CPET 575 Management Of Technology

Part One
Integrating Technology and Strategy: A General Management Perspective

- Technological Innovation
- Technological Innovation & Strategy

Lecture note based on the recommended 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

- 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

Integrating Technology and Strategy: A General Management Perspective

- Key Concepts and Their Relationships
  - Inventions/Discoveries/Technologies
  - Technological Innovations
  - Technological Entrepreneurship
  - Activities and Outcomes
  - Interrelations Among Key Concepts
Integrating Technology and Strategy: A General Management Perspective

- 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

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
Key Concepts and Their Relationships

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

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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 returns?)
  - 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)

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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
  - Outcome of development activities that put inventions and discoveries for practical use and applications
  - How to measure the success
    - Technical (Can it do the job?) rather than commercial (Can it do the job profitably?)

Key Concepts and Their Relationships (cont.)

- Inventions/Discoveries/Technologies
  - Technology – Success examples
    - The inventions of
      - Transistor (1947) at AT&T Bell Labs
      - Integrated Circuit (1959), and
      - Microprocessor (1971), Intel
    - Successive generations of new technologies in the semiconductor industry
      - Memory devices
      - Microprocessor, microcontrollers
      - Peripherals
    - Applications: business, industrial, manufacturing telecommunications, etc
Key Concepts and Their Relationships (cont.)

- 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.

Key Concepts and Their Relationships (cont.)

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

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Intel® 4004 microprocessor

Busicom® 141-PF printing calculator
Key Concepts and Their Relationships (cont.)

- Intel Museum – Microprocessor Hall of Fame, 
  http://www.intel.com/museum/online/hist_micro/hof/
  - 1972: 8008 Microprocessor
  - 1974: 8080 Microprocessor, (8085)
  - 1978: 8086-8088 Microprocessor
  - 1982: 286 Microprocessor
  - 1985: Intel®386™ Microprocessor
  - 1989: Intel® Pentium® Processor
  - 1993: Intel® Pentium® Processor
  - 1995: Intel® Pentium® Processor
  - 1997: Intel® Pentium® II Processor
  - 1998: Intel® Pentium II Xeon Processor
  - 1999: Intel® Celeron® Processor
  - 2003: Intel® Pentium® M Processor ...

Technological Innovations (cont.)

- 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 Management), SCM (Supply Chain Management), etc
Key Concepts and Their Relationships (cont.)

- **Technological Innovations**
  - Outcomes
    - New and marketable products and services and/or new production and delivery systems
  - Levels of Significance
    - Incremental innovations
    - Radical innovations
    - Architectural innovations

- **Technological Entrepreneurship**
  - Individual or corporate entrepreneurship
  - Fundamental drivers of the technological innovation process
  - Activities
    - Create new resource combinations to make innovation possible
    - Bring 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 Innovation Activities (iterative & concurrent)
      - Product, Process, Market Development
      - Development of Administrative Capabilities

EXHIBIT 1 The Relationships Among Key Concepts Concerning Technological Innovation
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

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 (cont.)

- 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)
  - b) Focused differentiation (a narrow set of industry segments)
  - c) Industry-wide cost leadership
  - d) Focused cost leadership (a narrow set of industry segments)

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

- Technology and Competitive Strategy
  - 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 diff. 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>Focus-seg. cost leadership</th>
<th>Focus-seg. diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall cost leadership</strong></td>
<td><strong>Overall diff.</strong></td>
<td><strong>Technological Policies</strong></td>
</tr>
<tr>
<td>- Product dev. to reduce prod. cost by lowering materials content</td>
<td>- Product dev. to enhance quality, features, deliverability, or switching costs</td>
<td>- Product dev. to design only enough performance for the segment’s needs</td>
</tr>
<tr>
<td>- Facilitating ease manufacturing</td>
<td>- Learning curve process improvement</td>
<td>- Product dev. to tune production and delivery system to seg. needs in order to lower cost</td>
</tr>
<tr>
<td>- Simplifying logistical req.</td>
<td>- Process improvement to enhance economics of scale</td>
<td>- Process dev. to tune the production &amp; delivery system to seg. need in order to improve performance</td>
</tr>
</tbody>
</table>

### 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?

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### 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>
<td></td>
<td></td>
<td></td>
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<td>*</td>
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</tr>
<tr>
<td>Technology ∞</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</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

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### 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>Relative Technology Position</th>
<th>Technology Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
</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

Exhibit 4 Developing the Technology Portfolio (cont.)

- 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 portfolios, 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
Exhibit 5 Matching Business and Technology Portfolios


Integrating Technology and Strategy: Technology and the Value Chain

- Broader sense of technology
  - Encompasses the entire set of technologies employed in the sequence of activities that constitute of a firm’s value chain

- Activities
  - R&D, designing, manufacturing, marketing, delivering, and supporting it’s product

- Value\(^{13}\)
  - 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 ...

\(^{13}\) M. Porter, Competitive Advantage
Exhibit 6 Representative Technologies in a Firm’s Value Chain

<table>
<thead>
<tr>
<th>Transportation technology</th>
<th>Basic product technology</th>
<th>Technology Evolution and Forecasting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material handling technology</td>
<td>Material technology</td>
<td>Technology change affecting firm’s competitive position</td>
</tr>
<tr>
<td>Storage and preservation technology</td>
<td>Machine tool technology</td>
<td>Firm find it difficult to respond to such changes</td>
</tr>
<tr>
<td>Communication system technology</td>
<td>Material handling technology</td>
<td>Integrating technology &amp; strategy</td>
</tr>
<tr>
<td>Testing technology</td>
<td>Packaging technology</td>
<td>Understand life cycle of various technologies it employs</td>
</tr>
<tr>
<td>Information system technology</td>
<td>Communication system technology</td>
<td>Potential for competitive advantage</td>
</tr>
<tr>
<td>Inbound logistics</td>
<td>Operation</td>
<td>Outbound logistics</td>
</tr>
<tr>
<td>Marketing sales</td>
<td>Services</td>
<td></td>
</tr>
</tbody>
</table>

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 7 Technology Life Cycle and Competitive Advantages

<table>
<thead>
<tr>
<th>Stages in Technology</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.</td>
</tr>
<tr>
<td></td>
<td>Have major impact on value-added stream (cost, performance, quality).</td>
</tr>
<tr>
<td>IV. Base technologies</td>
<td>Allow proprietary/patented positions</td>
</tr>
<tr>
<td></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)
Assessing Innovative Capabilities

- Innovation capabilities audit (address at least 3 questions)
  - Firm’s innovative areas: product and service offering and/or production and delivery systems?
  - The fit?
    - Between the firm’s current business and corporate strategies and its innovative capabilities
  - Innovative capabilities needed?
    - 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

- **Audit at both levels**
  - **Business unit**
    - A particular strategy and resource commitment
    - A distinct set of product markets, competitors, and resources
  - **Corporate (multi-business)**
    - Overall corporate innovation strategy

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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 followership
    - Scope of innovativeness, and
    - Rate of innovativeness
Business Unit Level: Innovative Capabilities Audit Framework

- 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
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
Assessing Innovative Capabilities: Assessing 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