Modularity (or Not!) and Strategy:
The Case of Bicycle Drivetrain Components

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Outline

• The Puzzle: Three Questions

• The Data: The Story of Bicycle Drivetrain Components

• The Analysis: Our Interpretation

• The Outlook
Background (very brief)

- Study of Technological Change and its Implication has a long history in various Disciplines
  - Economics, Sociology, and Technology History
    - e.g., Bijker, 1995; Nelson & Winter, 1982; Rosenberg, 1982; Sahal, 1981
  - Technology Management and Strategic Management
    - e.g., Anderson & Tushman, 1990; Henderson & Clark, 1990; Macher & Mowery, 2004; Utterback, 1994

- More recently, the specific role (and effect) of modular product architecture on industry structure and competition has been of particular interest
  - Baldwin & Clark, 2000; Schilling, 2000

- And most empirical studies suggest a general migration towards higher levels of modularity
  - Baldwin & Clark, 2000
  - MacCormack, Rusnak, & Baldwin, 2004
  - Jacobides 2005
  - Shibata, Yano and Kodama 2005

The Puzzle: Three Questions

- What is the Directionality of Product Architecture Change?

- What is the Directionality of Causality between Product Architecture and Industry Structure Changes?

- What is the Origin of these Changes?
The Situation – as mostly described

Product Architecture

Modular

PA2

Integral

Non-IS Causes

Direction of Causality?

Underlying Mechanisms?

Industry Structure

Disintegrated

IS2

Integrated

Non-PA Causes

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The Data:
The Industry Before and After

Fig. A.1.1. Product Architectures and Market shares (Road 1984)

Fig. A.1.7. Product Architectures and Market shares (Road 1990)

Fig. A.2.7. Product Architectures and Market shares (MTB 1990)
Industry Data:
Concentration within Bicycle Drivetrain Segments

Road Bicycles

Mountain Bicycles

Herfindahl Index $[10^4]$

Shifter
Derailleur
Frehweel
Brake
Chain
Hub

Industry Data:
Concentration across Bicycle Drivetrain Segments

Road Bicycles

Mountain Bicycles

Integration Index

N/A
Type 6
Type 5
Type 4
Type 3
Type 2
Type 1

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Data Summary
The Analysis: Consequences of Product Architecture Change

Product Architecture Change

More integral Function-Component Allocation

Mechanism 1
Increase in Synergistic Specificity

Improved Systems Performance

Mechanism 2
Decrease in Competitors’ Network Size

Systems Firms try to compete with own Systems

Mechanism 3
Systemic Performance difficult to copy

Component Firms try to form Alliances & JVs or exit the Industry

Lower Interface Standardization

Initial Event

Effect on Competition

Competitors’ Response

Effect on Industry Composition

The Analysis: Our Interpretation

- Product Architectures can shift from (more) modular to (more) integral states (at least temporarily)

- If this shift is successful, it can have powerful implications on the nature of competition in an industry (and ultimately on the industry composition)

- It appears as if the existence of cross-module knowledge is beneficial to create integral (systemic) innovation
The Outlook

• **Implications for Industry Studies Research**
  – This is one powerful link between Technical Change (in PA) and Industry Structure (Industry Architecture)
  – More Data needed to better understand Contingencies
  – Importance of Measurements!

• **Implication for Firm Strategy**
  – These Decisions are not ‘only’ Engineering Decisions, they are fundamentally Strategic in Nature!