



# From Observation to Theory in OM Empirical Research *Competitive Progression Theory*

**Aleda V. Roth**

Burlington Industries Professor of Supply Chain Management  
College of Business and Behavioral Sciences


**CLEMSON**  
UNIVERSITY

# Theory

- A theory is “a statement of relations among concepts within a set of assumptions and constraints” (Bacharach, 1989)
- Necessary Conditions
  1. Falsifiability – allows for an empirical refutation (Knowledge is advanced not by proving theories, but by disproving them (Popper 1959))
  1. Utility – ability to explain and predict important phenomena (why phenomena occurs and under what conditions it will occur)
- “Nothing is so practical as a good theory” (Simon 1967)

# What a Theory Is Not ...

(Weick 1995)

- 
1. **Accounts of previous research to justify hypotheses**
    - **Manufacturers should make trade-offs in quality and cost (Skinner 1978)**
  2. **Categories of raw data to provide order to objects and events**
    - **Companies x, y, and z have high levels of WIP; Toyota has low levels**
  3. **Empirical Patterns or Relationships in data**
    - **Data mining, correlations**
  4. **List of variables or constructs that define a research domain**
    - **Eight dimensions of quality (Garvin 1987)**
  5. **Typologies – conceptual classifications of raw data**
    - **Innovators, Marketeers, and Caretakers (Miller and Roth 1994)**
  6. **Diagrams/figures**
    - **“boxes and arrows” depicting causal flows to specify hypotheses**
  7. **Hypotheses – concise statements of the expected empirical patterns or relationships**
    - **H1: Conformance quality leads to lower costs (Summarize the theoretical arguments but does not contain the logical argument of why)**

# What Is A Good Theory?

*Six characteristics of a good inductive theory (Locke 2005):*


- 
1. Based on **observations and data**
  2. **Defines concepts** and notions ways that differentiates from other concepts
  3. Integrates concepts and **resolves apparent contradictions**
  4. Identifies **causal relationships**
  5. Has a long **gestation time** to develop
  6. Is **open-ended**, allowing for extensions and re-applications.

But 'good' is *not* enough:

**Theory must be interesting!** (Whetten)

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# Elements of a Theory in Social Sciences

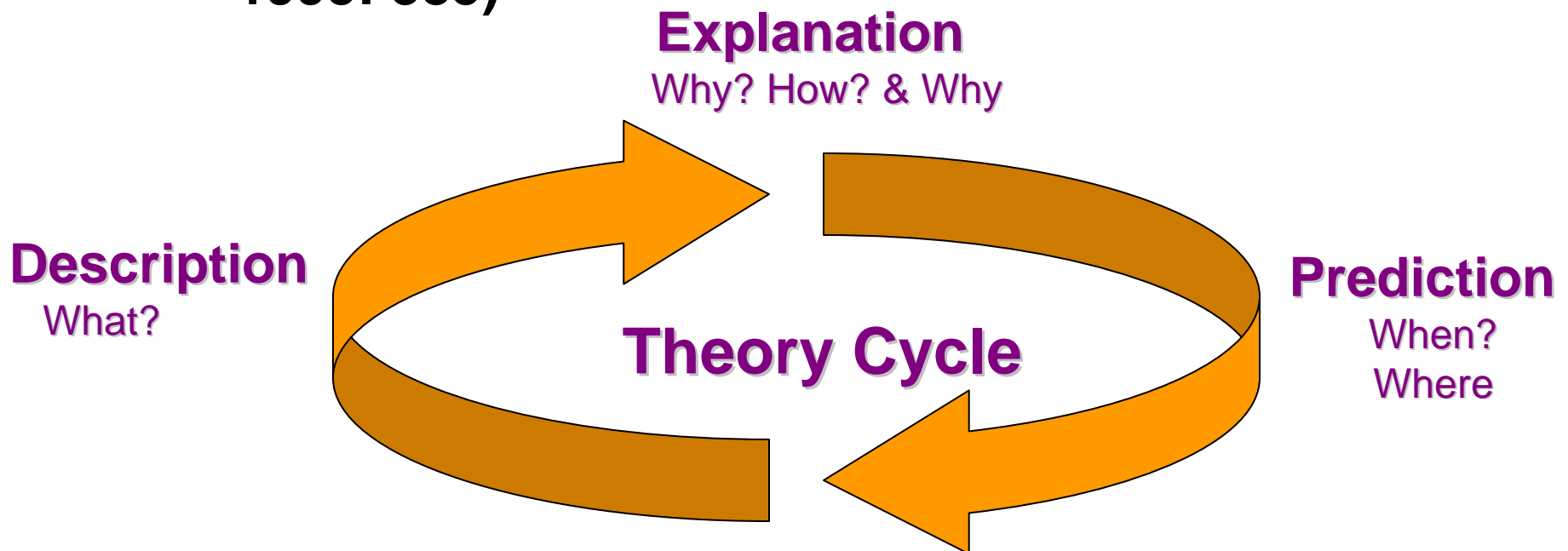
- 
- **Constructs** – unobservable conceptual entities (e.g. cooperative behavior, competitive priorities, effort, conformance quality)
  - **Variable** – observational or measurable entity that taps into the unobserved construct (e.g., error rate)
  - **Relationships** – covariation between two or more constructs captured by the theory
  - **Boundaries** – restrictions regarding context, sample, space and time that limit the phenomena a theory purports to explain

# Why Focus on Theory in OM Empirical Research?

- The objective for any science (McMullin 1993)
- Provide order and meaning to things that are well-studied and known to be true (Stafleu 1987)
- Valuable in explaining observation and data (dictionary.com 2005)
- Explain under what conditions phenomena or events occur (Bacharach 1989)
- Provide a verbal statement of ideas suitable to communication and rigorous testing within a scientific community (Bacharach 1989)
- OM empirical research has many frameworks, lots 'hypotheses testing', but is weak in "OM" theories (Roth et al. 2006)

# Good Theory Development Process

- ● ●
- Good theory development is a cyclical process that “represents interim struggles in which people intentionally inch toward stronger theory (Weick, 1995: 385)



# Today's Story

## *Two Decades of an Inductive Theory-Building Journey*



### ● ONCE UPON A TIME . . .

*Ten years of observations on  
competitive capabilities*

### IN THE MEANTIME . . .

*An explanation was sought, so  
a new theory was put forth.*

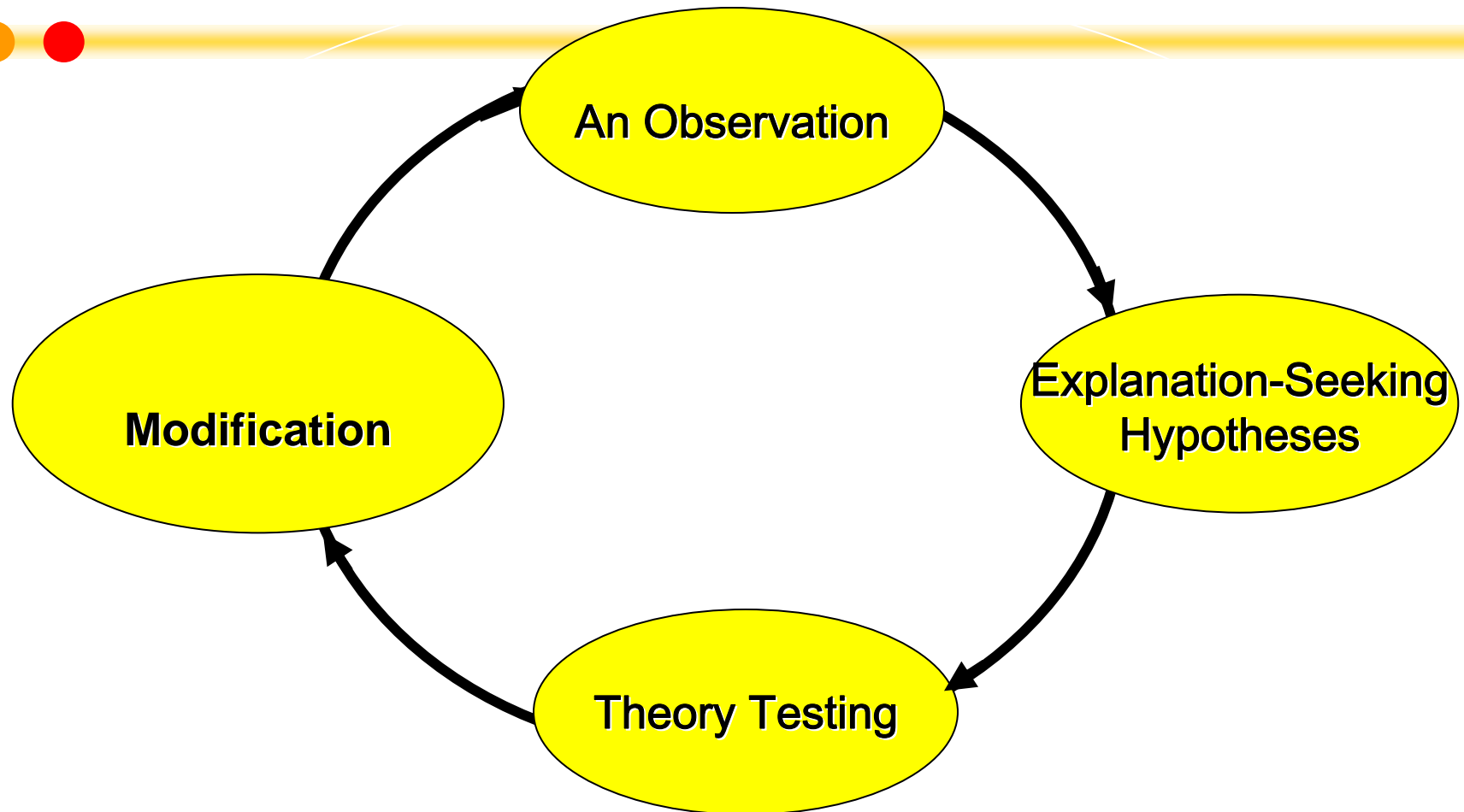
### ● AND HAPPILY THEREAFTER . . .

*Evidence was gathered and  
theory was tested*



# From Observation to Theory

## *The Scientific Method in OM Empirical Research Process*



# Once Upon a Time Competing Through Operations



## **Basic Question of Operations Strategy:**

*How does operations contribute to business success?*

*What must operations do well?*

***While One of the Basic Tenets of Operations Logic Has Been Trading Off One Capability\* for Another ...***

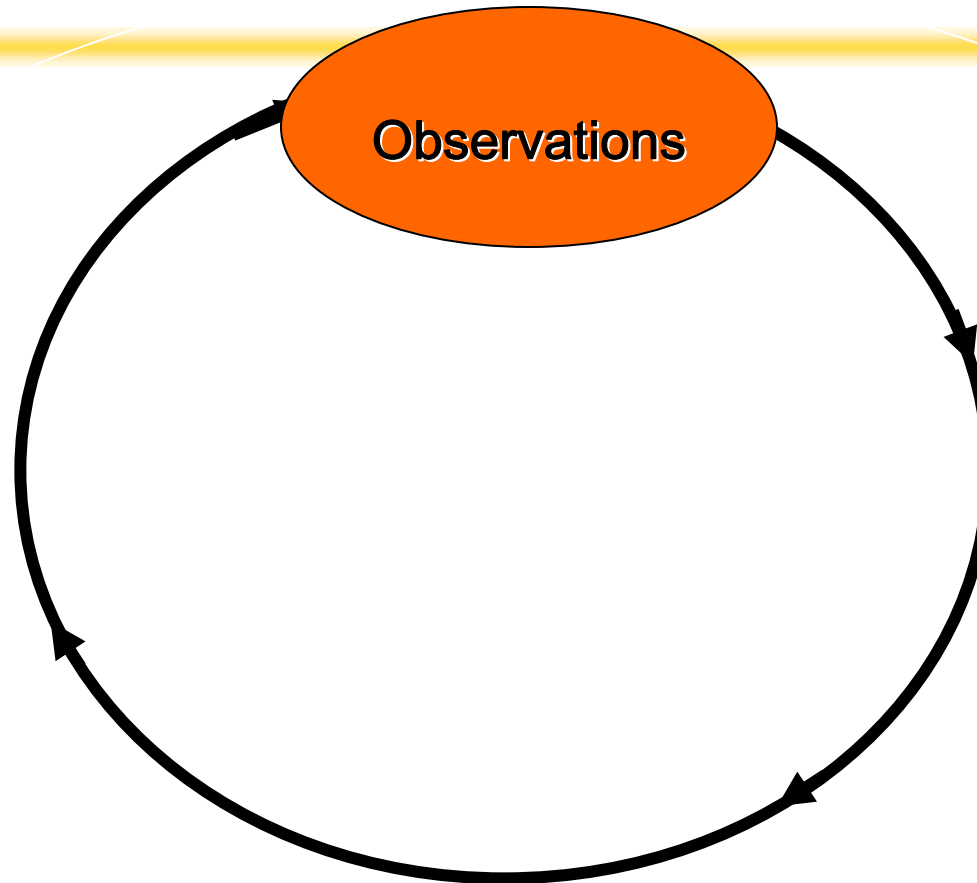
*Quality or Delivery or Flexibility or Low Cost*

***the Observations reveal otherwise. On average, firms have multiple capabilities, regardless of intentions or plans.***

**\*Capabilities are operationally defined constructs in terms of a firm's actual (or 'realized' competitive strength relative to competitors in its target markets (Aliases: Mfg Task, Order Winners/Qualifiers, Production Competencies, Production Criteria)**

# From Observation to Theory

## *The Scientific Method in OM Empirical Research*



# ONCE UPON A TIME . . .

*First 10 years of “observations” on  
capabilities-based competition...*

## Jinichiro Nakane (Int’l Manufacturing Futures Project, 1986)

“In general, if some (Japanese) companies want to offer **‘flexibility’** as a competitive priority, it is necessary that at least they have already qualified for a minimum level of abilities on **quality, dependability,** and **cost** improvement. If they have not such an ability, they get a chaos condition and end tragically.”

Source: J. Nakane, “Manufacturing Futures Survey in Japan: A Comparative Survey, 1983-1986, Tokyo: Waseda University, System Science Institute, May 1986.

# ONCE UPON A TIME . . .

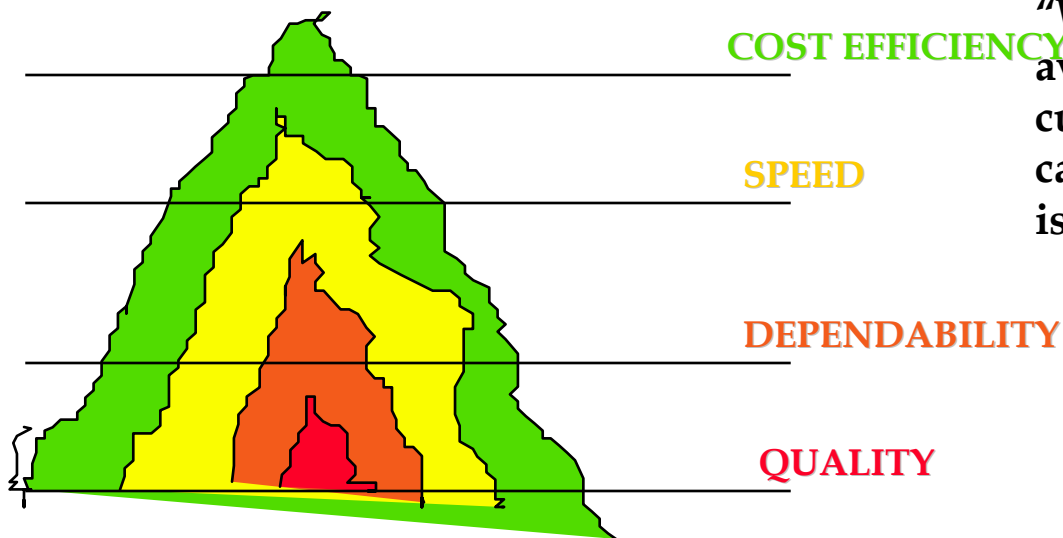
*First 10 years of observations on*

*capabilities-based competition ...*



K. Ferdows & A. De Meyer (Int'l Manufacturing Futures Project, 1988)

*“Sand Cone Effect” - Making A Case Against Capability “Tradeoffs”.*



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“We suggest that the approach which avoids trade-off and ensures the cumulative build-up of manufacturing capabilities in the long run is one which is in broad terms focuses on

**quality** first, then **quality & dependability**, then **quality, dependability, & speed**, and finally, on all three plus **cost efficiency**.

This sequence builds lasting and deep manufacturing capabilities”

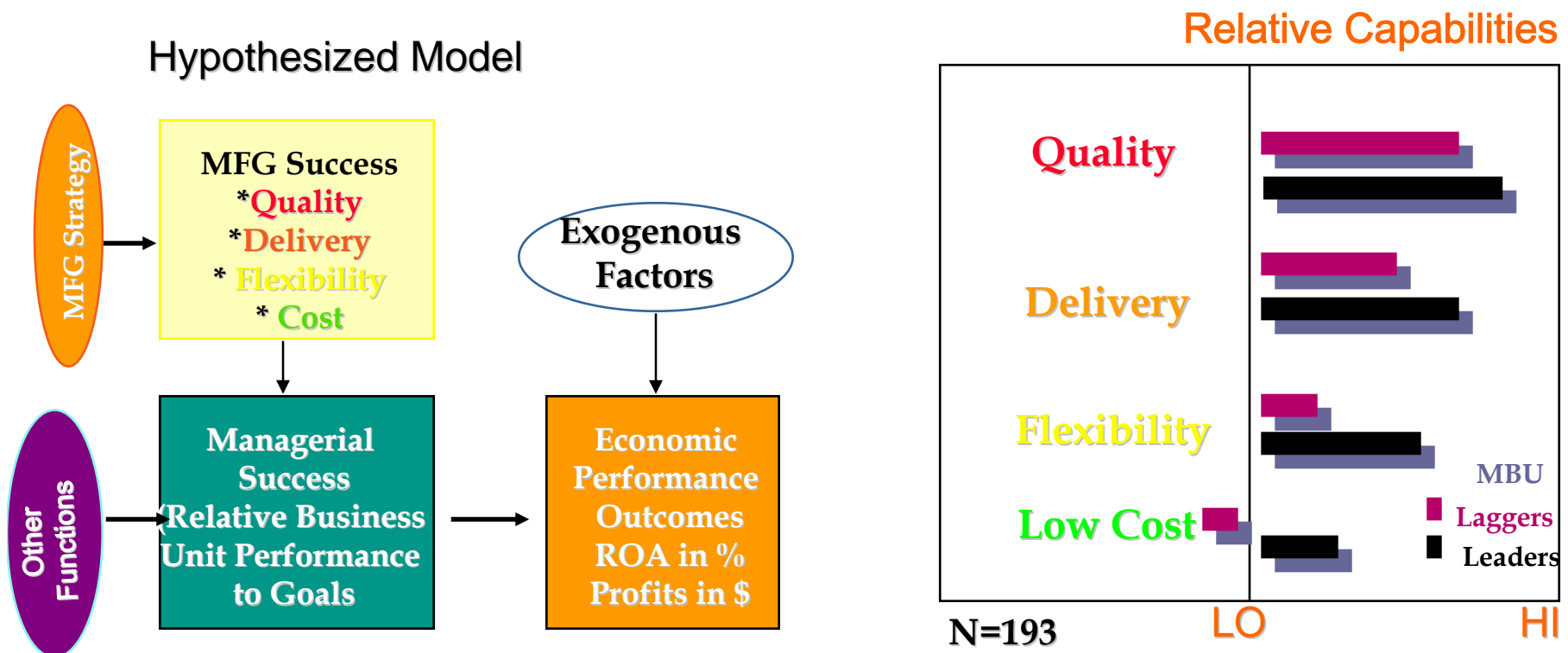
(p. 181).

Source: K. Ferdows and A. De Meyer, “Lasting Improvements in Manufacturing Performance: In Search of A New Theory,” *Journal of Operations Management*, 9:2, 1990, 168-184.

# ONCE UPON A TIME . . .

*First 10 years of observations on capabilities-based competition ...*

A. Roth & J. Miller ( **North American Manufacturing Futures Project, 1988**) Model Empirically Relates Combinative Capabilities to Economic (Objective) Measures of Business Performance

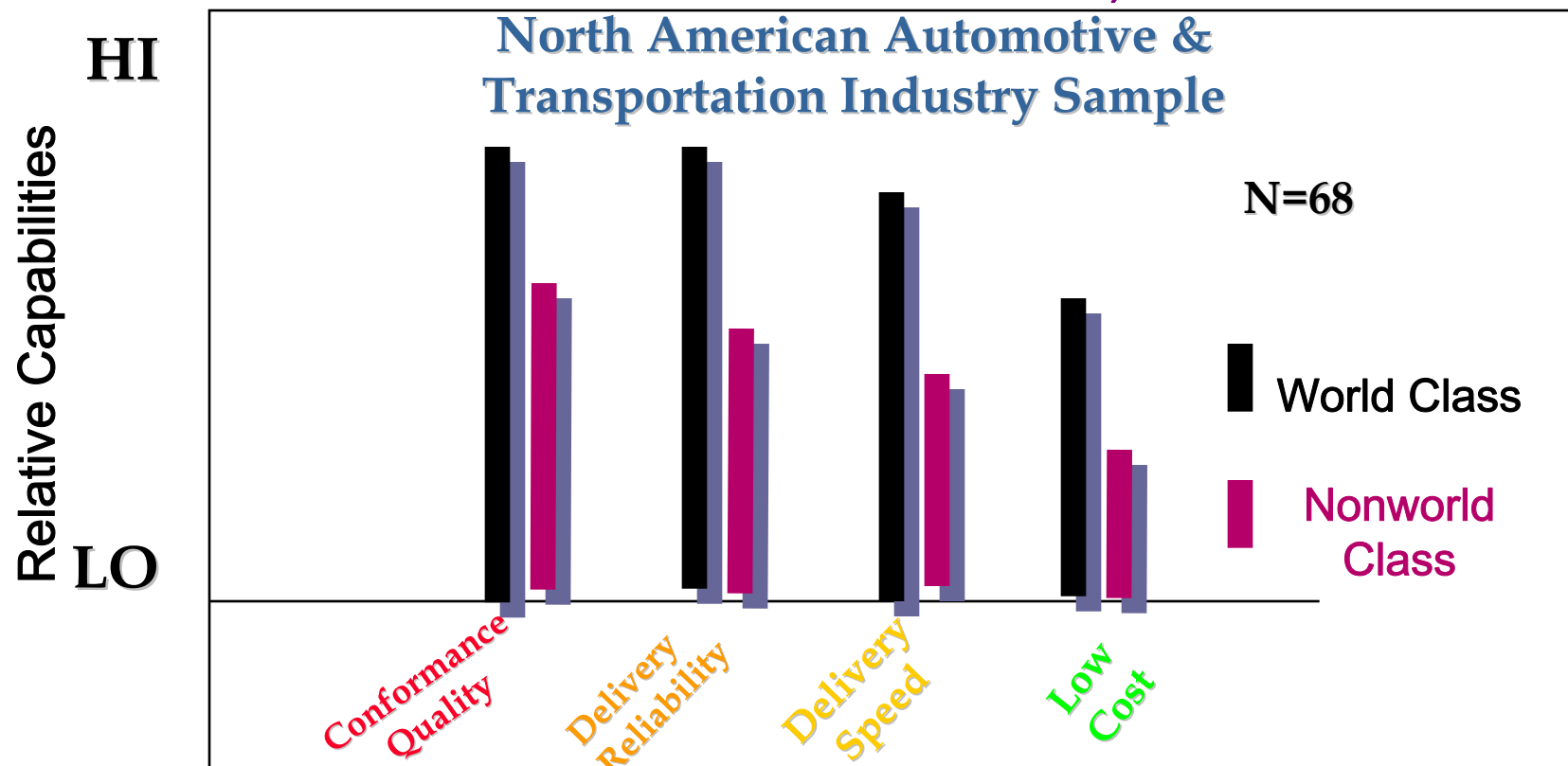


Source: A. V. Roth and J. G. Miller, "Success Factors in Manufacturing," *Business Horizons*, 35:4, July-August 1992

# ONCE UPON A TIME . . .

*First 10 years of observations on capabilities-based competition ...*

A. Roth & R. Miller (Deloitte Touche Tohmatsu- Roth Vision in Manufacturing Research, 1991 – WCM )

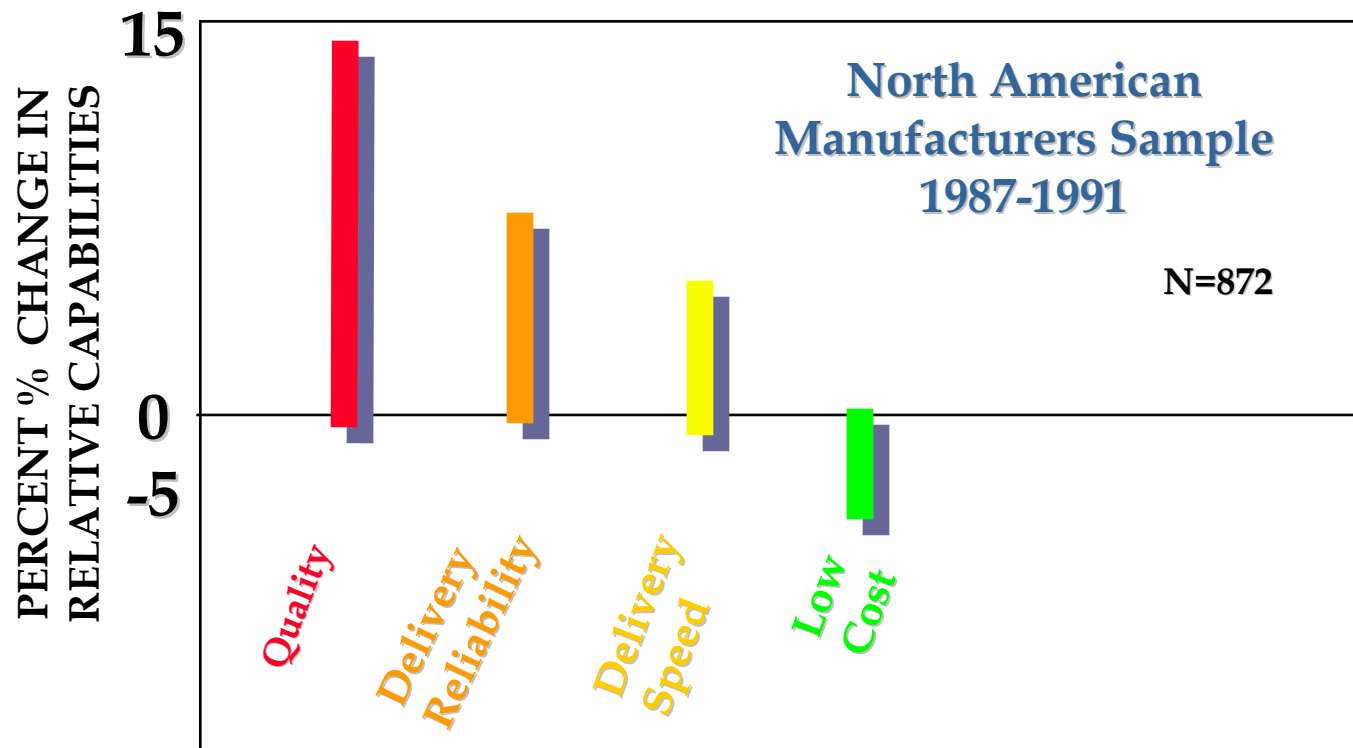


Source: A. V. Roth and R. W. Miller, "The Automotive Transportation Industry in Transition: Progress Towards World Class, Durham NC: Fuqua School of Business, Duke University, 1991.

# ONCE UPON A TIME . . .

*Ten years of observations on  
capabilities-based competition ...*

A. Roth & C. Giffi (DTT-Roth Vision in Manufacturing Research, 1987-1991)  
LONGITUDINAL ASSESSMENT OF CAPABILITIES



Source: Roth, A.V. and C. A. Giffi, "Winning in Global Markets: Neo-Operations Strategies in U.S. and Japanese Manufacturing," *Operations Management Review*, 10:4, 1995



# ONCE UPON A TIME . . .

*First 10 years of observations on  
capabilities-based competition ...*

## Other Observations...

### Competitive Progression in

Manufacturing (Miller and Roth 1986, 1988)

Services (Roth, 1993; Roth & Menor 1996; Roth & Johnson, 1996; )

Linking Strategy & Performance (Roth, 1987)

Case Research on World Class Manufacturing (Giffi, et al., 1990)

Quality & JIT (Flynn and Schroeder- WCM Project)

### Other Research - Multiple Priorities

Nobel (1995)

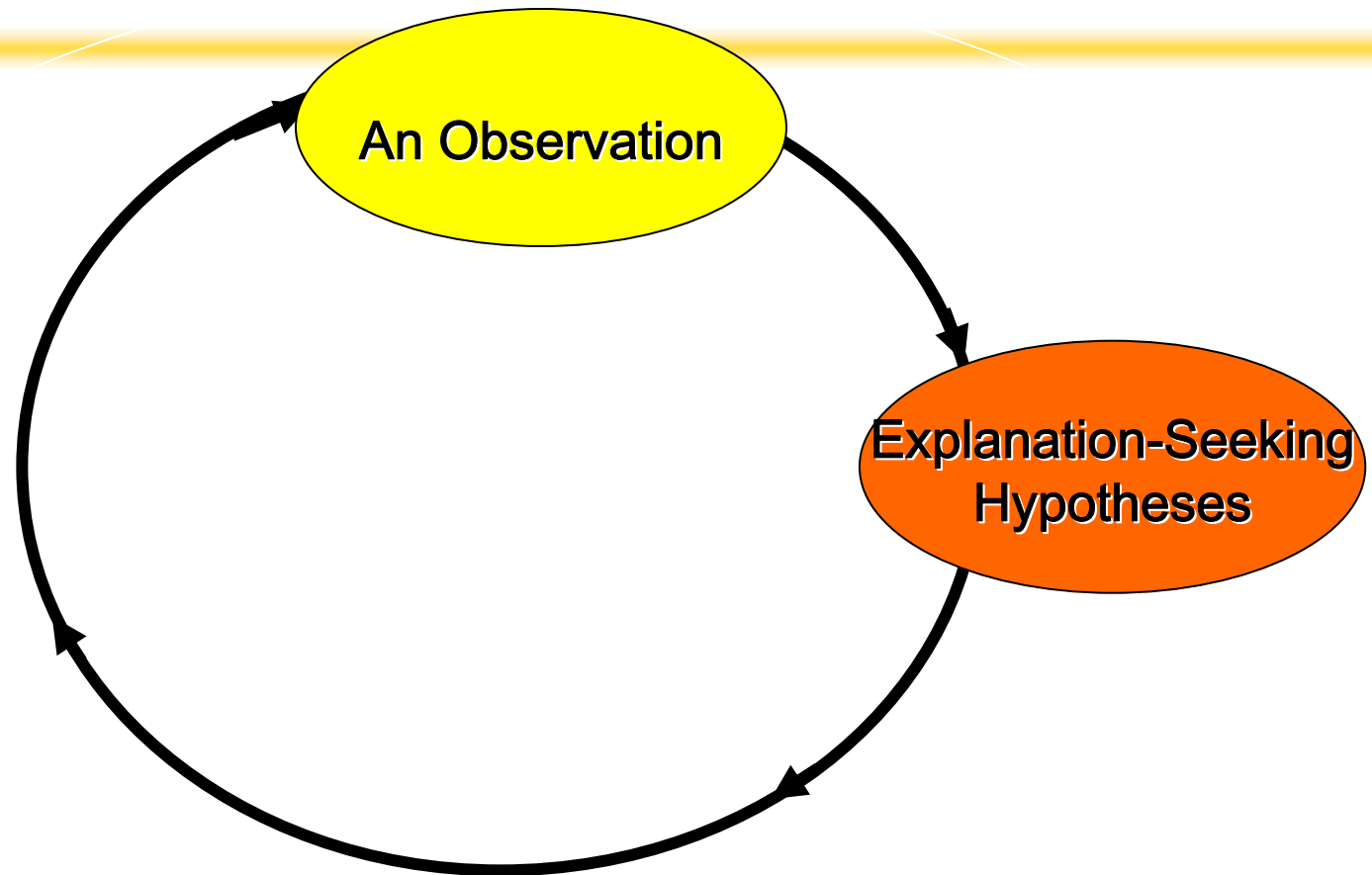
Miller and Roth (1994)

Agility Forum

Enough already !!

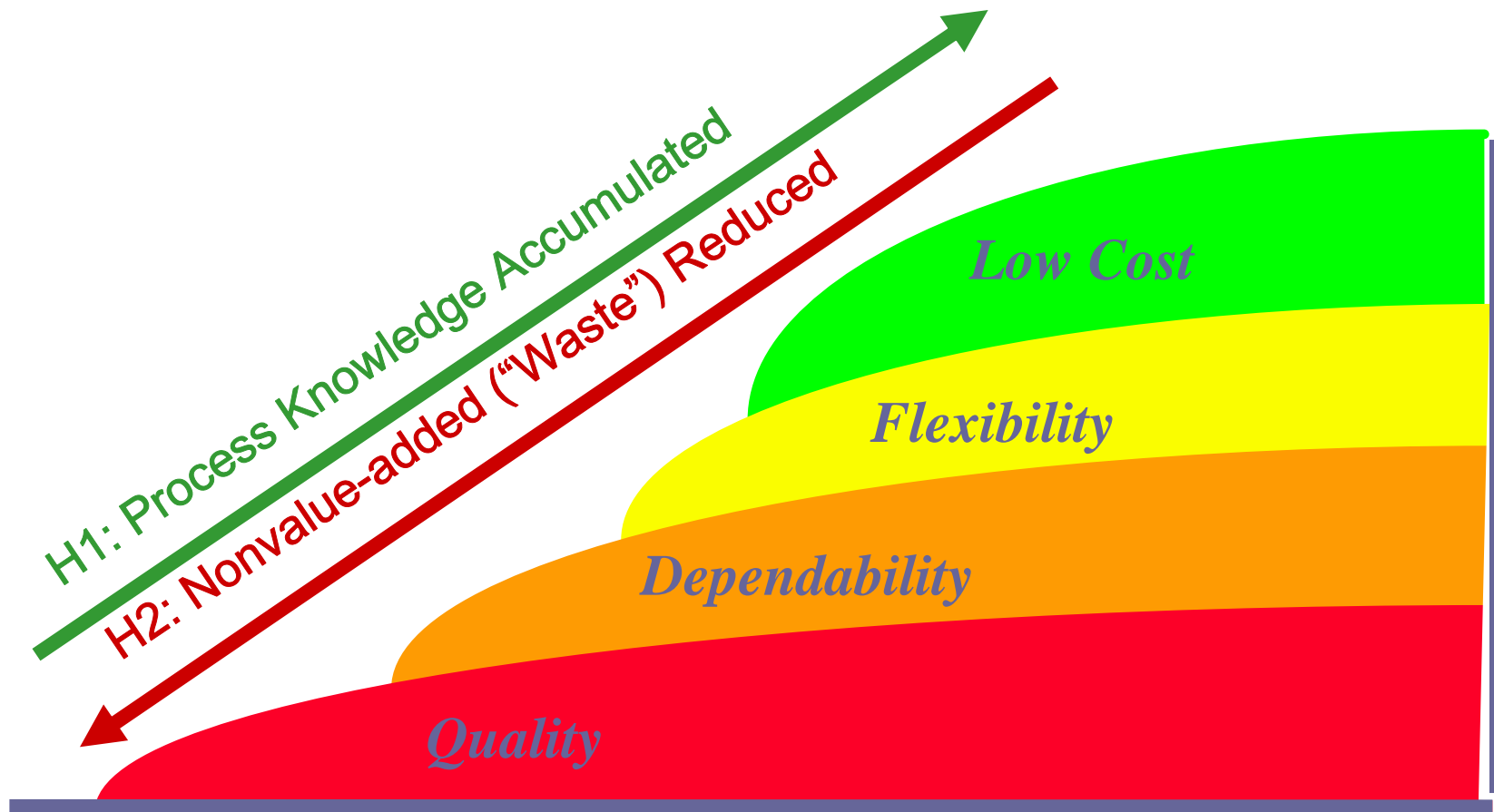
# From Observation to Theory

## *The Scientific Method in OM Empirical Research*



# IN THE MEANTIME . . . *An explanation was sought, so a new theory was put forth*

## ROTH'S COMPETITIVE PROGRESSION THEORY




GENERIC CAPABILITIES OVER AN INNOVATION CYCLE

Sources: A. V. Roth, "Achieving Strategic Agility through Economies of Knowledge," *Strategy and Leadership*, 1996, 30-37; A. V. Roth, "Neo-Operations Strategy," in

# IN THE MEANTIME . . .

*A new theory is put forth . . .*



“Sustainable combinative competitive capabilities accumulate in a sequential progression forward from

- **Quality and then to**
  - **Delivery and then to**
    - **Flexibility and then to**
      - **Low Cost Mfg**

over an innovation cycle...

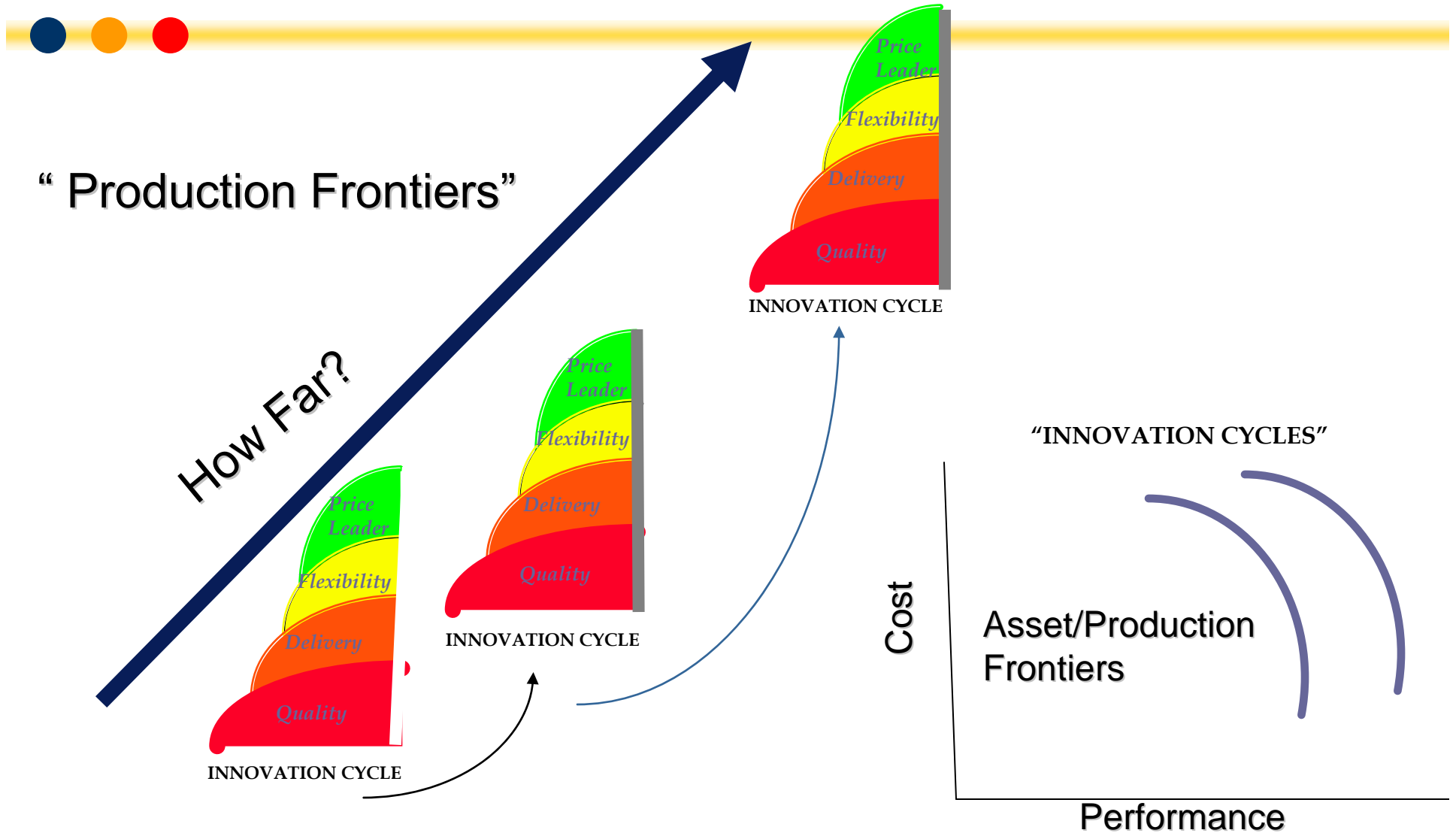
*Despite any intended priorities to the contrary*, higher level organizational knowledge-based competencies are required to move efficiently between successive stages with a cycle; and that over successive innovation cycles, increasingly higher levels of combinative competitive capabilities are attained by repeating the progression.

As innovation cycles are shortening due to the rapidity of technological progress and globalization, other sequences of generic capability-seeking behaviors produce system entropy, forcing firms either to recycle back to acquire first order capabilities (e.g., quality or delivery) or to make capability tradeoffs that are less endurable for the long run.”

Source: A. V. Roth, “Neo-Operations Strategy,” in *Handbook of Technology Management*, G.

# Roth's Competitive Progression Theory

## *Boundary Conditions*



# IN THE MEANTIME . . .

A new theory is put forth . . .

**COMPETITIVE PROGRESSION THEORY is...**

**GROUNDING THEORY**

- **Based upon multiple stages of data collection and the refinement and interrelationships among constructs**
- **Extensive Field research** (*Competing in World Class Mfg (Giffi, Roth and Seal 1990); Knowledge Factory Research (5 yr longitudinal case studies at IBM, Glaxo-Welcome, Nortel, Baxter Healthcare); Nestle; Baldrige companies (Roth et al. 1994; Roth 1996); Conference Board Company visits since 1989 - .*

**Two characteristics:**

- 1. Constant comparison of data with emerging theory**
- 2. Theoretical sampling of different groups to maximize the similarities and differences** (Strauss & Corbin 1990)



# IN THE MEANTIME . . .

A new theory explained. . .

## ROTH'S COMPETITIVE PROGRESSION THEORY

### 1. ROTH'S LAWS OF OPERATIONS PHYSICS EXPLAIN "COMBINATIVE CAPABILITIES"

- Generic capabilities share work processes and process variation. Processes can be partitioned into capability "unique" and "shared" - or "common"- process properties.
- Process synergies due to supporting tools and underlying shared knowledge and know-how.

### 2. PATH DEPENDENCY EXPLAINS CUMULATIVE MODEL

- Absorptive Capacity (**Cohen & Levinthal, 1990**) represents a synthesis of organizational know-how, technological prowess, and social values that enable the firm to identify, assimilate, and exploit new knowledge.
- Organizational knowledge is path dependent.

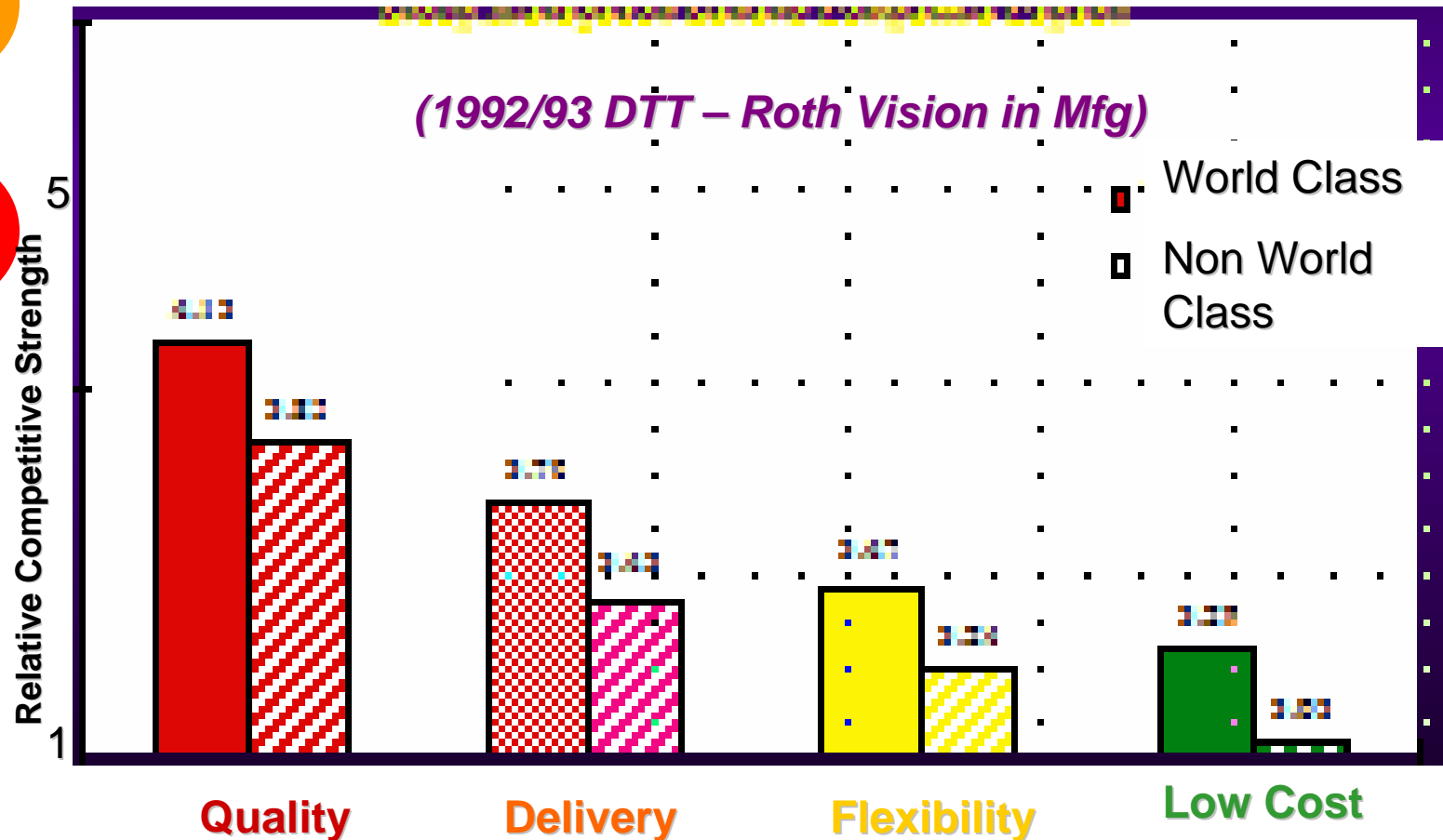
Roth, A. V., "Competitive Progression Theory: Explanation and Empirical Evidence," in *Manufacturing Strategy: Operations Strategy in Global Context*, (C. Voss, Ed.), London: London Business School, 1996, 309-314.

A. V. Roth, "Neo-Operations Strategy," in *Handbook of Technology Management*, G. Gaynor (Ed.), McGraw Hill, 1996.

# Competitive Progression Theory

*1200+ World Class vs. Non World Class*

*Manufacturing Business Units*



Source: A. V. Roth, "Neo-Operations Strategy," in *Handbook of Technology Management*, G. Gaynor (Ed.), McGraw Hill, 1996.



# Why did CPT take so long?

## *Key Barriers to New Theory Development*

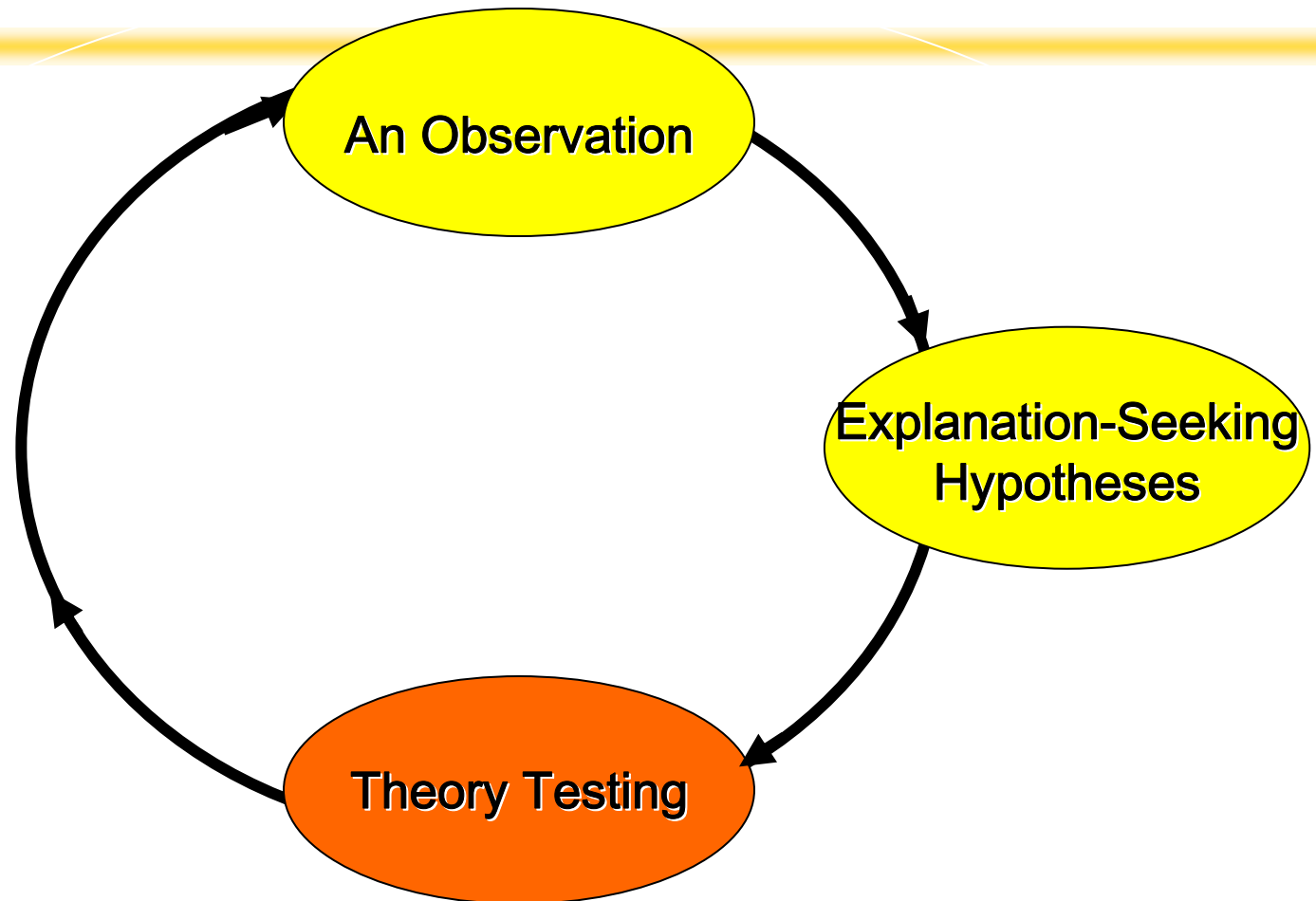
### 1. “Paradigm Paralysis”

- Assumptions shared by members of a given discipline (Thomas Kuhn 1970)
- Shapes the formulation of theoretical generalization, focuses data gathering, and influences the selection of research procedures and projects
- Couldn't see it!

### 2. Faulty Constructs and Measures in Extant Literature

# From Observation to Theory

## *The Scientific Method in OM Empirical Research*

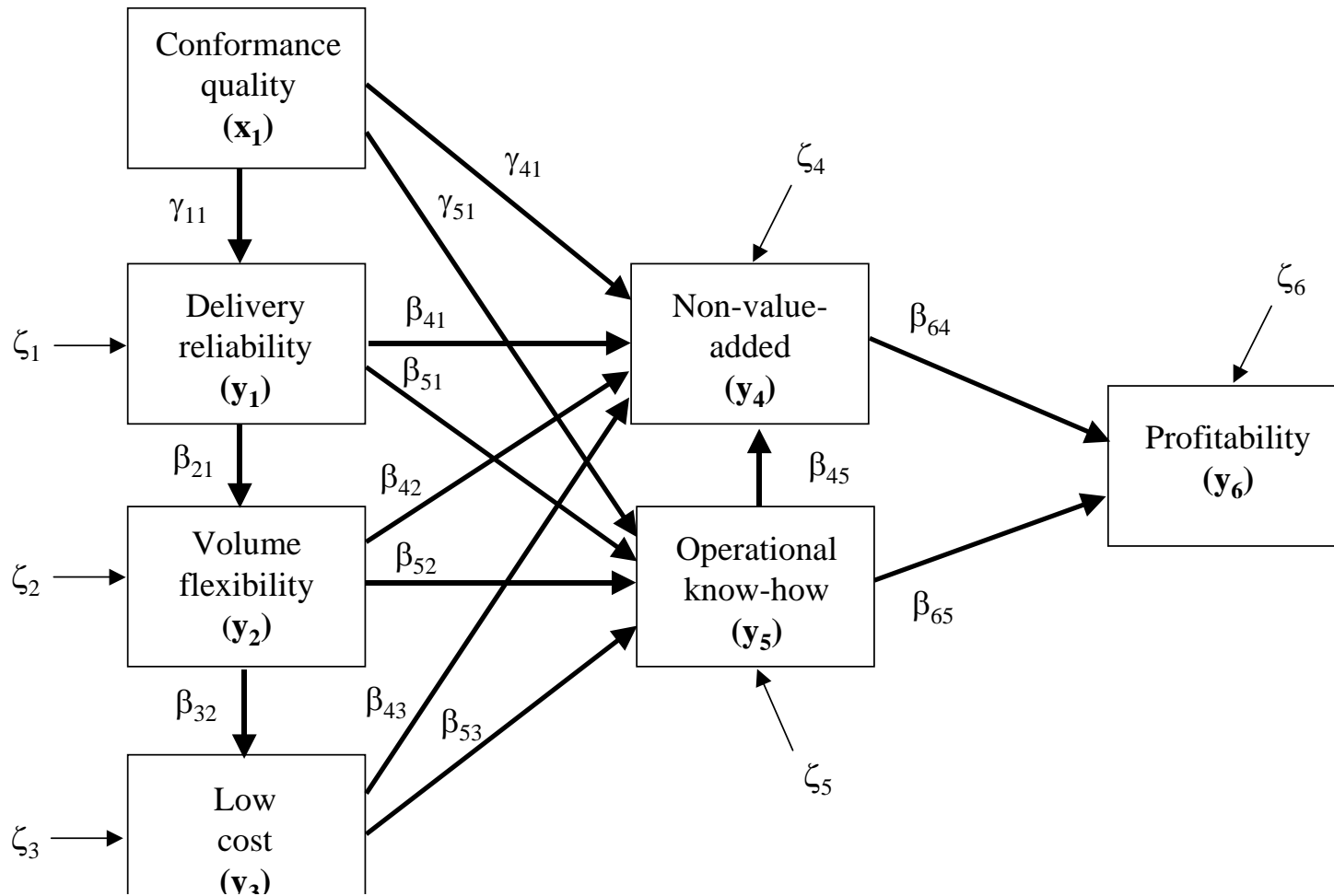


# Theory Testing Required...

- Precise definitions of constructs and operational measures
  - Conformance quality (meet customer specifications)
  - Delivery reliability (on-time delivery of target fill rates)
  - Volume flexibility (ramp production up/down to customer requirements)
  - Low cost (relative to competition)
- Specification of model in form of nomological net of hypothesized relationships
- New dataset (otherwise it would be data mining)
- Single industry sample

# Empirical Path Model Specified

## *Nomological Net of Hypothesized Relationships in CPT*



Rosenzweig, E. D. and A. V. Roth, "Towards a Theory of Competitive Progression: Evidence in High-Tech Manufacturing," *Production and Operations Management Journal*, 13(4), 2004, 354-368.

# Today's Story: Competitive Progression Theory

## *Two Decades of a Theory-Building Journey*



- **ONCE UPON A TIME . . .**

*Ten years of observations on  
capabilities-based competition.*

- **IN THE MEANTIME . . .**

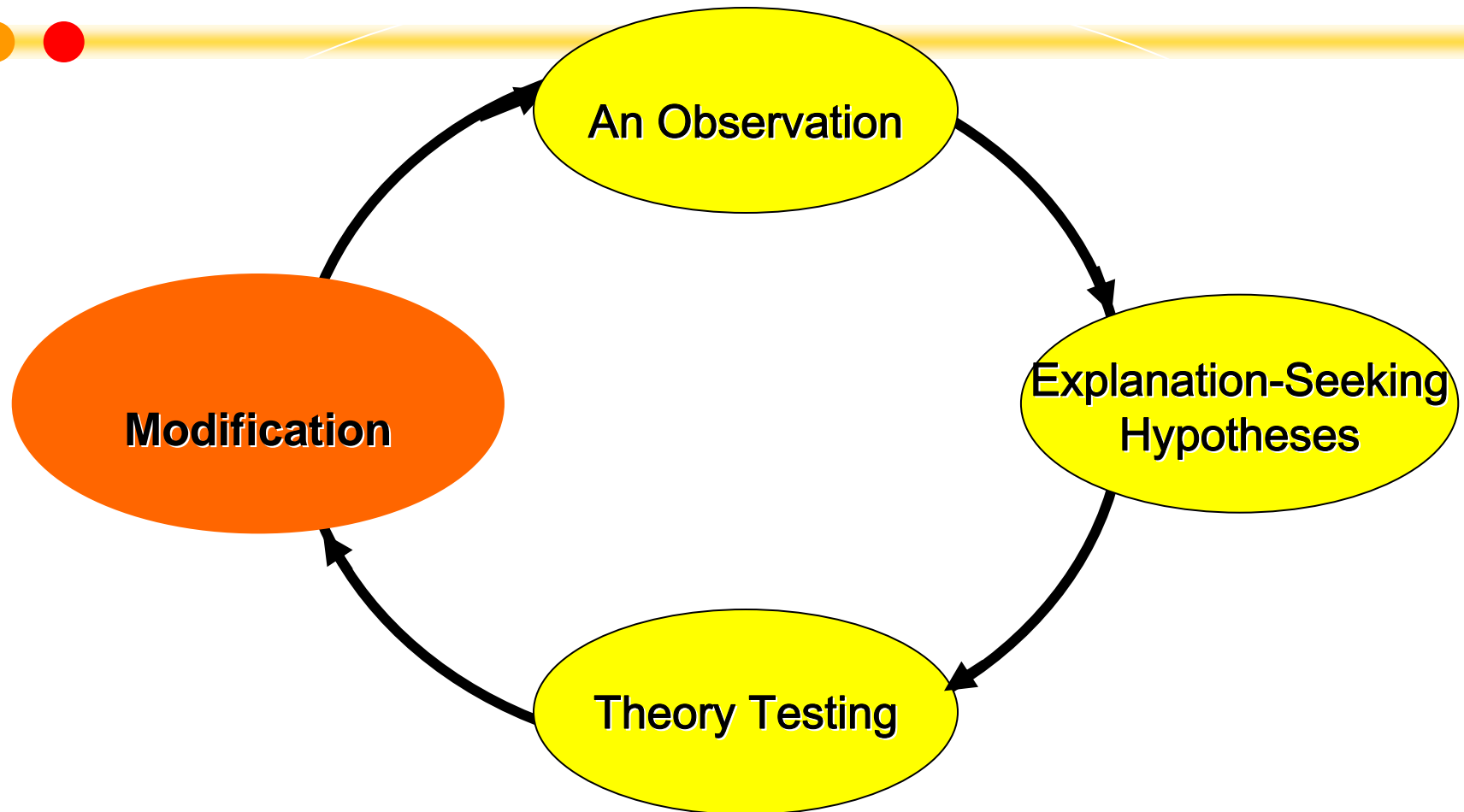
*An explanation was sought, so  
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- **AND HAPPILY THEREAFTER . . .**

*Evidence was gathered and  
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# From Observation to Theory

## *The Scientific Method in OM Empirical Research*



# Modifications to CPT Theory

- ● ●  
● **Contingency theory of**
  - **Production Frontier – Competitive progression breaks down in “job shops” where bottlenecks may act as a constraining resource and may act as pseudo “production frontier.”**
- **While progression holds, capability relationships to operational know-how and waste reduction were complex:**
  - e.g. “indirect” relationships (e.g. delivery acts through flexibility and cost to increase operational know how)**
- **Represents ‘an average’ phenomena, indicating that there may be a regression towards the mean for individual firms at any point in time.**

# AND HAPPILY THEREAFTER . . .

## *Attributes of a Good Theory Applied to*

## *Roth's Competitive Progression Theory*

- Based on a wide variety of research literature and industry observations over time
- Defines capability progression in a way that differentiates it from traditional logic of trade-offs
- Integrates prior models, notions and observations under a common basis (e.g. trade-offs, production frontier, and sand cone effect)
- Provides an explanation of the observed phenomena and describes the underlying causes of why such a competitive progression is observed
- Describes the boundary conditions under which the theory holds (bottlenecks, technical constraints, etc.)
- Clearly defined constructs and measures
- It is practical & interesting!



# CONCLUSIONS

## *Why Is CPT Theory Important to Practice?*

- Explains “why” despite best intentions (e.g. low cost priority or intention) may not get sustainable cost advantage
- Explains why some productivity plateaus may occur
- Indicates where resources should be placed:
  - >>developing knowledge-based processes\
  - >>kaizen
- Highlights the criticality of a progression for accelerating learning in manufacturing.
- Illustrates dysfunctional practices

# Conclusions

## *From Observations to Theory*

- ● ●
- **Observation plays a key role in theory building; difficult to detect a paradigm change.**
- **Explanation is critical for building theory**
- **Empirical testing of theory is powerful; theories are only falsified and not proved**
- **Modifications/contingencies to theories are useful in elaborating the context and conditions (e.g. the boundaries in which the theory holds)**

# THANK YOU!!

[ARoth@Clemson.Edu](mailto:ARoth@Clemson.Edu)

- Rosenzweig, E. D. and A. V. Roth, "Towards a Theory of Competitive Progression: Evidence in High-Tech Manufacturing," *Production and Operations Management Journal*, 13(4), 2004, 354-368.
- Menor, L. J., A. V. Roth, and C. H. Mason, "Agility in Retail Banking: A Numerical Taxonomy of Strategic Service Groups," *Manufacturing & Service Operations Management*, 2001, 3(4), 273-292.
- Roth, A. V., "Achieving Strategic Agility through Economies of Knowledge," *Strategy and Leadership* (formerly *Planning Review*), 24(2), March-April 1996, 30-37. (Cited in the selected bibliography of important articles, books and other materials and are useful to anyone who is interested in innovation, knowledge management and work in general <http://www.azurant.com/bibliography.htm>)  
Reprinted in *The Quality Yearbook: 1997 Edition* (J. W. Cortada and J. A. Woods, eds.), McGraw Hill, 1997, 81-90
- Roth, A. V., "Competitive Progression Theory: Explanation and Empirical Evidence," in *Manufacturing Strategy: Operations Strategy in Global Context*, (C. Voss, Ed.), London: London Business School, 1996, 309-314.
- Hirasawa, Y., L. Menor, and A. V. Roth, "Dynamic Manufacturing Strategy: Neo-Operations Strategy Framework," in *Manufacturing Strategy: Operations Strategy in a Global Context*, (C. Voss, Ed.), London: London Business School, 1996, 309-314.
- Miller, J. G. and A. V. Roth, "A Taxonomy of Manufacturing Strategies," *Management Science*, 40(3), 1994, 285-304 (In the Editor-in-Chief's top 10% of *Management Science* articles cited over past 50 years (See Commemorative CDE inside December 2004 issue of *ORMS Today*, 31(6))
- Roth, A. V. and C. A. Giffi, "Winning in Global Markets: Neo-Operations Strategies in U. S. and Japanese Manufacturing," *Operations Management Review*, 10(4), 1995 (Excerpted/reported in *Fortune*, September 21, 1992, 62-74, *Business Week*, and the *Associate Press*)
- Roth, A. V. and C. A. Giffi, "Critical Factors for Achieving World Class Manufacturing," *Operations Management Review*, 10(2), 1994, 1-29.
- Roth, A. V. and R. Chapman, "Competing in the Electronics Industry: Benchmarking World Class Performances," *Journal of Electronics Manufacturing*, 3, 1993, 39-57
- Roth, A. V., "Performance Dimensions in Services: An Empirical Investigation of Strategic Performance," in *Advances in Service Marketing and Management*, Vol. 2, (S. Swartz, D. E. Bowen, and S.W. Brown, Eds.), Greenwich, CT: JAI Press, 1993, 1-47.
- Roth, A. V., "Assessing Performance in Service Organizations," in *Service Superiority: The Design and Delivery of Effective Service Operations*, (R. Johnston and N. D. Slack, Eds.), Warwick, UK: Warwick Printing Co. Ltd., 1993, 367-374.
- Roth, A. V. and J. G. Miller, "Success Factors in Manufacturing," *Business Horizons*, 35(4), 1992, 73-81 (Cited in *References on Competition and Productivity: <http://www.usd.edu/~rlau/c.htm>*)
- Roth, A. V. and R. Miller, *The Automotive/Transportation Industry in Transition: Progress Toward World Class*, Fuqua School of Business-Deloitte & Touche Monograph, 1992, (Excerpted/reported by the *USA Today* (Nov. 30, 1992) and the Associated Press
- Roth, A. V. and J. G. Miller, "Manufacturing Strategy, Manufacturing Strength, Managerial Success and Economic Outcomes," in *Manufacturing Strategy*, (J. Ettl, M. Burstein, and A. Fiegenbaum, Eds.), Boston, MA: Kluwer Academic Pub., 1990, 97-108
- Giffi, C., A. V. Roth, and G. Seal, *Competing in World Class Manufacturing: America's 21<sup>st</sup> Century Challenge*. Business-One Irwin, 1990
- Miller, J. G. and A. V. Roth, "Manufacturing Strategies," *Operations Management Review*, 6(1), 1988, 8-20. (Excerpted/reported in *Iron Age*, *The Quality Review*, *Industry Week*, *The Atlanta Journal*, *Forbes*, *The Wall Street Journal*, *Metalworking News*, and *Industry Week*)