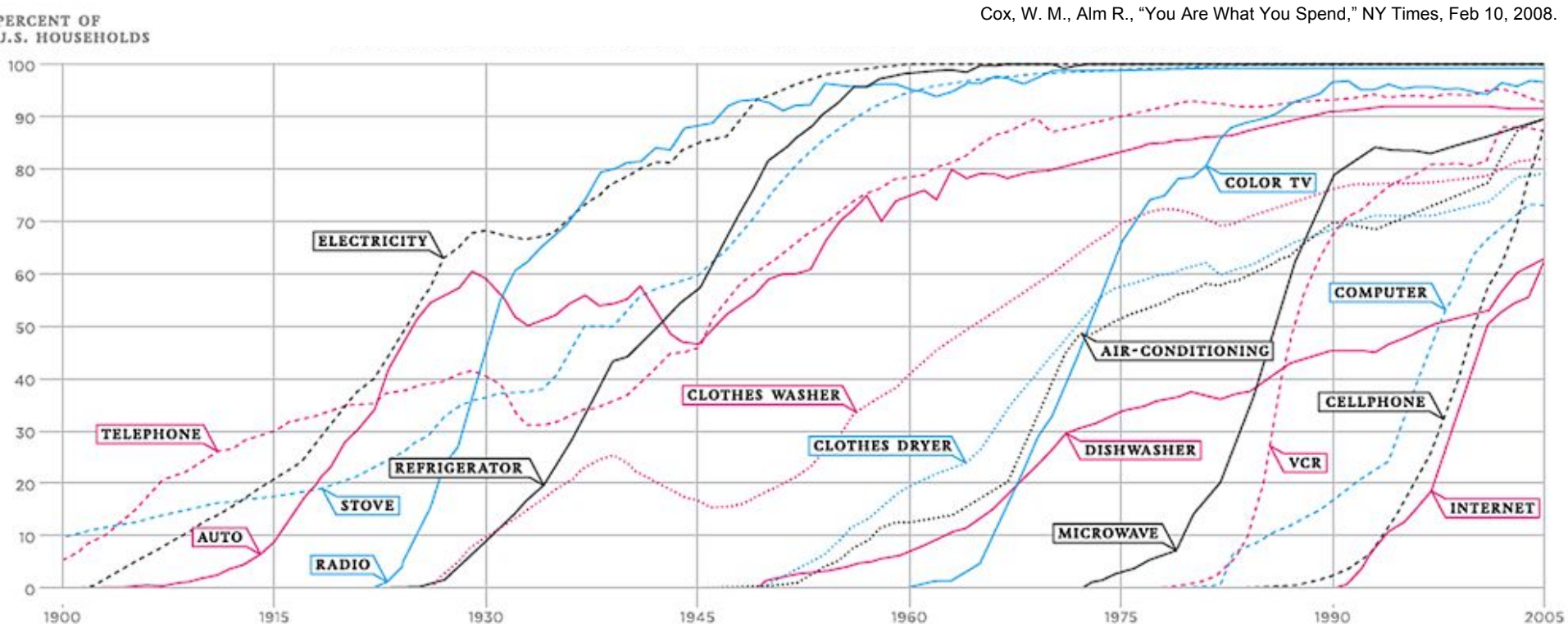


# Cultural Barriers to the Adoption of Systems Engineering Research



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# Objectives

1. Provide an overview of the research in adoption, culture/technology
2. Explore relevant factors
  - Attributes of successful measurement systems
  - Determinants of organizational culture
  - Culture of technology
3. Share survey results
4. Bridge the gap between the ivory tower and main street

# Guiding Questions

- What makes SE research adoptable?
  - Technology adoption, organizational culture
- What aspects of organizational culture enable/hinder adoption of SE research?
  - “Demand” side, instrumentalist view (adopter-based)
- What role do the embedded cultures play in the adoption of tools?
  - “Supply” side, determinist (developer-based)

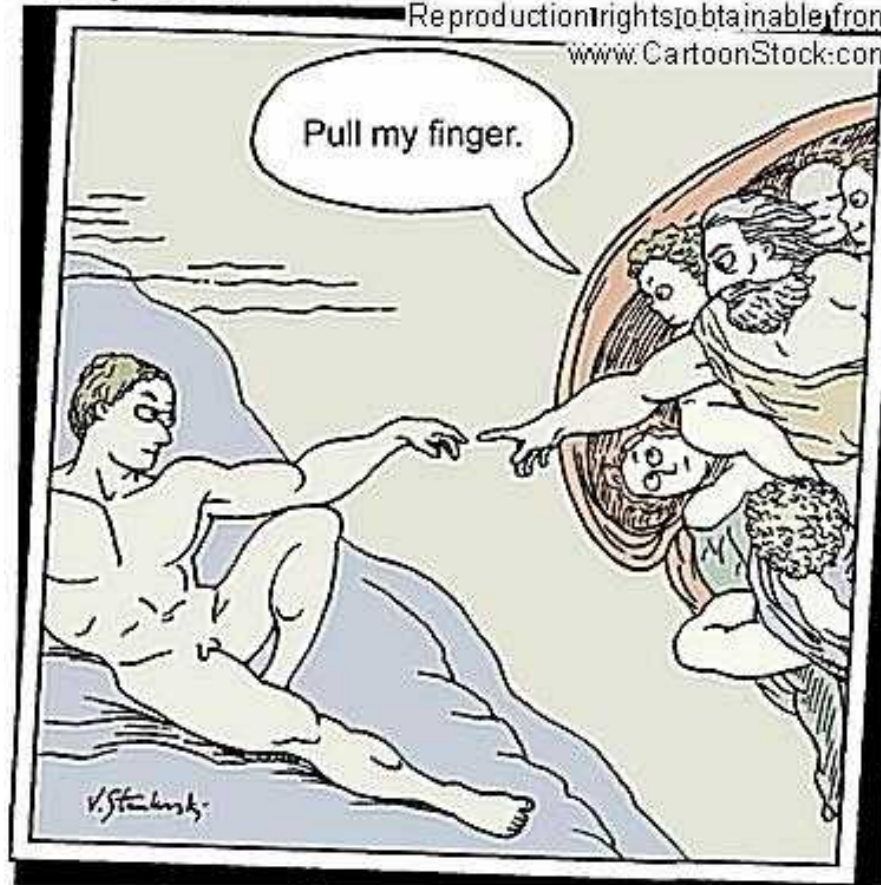
# Human-Human Interface

Snapshots

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# MoProSoft Example

- CMMI fared well in the U.S., but what about Mexico?
- 92% of Mexican software companies are small/medium-sized (< 100 people) and average process capability level is 0.9 (Oktaba 2006)
- Only 3 Mexican companies have achieved level 2; 33 are level 1

	Adequate for low-maturity SMEs	Inexpensive to adopt	Permissible as a national standard	Specific for SW dev. and maint.	Based on int. recognized practices
ISO9000:2000	Yes	Yes	Yes	No	No
CMM/CMMI	Yes	No	No	Yes	Yes
ISO/IEC 12207	?	?	Yes	Yes	Yes
ISO/IEC 15504	?	?	Yes	Yes	No

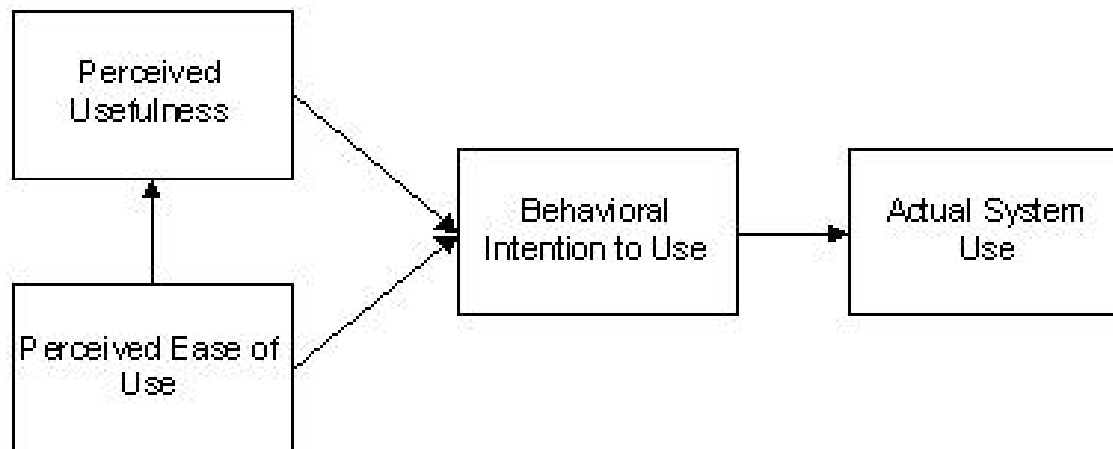
- Modelo de Procesos para la Industria de Software (MoProSoft)

Oktaba, H., "MoProSoft: A Process Model for Small Enterprises," Proceedings of the 1<sup>st</sup> International Research Workshop for Process Improvement in Small Settings, CMU/SEI-2006-SR-001, Software Engineering Institute – Carnegie Mellon University, 2006.

# Technology Acceptance Model

## Demand side/adopter based

- Perceived usefulness
  - The degree to which a person believes that using a particular system would enhance his or her job performance
- Perceived ease of use
  - The degree to which a person believes that using a particular system would be free of effort

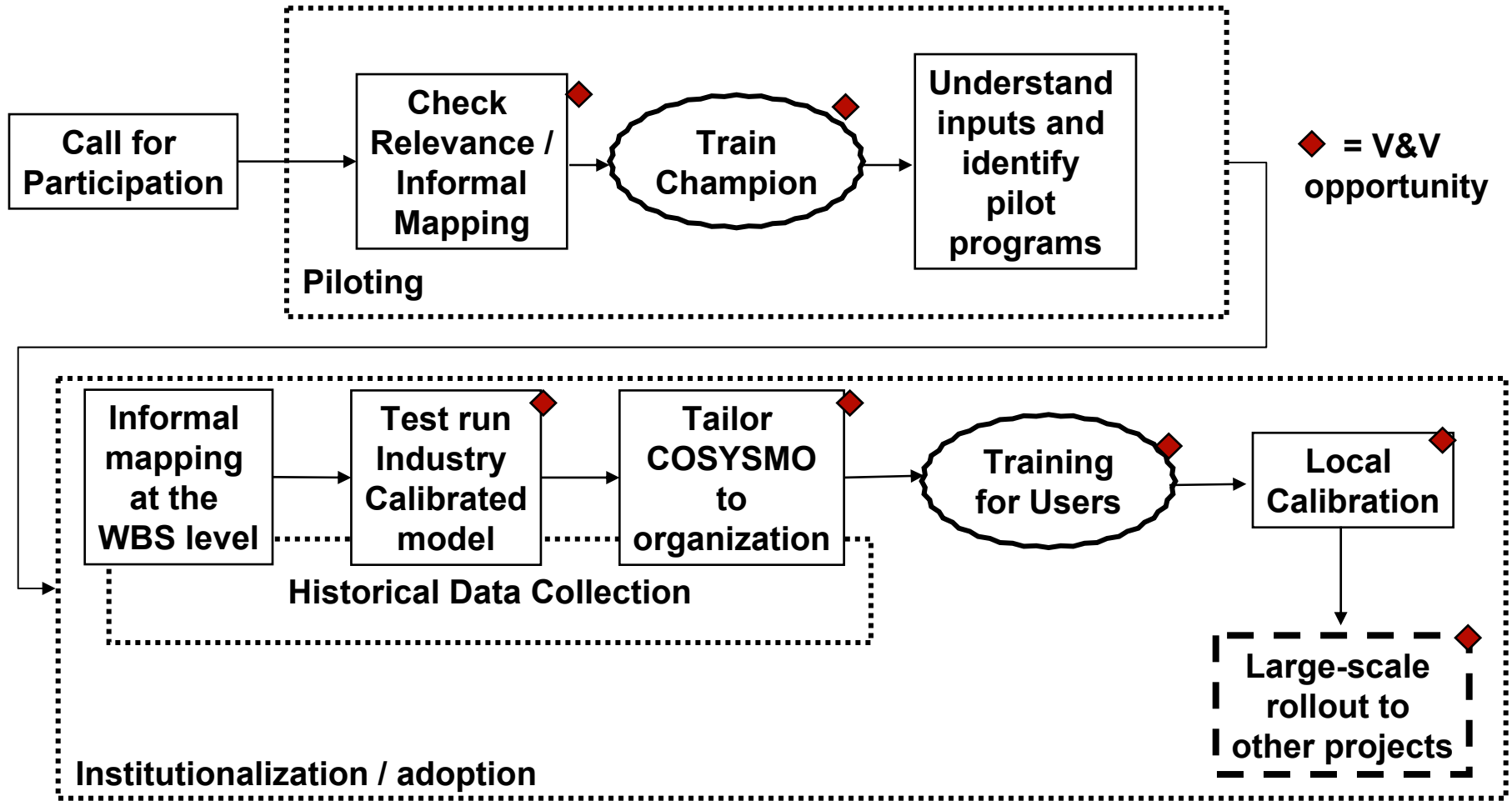


# What Makes an SE Tool Adoptable?

## (survey Qs)

- Well documented
- Trialability
- Low barrier of entry
- Transparency
- Demonstrates value
- Variety of incentives
- Tailorable
- Information freshness
- Relative advantage
- Compatibility
- On-going peer support
- Credibility
- Agility
- Flexibility
- Failure modes
- Enabled by IT

# COSYSMO Adoption Process





# Dimensions of Organizational Culture

## Social Science

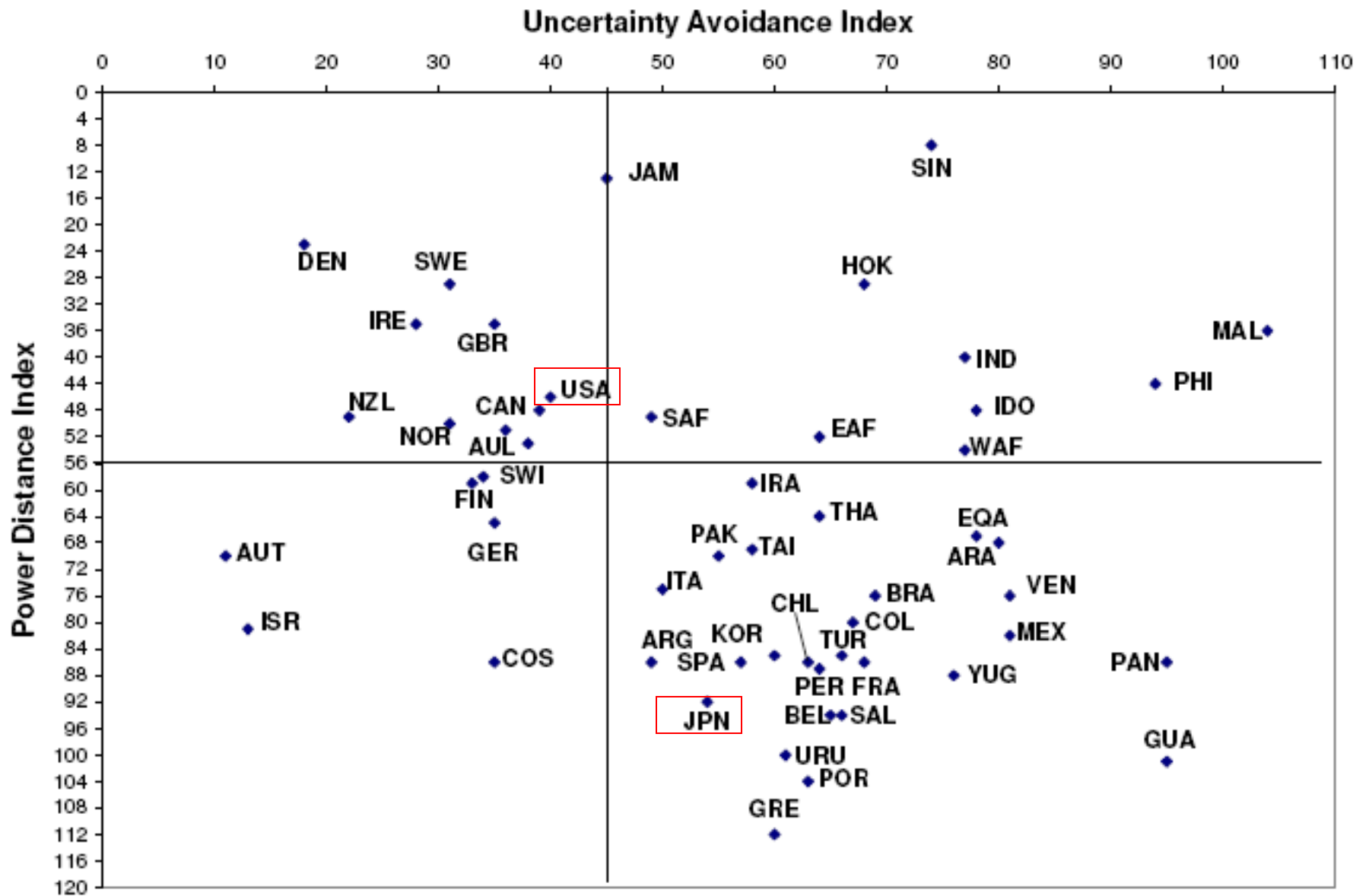
- **Power distance** – the extent to which a society accepts the unequal distribution of power in the organization
- **Uncertainty avoidance** – the extent to which people are comfortable or uncomfortable with uncertainty and little structure
- **Individualism** – the extent to which individuals are supposed to be self-reliant and look after themselves, versus being more integrated into a group
- **Masculinity or Femininity** – hardness vs. softness; toughness vs. tenderness
- **Long term or short term orientation** – the culture’s members having a stance on delayed, or immediate, gratification

Hofstede, G., *Culture and organizations: Software of the mind*. London: McGraw-Hill, 1991.

## Management

- **Innovation and risk taking** – willing to experiment, take risks, encourage innovation
- **Attention to detail** – paying attention to being precise vs. saying its “good enough for chopped salad”
- **Outcome orientation** – oriented to results vs. oriented to process
- **People orientation** – degree of value and respect for people. Are people considered unique talents, or is an engineer an engineer an engineer?
- **Individual vs. Team orientation** – are individuals most highly noted, or are collective efforts
- **Aggressiveness** – taking action, dealing with conflict
- **Stability** – openness to change

O’Reilly, C., Chatman, J., & Caldwell, D., People and organizational culture: A profile comparison approach to assessing person-organization fit. *Academy of Management Journal*, 34, 487-516, 1991.



# Example: Raytheon Legacy

- American Appliance Company (1922)
- Submarine Signal Corporation (1946)
- Raytheon Manufacturing Company (1959)
- Beech Aircraft (1980)
- Hughes/General Dynamics Missiles (1992)
- E-Systems (1995)
- Texas Instruments Defense Systems & Electronics (1997)



**Raytheon**

# Determinants of Culture

- Culture as: social heritage, human behavior, values, control, rules, etc. (Bodley 1996)
- Organizational culture is influenced by
  - Legacy processes
  - Customer demands
  - Product/systems delivered
  - Geographic location
  - Etc.

Which attributes of organizational culture enable or hinder the adoption of SE tools?

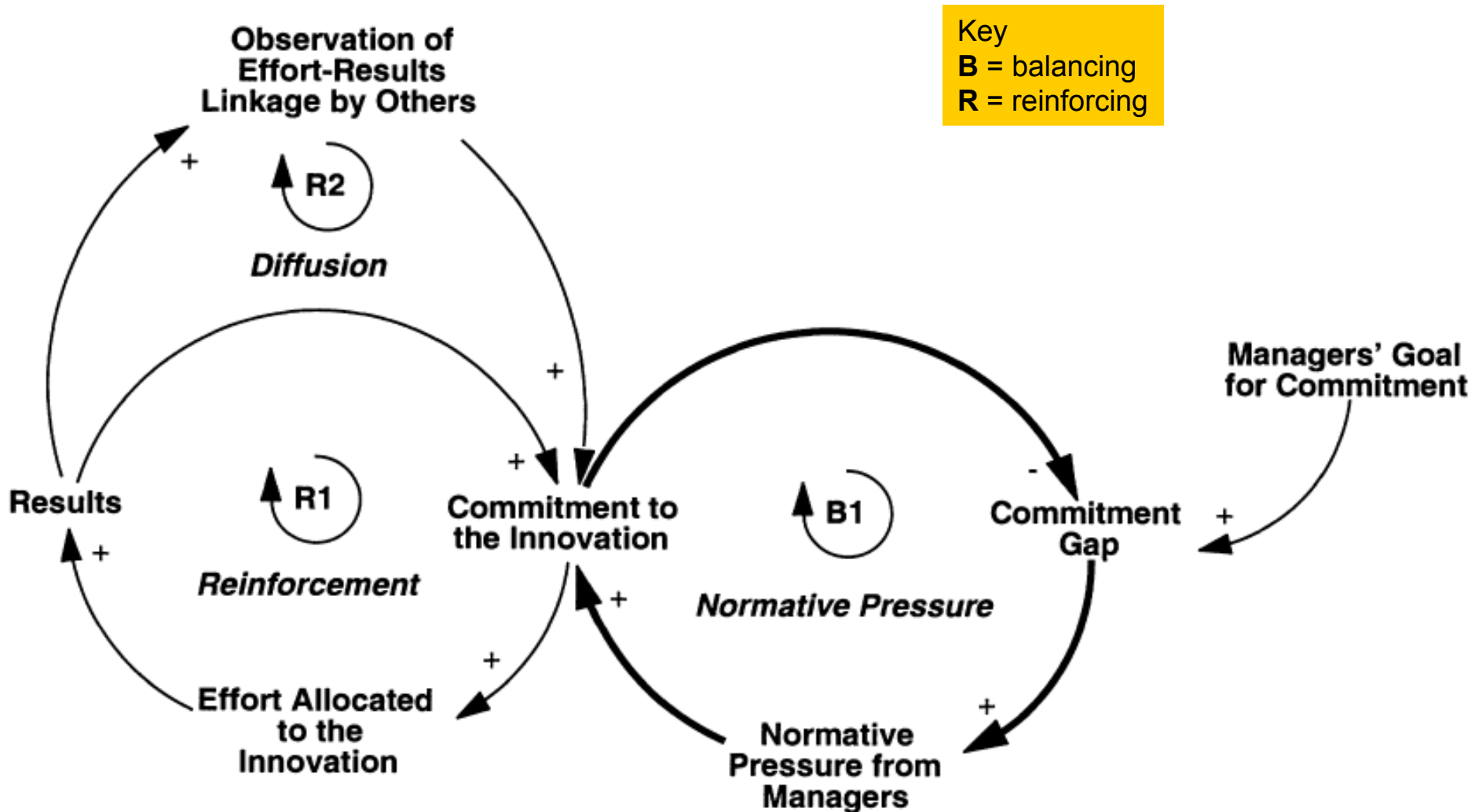
# Absorptive Capacity

- An organization's ability to value, assimilate, and apply new knowledge (Cohen & Levinthal 1990)
- One reason for companies to invest in R&D instead of simply buying the results (e.g. patents)
  - Internal R&D teams increase the absorptive capacity of a company

## Predictors

- **Receptivity:** The firm's overall ability to be aware of, identify and take effective advantage of technology
- **Innovative Routines:** Practiced routines that define a set of competencies the firm is capable of doing confidently and the focus of the firm's innovation efforts

# Dynamic Forces of Implementation



# Culture of Technology

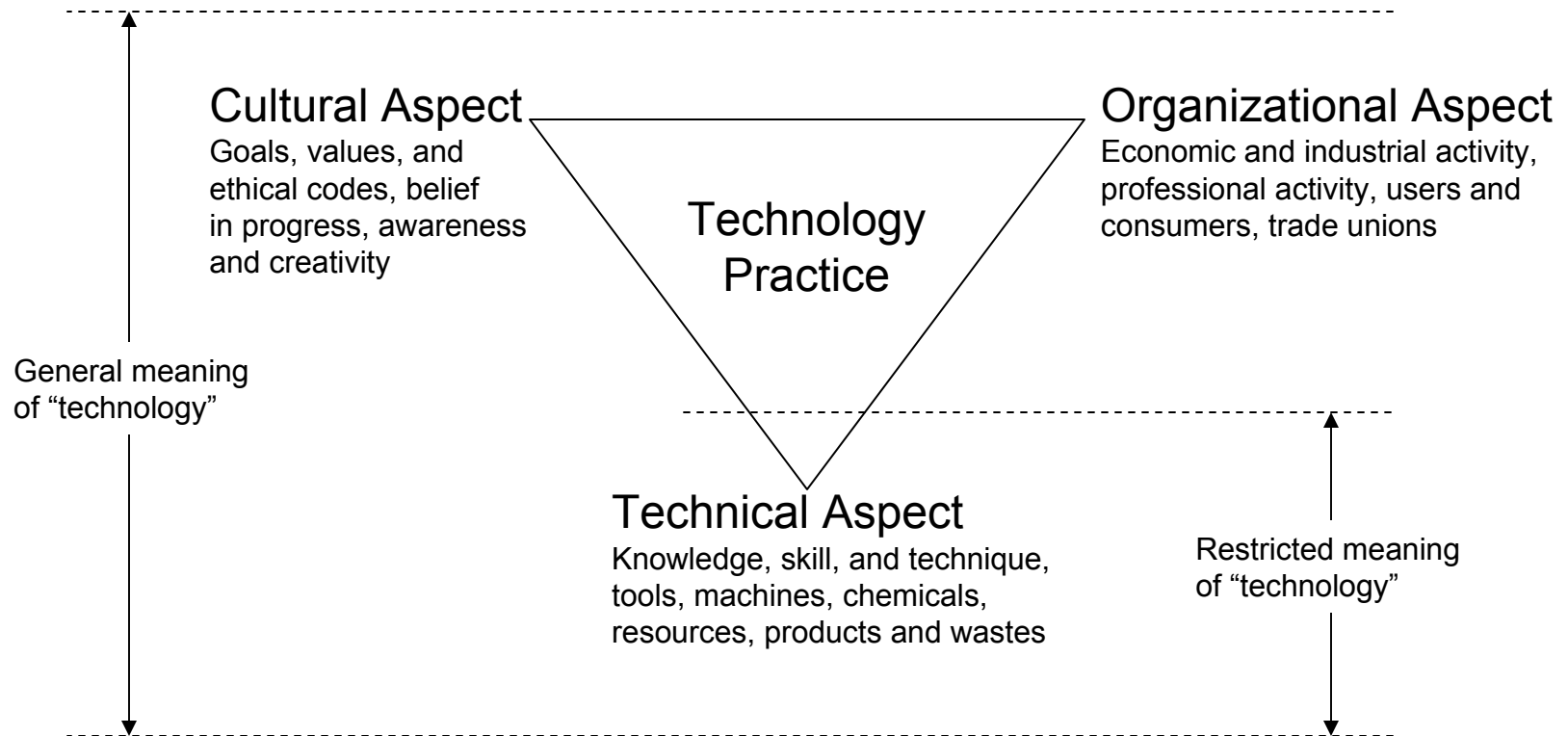
supply side/developer-based

- Product architecture often mirrors organizational architecture
- Technology is not culturally, morally, and politically value neutral (Pacey 1983)
  - Snowmobile must fit into a pattern of activity which belongs to a particular lifestyle and set of values



# Culture of Technology

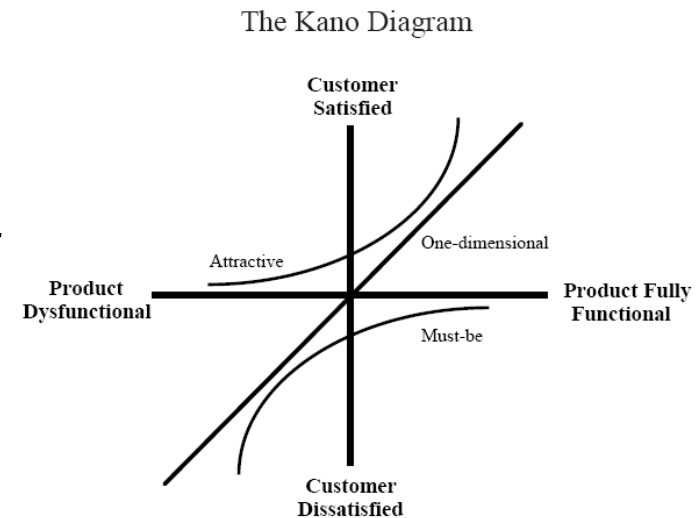
## Cont.



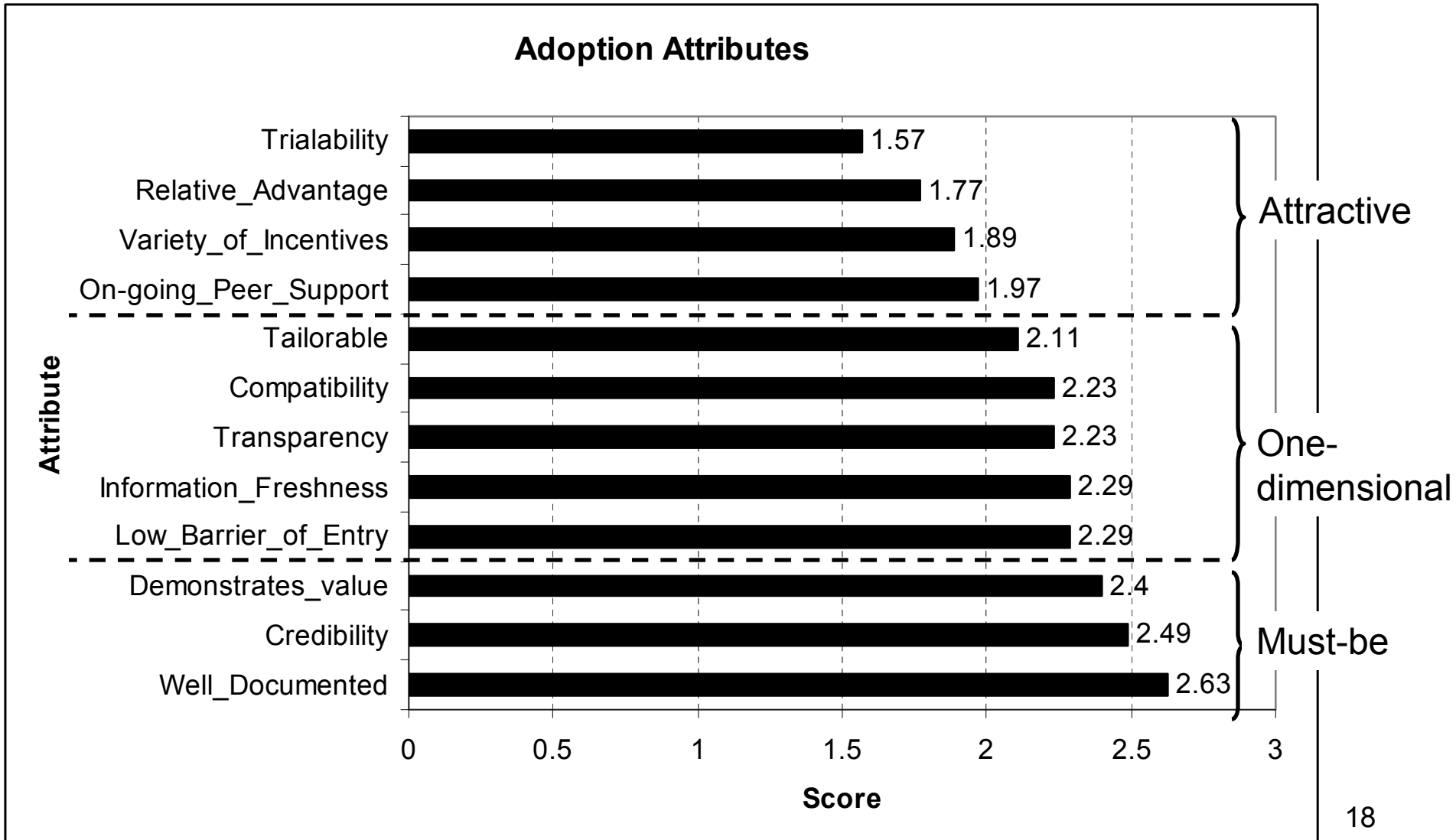


# Attributes Survey

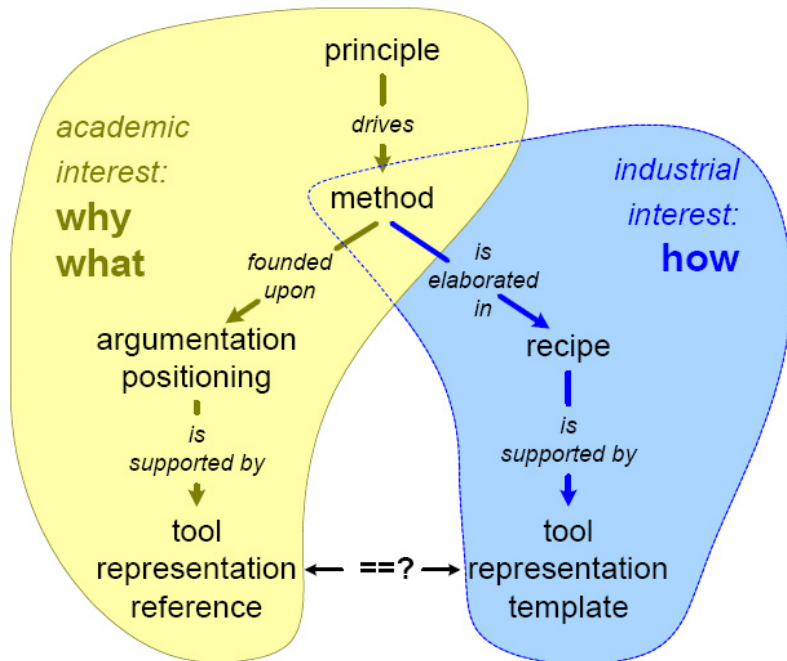
- **Must-be** – referring to attributes where user is dissatisfied from its absence but never rises above neutral no matter how much of the attribute exists (i.e., good brakes).
- **One-dimensional** – referring to increasing user satisfaction from the presence of this attribute and decreasing satisfaction from its absence (i.e., gas mileage).
- **Attractive** – indicates areas in which the user is more satisfied when the measurement system has the attribute but is not dissatisfied when it is absent; lack of an attribute leads to a neutral reaction (i.e., radio antenna that lowers into car body).



# Ranking of Adoption Attributes (n=35)



# Ivory Tower and Main Street



	<i>industrial</i>	<i>academic</i>
relevance	useful, valuable	new, original
orientation	goal, solution	knowledge
content	practical, how to	theoretical, why, what
style	clear, understandable juicy, low noise	clear argumentation, no loose statements
references	service to the reader	positioning in existing science
author	single author	all contributors as author
economic driver	writing and reading = cost public relation vs IPR and confidentiality	funding based on number of publications and citations