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.*

Why New Tech.

- 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)

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Cases

- *What characterizes new technology for both cases?*

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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

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

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- 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

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Product Development funnel filter

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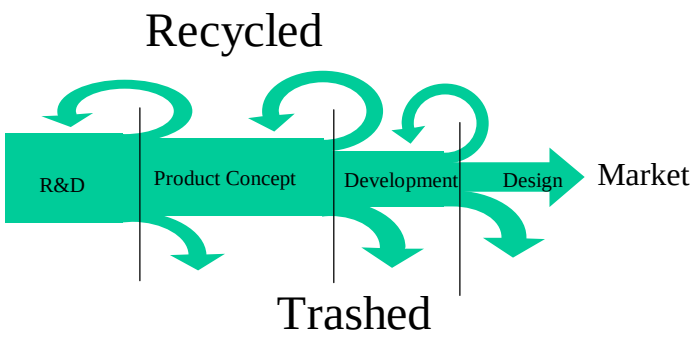
- R&D
- Product concepts for new technology
- Down select from the large set to pick the few that will be implemented



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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

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- 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

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Robustness

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

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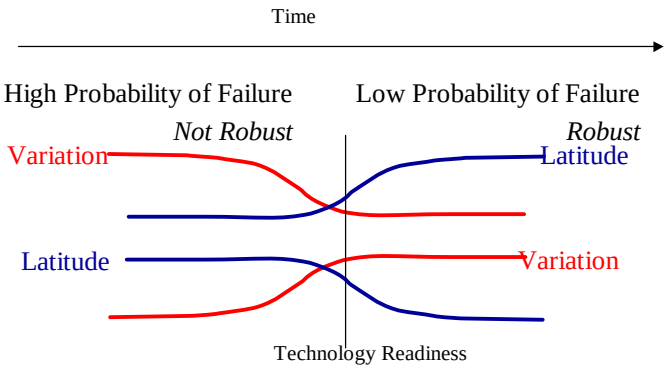
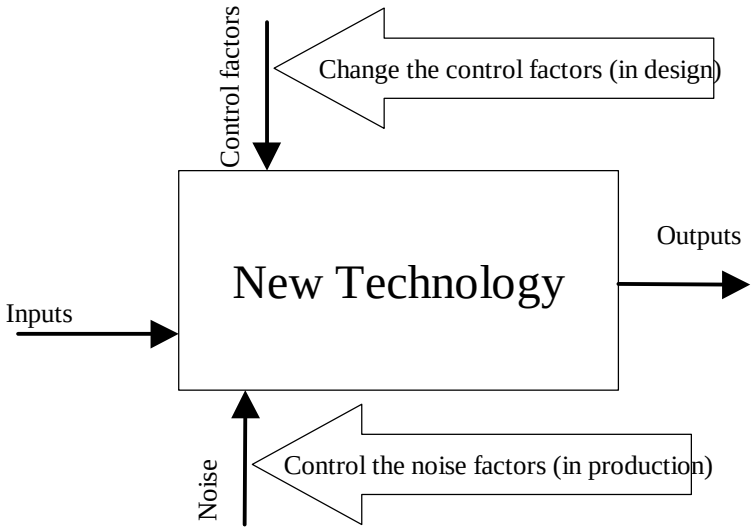
Yield problems

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





Variation Factors

Control Factors
- Dimensions
- Materials
- Process Variables

Noise factors
- Outer noise
  - temperature
  - humidity
  - people
- Inter 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

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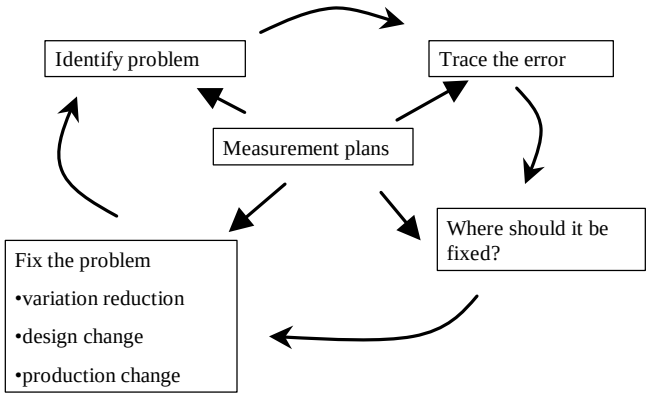

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Questions

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- 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?

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Advanced Micro Devices: A Tale of missed opportunities

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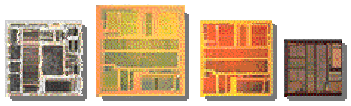
- AMD is a competitor to Intel
- Produces a compatible chip to Intel's Pentium
- Considered the "Also ran…."



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Some rough cost numbers

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- 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

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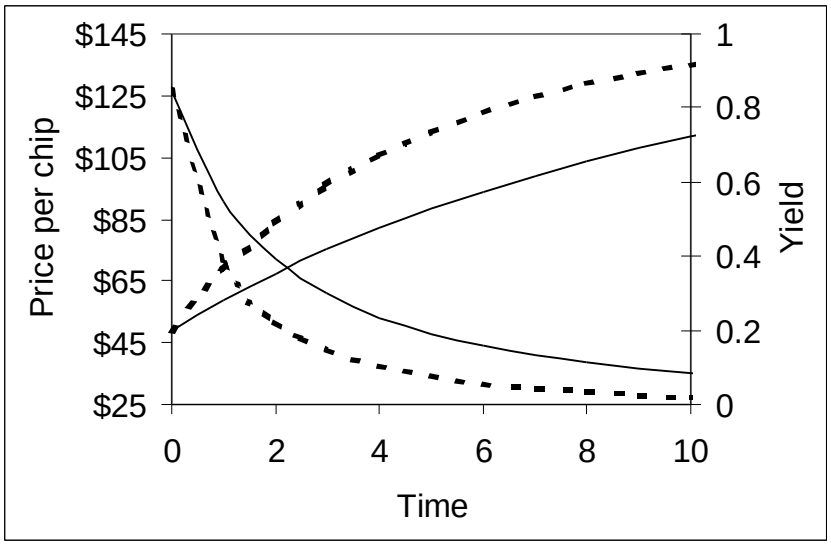

$$\frac{Volume * yield * price}{volume * (materials + labor) + capital} = (1 + profit\%)$$

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- 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

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- 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

- Henderson, R., and Clark, K. 1990. "Architectural innovation"
- Christensen, C., and Bower, J. 1996. "Customer power, strategic investment, and the failure of leading firms."
- Continuous Casting Investments at USX Corporation, (HBS #9-697-020)
- Trends in the United States Steel Market, 1980-1996, (HBS #N9-698-018)

- 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?