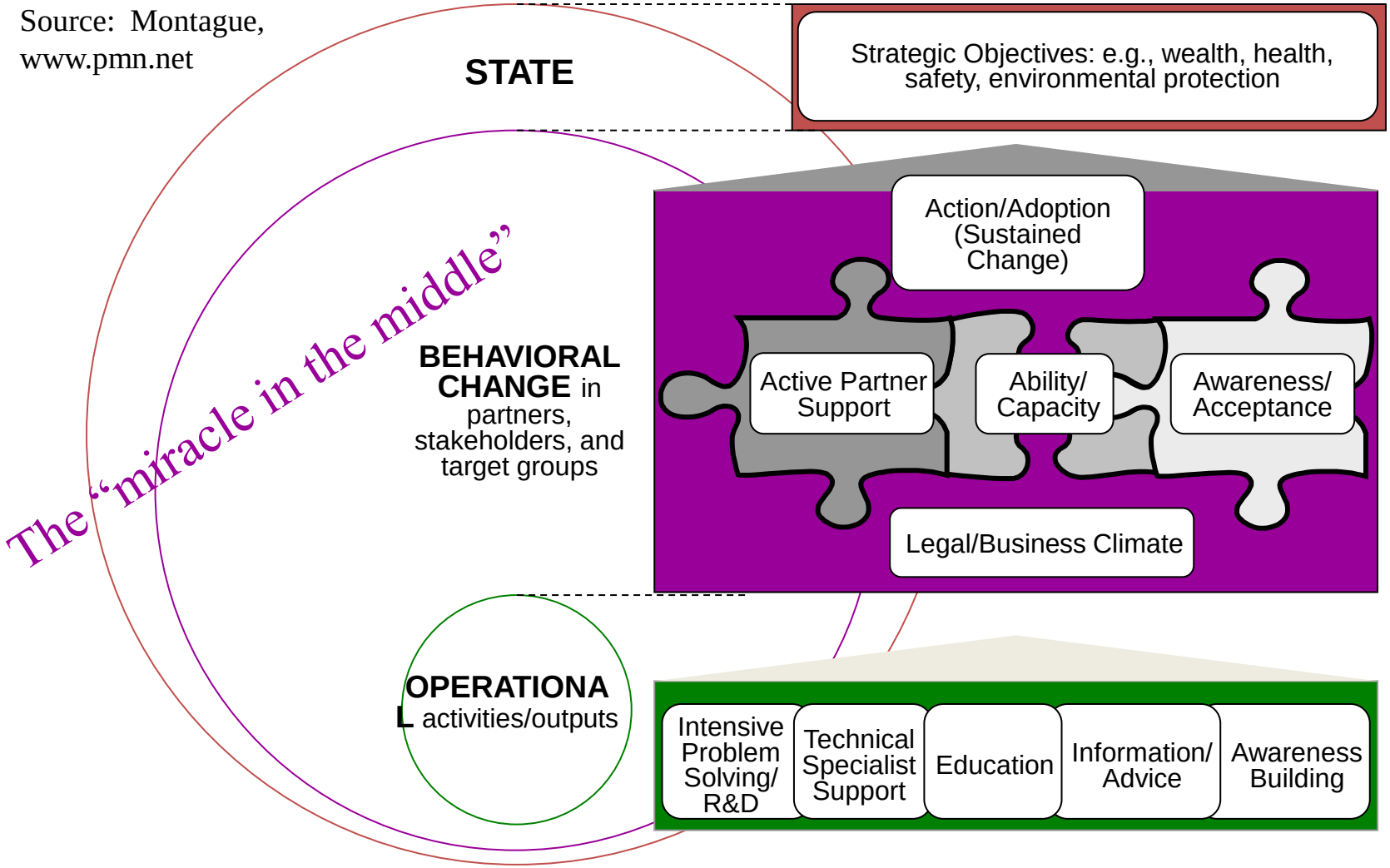
http://www.cs.unibo.it/schools/AC2005/docs/Bertinoro.ppt#266,11,The Blind Men and the Elephant

Frequently the "theory of change" associated with a program is not explicit

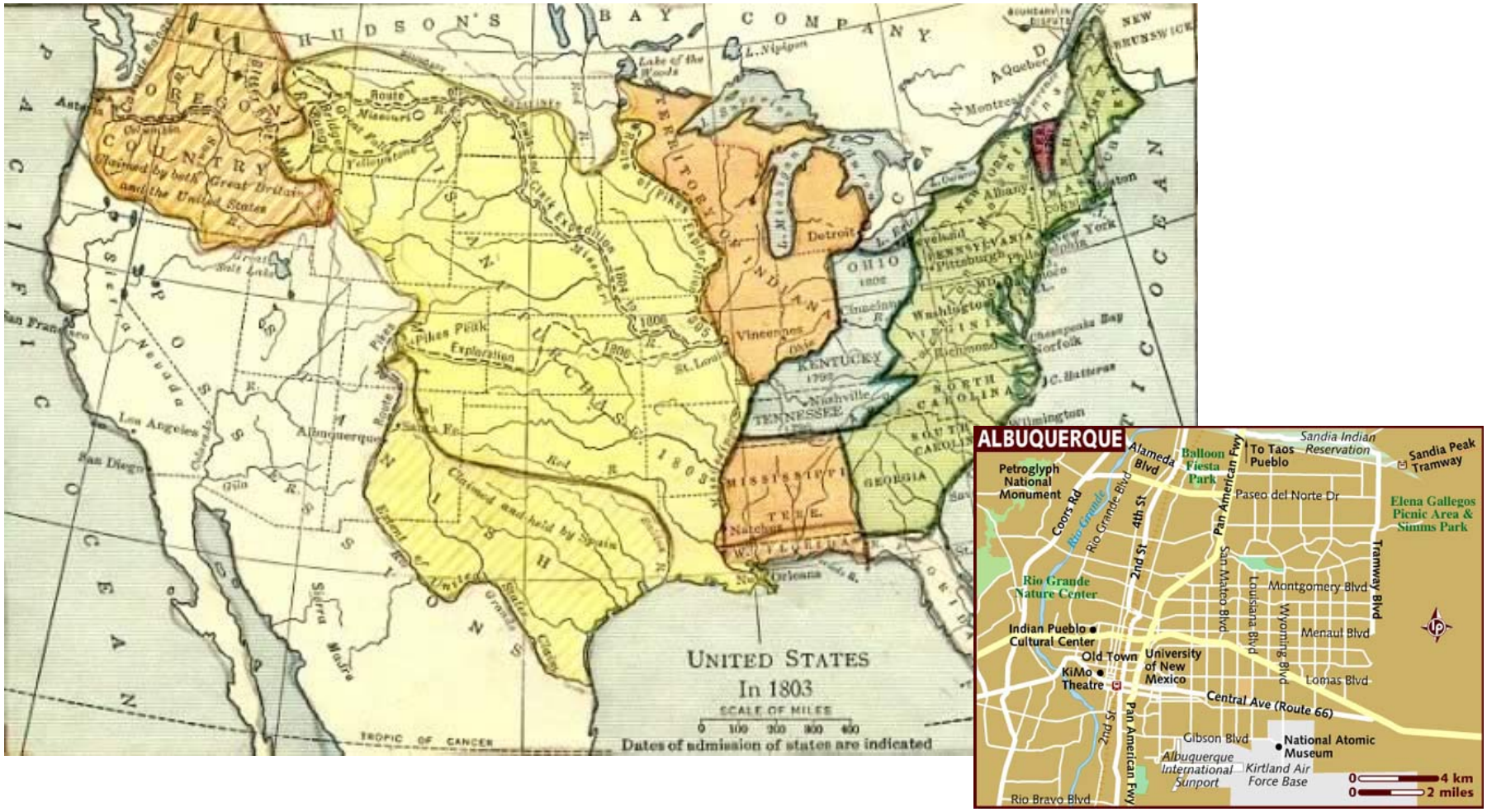


The hard part: intermediate outcomes

Source: Montague, www.pmn.net



Different views: 30,000 feet vs. on the ground; new territory vs. settled; many years vs. election cycle



Components and Relationships

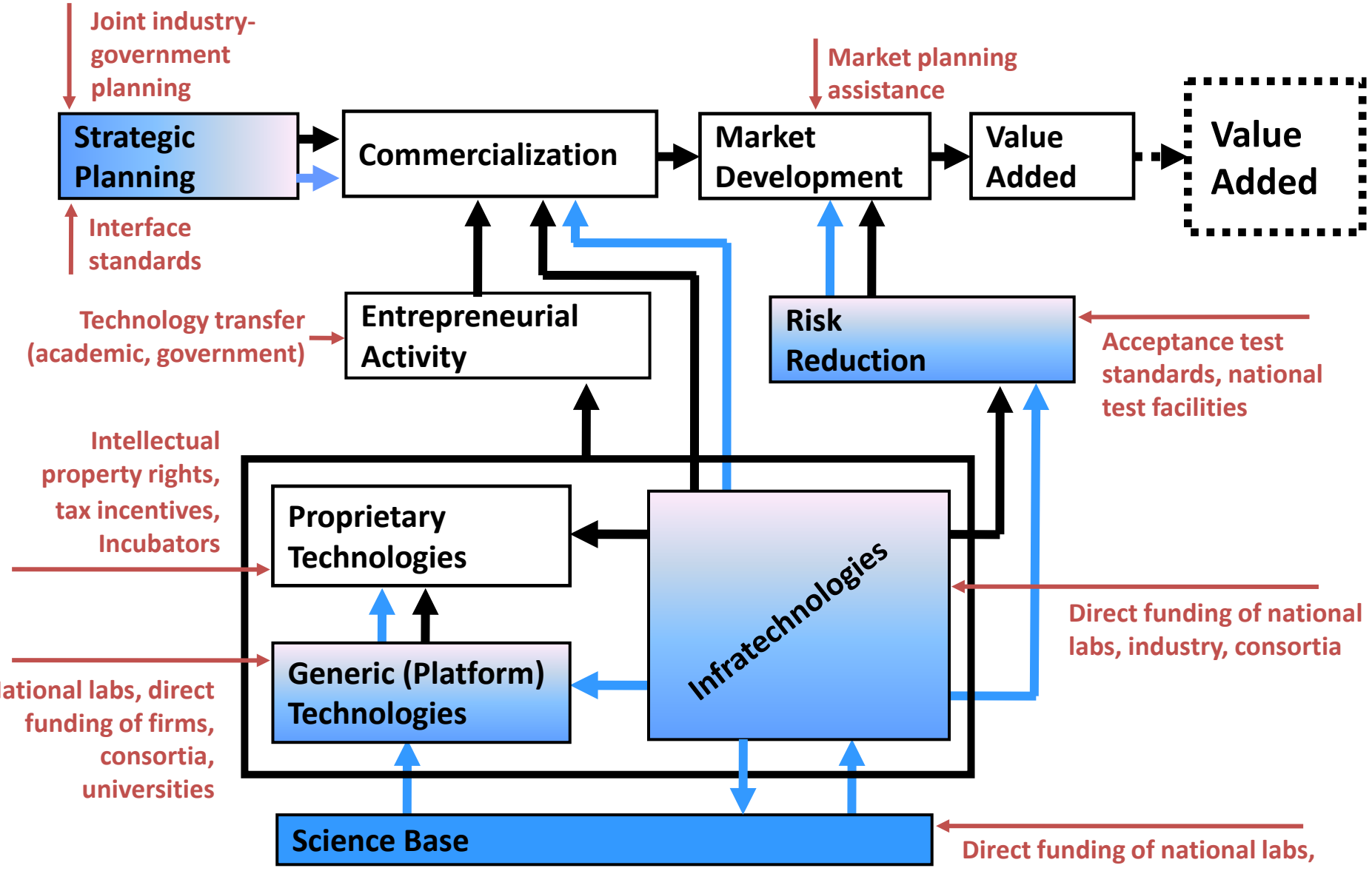
- science, technology, entrepreneurial activity

- actors, institutions

arenas of RTD, market domains

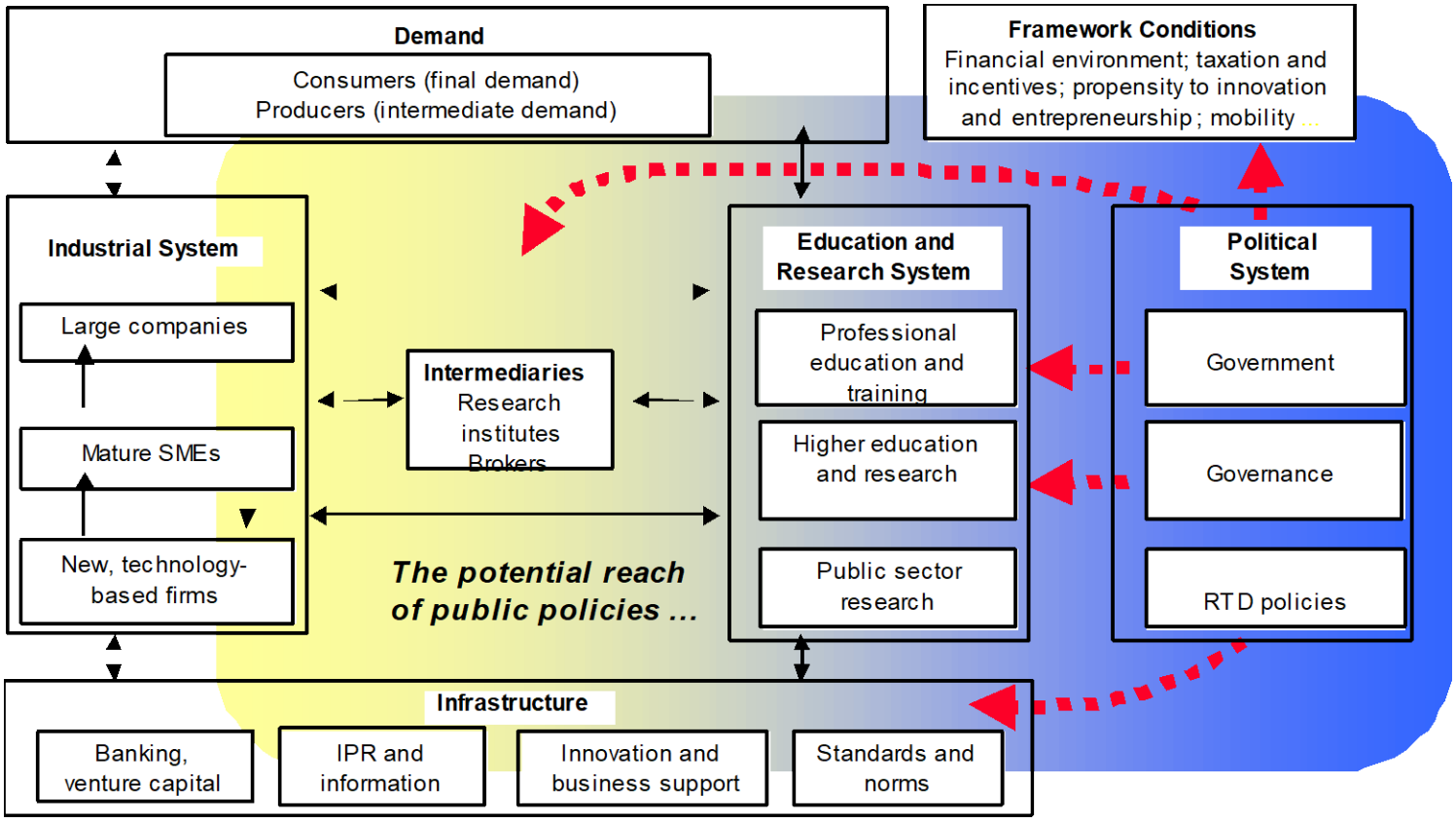
- input-output-outcome format

Steps in the RTD Policy to Value Added Life Cycle



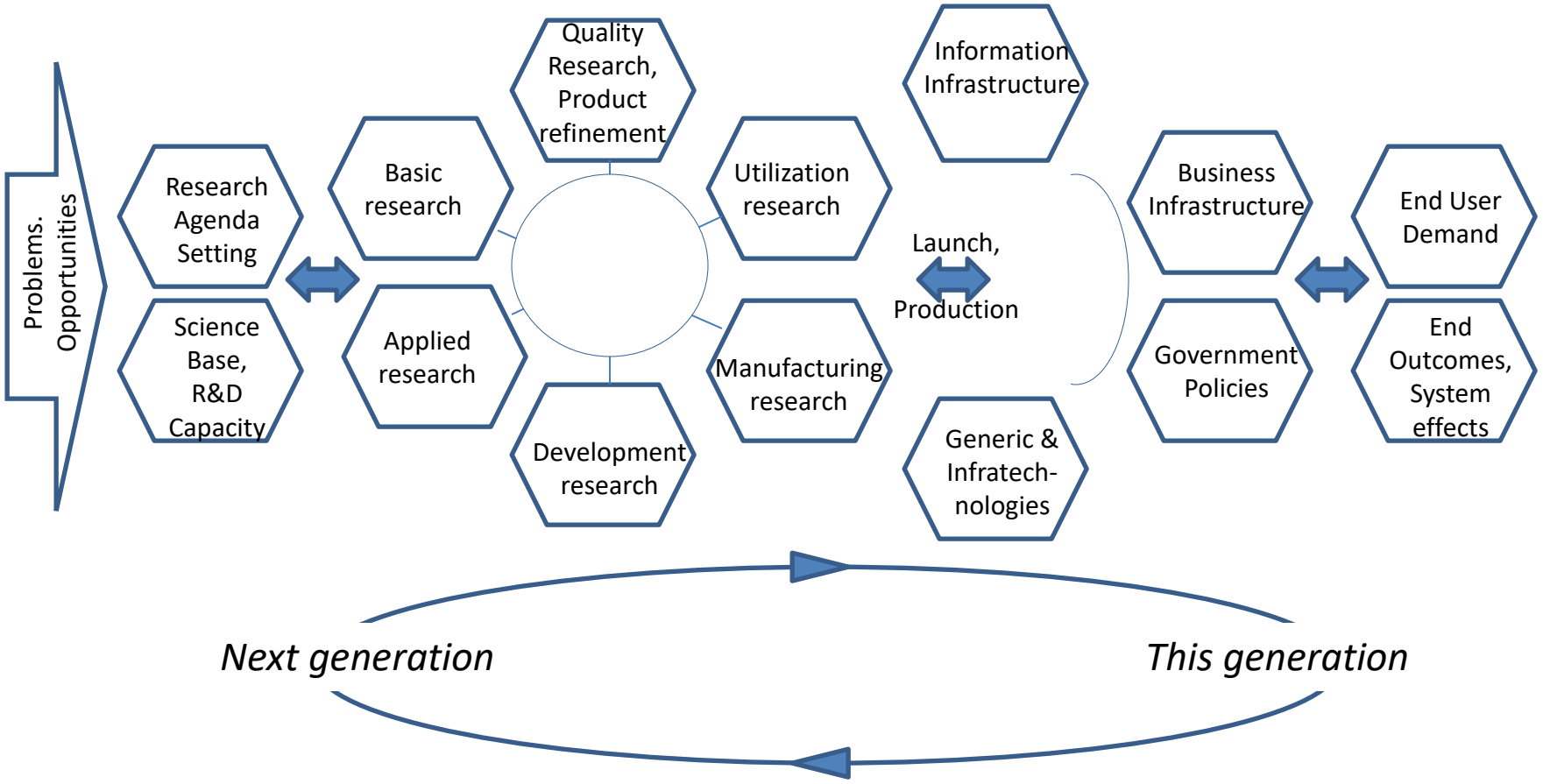
G. Tassey, *The Technology Imperative*, Edward Elgar, 2007

Actors/Institutions from a 'national innovation systems' perspective …



Source: Arnold and Kuhlmann, 2001

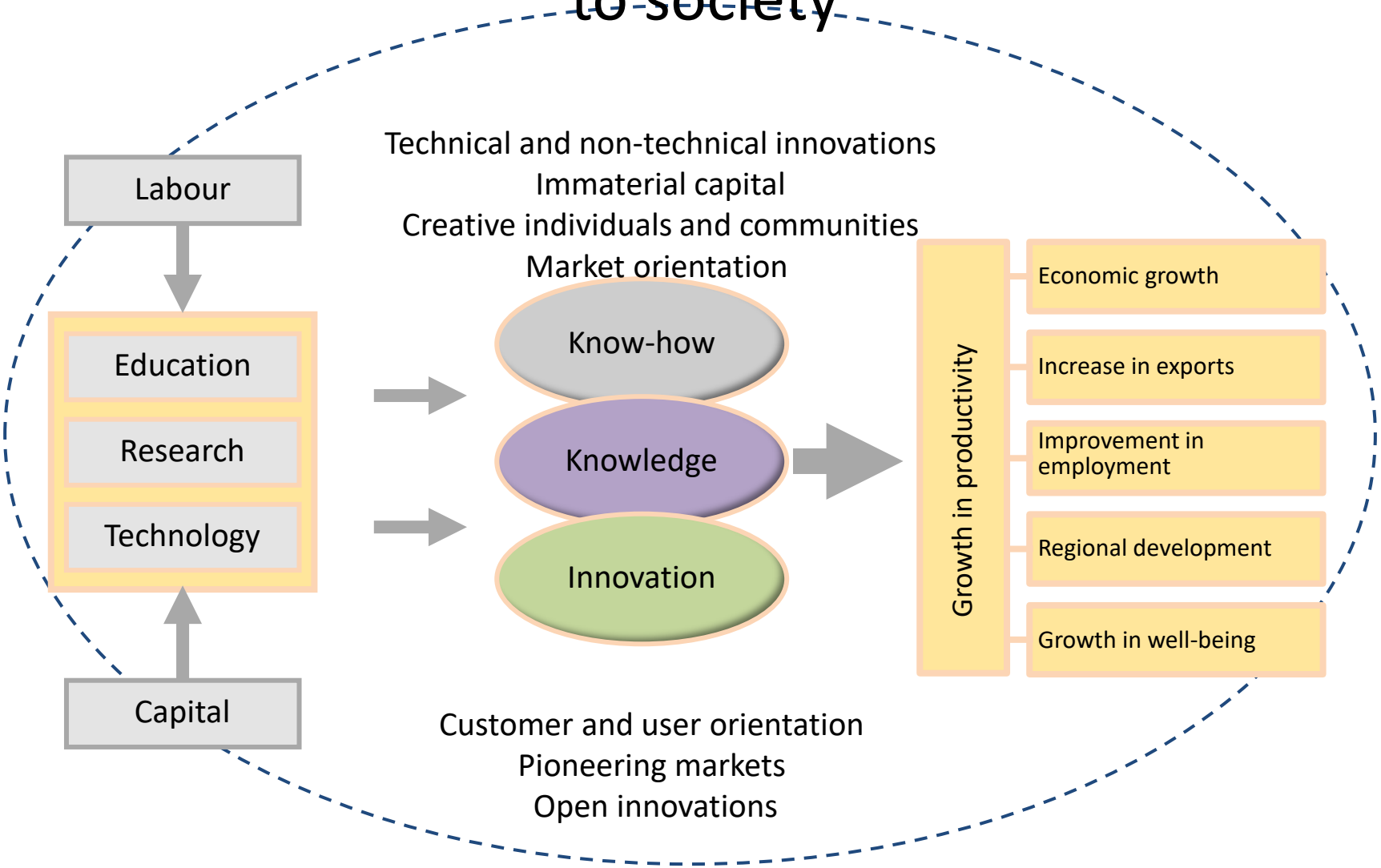
A more recent view of an innovation system



Source: G Jordan, 2010

Different perspectives on theories of change for diverse RTD initiatives

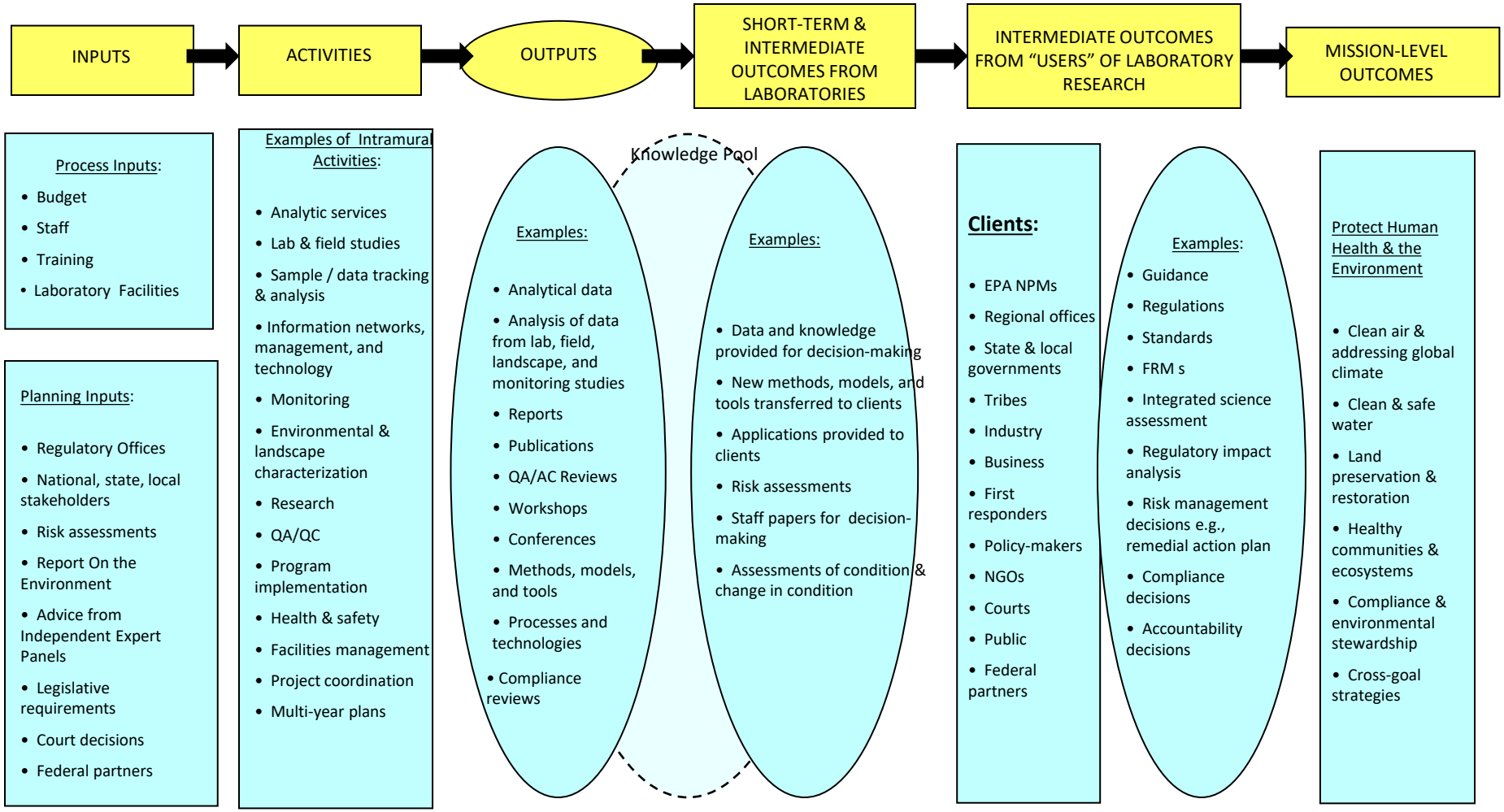
A macro level theory of RTD contribution to society



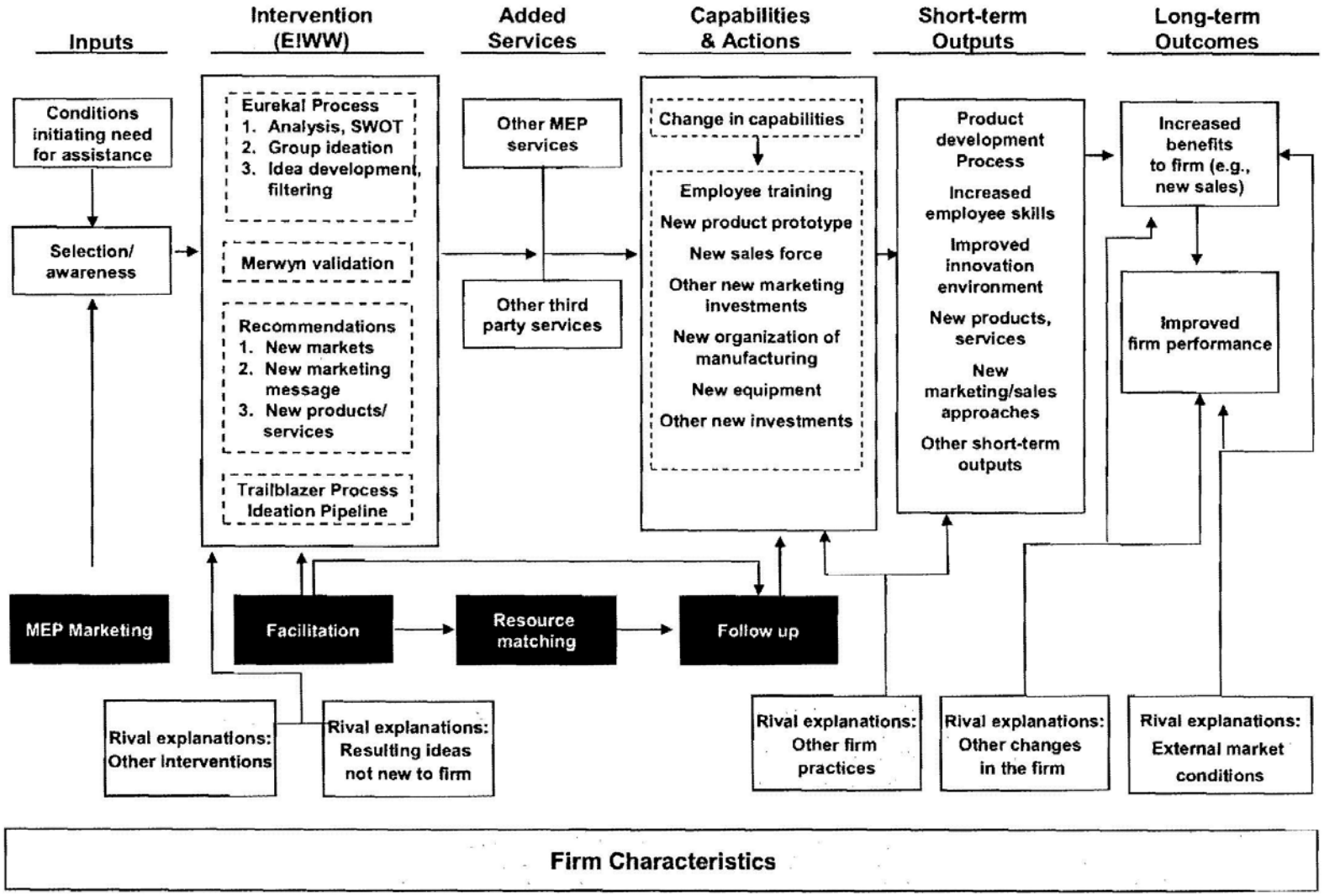
Source: Hyvarinen, Tekes

Logic Model of EPA Research

Adapted from Figure 4 – 1, page 54, *Evaluating Research Efficiency in the U.S. Environmental Protection Agency*, NRC, 2008)



Logic Model: Eureka! Winning Ways



Source: P. Shapira, et al, for NIST MEP

Draft 09/11/07

U.S DOE Logic of Technology and Market Readiness

Technology Readiness Projects

Market Readiness Projects

Activities

Applied R&D
- Materials & devices
- 3rd gen. PV
- Advanced CPV
- Solar hydrogen

R&D on Disruptive Technologies
- CSP Towers
- Solar hybrid lighting

System Development
- 1st & 2nd Generation PV
- Silicon PV
- CSP trough

Testing & Evaluation
- Techniques
- Facilities
- Validation

Business Support
-RD&D on
-- Manufacturing
--Built in PV
-training

Policy & Knowledge
Tech support for codes, policy, knowledge base

End User Assistance
-Tech support
-demos
-outreach

Outputs

R&D advances (non-stage gate)

Improvement in component/system:
- Efficiency
- Reliability
- Lifetime
- Capital cost
- O&M cost

Increasing industry cost share

Components/systems moves thru stages:
- Preliminary investigation
- Detailed investigation
- Development
- Validation
- Commercial launch

Assured performance and compatibility

Lower risk

Tech. scale up, lower costs; Improved design; Certified installers

Studies disseminated; Model legislation; Robust info channels; States adopt best practice

End users aware; Integrate into facilities design

Supply chain is in place and profitable

Supportive codes, policies, and public entities

End users persuaded to purchase technology

Economically attractive technology available

Outcomes

EERE knowledge transferred & utilized in further R&D or unintended products

Options value of non-commercialized technologies

Market penetration of technology
- Early adoption
- Replication
- Growing demand
- Sustainability

Utility-scale electricity generation (CSP, CPV)

Commercial electricity generation (PV)

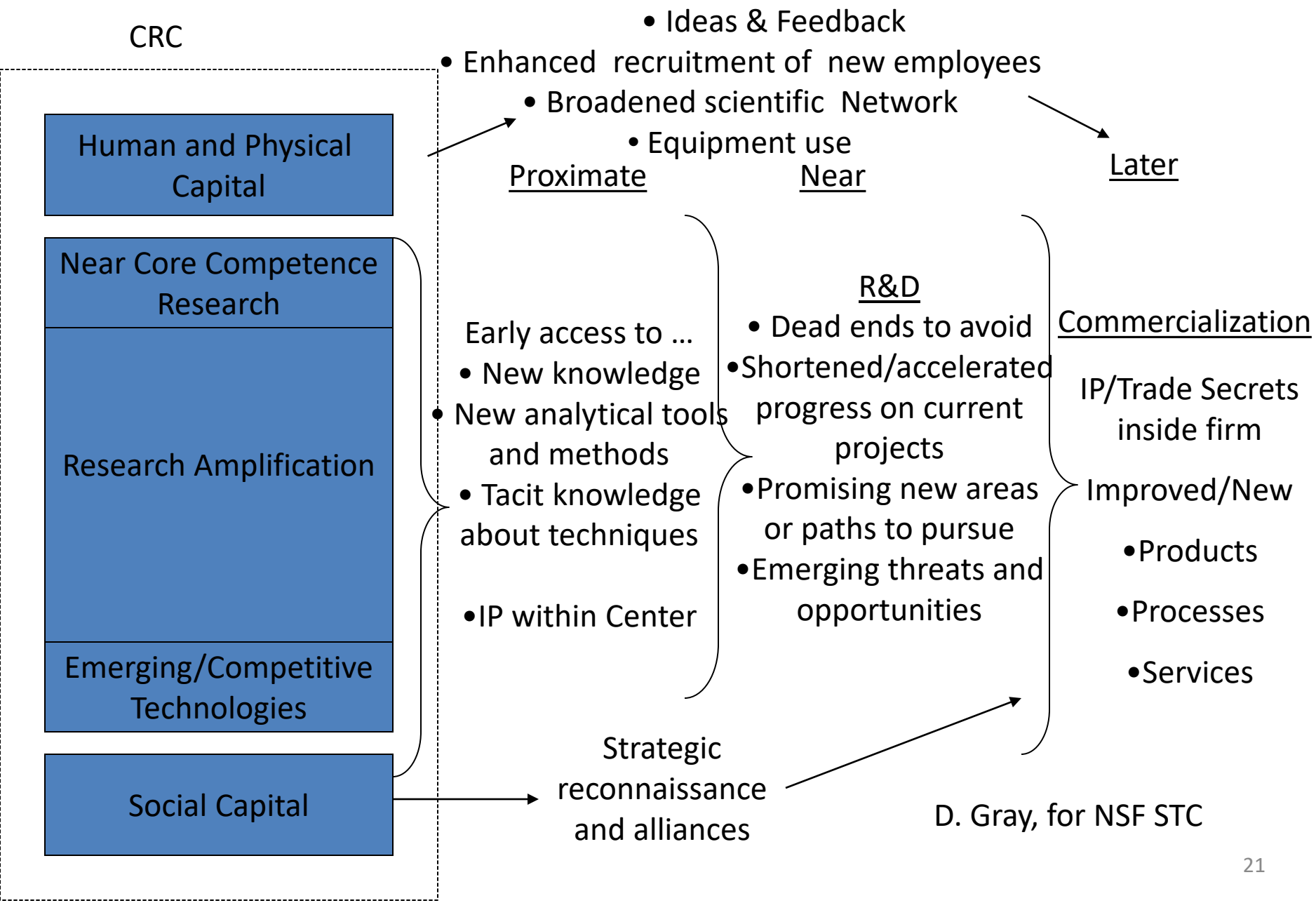
Residential electricity generation (PV)

Solar lighting in homes & businesses

Fuel diversity, oil savings, load reduction, energy system cost savings, emission reductions, U.S. jobs

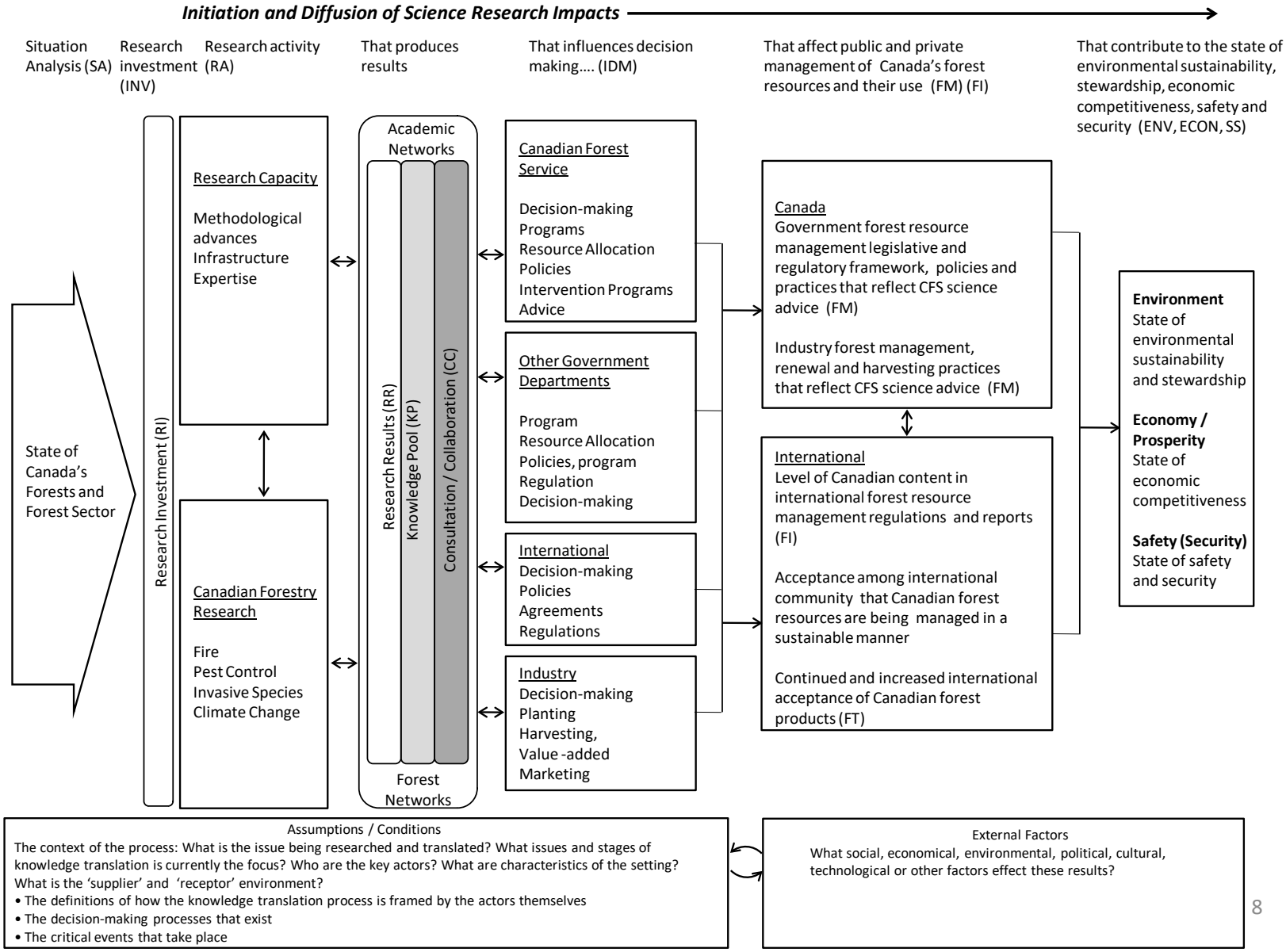
External Factors

Changes due to Cooperative Research Centers



CFS Logic Model of *Wildland Fire Research*

CFS Logic Model and Forest Research Contribution to Forest Sector Outcomes



Summary and Conclusions

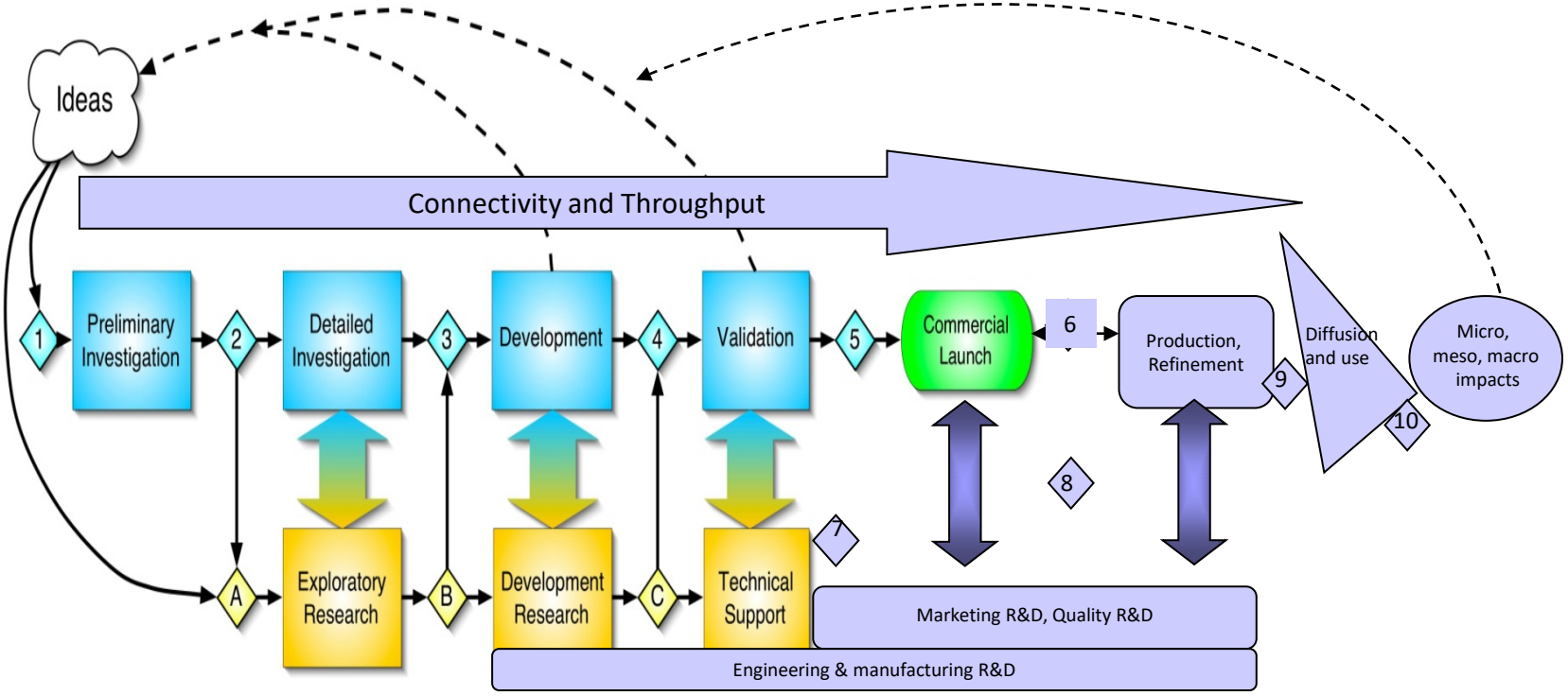
- Arriving at a comprehensive theory of change for RTD and innovation is important
- Progress is being made
- We have a way to go to understand the parts as well as the whole system
- A RTD Logic model repository can help us to move forward.

Thank you for your attention.

- See RTD TIG website from AEA TIG information page
- Contact me at

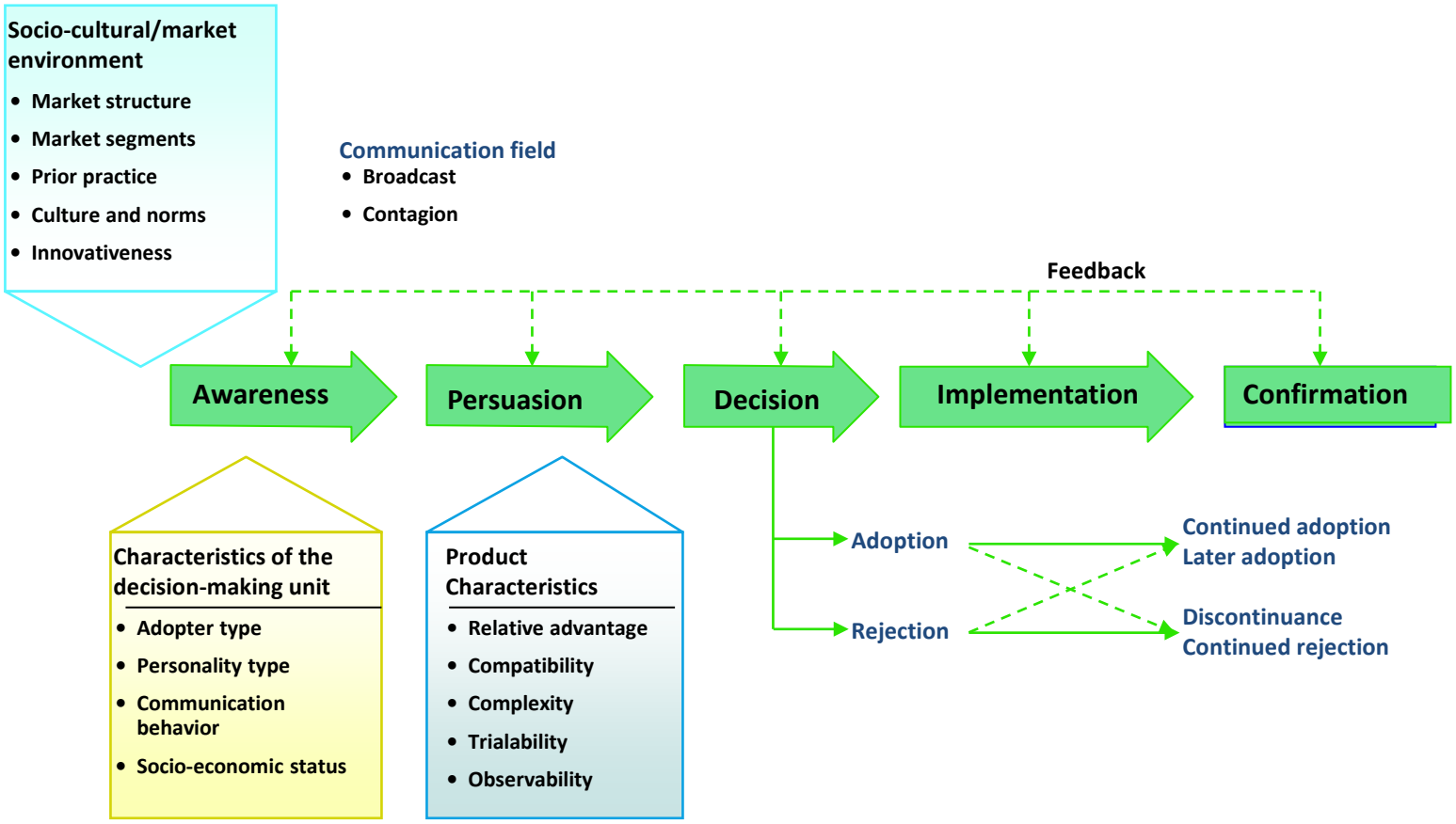
gretchen.jordan@comcast.net

A technology development view



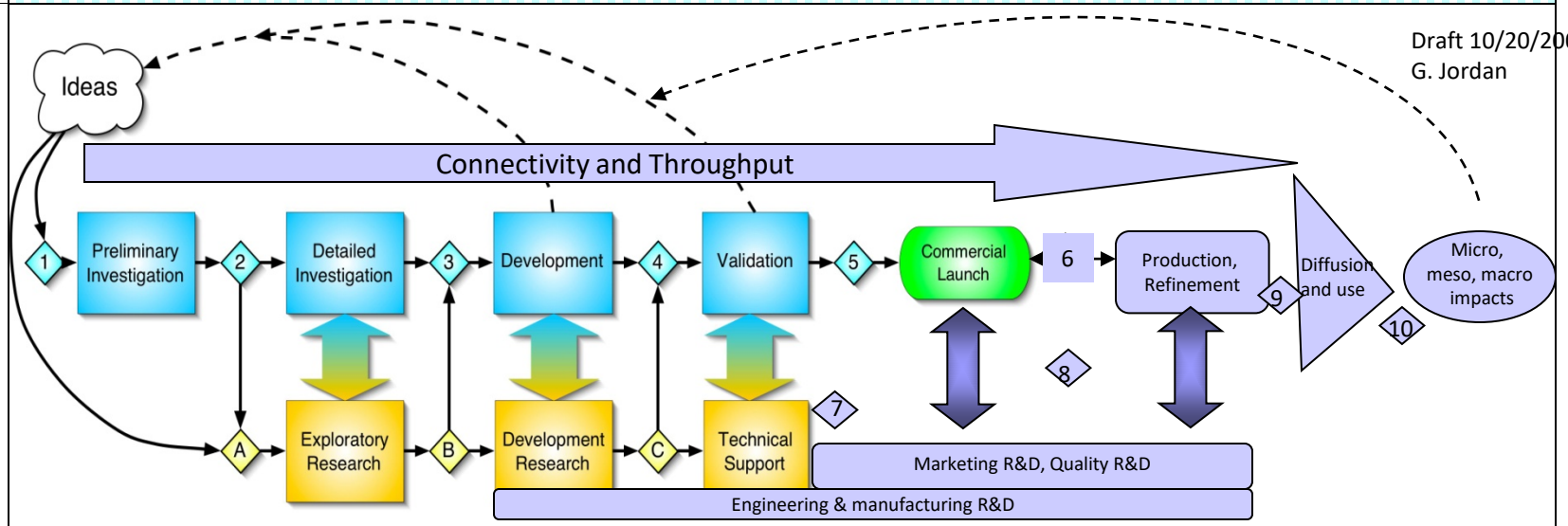
Source: G. Jordan, 2007. Modified from R. Cooper/ Exxon's Stage Gate, Hage & Hollingsworth's Idea Innovation Network

Theory of Diffusion of an Innovation



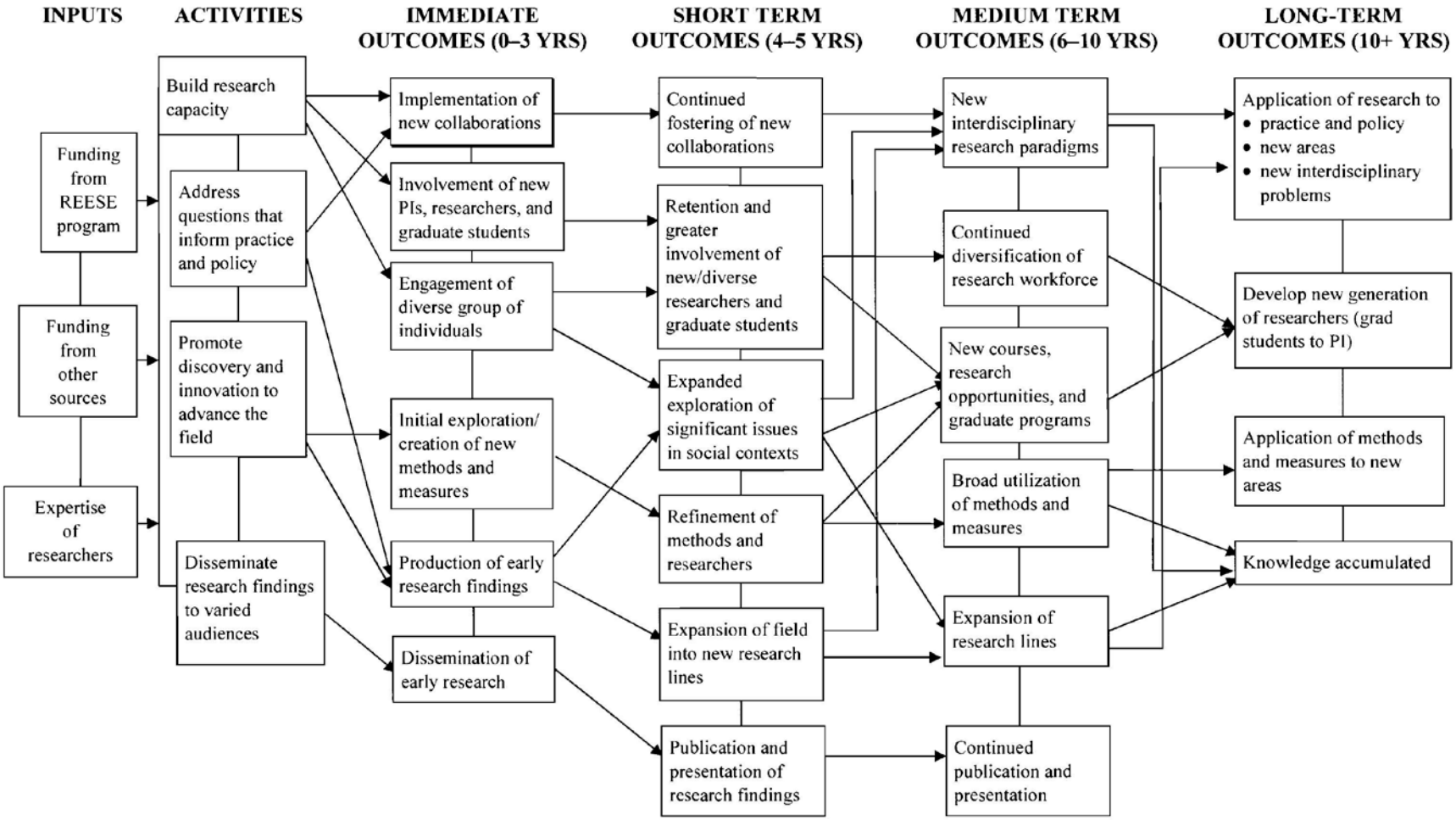
Source: Everett Rogers 1994 as modified by Innovologie, LLC. 2005

Multiple levels of influence and assessment within an emergent RTD system

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

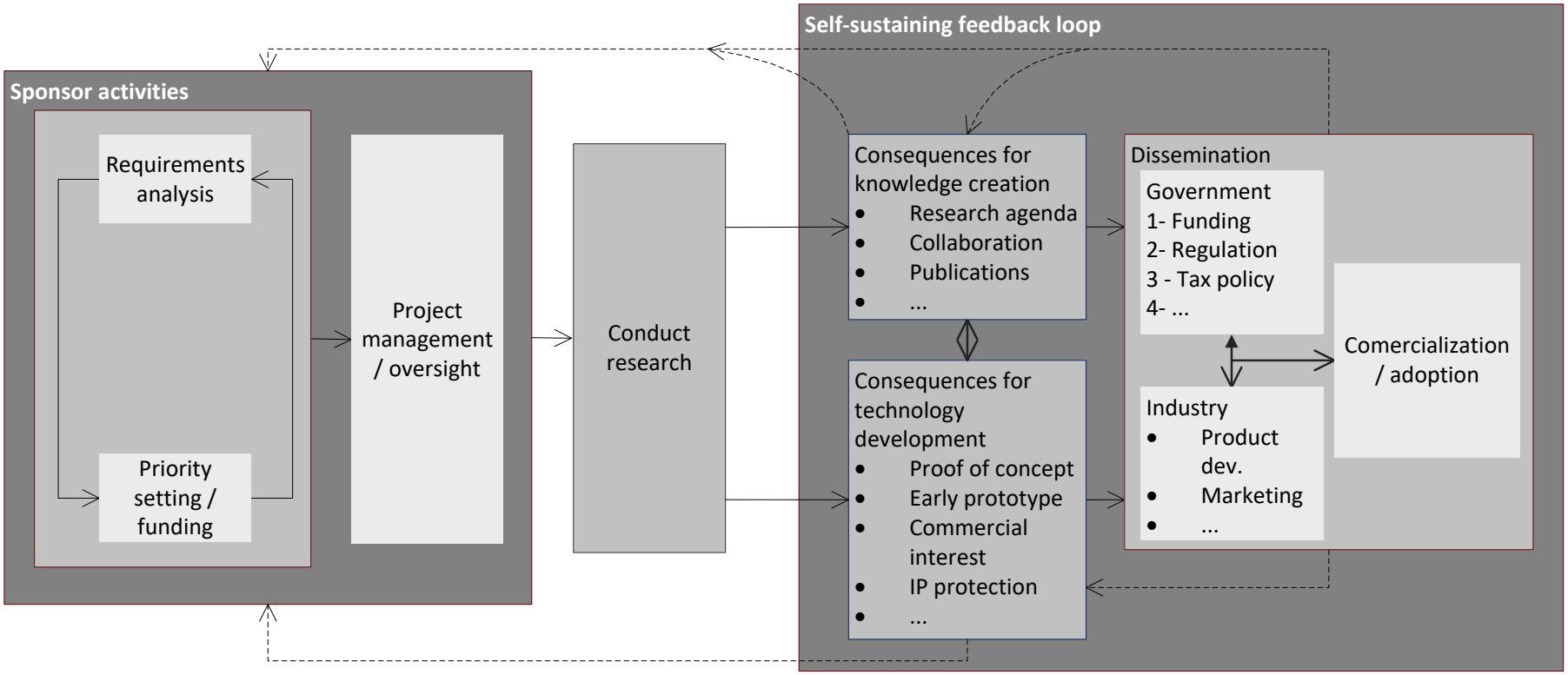
Pieces borrowed from R. Cooper/ Exxon, E. Rogers, Arnold & Kuhlmann, Hage & Hollingsworth, G. Tassey

REESE Logic Model – Basic Science



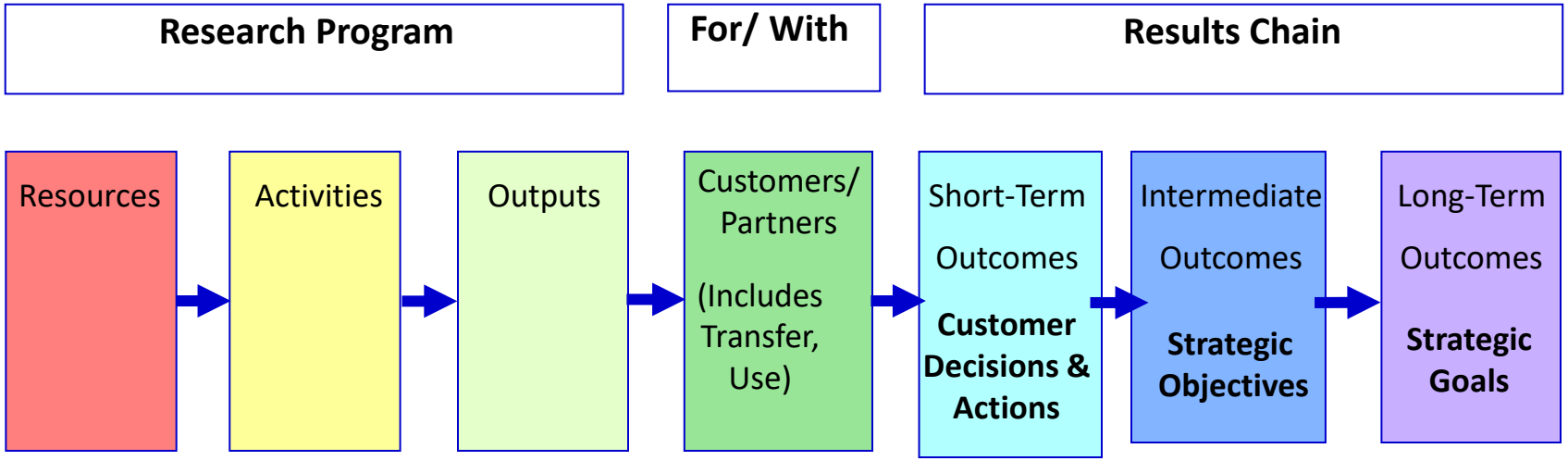
Source: Frechtling for NSF

Program level, with feedback loops to priority setting



Source: J. Morell for DOT

Rand-NIOSH. Helping researchers think through how their work contributes to organizational goals



Outcome Worksheet

Strategic Goals	Intermediate Outcomes	Short term outcomes	Customers/ Partners reached	Outputs	Activities	Resources

Modified from RAND- NIOSH

NYSERDA R&D Portfolio Logic – Revised DRAFT

Draft 07/18/2004

Inputs:
Funds, staff, NYSERDA competencies, partnerships

NYSERDA Select & Manage R&D Projects to:
-drive portfolio changes over time to respond to current needs, and
-Provide public benefits

	Policy Research	Product Development			Demonstration	Pre-deployment
Activities	Inform policy & R&D community	Study, Prove Concepts	Develop new or improved product	Test & improve products	Demonstrate products, inform markets	Educate, provide incentives to supply & delivery
Outputs	White papers, workshops; Etc.	New knowledge: -papers, articles -data	-Intermediate scale prototypes - Performance/cost specifications improving	- Data from tests - Establish standards - Hands on experience (industry) -Feedback to R&D	- Data from tests in different context - Feedback to R&D - Visibility & data from showcases	-Training, certification -Production incentives -Innovative designs
Outcomes	Informed policies & programs; R&D opportunities & standards identified, publicized	Dissemination builds common knowledge base -Lab prototypes -Future R&D & product options	-Investment/interest growing -Commercial scale product developed -Potential demonstrated	Product proven/ introduced in market	Producers & consumers see value	Business infrastructure supports the product

Policy and Product development and pre-deployment process (5-10 years)

Firms have credibility & with co-funders acquire capital and distribution channels

Products manufactured as replacement, stand alone, or part of system and purchased by early adopters [and early majority?]

- New
- Accelerated
- Expanded

Products in the areas of

Clean energy generation | Energy storage, distribution, & load management | Reduced energy use

And related to these are: Emission reduction, Lower cost of compliance, Manufacturing and job creation

External Influences:
Cost, Performance of existing technologies; Industry willingness to take risks; Uncertainty of R&D; Energy prices; Government policies