Design and Implementation of Technology Strategy: an Evolutional Perspective

- Overview
- Technological Competence and Capability
- Substance of Technology Strategy
- Evolutionary Forces Shaping Technology Strategy
- Experience Through Enactment of Technology Strategy
- Enactment Reveals Substance of Technology Strategy
- Conclusion
Overview

- Capabilities
  - Resource availability (financial, human, technology)
  - Complementary assets
    - Competitive manufacturing
    - Distribution
    - Service
  - Complementary technologies
  - Technology & Technology Development (R&D, lab teams, managing technology – admin, service function)
  - Marketing, Sales
  - etc

Overview

- Fundamental Business Strategy Decisions
  1) *Which* distinct technological competences and capabilities are necessary to establish and maintain competitive advantages?
  2) *Which* technologies should be used to implement core product design concepts and how should these technologies be embodied in products?
  3) *What* should be the investment level in technology development?
  4) *How* should various technologies be sourced – internally or externally?
  5) *When and how* should new technology be introduced to the market?
  6) *How* should technology innovation be organized and managed?
Overview – Technology Strategy Making

Technology Strategy: a function of the quantity and quality of technical capabilities and competences

Experience: obtained from enacting technology strategy feeds back to technological capability and technology strategy

Technological Competence and Capability

Core Competence

1) Potential access to a wide variety of markets
2) Significant contribution to the perceived customer benefits of the end product, and
3) Difficult for competitors to imitate

Distinctive Competence

- Technological and production expertise
- Differentiated skill
- Complementary assets
- Routines, processes used
- Marketing
GTE vs. NEC: Core Competence

NEC 1980 - 1990s
- 1980: Sales $3.6 billion, GTE comparable technological base and computer business
- No experience as an operating telecommunications company
- 1988: World leader in semiconductor, and 1st tier player in telecommunications products and computers
- Consolidates its position in mainframe computers

NEC 2008
- Consumer electronics: mobile phones, fax machines, laptop computers
- 1970’s Strategic Intent: Convergence of Computer & Communications (C&C)

www.nec.com

Substance of Technology Strategy

- Technology Strategy
  - Definition
  - Substantive dimensions
- Competitive Strategy Stance (Role of technology, Defensive, Offensive)
  - Technology Choice
  - Technology Leadership
  - Technology Entry Timing
  - Technology Licensing
What is Technology Strategy? [2]

- Firm’s approach to the development and use of technology
- Strategy
  - The creation of a unique and valuable position, involving a different set of activities (page 119)
  - Making trade-offs in competing (page 121)
  - Creating fit among a company’s activities (page 126)
- Must address three broad issues:
  - What technology to develop
  - Whether to seek technological leadership in those technologies
  - The role of technology licensing

Four Substantive Dimensions of Technology Strategy

1. The deployment of technology in the firm’s product-market strategy to position itself in terms of differentiation (perceived value or quality) and delivered cost and to gain technology-based competitive advantages;
2. The use of technology, more broadly, in various activities comprised by the firm’s value chain;
3. The firm’s resource commitment to various areas of technology; and
4. The firm’s use of organization design and management techniques to manage the technology function.
Substance of Technology Strategy: Competitive Strategy Stance

- Technology Choice
  - Careful assessments: technology, market factors, and targets
  - A room fan example (technology choice)
    - Core design concepts: move air
    - Implementations: manual or electrical power
    - Designing and building motors (components): require EE & ME knowledge
  - A product (dominant design): architecture that determine how its components fit and work together
  - Control and monitoring options: wired, wireless, Internet

Substance of Technology Strategy: Competitive Strategy Stance

- Technology Leadership
  - Developed distinctive technological competence and capabilities (also persistent)
  - Pioneering role vs. Monitoring role
    - Product market strategy
    - Can be the first mover but may chose no to
  - Identifying and tracking key technical parameters
  - Considering the impact on speed and flexibility of product and process development as technologies move through their life cycles
  - Distinguishing common and high impact technologies
  - Paying attention to new technologies
Substance of Technology Strategy:
Competitive Strategy Stance

- Technology Leadership
- Pioneering role vs. Monitoring role
- Product market strategy
- Cannon Technology: http://www.canon.com/technology/
- Canon History: http://www.canon.com/about/history/05.html

<table>
<thead>
<tr>
<th>EXHIBIT 3 Core Competencies at Canon</th>
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<tbody>
<tr>
<td>Precision mechanics</td>
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<td>Basic Camera</td>
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<td>Compact fashion camera</td>
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<td>Electronics camera</td>
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<td>EOS autofocus camera</td>
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<tr>
<td>Video still camera</td>
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<tr>
<td>Laser beam printer</td>
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<td>Color video printer</td>
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<tr>
<td>Bubble jet printer</td>
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<td>Laser fax</td>
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<td>Laser fax</td>
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<tr>
<td>Calculator</td>
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<td>Plain paper copier</td>
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<tr>
<td>Battery PDC</td>
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<td>Color copier</td>
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<td>Laser copier</td>
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<td>Color laser copier</td>
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<td>NAIV</td>
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<tr>
<td>Still video system</td>
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<td>Laser imager</td>
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<td>Cell analyzer</td>
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<tr>
<td>Mask aligners</td>
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<tr>
<td>Stepper aligners</td>
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<tr>
<td>Enlarger laser aligners</td>
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</tbody>
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Every Canon product is the result of at least one core competence.
**Reproduced from reference[11], page 112.

Substance of Technology Strategy:
Competitive Strategy Stance

- Technology Entry Timing
  - Timing of commercial use of new technology (relative to rivals)
  - Porter (1985): First mover advantages
- Teece (1986):
  - Appropriability regimes – concerns the first mover’s ability to protect proprietary technological advantages
  - Example: the legal battle between Intel and Advanced Micro Devices (Steere and Burgelman, 1994)
  - Control of special assets: a first mover must have access to
Substance of Technology Strategy: Competitive Strategy Stance

- Technology Licensing
  - Technology not fit into firm’s business and corporate strategy
  - Maximize the ROI of R&D efforts and discourage imitation
  - Lack the necessary cash and/or complementary assets (manufacturing, distribution, service, etc)
  - International market development for the technology may require licensing local firms
  - Antitrust legislation may prevent a company from fully exploiting its technological advantage on its own

Substance of Technology Strategy

- Value Chain Activities (page 8)
  - Inbound Logistics Related Technologies
    - Transportation, Material Handling, Storage & Preservation, Communication System, Testing, IT & IS Technologies
  - Operations
    - Basic product, Material, Machine Tool, Material Handling, Packaging, Maintenance, Testing, Building Design Operation, IT & IS Technologies
  - Outbound Logistics
    - Transportation, Material handling, Packaging, Communication System, IT & IS Technologies
  - Marketing Sales: Media, Audio, Video, Communication, IT & IS technologies
  - Services
Substance of Technology Strategy:
Value Chain Stance

- Developing and enriching technological competences
- Avoiding from the threats of new entrants
- Scope of Technology Strategy
  - Broader set of core technologies – less vulnerable to attacks
  - Resource constraints
  - May be a significant extent by its scale and business focus
  - New technology issues & impacts

Substance of Technology Strategy:
Resource Commitment Stance

- R&D Funding (0%, 10%, etc)
- Depth of Technology Strategy
  - In terms of the number of technological options that the firm has available
  - Correlated with the firms capacity to anticipate technological developments in particular areas early on
  - Greater depth => increase flexibility and ability to respond to new demands from customers/users
Substance of Technology Strategy: Management Stance

- Organizational Fit
  - Meet the organizational requirements flowing from their competitive, value chain and resource commitment stances
  - More likely to have an effective technology strategy

Evolutionary Forces Shaping Technology Strategy

- How a firm’s technology strategy actually comes about and changes over time?
- Determinants of Technology Strategy (Exhibit 2)
  - Shaped by the generative forces, and mechanisms:
    - Technology Evolution
    - Strategic Action
    - Organizational Context
    - Industry Context
    - Generative Mechanism and Integrative Mechanism
    - Internal Environment/External Environment
- Applying the Framework: Research and Practice
Evolutionary Forces Shaping Technology
Strategy: Technology Evolution

- Technology Adoption Cycle

- Technology S Curve

Evolutionary Forces Shaping Technology
Strategy: Industry Context

1. Five Major Forces [2]: Industry Competitors, New Entrants, Buyers, Suppliers, Substitutes
2. Appropriability Regime associated with a technological innovation (Teece, 1986)
3. Complementary Assets needed to commercialize a new technology (Teece, 1986)
4. Emergence of dominant designs
5. Increasing returns to adoption
6. Emergence of industry standards
7. Social systems aspects of industry development
8. The competitive effects of the interplay of social systems characteristics and technological change
Evolutionary Forces Shaping Technology Strategy: Strategic Action

- Past & current success
- What actions?
  - When confronted with the threat of radically new technology (switch to new technology, improved existing technology? 5.25 inch disk vs. 14 inch disk drive )
  - Faced with architectural innovations (Example: CICS vs RISC computer architectures)
  - Getting into the new areas of business
  - Corporate R&D capabilities

Evolutionary Forces Shaping Technology Strategy: Organizational Context

- Reflects the administrative approaches a dominant culture of the firm
- The dominant culture – relates to technology
  - Science (pharmaceutical firms)
  - Engineering (semiconductor firms)
  - Manufacturing (Japanese firms)
  - Services
  - Product development processes – driven by technology push, need pull, or a balanced approach)
Evolutionary Forces Shaping Technology Strategy: Organizational Context

- Firm abilities to
  1. Exploit opportunities associated with current strategy (induced process)
  2. Take advantage of opportunities that emerge spontaneously outside the scope of the current strategy (autonomous process)
  3. Balance challenges (1) and (2) at different times in the firm’s development

  Shaping technology strategy
  - Substantive
  - Generic corporate strategy

Applying the Framework: Research and Practice

- Research
  - Disruptive technologies
  - Examples of their impacts to industries:
    - Magnetic disk drives
    - Transistors
    - Electronic fuel injection
    - Personal computer
  - Sustaining technologies (complements)
  - Not receptive to opportunities of the newly discovered technologies
    - Sales forces focus on existing customers – improving technologies
    - Lack of interest – different dimension
Applying the Framework: Research and Practice

- Research - Some effects
  - The initiators of the new technology
    - Leave incumbent firm
    - Start their own to pursue the technological opportunity
  - The new entrepreneurial firm
    - Find and pursue new customers
    - Provide improvements offered by the new technology along the different dimensions
- Examples
    - In 1972, five former IBM employees, launched SAP in Germany with the vision to develop standard application software for real-time business processing
  - The 1980s: Rapid Growth
  - The 1990s: A New Approach to Software and Solution
  - The 2000s: Innovation for the New Millennium

Applying the Framework: Research and Practice

- Practice – Technology Strategy
  - National Cash Register, [www.ncr.com](http://www.ncr.com)
    - 1991: Acquired by AT&T
    - 1994: NCR name changed to AT&T Global Information Solutions (GIS)
    - 1995: AT&T GIS spin-off
    - 1996: AT&T GIS changed its name back to NCR Corporation
    - NCR History Timeline, [http://www.ncr.com/about_ncr/media_information/history.jsp?lang=EN](http://www.ncr.com/about_ncr/media_information/history.jsp?lang=EN)
Experience Through Enactment of Technology Strategy

- A Note of Performance (Enactment) as Experience
  - In terms of Outcomes
    - Return of Equity (ROE) = Net Income/ Share Holder Equity
    - P/E (Price Earning Ratio) = Market Value per Share / Earning per Share (EPS)
    - Market share
    - Growth
  - In term of Derived Experience (Feedback)
    - Quantity and quality of the firm’s technical competences and capabilities
    - Effectiveness of strategy

Experience Through Enactment of Technology Strategy

- Implementing Technology Strategy through enactment of key tasks:
  1. Technology sourcing: Internal and external
  2. Deploying technology in product and process development
  3. Using technology in technical support activities
Experience Through Enactment of Technology Strategy

- Implementing Technology Strategy through enactment of key tasks:
  
  1. Technology sourcing: Internal and external
     
        • Internal sourcing
        
        - Firm’s science-based R&D, applied R&D
        
        - Absorptive capacity: “firm’s ability to recognize the value of new, external information, assimilate it, and apply it to commercial ends”
        
        • External sourcing
        
        - Exclusive or preferential licensing contracts
        
        - Strategic alliances
        
        - Acquire certain technologies (structure ways)
        
        - Continuous improvement in all aspects of the value creation and delivery process …..

Experience Through Enactment of Technology Strategy: Key Tasks

1. Deploying technology in product and process development
   
   • New product/market, and processes
   
   • Technology drive product development?
   
   • Product and/or market development to drive technology?
      
        ▪ Notebook computer => new drive technology, semiconductor “Flash” memory
   
   • Three potential benefits (Wheelwright and Clark, 1992)
      
        ▪ Market position
        
        ▪ Resource utilization
        
        ▪ Organizational renewal and enhancement
1. Deploying technology in product and process development
   - Technology Integration (Iansiti 1997)
     - Focus on the role of technology evaluation and selection processes that precede actual product development process
     - Concerned with how choices of new technological possibilities (deriving from fundamental research) in relation to the existing application context (represented by the current product, manufacturing, and customer/user systems) affect the speed and productivity of the product development at the project level

1. Using Technology in Technical Support Activities
   - Field services: an interface between the firm’s technical function and the users of its product or services
   - Experience in use: feedback to enhance the firm’s technical capabilities
     - Example: Jet Engine Technology – feedback from airline operations
   - Two way information flow
     - Expert knowledge from product developer => Enhance => Effectiveness of field operations
     - Feedback from the field => Inform => Future development
Enactment Reveals Substance of Technology Strategy

- Technology Strategy Planning => Executing => Feedback

**EXHIBIT 3 Substance and Enactment in Technology Strategy**

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<thead>
<tr>
<th>Substance</th>
<th>Enactment (modes of experience)</th>
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<tbody>
<tr>
<td>Competitive strategy stance (choice/leadership/entry timing/licensing)</td>
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<tr>
<td>Value chain stance (scope)</td>
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<tr>
<td>Resource commitment stance (depth)</td>
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<tr>
<td>Management stance (organizational fit)</td>
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Conclusion