CPET 575 Management Of Technology

Part One
Integrating Technology and Strategy:
A General Management Perspective

- Technological Innovation
- Technological Innovation & Strategy

Text Book:

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Integrating Technology and Strategy:
A General Management Perspective

- Overview
- Key Concepts and Their Relationship
- Integrating Technology and Strategy
- Assessing Innovative Capabilities
- Conclusion

Overview
Key Concepts and Their Relationship
• Inventions/Discoveries/Technologies
• Technological Innovations
• Technological Entrepreneurship
• Activities and Outcomes
• Interrelations Among Key Concepts

Integrating Technology and Strategy
• Perspective on Strategy
  • Positive Versus Normative Views
  • Product-Market Versus Resource-Based Views
• Connecting Technology and Strategy
  • Technology & Competitive Strategy
  • Technology and Product-Market Strategy
  • Technology Portfolio
  • Technology Portfolio and Business Portfolio
• Technology and the Value Chain
• Technological Evolution and Forecasting
  • Technology Forecasting
Integrating Technology and Strategy: A General Management Perspective

- Assessing Innovative Capabilities
  - Innovative Capabilities Audit Framework
    - Innovative Capabilities
    - Business Unit Level Audit
    - Corporate Level Audit
    - Audit Frames of Reference
    - Who Should Do the Audit?
- Conclusion

Overview

- Importance of Technology and Innovation
- Budget and spending on technology and innovation – related activities
  - High-tech company
  - Tech-oriented company
  - Start-up company, …
- Who is responsible for strategic management of technology & innovation of a company, organization, firm, etc?
- Responsibilities
  - Acquire, develop, resource allocations
  - Develop and exploit the firm’s capability for innovation

Key Concepts and Their Relationships

- Inventions/Discoveries/Technologies
- Technological Innovations
- Technological Entrepreneurship
- Activities and Outcomes
- Interrelations Among Key Concepts

Key Concepts and Their Relationships

- Inventions/Discoveries/Technologies
  - Inventions/Discoveries
    - Results of creative process
    - How to measure the success
      - Technical (Is it true/real?) rather than Commercial (Does it provide a basis for economic rents?)
      - Patents – allow their inventors/originators to establish a potential for success
      - Successful innovations (subsequent refinement may be needed, with significant time lag, 10 years or more)
**Key Concepts and Their Relationships (cont.)**

- **Inventions/Discoveries/Technologies**
  - **Technology**
    - Refers to the theoretical and practical knowledge, skills, and artifacts that
      - Can be used to develop products and services as well as their production and delivery systems
      - Can be embodies in people, materials, cognitive and physical processes, plant, equipment, and tools
    - Technologies are usually the outcome of development activities to put inventions and discoveries to practical use
    - How to measure the success
      - Technical (Can it do the job?) rather than commercial (Can it do the job profitably?)

- **Invention of Microprocessor**
  - 1969
    - Nippon Calculating Machine Corporation, visited Intel to discuss its idea for custom Large-scale Integrated (LSI) circuits; and asked for designing 12 custom chips for its new Busicom 141-PF printing calculator
    - Ted Hoff, heading Intel’s application efforts, realized there was no practical way to implement the devices, and was sure a small general-purpose computer could do the job
    - Engineers Marcian E. “Ted” Hoff, Deferico Faggin, and Stan Mazor came up with a design that involved a set of four chips called MCS-4: 4004 CPU, ROM, RAM, and I/O

- **Invention of Microprocessor**
  - Busicom eventually sold some 100,000 calculators

- **Successive generations of new technologies in the semiconductor industry**
  - Memory devices
  - Microprocessor, microcontrollers
  - Peripherals
  - Applications: business automation, telecommunications, etc
Key Concepts and Their Relationships (cont.)

  - 1972: 8008 Microprocessor
  - 1974: 8080 Microprocessor, (8085)
  - 1978: 8086-8088 Microprocessor
  - 1982: 286 Microprocessor
  - 1985: Intel® 386™ Microprocessor
  - 1989: Intel® 486™ DX CPU Microprocessor
  - 1993: Intel® Pentium® Processor
  - 1995: Intel® Pentium® Processor
  - 1997: Intel® Pentium II Processor
  - 1998: Intel® Pentium III Xeon Processor
  - 1999: Intel® Celeron® Processor
  - ...
  - 2003: Intel® Pentium® M Processor ...

Key Concepts and Their Relationships (cont.)

- Technological Innovations
  - Technology-based Innovations
    - Examples: disposable diapers, oversized tennis racquets, electronic fuel injection, personal computers
  - Technology-facilitated Innovations
    - Examples:
      - Business data processing & automation
      - ERP (Enterprise Resource Planning)
      - CRM (Customer Relationship Manag.)
      - SCM (Supply Chain Management)

Key Concepts and Their Relationships (cont.)

- Technological Entrepreneurship
  - Individual or corporate entrepreneurship
  - Activities
    - Create new resource combinations to make innovation possible, bringing together the technical and commercial worlds in a profitable way
  - Administrative capabilities: efficient, effective
Key Concepts and Their Relationships (cont.)

- Activities and Outcomes
  - Activities
    - Tinkering & Experimenting, and Systematic Basic and Applied R &D
  - Outcomes
    - Inventions, Discoveries, and Technologies
  - Innovation Activities:
    - Product, Process and Market Development
  - Innovation Outcomes:
    - Technological Innovations
  - Technological Activities
    - Product, Process, Market Development
    - Development of Administrative Capabilities

Integrating Technology and Strategy: Perspective on Strategy

- Positive vs. Normative Views
  - Positive View of Strategy:
    - Concerned with the firm’s actual strategy and how it comes to be
    - Resulted from organizational learning process
    - Top management belief’s about the basis of firm’s past and current success
      a) Core competencies
      b) Product market areas
      c) Core values, and
      d) Objectives, etc
  - Normative View of Strategy
    - Concerned with what the firm’s strategy should be

Integrating Technology and Strategy: Perspective on Strategy (cont.)

- Product-Market vs. Resource-Based Views
  - Product-Market View of Strategy
    - Concerned with how the firm competes with its products and services
  - Resource-Based View of Strategy
    - Concerned with how the firm can secure the factors needed to create core competencies and capabilities that form the basis for establishing and sustaining competitive advantages
    - Asks: “How do competencies and capabilities help create and sustain competitive advantages?”
  - Current Trend: Integrating Product-Market & Resource-based views
Integrating Technology and Strategy: Connecting Technology & Strategy

- During the 1980s, technology is recognized as an important element of business definition and competitive strategy
- Abell: “technology adds a dynamic character to the task of business definition, as one technology may more or less rapidly displace another over time.”
- Porter observes that technology is among the most prominent factors that determine the rule of competition
- Friar and Horwitch explain the growing prominence of technology as the result of historical forces

Technology and Competitive Strategy
- Porter’s “generic strategies”, 1985, – a framework for classifying competitive strategies: Technology Strategy
  a) Industry-wide differentiation (broad range of industry segments)
    - Quality, performance, features, delivery, supports, etc
    - Better products, services
  b) Focused differentiation (a narrow set of industry segments)
    - Customers’ willingness to pay a premium price
  c) Industry-wide cost leadership
    - Lower price, comparable products & services
  d) Focused cost leadership (a narrow set of industry segments)
    - Lower delivering cost infrastructure

Product-Related Technology
- May be the basis for lower cost
- Example: designing different models of cars, sharing common structural components (e.g. chassis), to lower the cost of the different models
- Process-Related (manufacturing) Technology
- May be the key to product performance and hence differentiation
- Manufacturing excellence example: early 1980s, it allowed Japanese DRAM manufacturers to differentiate their products from U.S. based competitors

Exhibit 2 Technological Policies and Generic Competitive Strategies

<table>
<thead>
<tr>
<th>Generic strategy</th>
<th>Overall cost leadership</th>
<th>Focus-seg. cost leadership</th>
<th>Focus-seg. diff.</th>
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</thead>
<tbody>
<tr>
<td>Overall diff.</td>
<td></td>
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<tr>
<td>Technological Policies</td>
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<tr>
<td>Product Tech. Change</td>
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<tr>
<td>- Product dev. to reduce prod. cost by lowering materials content</td>
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<td>- Facilitating easy manufacturing</td>
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<td>- Simplicity of logistical req.</td>
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<td>Process Tech. Change</td>
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<tr>
<td>- Learning curve process improvement</td>
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<tr>
<td>- Process improvement to enhance economics of scale</td>
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<tr>
<td>- Faster response time to orders</td>
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<tr>
<td>- Others</td>
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<tr>
<td>- Process dev. to design only enough performance for the segment’s needs</td>
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<tr>
<td>- Product dev. to meet exactly the needs of the particular business seg. application</td>
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Integrating Technology and Strategy: Connecting Technology & Strategy (cont.)

- Technology and Product-Market Strategy
  - Expressed in the products and services it brings to market
  - Analyze the degree of integration
    - Decompose each product and service into its constituting technologies
    - Assess the relative strength – the degree of distinctive competence – the firm has with respect to that technology
  - Example: a firm manufacturing & marketing cameras
    - Competence in optic
    - Sufficient info is needed to determine firm’s capabilities
    - Need to specifying how the strength can help – higher quality or lower cost?

Exhibit 3 The Product/Technology Matrix

<table>
<thead>
<tr>
<th>Technology 1</th>
<th>Product A</th>
<th>Product B</th>
<th>...</th>
<th>Product N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology 2</td>
<td>(*/ )</td>
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<td>...</td>
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<tr>
<td>Technology n</td>
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</tbody>
</table>

Note: Each entry (*/) should establish the firm’s relative strength vis-à-vis the state of the art.
Source: Adapted from A. Fusfeld, "How to Put Technology into Corporate Planning," Technology Review, May 1978

Integrating Technology and Strategy: Connecting Technology & Strategy (cont.)

- Technology Portfolio
  - Technology Life Cycle
  - Technology Importance
    - Value it brings to a particular class of products
    - Value it could potentially bring to other classes for the customer/user
  - Relative Technology Position (reference to competitors)
    - Patent position, know-how and trade secrets, learning curve effects, and key talent
    - Strongly affected by the firm’s historical and future levels of investment

Exhibit 4 Developing the Technology Portfolio

<table>
<thead>
<tr>
<th>High</th>
<th>Draw</th>
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</thead>
<tbody>
<tr>
<td>Bet</td>
<td></td>
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<tr>
<td>Low</td>
<td>Fold</td>
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</tbody>
</table>

Bet quadrant (Rel. Tech. Pos. – High, Tech. Imp. – High)
  • Warrant the full commitment:
  • Frontier R&D, push the limits of its product development process, and invest in the newest equipment

Cash in quadrant (RTP – High, TI – Low-Mid)
  • Examined carefully
  • Tech may have been important at one time, but it’s importance is reduced
  • Suggest that no further investment in these technologies

Draw quadrant (Rel. Tech. Pos – Low, Tech Imp – High)
  • Technology is positioned ambiguously
  • Important to ask why and how this change came about
  • React: Invest, probably heavily, in the technology?
  • Disengage

Fold quadrant (RTP – Low, TI – Low)
  • Inertial forces often lead to continue investment in R&D beyond the level at which reasonable ROI can be expected
  • Requires reconsider its investments

Integrating Technology and Strategy: Connecting Technology & Strategy (cont.)
  • Technology Portfolio and Business Portfolio
    - Companies
    - Has multiple businesses in their corporate portfolio, each with its own technologies
    - Portfolio planning tool - McKinsey’s framework based on industry attractiveness and competitive position dimensions
    - Harris, Shaw, and Somers suggest examining the relationship between
      - Traditional portfolio planning matrix
      - Technology portfolio matrix

Integrating Technology and Strategy: Technology & the Value Chain

- Broader sense of technology
  - Encompasses the entire set of technologies employed in the sequence of activities that constitute a firm’s value chain
- Activities
  - R&D, designing, manufacturing, marketing, delivering, and supporting it’s product
- Value
  - The amount buyers are willing to pay for what a firm provides them
  - Measured by total revenue, a reflection of the price a firm’s product commands and the units it can sell
- Value chain (total value, value activities)
  - Supplier’s value chain
  - Channel’s value chain
  - Buyer’s value chain …

Integrating Technology and Strategy: Technology Evolution and Forecasting

- Technology Product Life Cycle
  - Technology change affecting firm’s competitive position
  - Firm find it difficult to respond to such changes
  - Integrating technology & strategy
    - Understand life cycle of various technologies it employs
    - Potential for competitive advantage

Exhibit 6: Representative Technologies in a Firm’s Value Chain

Exhibit 7: Technology Life Cycle and Competitive Advantages

<table>
<thead>
<tr>
<th>Life Cycle</th>
<th>Importance of Technologies for Competitive Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Emerging technologies</td>
<td>Have not yet demonstrated potential for changing the basis of competition.</td>
</tr>
<tr>
<td>II. Packing technologies</td>
<td>Have demonstrated their potential for changing the basis of competition.</td>
</tr>
<tr>
<td>III. Key technologies</td>
<td>Are embedded in and enable product/process. Have major impact on value-added stream (cost, performance, quality). Allow proprietary/patented positions</td>
</tr>
<tr>
<td>IV. Base technologies</td>
<td>Have minor impact on value-added stream; common to all competitors; commodity</td>
</tr>
</tbody>
</table>
Assessing Innovative Capabilities

- Persons – who responsible for managing the innovation process
- Firm’s innovative potential and into the barriers to innovation
- Decisions on Innovations: managerial attention, resources
- Innovation capabilities audit (address at least 3 questions)
  - How has the firm been innovative in the areas of product and service offering and/or production and delivery systems?
  - How good is the fit between the firm’s current business and corporate strategies and its innovative capabilities?
  - What are the firm’s needs in terms of innovative capabilities to support its long-term business and corporate competitive strategies?

Assessing Innovative Capabilities: Innovative Capabilities Audit Framework

- Innovation depends on
  - Technological Capabilities, and other critical capabilities in the areas
    - Manufacturing
    - Marketing and distribution
    - Human resource management
- An example:
  - Technology strategy – achieve superior product performance, must be complemented by
    - A technically trained sales force that can educate the customer regarding the product’s performance advantages, and
    - A high-quality manufacturing system
  - A 1978 case: 16-bit microprocessors
    - Intel 8086/Motorola 68000/Zilog Z800

Assessing Innovative Capabilities: Innovative Capabilities Audit Framework

- Innovation Capabilities
  - The comprehensive set of characteristics of an organization that facilitate and support innovation strategies
- Exist at both levels
  - Business unit
    - A particular strategy and source commitment
    - A distinct set of product markets, competitors, and resources
  - Corporate (multi-business)

Assessing Innovative Capabilities: Innovative Capabilities Audit Framework

- Business Unit Level Audit
  - Focus on
    - New products and services, and/or
    - New production and delivery systems
  - Can be characterized in terms of
    - Timing of market entry
    - Technological leadership or follower-ship
    - Scope of innovativeness, and
    - Rate of innovativeness
Five important categories of variables influence the innovation strategies of a business:

Important for formulation
1. Resources available for innovative activities
2. Capacity to understand competitors’ strategies and industry evolution with respect to innovation
3. Capacity to understand technological developments relevant to the business unit

Important for implementation
4. Structural and cultural context of the business unit affecting internal entrepreneurial behavior
5. Strategic management capacity to deal with internal entrepreneurial initiatives

Exhibit 9 Business Unit Level: Innovative Capabilities Audit Framework

1. Resources Availability and Allocation
   • Level of R&D funding and evolution:
     ■ In absolute terms
     ■ As percentage of sales
     ■ A percentage of total firm R&D funding
     ■ As compared to main competitors
     ■ As compared to leading competitors
   • Breadth and depth skills at business unit level R&D, engineering, and market research
   • Distinctive competences in the areas of technology relevant to business unit
   • Allocation of R&D to
     ■ Existing product/market combinations
     ■ New product development for existing product categories
     ■ Development of new product categories

Exhibit 9 Business Unit Level: Innovative Capabilities Audit Framework (cont.)

2. Understanding Competitors’ Strategies and Industry Evolution
   • Intelligence systems and data available
   • Capacity to identify, analyze, and predict competitors’ innovative strategies
   • Capacity to identify, analyze, and predict industry evolution
   • Capacity to anticipate facilitating/impeding external forces relevant to business unit’s innovative strategies
3. Understanding the Business Unit's Technological Environment
   • Capacity for technological forecasting relevant to business unit's technologies
   • Capacity to assess technologies relevant to business unit
   • Capacity to identify technological opportunities for business unit

4. Business Unit Structural and Cultural Context
   • Mechanisms for managing R&D efforts
   • Mechanisms for transferring technology from research to development
   • Mechanisms for integrating different functional groups (R&D, engineering, marketing, manufacturing) in the new product development process
   • Mechanisms for funding unplanned new product initiatives
   • Mechanisms for eliciting new ideas from employees
   • Evaluation and award systems for entrepreneurial behavior
   • Dominant values and definition of success

5. Strategic Management Capacity to Deal with Entrepreneurial Behavior
   • Business unit level management capacity to define a substantive development strategy
   • Business unit level management capacity to assess strategic importance of entrepreneurial initiatives
   • Business unit level management capacity to assess relatedness of entrepreneurial initiatives to unit's core capabilities
   • Capacity of business unit level management to coach product champions
   • Quality and availability of product champions in the business unit
Exhibit 10 Corporate Level: Innovative Capabilities Audit Framework

1. Resource Availability and Allocation
   • Level of R&D funding and evolution:
     - In absolute terms
     - As percentage of sales
     - A percentage of total firm R&D funding
     - As compared to main competitors
     - As compared to leading competitors
   • Breadth and depth skills at corporate level R&D, engineering, and market research
   • Distinctive competences in the areas of technology relevant to multiple business units
   • Corporate R&D allocation
     - Exploratory research
     - R&D in support of mainstream business
     - R&D in support of new business definition
     - R&D in support of new business development

2. Understanding Competitors’ Strategies and Multi-Industry Evolution
   • Intelligence systems and data available
   • Capacity to identify, analyze, and predict competitors’ innovative strategies spanning multiple industries
   • Capacity to identify, analyze, and predict industry evolution of interdependencies among multiple industries
   • Capacity to anticipate facilitating/impeding external forces relevant to firm’s innovative strategies

3. Understanding the Corporate Technological Environment
   • Capacity for technological forecasting in multiple areas
   • Capacity to forecast cross-impacts among areas of technology
   • Capacity to assess technologies in multiple areas
   • Capacity to identify technological opportunities for business unit

4. Corporate Context (Structural and Cultural)
   • Mechanisms to share technologies across unit boundaries
   • Mechanisms to define new business opportunities across business unit boundaries
   • Internal and external organization designs for managing new ventures
   • Mechanisms for funding unplanned initiatives
   • Evaluation and award systems for entrepreneurial behavior
   • Movement of personnel between mainstream activities and new ventures
   • Dominant values and definition of success
Exhibit 10 Corporate Level: Innovative Capabilities Audit Framework (cont.)

5. Strategic Management Capacity to Deal with Entrepreneurial Behavior
   • Top management capacity to define a substantive long-term development strategy
   • Top management capacity to assess strategic importance of entrepreneurial initiatives
   • Top management capacity to assess relatedness of entrepreneurial initiatives to firm’s core capabilities

Exhibit 10 Corporate Level: Innovative Capabilities Audit Framework (cont.)

5. Strategic Management Capacity to Deal with Entrepreneurial Behavior
   • Middle-level management capacity to work with top management to obtain/maintain support for new initiatives (organizational championing)
   • Middle-level management capacity to define corporate strategic framework for new initiatives
   • Middle-level management capacity to coach new venture managers

Assessing Innovative Capabilities: Innovative Capabilities Audit Framework (cont.)

- Audit Frames of Reference
  1. Interpreting the results of the innovative capabilities audit
    • How the current situation compares to the past
  2. Firm’s position relative to current competitors
    • Identify - positions desired

- New venture managers’ capacity to build new organizational capabilities
- New venture managers’ capacity to develop a business strategy for new initiatives
- Availability of product champions to identify and define new business opportunities outside of mainstream activities
Assessing Innovative Capabilities: 
Innovative Capabilities Audit Framework (cont.)

- Who Should Do the Audit?
  - Vice-president (General Manager, Senior Manager)
  - Insiders - advantages/disadvantages
  - Outsiders - advantages/disadvantages
  - Undertaken by
    - Firm’s strategic planning department
    - Ad Hoc Audit team (task force)
      - Strategic planning
      - R&D
      - New product managers
      - Key functional managers

Conclusion

- Key Concepts and Their Relationship
  - Technology
  - Innovative Strategies
  - Integrating Technology and Strategy
  - Assessing Innovative Capabilities