The Impact of New Technology on Product Development

Outline

- Introduction
- Selection of new technology
- New Technology Management
  - Design
  - Manufacturing

- Lecture mixed with case discussion -- I will ask questions throughout to start discussion.

- In order to be competitive you need to introduce a known product with 8-10X change in
  - performance
  - cost
  - feature sets
- Uncertainty about
  - performance needs
  - cost targets
  - expected volumes
  - yields

Introduction

- Summarize the Cannon case...
What do we mean by New Technology

- New product families
  - Ink Jet portable printers
  - Compact Disks
- New technology
  - Antilock brakes
- New process
  - .5 - .35 micron line widths
  - Determinate Assembly (aircraft)

Cases

- *What characterizes new technology for both cases?*
Benefits of New Technology

- Significant edge over competitors
- Open new customer groups/new markets
  - portable printer
  - low cost computer
- Ability to share new technology across many products
  - Sony Walkman

Risks of New Technology

- You don’t understand the customer very well
  - how many will be purchased (volumes)
  - how much will the customer pay (costs).
- You don’t understand the product very well
  - what are the yields
  - what are the costs
  - how long to ramp the product
**Metrics**

- What are the metrics which measured Cannon's success?
  - Cost of sensor
  - Size of the sensor / fax machine
  - Yield
  - Ramp time
  - Volumes
  - Reliability
  - Market Size

**Risks**

- What are the uncertainties that they face
  - Risks
    - Could not make new component
    - Competitors have large market share (market not growing too fast)
    - Process/yields and costs
    - Customer wants
  - Resources
    - Line requires sign. Resources ($15M)
    - Yen value high
    - Bringing up CS-II takes away from CS-I
Technology push vs. pull

- **Push**
  - technology developed in-house
  - look for a product to put it in
  - patents to protect intellectual property
- **Pull**
  - have a product -- looking for a technology
    - internally develop it -- risky from a schedule perspective
    - externally purchase it -- risky from a market share perspective (competitive position compromised)
Two approaches

- Bet the farm (big returns, high risk)
  - Building an entire new product platform on a new technology
    - Xerox’s digital office platform
- Start slow (medium returns, medium risk)
  - Incorporate into one product
  - Test it, get the bugs out
  - Incorporate into other products

Product Development funnel filter

- R&D
- Product concepts for new technology
- Down select from the large set to pick the few that will be implemented

Recycled

Trashed

Market
Questions

- How did Cannon down select from their many technologies?
- Why was their technology strategy successful?
- How did they mitigate the risks?
  - Cross functional teams
  - Product development process
  - Diversification
  - Vertical integration
  - Core technologies
  - Product focused research and development
    - focus on future customer needs not existing customers
    - focus on on product and then diversify

New Technology: Design
Develop Technology maturity before entering manufacturing

- Reduce uncertainty about
  - time to develop/ramp
  - performance
  - robustness
  - work required to get it to perform

- Understand
  - how to manufacture
  - what the yields are
  - robustness
  - noise variables and their impact

Robustness

- Design latitude -- how much variation can be tolerated
- Manufacturing variability -- how much variation is going to be introduced by the manufacturing process
Yield problems

- Noise factors are affecting the quality of the product such that it violates the allowable latitude.

![Graph showing yield problems and technology readiness.]

Control factors:
- Change the control factors (in design)

Noise factors:
- Control the noise factors (in production)

New Technology

Inputs

Outputs
Variation Factors

Control Factors
- Dimensions
- Materials
- Process Variables

Noise factors
- Outer noise
  - temperature
  - humidity
  - people
- Inner noise
  - Wear
  - Fade
- Product noise
  - Part to part variation

1- During Design

- Use prototypes (virtual and physical) to determine
  - What are the noise variables
  - How do they affect the final product
- Change the control variables (dimensions, etc.) to make the system as robust as possible
2 - Ramp

- What are the potential noise variables that may affecting quality
- What are their contributions
- Set up measurement plans to track both the
  - noise factors (inputs)
  - quality characteristic (outputs)
- Set up root cause diagrams (Fishbone, FMEA) to enable rapid diagnosis of errors
- Institute learning cycles to map input/output noise and remove the sources

Learning Cycle

- Learning in ramp increases the rate/quality of production by
  - reducing uncertainty about what noise factors are the large contributors
  - identify and resolve unknown problems (door example)
- Four stages
  - identification, root cause analysis, fix selection, fix execution
Learning cycle

Identify problem → Trace the error

Measurement plans

Fix the problem
- variation reduction
- design change
- production change

Where should it be fixed?

Questions

- Why weren’t they successful on the CS-I? Why did they have to wait until the next generation?
- What were the success factors at Cannon? Why do they continue to be world leaders?
- What are the differences between Cannon and EMI? Is one “better” than the other?
Advanced Micro Devices: A Tale of missed opportunities

- AMD is a competitor to Intel
- Produces a compatible chip to Intel’s Pentium
- Considered the “Also ran….”

Some rough cost numbers

- To build a new fab is on the order of 500M - 1B dollars
- 50% of the cost of a chip is the cost of the factory
• Nov. 1994
  – AMD announces the K86 family
    • low cost, high performance alternative to the Pentium family
  – All capacity committed for 1995 to customers
  – K5 design almost completed (100MHz)
  – Plan to move from .5 micron to .35 micron in 1996
• Nov 1995
  – Only a a few thousand K5s at 75 MHz being produced

\[
\text{Volume} \times \text{yield} \times \text{price} = \frac{\text{volume} \times (\text{materials} + \text{labor}) + \text{capital}}{1 + \text{profit} \%} \]
• June 1996
  – K5 finally shipping for low end machines (9 months late)
  – “tardiness caused a lukewarm reception for the chip”
• Nov 1996
  – Producing at 2M/yr volumes K5 (orig. plan was 5M/yr)
  – sales slumping -- volume and price problems (competition from Intel

• Dec. 1996
  – Ended the fiscal year $69M in the red
  – Samples of K6 being released
  – Persuaded laptop manuf. To use K6 because the laptop Pentium not coming out until 1997
• June 1997
  – K6 still not at volumes, slower than Pentium but $167 cheaper.

• October 1997
  – K6 for laptop actually comes out -- same time as Intel’s Pentium Pro chip.
  – Yields still not up for the k6 -- not enough capacity
• Nov 1997
  – 97Q3 losses of 31.7M
  – Shipped 1 million k6
  – goal to ship 2 million in 97Q4
• Jan 1998
  – Move to .25 micron fab
  – No experience and had troubles with .35
• April 1998
  – Downsized year predictions from 15M to 12M K6s
  – Shipped 1.5M in 98Q1 (goal was 2 in 97Q1)
  – Goal to ship 2M in 98Q2
Summary

• AMD had a theoretical advantage
  – same product
  – lower price
• They failed because
  – they couldn’t get the volumes
  – they couldn’t support the price
    • aggressive yield predictions
    • failure to achieve yields/throughput

Summary

• Target costing
  – Design to cost so the product fits the market
• Volumes
  – volumes drive manufacturing strategy and pricing especially where there is significant capital equipment costs
• Yields
  – pick the right process and design the product so that yields are high
• Ramp
  – quick ramps are a requirement for cost effective development
Next lecture

- Continuous Casting Investments at USX Corporation, (HBS #9-697-020)

- Do you think Kappmeyer should sign the proposal? Why or why not?
- What position should USX take with respect to CSP tech.?
- Why do Henderson and Clark believe that established firms fail in the face of "architectural innovations"?
- Compare Henderson and Clark’s explanation for the failure of established firms with that of Christiansen and Bower. How are they similar? How do they differ?