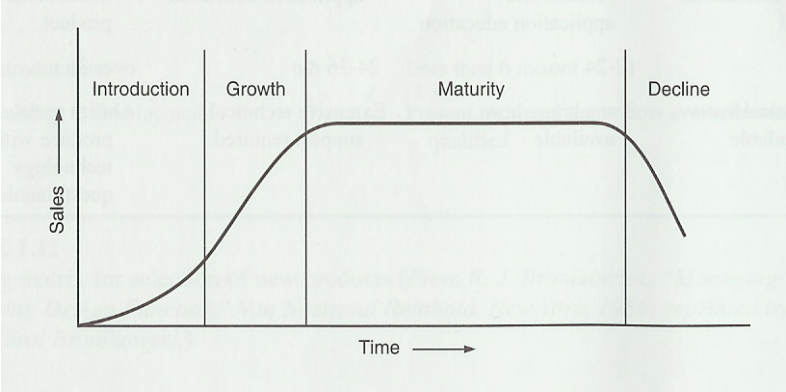
# ECE 411
# Engineering Practices
# “The Product Development Process”

Portland State University
Mark G. Faust

# Outline

- Overview of Product Life Cycle
- Back of Envelope Calculations
  - Price, Cost, COGS
- Market Window
- Impact of Product Delays
  - Example: LCD
- Company and Product Profiles
- The Lesson: Time to Market!
- Design Process
  - Conceptual, Preliminary, Detailed Design
  - Approaching Design Problems
  - Technology-Specific Processes
- Planning and Design for X
- Example: NPL Process
- Role of Documentation
- Concurrent Engineering
- Rule of 10
- Engineering Documentation
  - Engineering Logbooks
  - Project Notebooks
  - Weekly Progress Reports (WPR)

# The Product Life Cycle




| Premarket phase | Market phase |
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| 1. Idea generation | 9. Product introduction |
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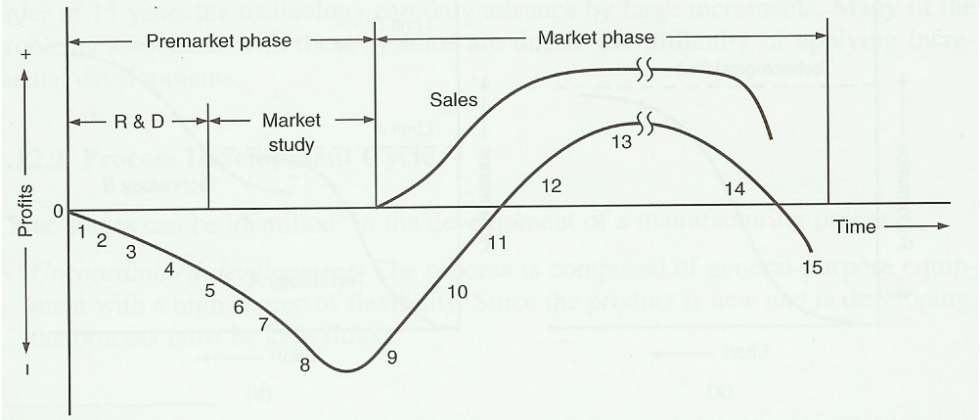
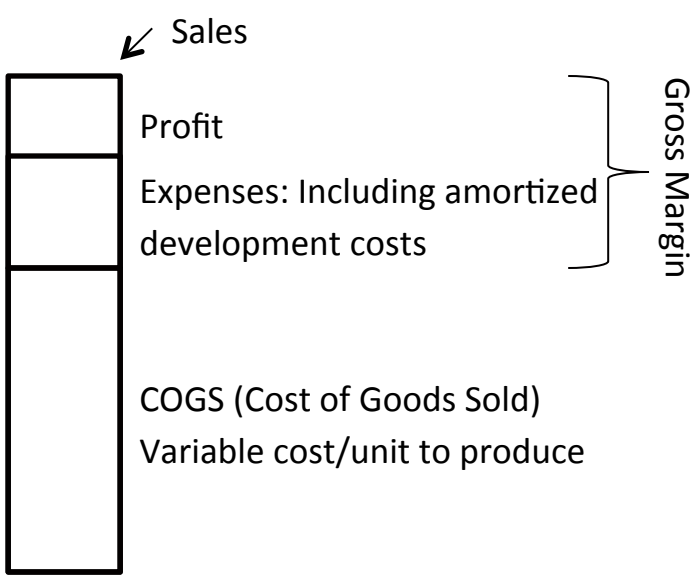


# Back of envelope calculations

$$Gross\ Profit = Gross\ sales\ \times Gross\ Margin - Expenses$$

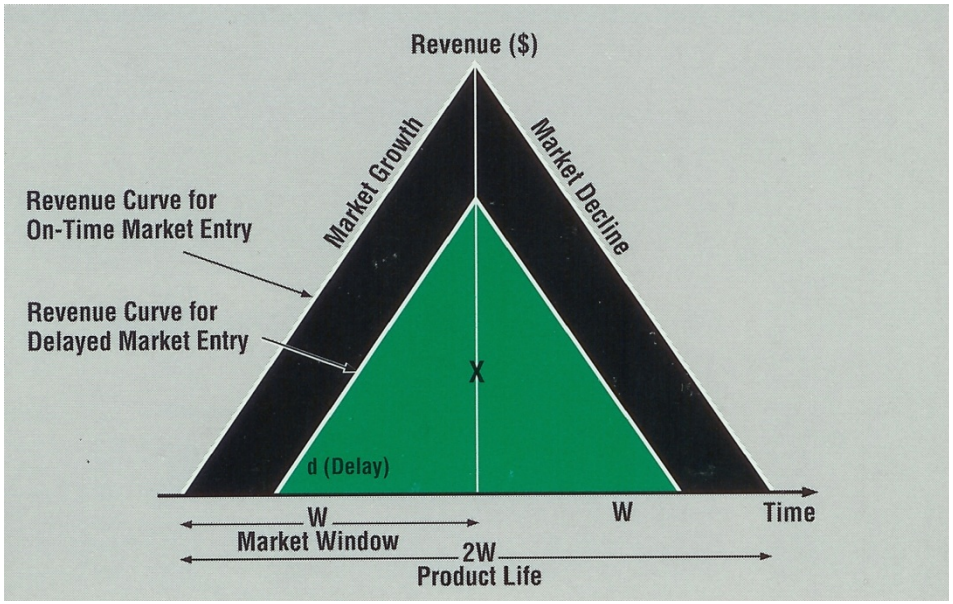
$$Gross\ sales = \ 30\ years\ \times \frac{50\ units}{year} \times \frac{\$130M}{unit} = \$195B$$

$$\$195B\ \times 16\% - \$6B\ = \$25.2B$$

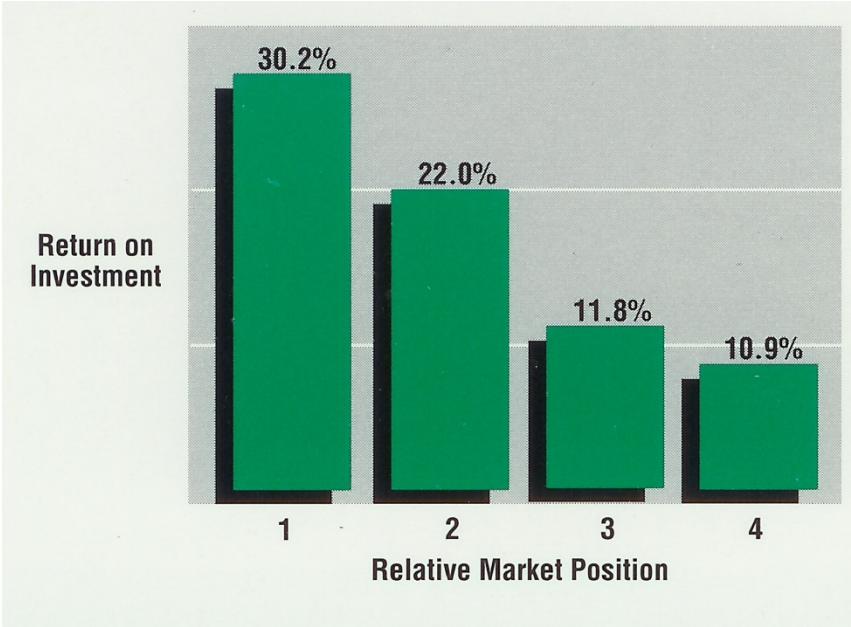



| | Stanley Screw-driver | HP DeskJet Printer | Volkswagen Beetle | Boeing 777 Airplane |
|---|---|---|---|---|
| **Annual production volume** | 100,000 units | 4 million units | 100,000 units | 50 units |
| **Sales Lifetime** | 40 years | 2 years | 6 years | 30 years |
| **Sales Price** | $3 | $300 | $17,000 | $130 M |
| **Number of Unique Parts** | 3 parts | 200 parts | 10,000 parts | 130,000 parts |
| **Development Time** | 1 year | 1.5 years | 3.5 years | 4.5 years |
| **Internal Development Team (peak size)** | 3 people | 100 people | 800 people | 6,800 people |
| **External Development Team (peak size)** | 3 people | 75 people | 800 people | 10,000 people |
| **Development Cost** | $150,000 | $50 million | $400 million | $3 billion |
| **Production Investment** | $150,000 | $25 million | $500 million | $ 3 billion |

# Market Window




- Is the market window still open for
  - Laptop PC without WiFi
  - CD player without MP3 capability
  - Zip drive

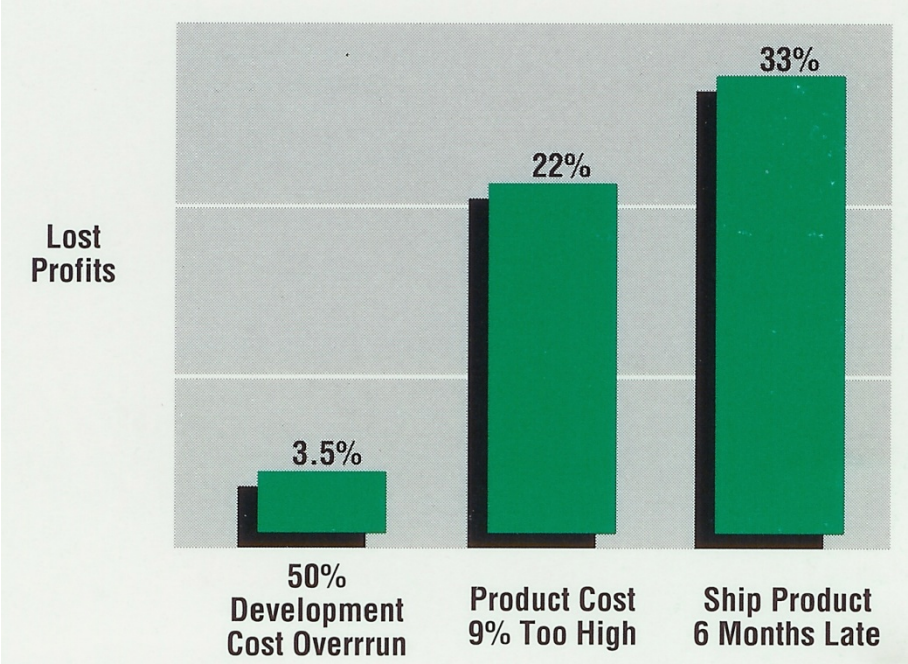



- Is it possible to be too early to market?
  - Plug-in electrics without infrastructure
  - Web-based movie downloads when too few households have high bandwidth Internet access

# Impact of Product Delays

| Delay in Months | Market Window in Months 6 | 12 | 18 | 24 | 30 | 36 |
|---|---|---|---|---|---|---|
| 1 | 24% | 12% | 8% | 6% | 5% | 4% |
| 2 | 44% | 24% | 16% | 12% | 10% | 8% |
| 3 | 63% | 34% | 24% | 18% | 15% | 12% |
| 4 | 78% | 44% | 31% | 24% | 19% | 16% |
| 5 | 90% | 54% | 38% | 29% | 24% | 20% |
| 6 | 100% | 63% | 44% | 34% | 28% | 24% |
| 7 | 100% | 70% | 51% | 39% | 32% | 27% |
| 8 | 100% | 78% | 57% | 44% | 36% | 31% |
| 9 | 100% | 84% | 63% | 49% | 41% | 34% |
| 10 | 100% | 90% | 68% | 54% | 44% | 38% |
| 11 | 100% | 95% | 73% | 58% | 48% | 41% |
| 12 | 100% | 100% | 78% | 63% | 52% | 44% |

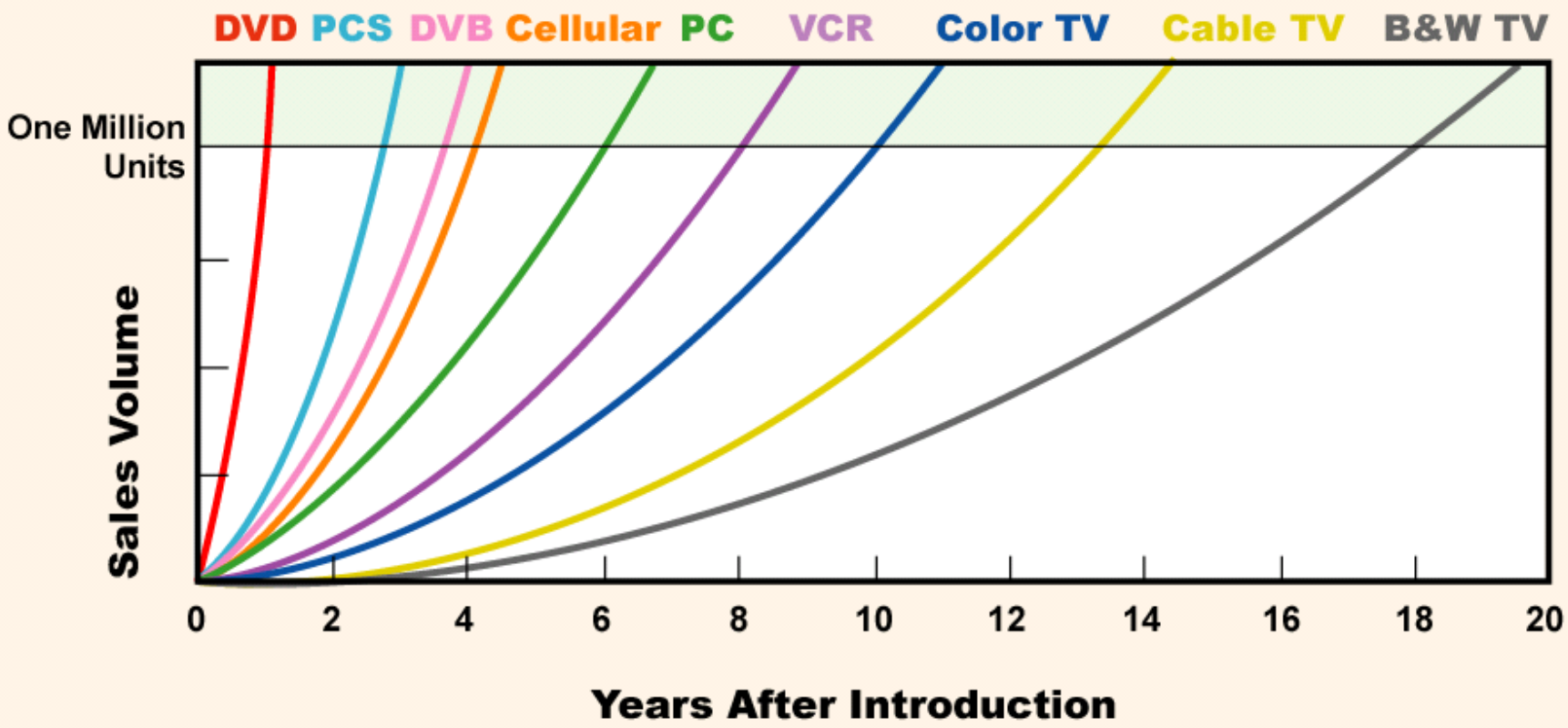
Revenue Lost Due to Product Introduction Delay




- Consequences of being late to market
  - Forced to add features
  - Compete on price (commodification)
  - Exit the market

# Increasing Importance of Time-to-Market

The impact of being late to market is becoming more significant




Apple iPhone 5 sold 2M units in 24 hours

**What factors have accelerated the attainment of the "One Million Unit" threshold?**

**Larger population**

**"Better" Marketing**

**Accelerated rapid ASP decline!**

# A Current Example: LCD Panels

*Big Display*

## Once a Footnote, Flat Screens Grow Into Huge Industry

### Asian Makers Pour $20 Billion Into Factories as Demand Surges for TVs, Monitors

### The Rise of 'Crystal Cities'

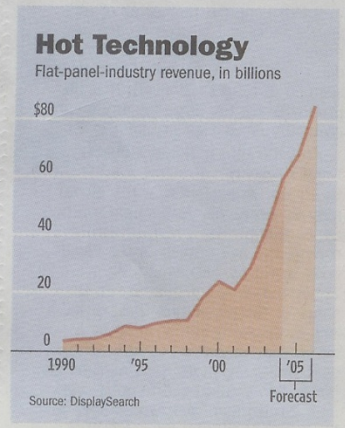
By Evan Ramstad

TAOYUAN, Taiwan—When executives at AU Optronics Corp. ordered a 210-ton machine for their new flat-screen factory in central Taiwan, they asked its manufacturer to rush its delivery from Germany.

That meant using the world's largest plane—the Soviet-built, six-engine Antonov 225—and paying around $500,000, twice the amount that delivery by sea would have cost.

But the move will shorten AU's construction of its $2.3 billion factory by 40 days, time that could mean tens of millions of dollars in production. "We could do a lot of work" in that time, says C.Y. Lin, AU's director of operations.

With consumers grabbing up more flat-panel TVs, the makers of flat screens—all located in Taiwan, South Korea and

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$2.3B x 5% (cost of capital) = $115M/yr

= $315K/day

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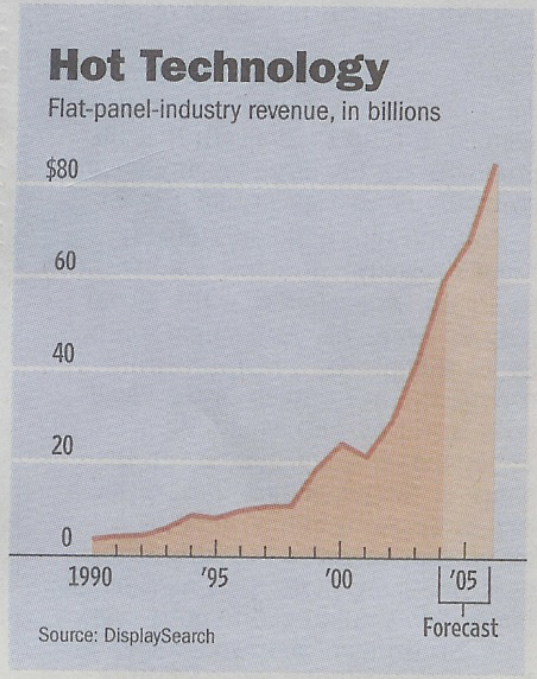



Japan—are racing to finish new factories and stake a position in what will become their biggest and most lucrative market. Ten such factories are now under construction and will cost a total of about $20 billion to build and equip.

# Prices for Large LCD Panels Slid in August

*Dow Jones Newswires*

EL SEGUNDO, Calif.—Prices of large liquid-crystal display panels slid at a faster-than-expected rate in August due to disappointing demand and rising supply and inventories, paving the way for stronger sales in the fourth quarter, market-research firm iSuppli Corp. said.

The California company said the steepest decline was for LCD panels used in desktop personal-computer monitors, with prices for 15-inch and 17-inch panels dropping 18% to 19% in August from July. ISuppli attributed the price declines to rising supply due to increased production at several new plants that can produce more and bigger LCDs at lower costs, and slow sales of monitors and television sets in July and August.

The company said the third-quarter price reductions should enable system manufacturers to cut prices in the fourth quarter, a move that should boost holiday demand.

ISuppli forecasts some panel prices may rise in December as manufacturers aim to improve their profit margins

third qu

# Philips's Net Profit Plunges 79%

## *Fall in Flat-Panel Prices, Chip Sales Crimp Results; Display Unit Is in Question*

By Stefan Simons
And Cassell Bryan-Low

**Philips Electronics** NV reported a 79% decline in first-quarter net profit, hit by falling prices for flat-panel screens and lower sales in its semiconductor business.

Shares in the consumer-electronics giant tumbled after the earnings report, adding to the gloom in a jittery technology sector following downbeat noises recently from heavyweights including **International Business Machines** Corp. and **Samsung Electronics** Co.

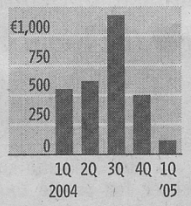
The results from Philips show that despite the Dutch conglomerate's efforts to restructure in recent years, it remains exposed to certain highly cyclical technology businesses. That has raised questions among analysts about whether further disposals are on the horizon.

One business that analysts see as a potential candidate for a sale or moving into a joint-venture operation is the unit that makes displays for cellphones and other mobile devices. Philips, Europe's largest consumer-electronics concern based on revenue, recently moved these activities out of semiconductors and put them into a different group for financial-reporting purposes.

Jan Hommen, chief financial officer, said, "we are evaluating what type of options we have for the display business." He added that the company likely will make a decision in the next quarter.

**Sharp Drop**

Philips's net income, in millions of euros




Note: €1 = $1.3015
Source: the company

Net profit at Philips fell to €117 million ($151 million) for the first quarter, falling short of analysts' expectations, from €550 million a year earlier. Sales were flat at €6.64 billion. Philips shares fell 3% in Amsterdam yesterday.

Lower sales at the semiconductor division, losses from the liquid-crystal-display venture with **LG Electronics** Inc. and weaker-than-expected profit at its medical unit crimped earnings. Analysts and the company's executives highlighted the consumer-electronics unit's performance as a bright spot.

Earnings at Philips, whose products range from coffee makers and television sets to medical scanners and chips for mobile phones, are heavily influenced by the variety of stakes it holds in other listed companies.

Business suffered at the liquid-crystal-display joint venture due to continuing price declines and the strong South Korean currency against the dollar.

# A Current Example: LCD Panels

SATURDAY ◆ SEPTEMBER 17, 2005

## InFocus unplugs flat-screen TV sales

### Falling prices prompt the Wilsonville-based company to refocus on selling digital projectors

**InFocus Corp.**

Amid strategic missteps and competitive pressures, InFocus' share price has fallen by more than 60 percent since Kyle Ranson became chief executive officer.

Source: Bloomberg News TED MITCHNER/THE OREGONIAN

By MIKE ROGOWAY
THE OREGONIAN

InFocus Corp. on Friday abandoned its ongoing efforts to break into the market for flat-screen televisions, announcing plans to restructure the company and concentrate on reviving its core digital projector business.

The faltering Wilsonville company replaced two key executives, reassigned others and said it would make unspecified job cuts in coming months to reduce costs and return to profitability. Once a pioneer in the market for high-end video projectors, InFocus has lost market share as established brands such as Epson and Sony jumped into the field.

On Friday, InFocus said an effort to use projector technology to break into an entirely new market — flat-screen televisions — had failed because of falling prices for LCD and plasma TVs. The company said it plans to press ahead with a new joint venture in China that it hopes will establish a foothold for InFocus projector sales there.

The value of InFocus' stock has dropped by more than 60 percent since chief executive Kyle Ranson took over in September 2004, and slipped another 10 cents after Friday morning's announcement, closing at $3.36.

The company lost $33.5 million in the first half of 2005 and doesn't expect to be profitable before next year, at the earliest.

"Our financial results were unacceptable and we needed to make significant changes in our overall cost structure to get us back on track to profitability," Ranson told analysts during a conference call Friday.

The restructuring plan calls for cutting operating expenses by 25 percent, in part through layoffs, and eliminating a number of key executives. InFo-

Please see **INFOCUS,** Page D2

**Overhaul at a glance**

Key points of InFocus Corp.'s restructuring plan:

- Reduce operating costs by 25 percent and lay off an unspecified number of InFocus' 670 employees
- Drop its line of thin, rear-projection TVs
- Replace top managers, including Chief Financial Officer Mike Yonker

**InFocus Corp. employees gathered in July at the company's Wilsonville headquarters to review this 60-inch, ultrathin television. InFocus said on Friday that it will end its efforts to break into the flat-panel TV business.**

STEVEN NEHL
THE OREGONIAN

# A Current Example: LCD Panels

SATURDAY/SUNDAY, APRIL 15 - 16, 2006

## Flat-Panel TVs, Long Touted, Finally Are Becoming the Norm

By Evan Ramstad

After years as the Next Big Thing in consumer electronics, flat-panel TVs are finally becoming the mainstream standard.

A price war among makers of the two main flat-panel technologies, an expanding menu of high-definition content and the aesthetic and practical appeal of thinner boxes are luring consumers to switch from tube-based televisions to flat screens much sooner than expected. Already, many flat-panel models with screens 30 inches or smaller are selling for less than $1,000, and 32-inch models could be in that range by year's end.

Last year, flat-screen TVs for the first time accounted for the majority of TVs bought in Japan, Hong Kong and Singapore. That crossover will happen this year or next in the U.S. and most European countries, industry watchers say, and at least one company has already stopped shipping tube TVs in the U.S. "It's happening faster than the most optimistic targets," says Ross Young, president of DisplaySearch, an Austin, Texas, market-research firm.

World-wide, sales this year of liquid-crystal display and plasma flat-panel TVs are on track to total about 44 million units, valued at as much as $54 billion, out of an overall market of 185 million TVs, according to market research firms. In the U.S., sales are expected to reach between 12 million and 14 million flat-panel TVs, or roughly

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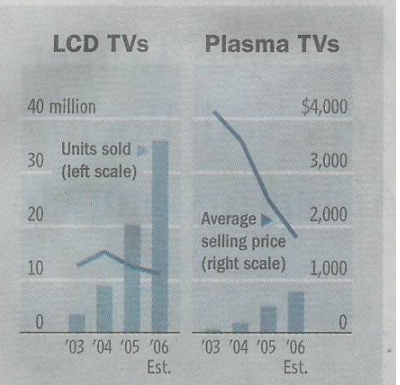


**More for Less**

As prices have fallen for LCD and plasma flat-panel TVs world-wide, sales have risen.

Source: iSuppli

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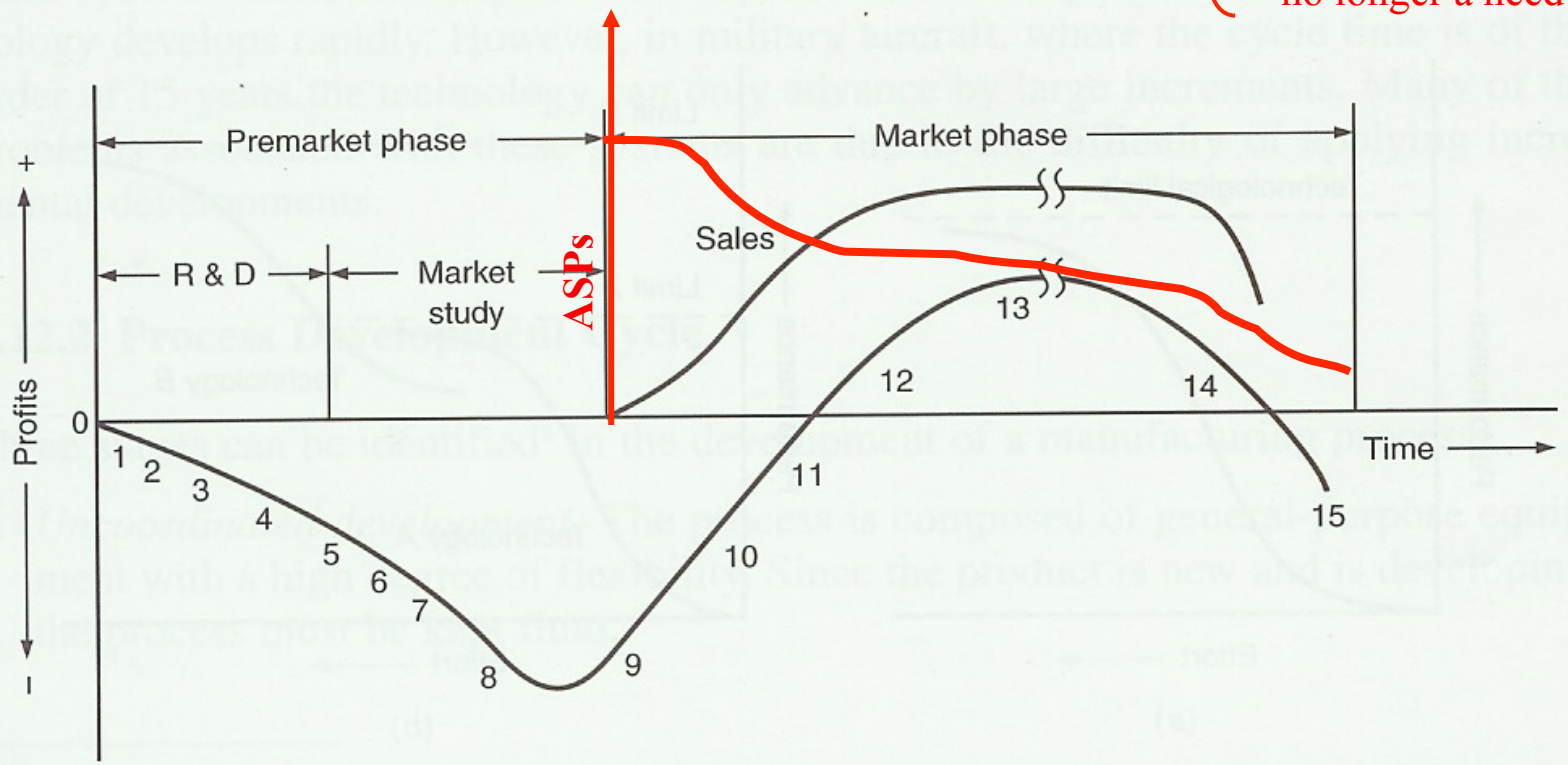
Market saturation
Direct competition
Reduced ASPs
Closing market window
indirect competition
no longer a need



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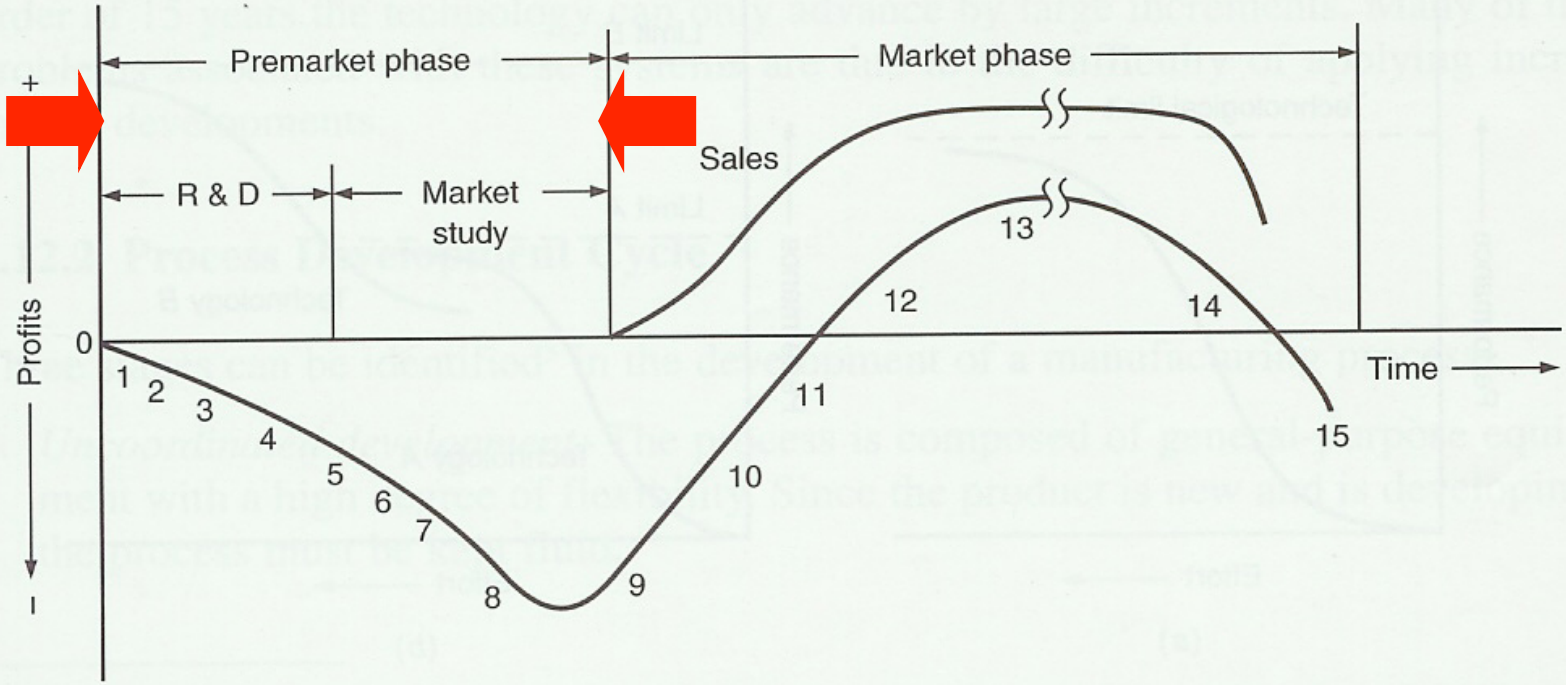
Our Focus



# Company and Product Profiles

First in field
- Technology leader
- Risk-taking environment

SiliconImage

Fast follower
- Good product development process
- Less R&D expenditure

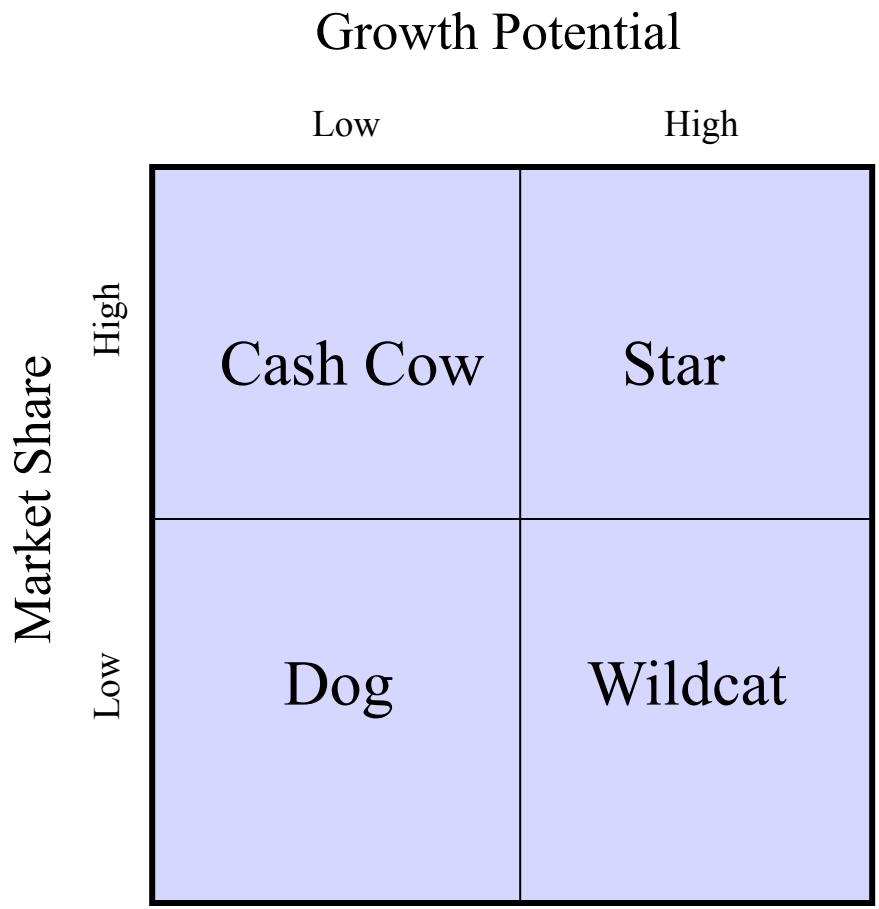
Siemens

High-volume, low-cost producer
- Very low R&D expenditures
- Focus on volume, manufacturing

SunPlus

Niche player
- Narrow market, end-user focus

Apple (computers!)



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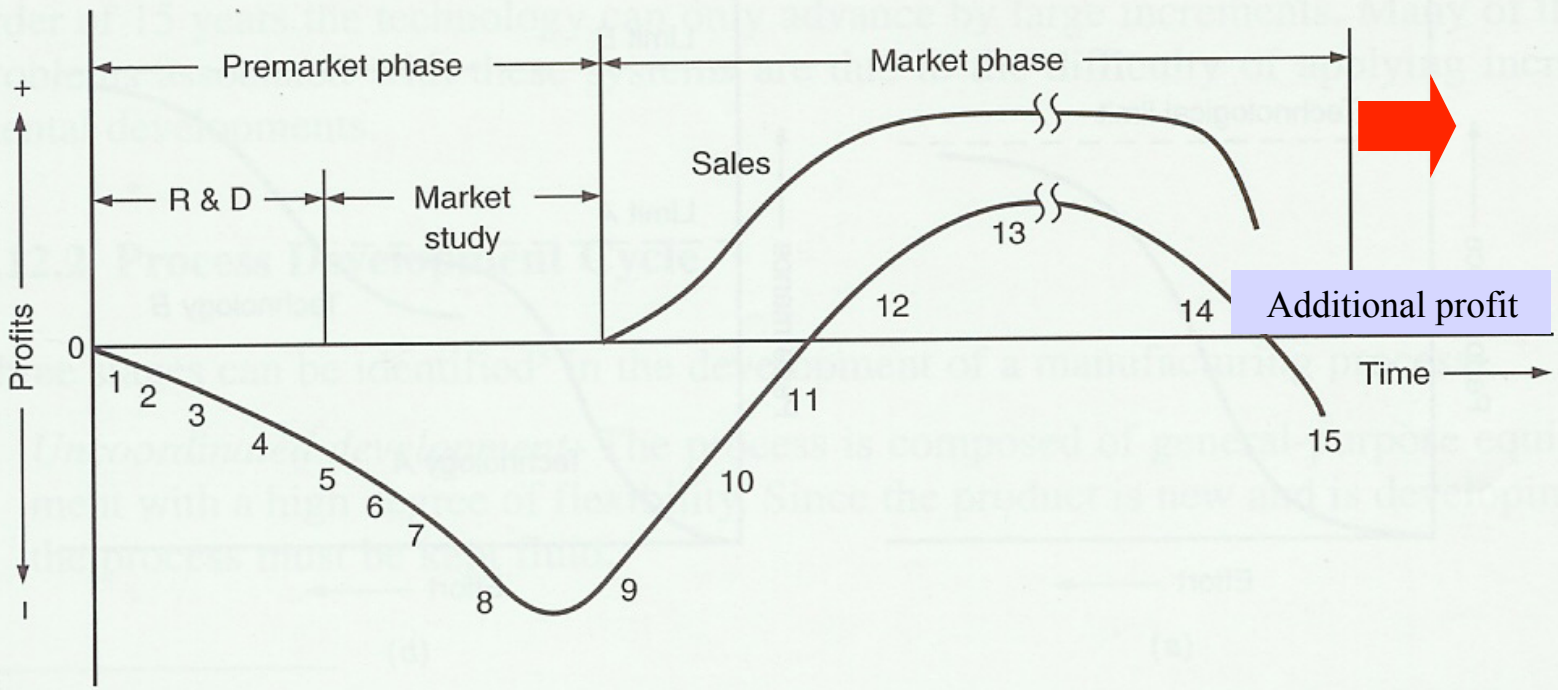
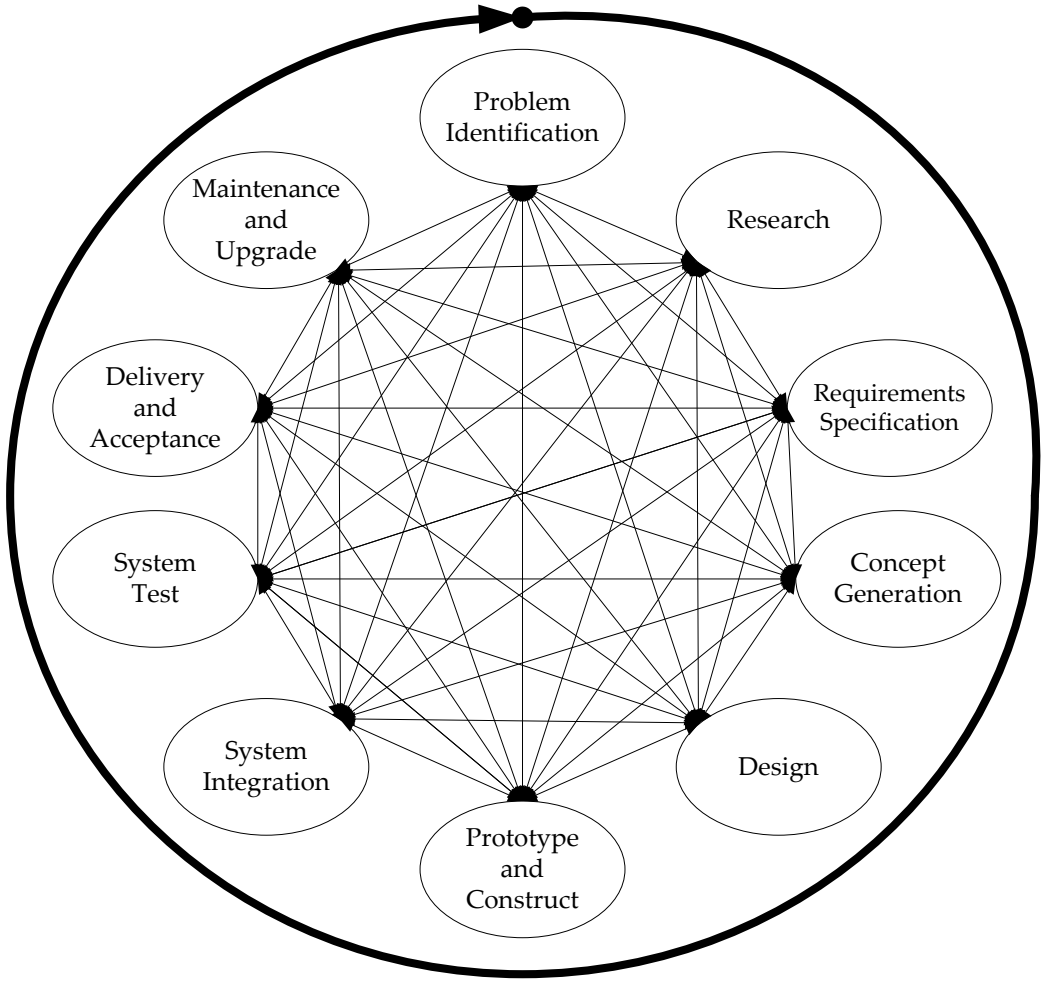


# Lesson

- Intense competitive pressure to be first to market
  - Or have significantly lower cost product
- How do we achieve this?
  - Tools
  - Methodology (Processes)
  - Teamwork (People)
- Even more important because…
  - Global competition
  - Easy migration of capital
  - Off-shore development
  - Low cost design tools

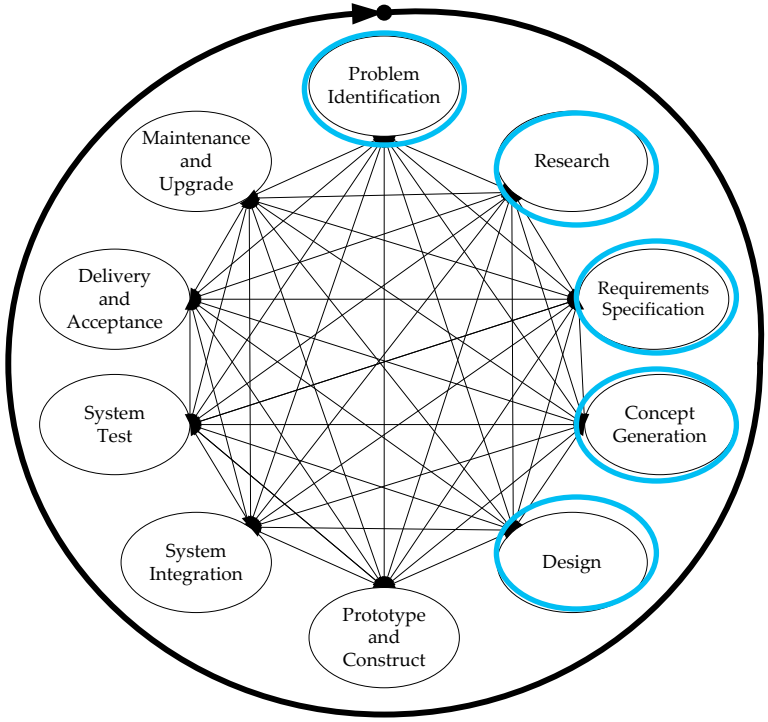
allow everyone to compete!

# Descriptive Overview of Design Process



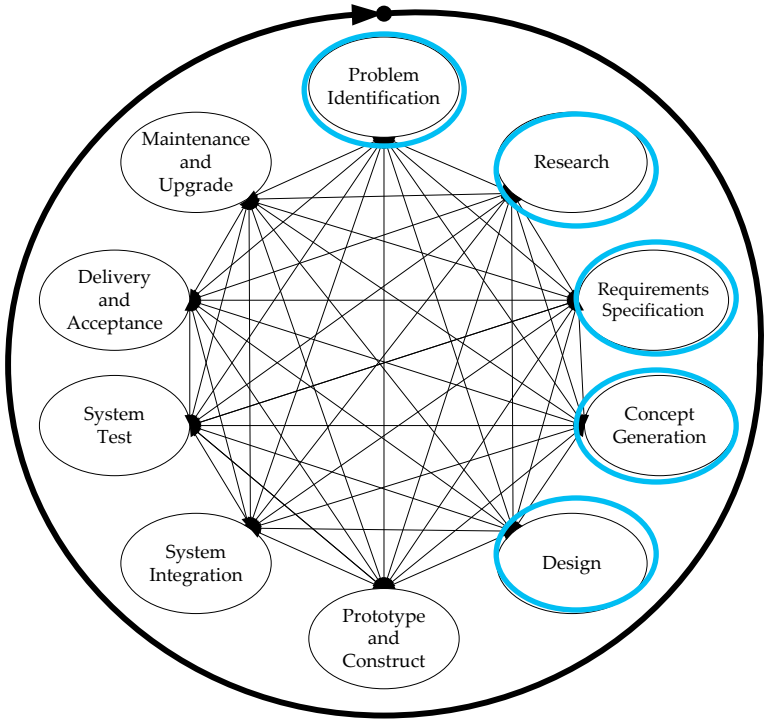
# Product Development Process

- Conceptual Design
- Preliminary Design
- Detailed Design
- Planning for Manufacture
- Planning for Distribution
- Planning for Use
- Planning for End of Life (Product Retirement)



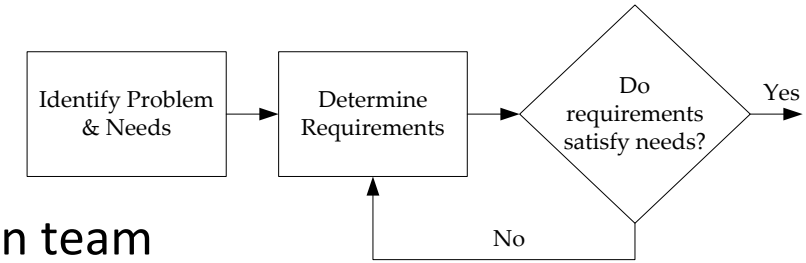
# Product Development Process

- Conceptual Design
  - Identification of Customer Needs
  - Problem Definition
  - Gathering Information (research)
  - Concept Generation
  - Concept Selection
  - Refinement of Requirements Product Design Specification (PDS)
  - Design Review



# Conceptual Design

- Identify customer needs
  - Understand customer needs
  - Validate them
  - Communicate them to the design team




- Define problem
  - Create statement which describes what needs to be done to satisfy the customer needs
  - Analyze of competitive products/solutions
  - Create target specifications
  - Identify constraints and trade-offs
- Gather information (research)
  - Determine size/extent of problem, value of solution
  - Identify existing solutions
  - Research patents
  - Locate available technology
  - Identify relevant standards

# Conceptual Design

- Conceptualization
  - Generate concepts (possible solutions)
- Concept selection
  - Evaluate, modify, refine
  - Choose preferred solution
- Refinement of the requirements document
  PDS (Product Design Specification)
  - Design team commits to key parameters/specifications
  - Agree on trade-offs
- Design review
  - Is design physically realizable (can we build it?)
  - Is it economically worthwhile?
  - Review development schedule (hit market window?)

# Preliminary Design

- Product Architecture
  - Divide system into modules, sub-modules
  - Communication between subsystems
- Configuration design of parts and components
  - Top-level definition of subsystems, modules
  - Prototypes or models (e.g. GUI, “transaction”)
- Parametric design of parts and components
  - Detailed specification (speeds, feeds)
  - Process/technology (e.g. FPGA, ASIC, Standard Parts)

# Approaching the Design

- Research, Research, Research
- Think, Think, Think
- Develop <u>detailed</u> specifications for the product
- Make high-level block diagram
- Break block diagram into modules
  - Successive decomposition
- Specify the interfaces between modules

*"Days of debugging have saved me hours of planning and design"*

*- an engineer*

# Approaching the Design

- Assign modules to group members based upon their individual strengths, experience
- Schedule tasks to balance workloads
- For each module develop the overall block diagram, specifications, and design

# Approaching the Design

- For each module, research to determine if that module or significant parts of the module has already been developed by some other company and can be purchased rather than designed from scratch. Remember: time to market!
- For each module, develop a sequence of intermediate goals or checkpoints

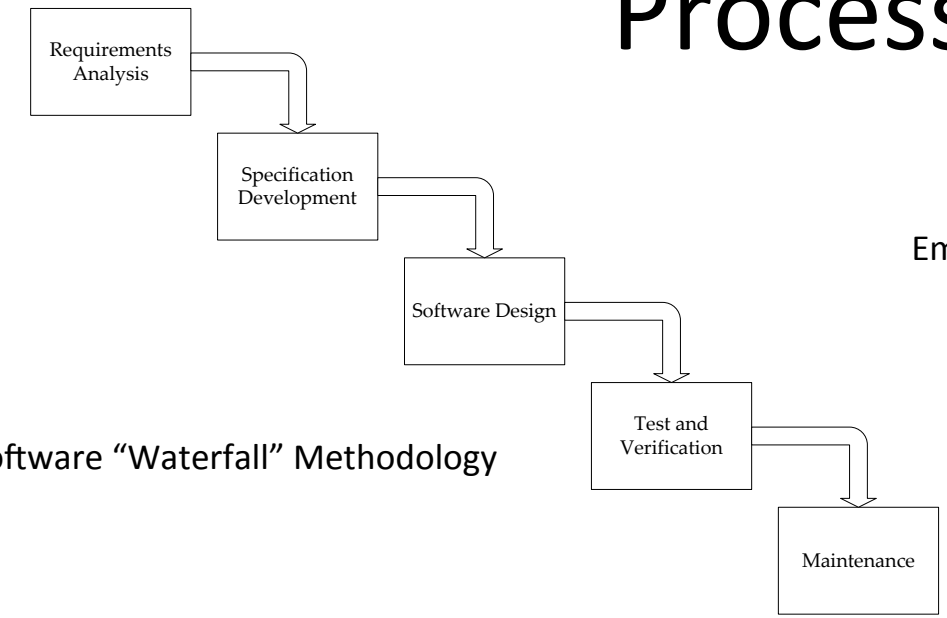
# Approaching the Design

- "Fast is slow"
  - Fastest way to a working product is to build, test, debug, and integrate the design one very small step at a time. Facilitates allocation of people to tasks, allows you to work on one or more pieces at a time if you get blocked
- Document!
  - Requirements, Specifications, Detailed Design Documentation, Test Plans, Test Results
- Integrate the Modules and Test

# Detailed Design

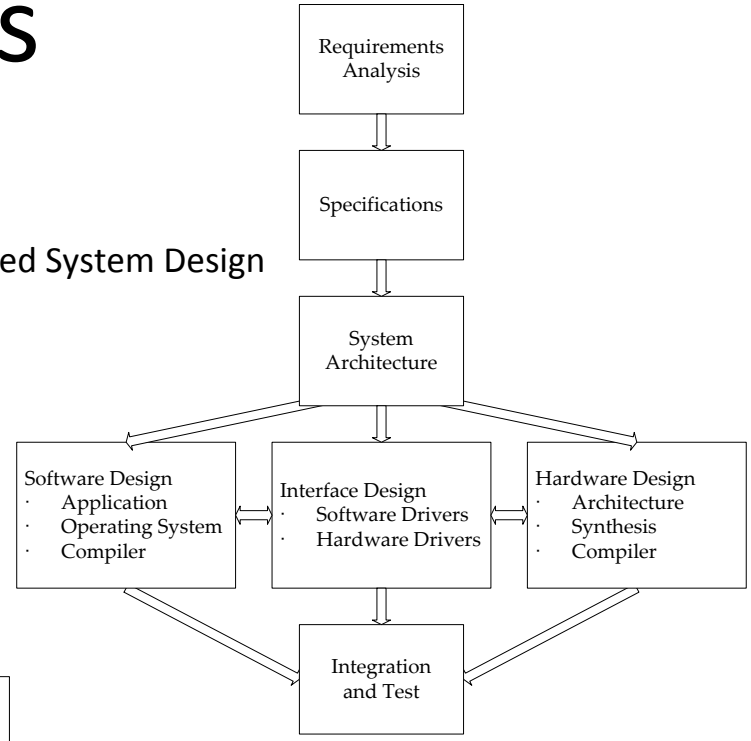
- Coding and testing
- VLSI Design
- FPGA debug
- Board layout
- Prototype debug

# Technology-Specific Design Processes



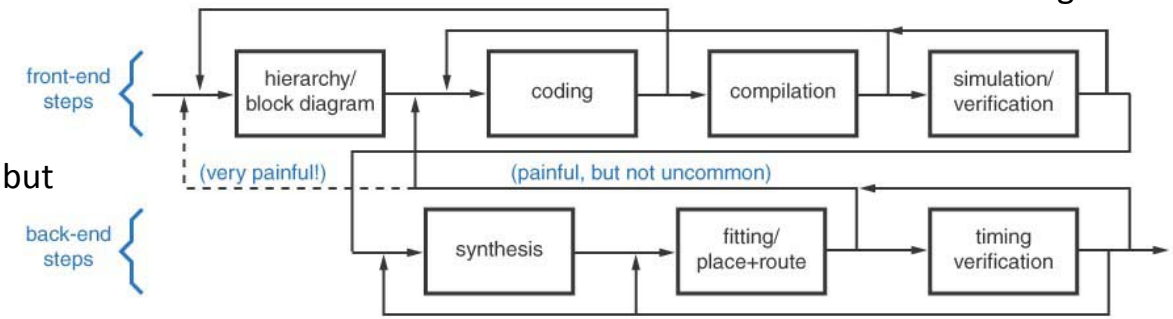

Software "Waterfall" Methodology

Embedded System Design



VLSI Design

FPGA Design




In reality, most aren't linear, forward only, but require re-visiting earlier steps…

# Planning for Manufacture

- Design for manufacturability
  - COGS (Cost of Goods Sold)
- Share subsystems/components across products
- Manufacturing documentation
  - Processes, procedures, quality, test requirements
- New/unique manufacturing methods required?

# Planning for Distribution

- Marketing
  - Trade shows, seminars, advertising
  - Application notes, demos, white papers
  - Reference designs
- Distribution channel
  - Direct sales, distributors, partners
  - E-commerce
- Product delivery
  - Demo units/trial period
  - Configurable capability/extensibility

# Planning for Use

- Reliability (MTBF)
- Safety
- Convenience
- Ergonomics
- Aesthetics
- Cost of ownership (COO models)
- Ease of maintenance/service (MTTR)
  - Service, spares, warranty support

# Planning for Product Retirement (End of Life )

- Product succession planning
  - Migrate customer to (your) new product
    - Windows XP to Windows 7 migration
  - Pricing, trade-in/trade-up
  - Conversion (e.g. formats)
- End of Life
  - Customer notification required?
  - Last time buy?
  - On-going service/support?

# Design for “X”

- Consider other criteria early in the design process…
  - Design for manufacturing
  - Design for service
  - Design for extensibility
  - Design for cost of ownership
  - Design for test
  - Design for environment
- Unintended Consequences

# Design for Manufacturing & Service

- Consider other criteria early in the design process…
  - Design for manufacturing
    - Allows existing factory or tooling to be used
    - Permits use of multiple subcontract assembly/test services
    - Uses few unique components/parts
    - Allows multiple factories to build (crossover)
    - Reduces manufacturing time
  - Design for service
    - Customer vs. Field vs. Factory service
    - Facilitate diagnosis, repair
      - Diagnostics (remote access?)
      - Easily field/customer replaceable parts/components
      - Product bug fixes/updates
    - Minimize number of unique spares to stock

# Design for Manufacturing

TUESDAY, APRIL 11, 2006

*Shifting Gears*

## Chrysler Gains Edge by Giving New Flexibility to Its Factories

### Some Can Build One Vehicle, Then Switch to Another, A Skill Japanese Pioneered

### For Robots, a Show of 'Hands'

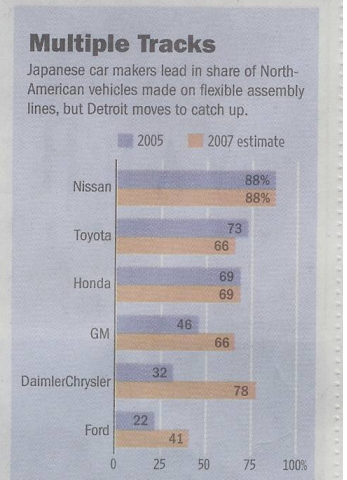
By NEAL E. BOUDETTE

BELVIDERE, Ill.—In the car industry, the Chrysler assembly plant here in the farmland west of Chicago is known for an infamous gaffe. In 2001, DaimlerChrysler AG's U.S. arm had a hot new model in the retro-styled PT Cruiser, built at a plant in Mexico. With orders pouring in, Chrysler hoped to boost output by assembling some in Belvidere, where it made the Dodge Neon, a small car that used many of the same parts.

But Belvidere could make only Neons. Chrysler engineers discovered that the PT Cruiser was an inch too tall to fit through the plant's paint shop. Chrysler, which was losing money at the time, ended up spending $300 million to expand the assembly line at the PT Cruiser plant in Toluca, Mexico.

Meanwhile, Chrysler took another hit at Belvidere: Because Neon sales were slow, it had to cut production there, leaving the Illinois plant's assembly line operating just eight hours a day. The rest of the time, hundreds of millions of dollars in equipment sat idle.

Determined not to make such a mistake again, Chrysler rethought how it assembles cars, looking at everything from the order in which door parts are welded together to whether it's cheaper to install windshields manually or by machine. The result is a new, flexible assembly system that Chrysler is betting can transform the company's economics. Its central fea-




system, the plant makes two models, the Dodge Caliber and Jeep Compass, both new. Last month Belvidere added a second production shift. A third model will join the mix later this year, and Belvidere will be on course to produce twice as many vehicles as in 2005. That will slash each one's share of fixed costs.

Chrysler's move is part of a broad shift in thinking that has been rippling through the auto industry for years, but is now starting to bring big changes.

For decades, mainstream models such as the Ford Taurus sold in such large volumes they could keep a plant or two running at full capacity for years. Not only was the plant limited but so was its costly equipment, much of which had to be scrapped when the model was dropped.

But mega-selling cars now are rare, especially for Detroit's Big Three. Car companies are trying to tap into buyers'

## Costly parts only add to Big 3's losses

**Automakers** | A study says common components give Japanese companies the edge

By TOM KRISHER
THE ASSOCIATED PRESS

TROY, Mich. — One of Detroit's automakers is about to come out with a new model that has 81 side-view mirror options.

A comparable model built by Honda Motor Co. has only two.

According to a new study of the domestic auto industry's woes, the mirrors are one costly example of why Detroit-based carmakers made an average of $2,400 less per vehicle last year than their Japanese competitors.

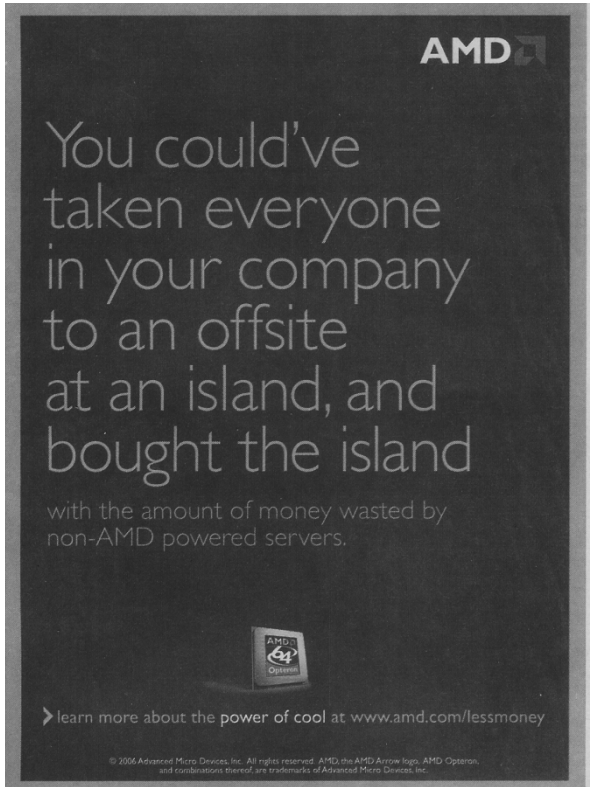
The study, released Monday by the Royal Oak-based Harbour-Felax Group, also blames high labor costs, huge employee- and retiree-benefit expenses, bad pricing strategies and the low value of the yen to the dollar as factors that make the Big Three's vehicles more expensive to produce than those made by Japanese com-

# Design for Extensibility, COO

- Consider other criteria early in the design process…
  - Design for extensibility
    - Facilitate easy upgrade/extension of product
    - New software revisions
    - Reconfigurable (e.g. FPGA, firmware)
      - PC software auto-update
      - iPhone software update during sync/charging
  - Design for cost of ownership (COO)
    - Reduce user's total cost of ownership
    - Considers use and life cycle
    - Power consumption, replacements (spares and consumables)
      - laser printer vs. ink jet printer
      - Airbus A380 vs. Boeing 787 Dreamliner

# Design for Cost of Ownership

- Cost of Ownership
  - Space occupied by product
  - Power or fuel required to operate
  - Air conditioning
  - Installation costs
  - Cost for spares
  - Cost of routine maintenance
  - Cost for repair
  - Labor costs to operate product
  - Training costs
  - Cost of consumables



# High-Stakes Bet on a Giant Plane Trips Up Airbus

*Continued From First Page*

tional advantage.

Airbus faces another challenge: It must find the engineering power and funding to sustain its multiple programs. Officials have said over the past year that stretched engineering resources are one of their biggest headaches. The U.S. and the European Union are already suing each other at the World Trade Organization over whether Airbus should be entitled to the preferential government loans that it used to fund the development of its current product line. The U.S. says these loans are unfair subsidies; the EU disagrees. If Airbus seeks such loans while the case is pending, it could help fan the flames of a potential trade war.

Airbus's need for financing could be intensified by the recent decision by British defense giant BAE Systems PLC, which owns 20% of Airbus, to exercise its right to make EADS buy out BAE's stake in Airbus. Analysts recently valued that stake at around $5 billion, although that figure is now being downgraded and BAE's shares fell yesterday.

Airbus appears to have little choice but to make the investment in a new midsize plane.

Rising fuel prices and a recent trend toward long-haul flights that avoid connecting at busy hub airports are prompting many to wonder whether the 555-seat A380—which was designed to fly between major hub airports—might have been the wrong long-term bet for Airbus. The A380 has a catalog price of $300 million, but customers generally receive significant discounts.

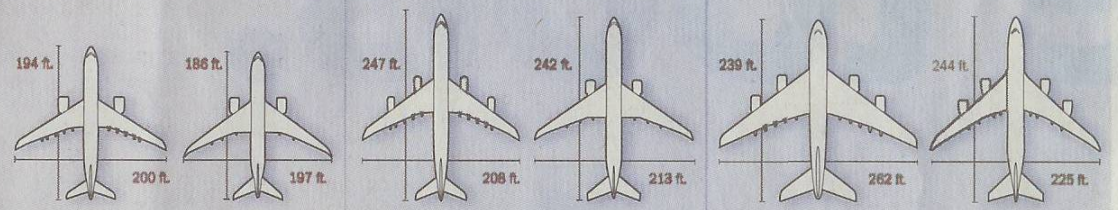
Boeing, on the other hand, successfully marketed its 787 and 777 models as more comfortable and more efficient than Airbus's comparable twin-aisle planes. As a result, Boeing has been able to win most of the major sales competitions during the last two years, in some cases enticing Airbus customers to switch brands.

"We spent a great deal of time on product strategy and trying to come up with airplanes that were pleasant for cus-

## Clash of the Titans

Some competing models by the world's two biggest passenger aircraft makers:

| Class | Airbus A350 | Boeing 787 | Airbus A340 | Boeing 777 | Airbus A380 | Boeing 747 |
|---|---|---|---|---|---|---|
| 2005 ORDERS | 87 | 235 | 15 | 155 | 20 | 48 |
| Sub-class | A350-800 | 787-8 | A340-600 | 777-300 ER | A380 | 747-8 |
| MAX. SEATING[1] | 253 | 250 | 380 | 365 | 555 | 450 |
| MAX. RANGE, miles | 10,120 | 9,775 | 9,085 | 9,062 | 9,200 | 9,200 |
| IN SERVICE | 2012 | 2008 | 2002 | 2004 | 2006 | 2009 |
| LIST PRICE, millions | $160.0 | $152.8 | $218.0 | $250.8 | $292.0 | $277.5 |




1. Three-class configuration

Source: the companies

delay, exact terms are confidential and vary by customer. The initial delays cost Airbus several tens of millions of dollars, officials say.

The delay arose because Airbus engineers and production managers had underestimated the complexity of wiring up the massive aircraft with sophisticated custom equipment such as in-flight entertainment and communications units that customers such as Singapore Airlines, Dubai's Emirates Airlines and Qantas Airways of Australia were providing for installation. Because the plane's electronic systems are highly integrated, a small change in one area rippled throughout the design, Airbus officials say.

As A380 production began ramping up last year, managers thought they had licked the problem. But by mid-April, it became clear the problem remained.

history, customers began clamoring for an airplane that would cost less to own, operate and maintain. At the time, Boeing was searching in particular to replace its aging 767 midsize jetliner, which airlines were abandoning in favor of Airbus's newer A330.

The plane that evolved was the Dreamliner. With a new generation of fuel-efficient engines and a skin and frame made largely from carbon-reinforced plastic, the Dreamliner is being advertised as 20% less expensive to operate and a third less expensive to maintain than the Airbus A330. It has been a huge success in winning orders.

### Tweaking the A350

As a result, Airbus has tried since 2004 to counter Boeing's marketing accomplishments with the 787 through a

2012, a year behind Boeing.

This spring, some of Airbus's most important customers—including Singapore Airlines Chief Executive Chew Choon Seng and Steven Udvar-Hazy, the chairman of leasing giant International Lease Finance Corp.—said Airbus should scrap its piecemeal approach to improving the A350 and start over with a new plane.

The Airbus board is expected to consider a plan later this month that calls for three models of the plane that would be aimed at competing with both the 787 and Boeing's 777.

During an analysts' conference in St. Louis last month, Boeing Commercial Airplanes Chief Executive Alan Mulally said that, as an airplane designer, it would be "really tough to make one airplane that can compete against the 787 and compete against the 777." Mr. Mula-

# Design for the Environment

- Environmentally conscious product development
  - Design for “green” manufacturing
    - Uses recycled materials
    - Employs non-polluting manufacturing processes
    - Eliminates/reduces hazardous waste
    - Energy efficient manufacturing
    - Reusable shipping containers from suppliers (bins instead of boxes)
  - Design for “green” use
    - Energy efficient product
    - Non-polluting
  - Design for “green” end of life
    - Product is easily disassembled
    - Subcomponents recycled, re-used, returned, safely disposable

# Design for "X": The Environment

## Designs on a green future

*An HP engineer works within the system for the environment*

By **DEE ANNE FINKEN**
SPECIAL TO THE OREGONIAN

VANCOUVER —

Engineer Erin Gately finished a class with the nonprofit Northwest Earth Institute and promptly suffered what she calls a crisis of faith.

Her conscience had been pricked by learning that Americans make up 5 percent of the world's population but consume about a quarter of the planet's resources. Gately was ready to quit her work in marketing for technology giant Hewlett-Packard and get a new job.

"I thought, maybe I don't want to work anymore for a big company that makes more things for people to buy," the 37-year-old Northeast Portland resident said.

Five years later, Gately is still with HP and feeling good about it. Now she's working to make changes from within the system. One of seven product stewards split between the company's Vancouver and Corvallis operations, the industrial engineer works to ensure HP products and services affect the environment less severely than previous models and designs.

Gately is an educator. When a product needs an alteration or adaptation to meet a government standard, such as the Environmental Protection Agency's "Energy Star" rating, Gately informs managers, designers and engineers of the requirements. And she encourages them to consider more environmentally sound alternatives.

"I'm not a designer, but what I own is an expertise on environmental attributes," she said during a recent interview. "I'm always looking at our products and considering ideas."

The DeskJet 6540 printer, for example, was a recent focus for Gately, and it has won rave reviews from consumer and computer magazines for its performance and its environmentally friendly design. She persuaded the company to build it without painted plastic, a nonrecyclable

Please see **HP,** Page C2

# HP: EU requires makers to pay recycling costs

*Continued from Page C1*

material.

Her imprint on that model is one reason Sierra Club magazine profiled Gately in July, naming her among six "technological pioneers" — Northern American innovators who have discovered a way to master technology while reducing environmental clutter, not adding to it.

In recent months, Gately has been working on a range of other projects, including a printer case made from corn and easy-to-disassemble printers that can be recycled more readily.

She also is watching as manufacturers — including HP — prepare to deal with a new European Union law that makes them financially responsible for recycling all of their electronic equipment. The Waste Electrical and Electronic Equipment directive, which becomes effective Saturday, means landfills throughout Europe will no longer be improper dumping grounds for electronic and electrical discards. Consumers will be able to return their worn-out computers, printers, cameras and other devices to a store or to a recycling center.

The U.S. would benefit from similar product-stewardship laws, said Jan Whitworth, a policy analyst for the Oregon Department of Environmental Quality.

"Our waste stream is a growing waste stream, and we all know just how much more electronic equipment we have in our lives than 10 years ago," Whitworth said. "The main problem is there aren't many convenient places to have it recycled or reused."

Earlier this year in Oregon, legislation aimed at making manufacturers responsible for recycling electronic devices died when industry officials collided over how to collect the money to cover the costs of proper disposal, Whitworth said.

In the state of Washington, Jay Shepard, a policy adviser for the Department of Ecology, said his division is developing a plan to address the issue and expects to have a report for state lawmakers in December.

"We are in the throes of doing the study now, and we hope to have a recommendation the Legislature can run with shortly after that," he said.

Key to any recycling plan's success in the U.S. is involvement by stakeholders, Shepard said, including manufacturers such as HP.

### Change in approach

It was a class on "voluntary simplicity" — presented by the Portland-based Northwest Earth Institute, an environmental awareness and education group — that got Gately squirming in her job a few years ago.

After seeing how people's eating, driving and spending habits in general gobble up a lion's share of the globe's oil, air, water and food resources, and after examining her own lifestyle, Gately felt compelled to make a change.

Before quitting her marketing job, though, Gately spoke with Jeanne Roy, one of the institute's founders, and explained her predicament — she had a good job working for a firm that had billions of dollars in revenues annually from the sale of products that often end up in landfills.

Gately said she asked herself how she could continue to work there considering what she had learned about "the human footprint on the environment."

"But Jeanne told me, 'You need to stay where you are. We need people like you in big corporations,'" Gately said.

A chance encounter led her to a new program within HP dedicated to helping the environment. A former boss encouraged her to stay at HP and apply for a position as a product steward.

Roy said Gately is among many professionals nudged into action. Gately said she knows of such positions at Xerox and Microsoft.

Other high-tech companies have similar positions. Intel, for example, has a group of environmental health and safety personnel who study the chip maker's products and manufacturing techniques to look for ways to reduce environmental impact.

> ***"Our waste stream is a growing waste stream, and we all know just how much more electronic equipment we have in our lives than 10 years ago."***
>
> **JAN WHITWORTH,**
> POLICY ANALYST FOR THE OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

◆

The efforts aren't limited to technology companies. Nike devotes staff to find ways to reduce waste and the environmental impact of its products. The Beaverton-based company recently debuted Nike Considered, a new line of footwear billed as using more environmentally sustainable materials and manufacturing processes. The company runs a "Reuse-a-shoe" program that grinds old shoes into materials for building playground surfaces, baseball fields and tennis courts.

"There are leaders, progressive leaders in business and elsewhere, who understand sustainability and are making changes," Roy said. "And there are a small minority of companies that understand the environmental situation that are making changes, but there still aren't enough making significant changes to sustain our environment."

### HP program dates to '92

Recognizing the value of being more environmentally sensitive, HP in 1992 established its Design for Environment program, which now sponsors the work of some 50 product stewards in its plants around the world. In Vancouver and Corvallis, the stewards focus on hardware and ink products.

David Lear, an HP vice president for social and environmental responsibility, said the first steps his company and others in the industry took involved making changes at the manufacturing sites.

"The focus was on factories, and we were looking at emissions into water, smokestacks and those issues," he said. "The industry has done a great job cleaning up the factories and coming up with manufacturing and processing alternatives."

And now, the focus, Lear said, is on the products.

"We're dealing with design and the logistics in shipping and what to do at the end of a product's life."

Trained as an industrial engineer, Gately was working in HP's marketing department when she took the detour that led to her becoming a product steward. Today, her work is seen on all of the printers the company sells for home and home office use.

### Occasional misfires

But, a few of her ideas never made it into stores.

"I brought some biodegradable spoons into our designers and said, 'Hey, maybe we can do this,' and we ended up shooting the corn-starch printer," she said. The prototype didn't work out, though. It proved too brittle.

That her suggestion ended up discarded didn't dissuade Gately, who has plenty of other ideas for the company — and for consumers.

Even with inroads the company makes to ensure its products are less damaging, users can make a difference, too. A printer's impact on the environment stems not so much from the materials it's made of, as from the amount of paper it uses, she said.

"People ought to print on both sides of the paper," she said. "It's the biggest way to help save planet Earth."

◆

*Helen Jung and Mike Rogoway of The Oregonian staff contributed to this report.*

# One Company’s New Product Lifecycle Process

# New Product Lifecycle

Concurrent Engineering!

CHART KEY - STEP | PHASE REVIEW | KEY FUNCTIONAL REVIEW

*Bold contour shows "hard stops and starts" in phases*

PROPOSAL | PLANNING | DEVELOPMENT | VERIFICATION | LAUNCH | PRODUCTION | END OF LIFE

**Core Team**

- C2 Project Plan
- C3 Detailed Business Case
- C4 Product Transition Plan
- C8 PDD, PVD & PRD Approval documents
- C6 EOL Plan
- C5 PQRS Reviews
- C7 EOL Execution

**Engineering**

- E1 Preliminary Product Definition
- E2 Product Architecture & Target Specs
- E3 Specifications & Documentation
- E4 Engineering Test Plans
- E5 Prototype Design & Build
- E6 Alpha Build & Checkout
- E9 Alpha Test
- E8 Design & Documentation Updates
- E7 EDVT & Agency Certifications
- E10 Beta Build
- 1 *Alpha Build Review*
- 2 *Beta Build Review*
- 3 *Design Maturity Reviews*

**Operations**

- O1 Sourcing Review & Analysis
- O2 Manufacturing Plan
- O3 Manufacturing Infrastructure Planning & Design
- O4 Development & OEM/SLA Agreements
- O5 Manufacturing Infrastructure Deployment
- O7 Product Transition
- O6 Production Builds
- 4 *Mfg Readiness Review*

**Marketing**

- M1 Market Analysis
- C1 High Level Business Case
- M2 Product Strategy
- M3 Market Launch Plan Development
- M8 Beta Test Plan
- M4 Marketing/Sales Material Development
- M5 Beta Test
- M6 Market Launch
- M7 Customer Surveys
- 5 *Product Sales Review*

**Service**

- S1 Service Strategy, Requirements and Planning
- S2 Special Support Planning & Implementation
- 6 *Alpha Support Review*
- 7 *Beta Support Review*
- S3 Service Infrastructure Planning
- 8 *SIP Review*
- S4 Service Implementation
- 9 *Implementation Review*

**Tech Pubs**

- T1 Tech Pubs Strategy & Planning
- T2 Technical Publications Develpment

Phase Review | Phase Review | Phase Review | Phase Review | Phase Review | Lessons Learned Review

Core Team Formed

Finance? Legal? Sales? Human Resources?

## Proposal Phase

This Phase consists of the investigation process by a team from Marketing & Engineering, with input from operations, service & finance organizations. The objective of this process is to develop a high-level business plan for the proposed product. A main deliverable is the Product Investigation Proposal, (PIP) which includes:

- **Executive Summary of the Proposed Product**
- **Market Analysis of the Proposed Product**
- **Product Definition**
- **Preliminary Product Development Description & Estimate**
- **Financial implications**

- A Core Team with clear responsibility and authority is formed at approval of the Proposal Phase.
  - A Core Team Leader drives the overall project.
  - Core Team Members represent functional groups.
  - An Extended Team is made up of the individual contributors who actually bring the product to market.

## Planning Phase

The Product Planning Phase consists of defining a product's design approach including the plan, schedule, budget, resources, materials and capital. The estimated cost of goods; and a detailed list of any risks and a management plan for these risks is also detailed in the PPD.
A main deliverable of the Planning Phase is an approved Product Planning Document, (PPD).

**The PPD includes:**

- Detailed Product Description
  - Features & Specs, COG's, ROI
- Detailed Product Plan
  - Deliverables, Schedule, Resources, Budget
- Risks & Issues Plan
  - Assumptions, Risk Management, Open issues

**Additional deliverables include:**

- **Conceptual Design**
- **Concept of Operations**
- **Impact statements**
- **Product Transition Strategy (PTT)**
- **Business case (ROI)**

## Development Phase

During the Product Development Phase the product design is accomplished by the various functional groups. Their input consists of the product requirements contained in the **PPD**; their output is one or more prototypes and a fully documented design package.

- Marketing group prepares product nomenclature and draft marketing plans and collateral.
- Operations support Engineering builds and prepares plans to support production.
- Service develops plans for field support and represents Training and Technical Publications in their early activities.

**Deliverables include:**

- Working alpha system & documentation
- Product specifications, Detailed design & Test Plans
- Agreements with strategic partners
- Updated business case
- Product transition plan

## Verification Phase

This Phase consists of the verification to product specifications and complete beta build.

The Core Team performs Alpha tests, EDVT and agency tests on the prototype and alpha systems to ensure all identified issues are addressed. This is the phase in which the Beta customers are identified; Manufacturing and Service infrastructure plans are in process. Supplier agreements are developed and product transition has begun.

**Deliverables include:**

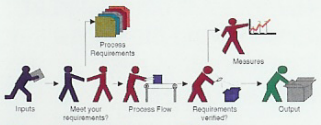
- **Beta system**
- **Final product specifications**
- **Final agreements with strategic suppliers**
- **Alpha and EDVT test results**
- **Beta plans, agreements. support process and resources**
- **Product documents**
- **Updated list of risks with mitigation plans & updated business case**

## Launch Phase

The Launch Phase is to validate the features of the product and the reproducibility of the product. It does this by providing a number of pilot systems on which to measure critical data, and provide the opportunity to learn the manufacturing and service processes.

**Deliverables include:**

- Pilot Review results
- Customer acceptance
- Complete product documentation
- Production equipment & Supplier base
- Marketing collateral
- Service Readiness Review results & infrastructure




## Production Phase

This Phase consists of the activities in the build to volume production phase of products Regular PQRS reviews the product quality and reliability to address issues identified from production and installation.

The Core Team is disbanded at the end of Launch Phase but reunited after the product has been out in the field for more than a year for a "Lessons Learned Review" to review the effectiveness of the NPL process. The objective of this process is to meet the business goals and objectives, identify areas for improvement and provide revenue for the company.

**Deliverables include:**

- PQRS data
- Revenue

## End of Life Phase

Carry out the tasks in the approved End of Life plan related to stopping the selling of the product. Review and revise EOL Project Plan as appropriate.

**Deliverables include:**

- Execute, track and revise the manage inventory portion of the EOL Project Plan
- Execute, track and revise manage support portion of the EOL Project Plan

## NPL Process Reviews

NPL process contains Event Driven and Periodic Reviews throughout the phases.

**Phase Reviews are** conducted at the end of each phase to determine if the project can move to the next phase with a Go / No-Go / Redirect decision based on business criteria.

**Functional Reviews** are conducted at specific milestones during the phase steps. The approval is by functional area experts, core team leader & members.

**Project Updates** are held periodically on all projects and include updates on status of all projects in the division. Review is by the Division GM and Core Team leaders.

An **Interim Review** is called when a project is at a major risk. It is called by Core Team or Product Group GM & focuses on the issue, its causes, and its impact. Continuation of the project is determined by the Phase Approval Committee in a Go / No-Go / Redirect decision based on issues & corrective actions.

**The NPL Deliverables list is the working document in the NPL system.** It should be used as a checklist to ensure that we have addressed actions within our projects.

**The Deliverables List identifies:**

**Type** identifies if the deliverable is a document or a physical item or an update to an existing deliverable.

**Required** identifies the deliverables that are required to be addressed.

**Opt Out** column is the section to identify the deliverable that does not apply to your project. If the deliverable is NOT applicable to your project then an exception report detailing any exclusions is required at the phase review.

**Name** is just a title of the deliverable

**Owning Function** is the function that is required to address the deliverable.

**Owner** is the individual or group within the function that has the responsibility to provide the deliverable.

**Description** is a brief overview of what the deliverable includes.

**Step Index** are the steps identified in the overview chart.

**% Complete** is the column used to keep track of the status of the deliverable for project reviews.

**Location** is where you can identify a server, web page or location where the deliverable resides.

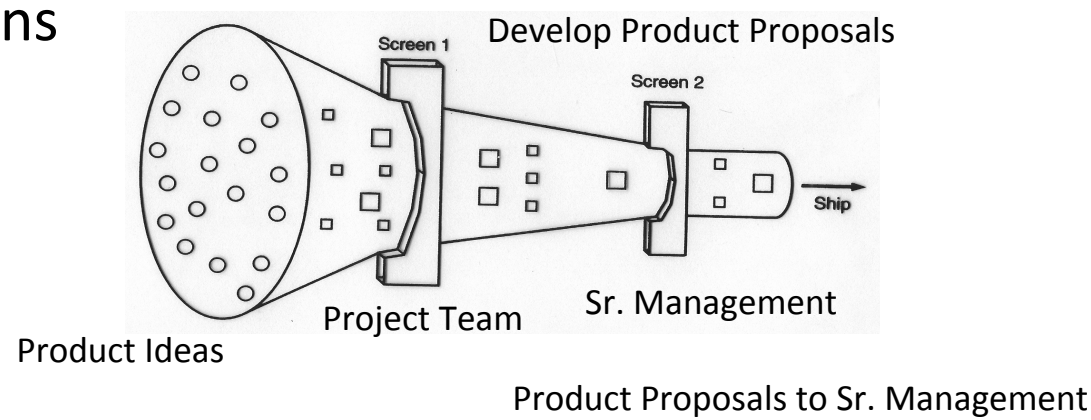
**Example** is an example of what a deliverable looks like (where applicable) we will have a link here.

**Template** is the current released templates to be used to create the deliverable.

**Doc Number** is where an Agile generated 9XX number has been assigned to this type of document.

# Product Investigation Proposal (PIP)

- Written by
  - Interdisciplinary project team
- Contains
  - Executive summary
  - Market analysis of proposed product
  - Product definition
  - Preliminary product development description & estimate
  - Financial implications
- Executive staff
  - Approve
  - Table
  - Ask for revision



# Product Planning Document (PPD)

- Written by
  - Interdisciplinary core team (with extended team contributing)
- Contains
  - Detailed product description
    - Features, Specifications
    - COGS, ROI
  - Detailed product plan
    - Deliverables
    - Schedule
    - Resources
    - Budget
  - Risks and Issues Plan
    - Assumptions
    - Risk management
    - Open issues

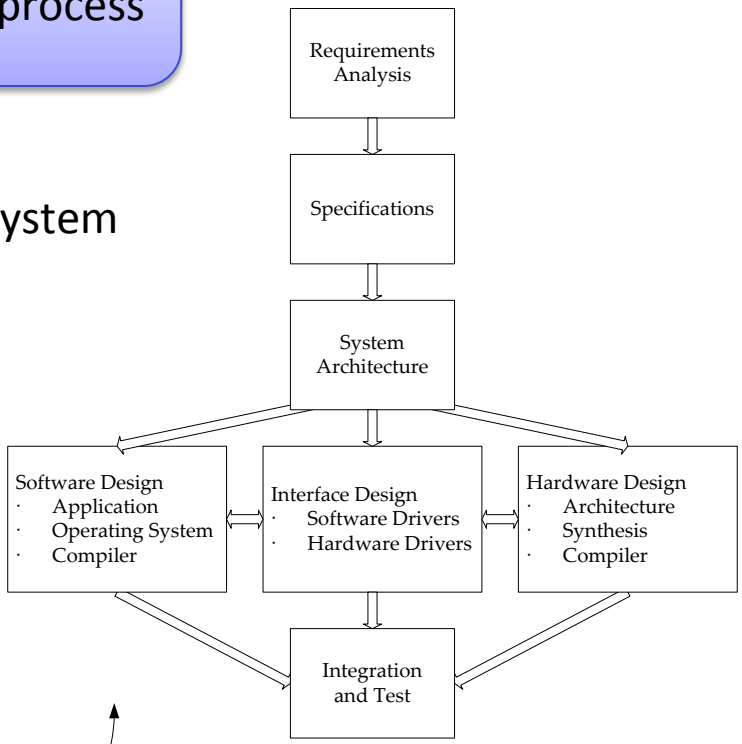
# Why So Many Documents

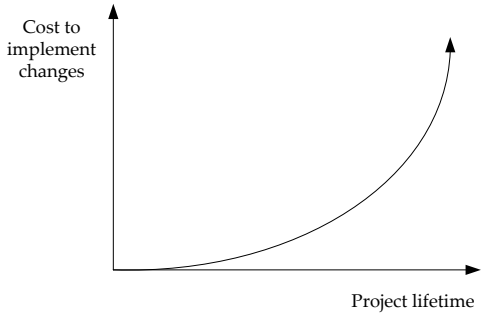
- Record outcome of consensus/decision
  - Don't revisit same decision
- Multiple people/teams on a project need to communicate effectively
- Everyone needs to be on the same page
  - Someone working on a small piece should know what the overall objectives are (e.g. cost savings, weight, throughput) so that proper trade-offs are made throughout the design
  - Not everyone joins the project at the same time
- Support Concurrent Engineering
  - Surface issues early. Example: field service: "that would require each of our field techs to carry an $18,000 instrument"
  - Other teams can begin doing useful work before "upstream" team is complete if there's a specification or interface document

# The Rule of 10

The cost to detect, identify, and correct a problem increases by a factor of 10 at each successive stage in the development process

- Why?
  - IC → PCB → Subsystem → System → Deployed system
- How much effort to…
  - Edit a requirements specification
  - Change the high level architecture
  - Re-design a circuit
  - Re-write a program or driver
  - Re-spin an ASIC
  - Re-layout a PCB
  - Recall and re-ship a product
- Remember
  - Need to re-simulate, re-test…



# Some Costs Aren't Just Economic

U.S. Food and Drug Administration

U.S. Department of Health and Human Services

FDA Home Page | Search FDA Site | FDA A-Z Index | Contact FDA

## FDA News

**FOR IMMEDIATE RELEASE**
P05-46
July 22, 2005

**Media Inquiries:**
Julie Zawisza, 301-827-6242
**Consumer Inquiries:**
888-INFO-FDA

### FDA Announces Guidant's Class I Pacemaker Recall

The U.S. Food and Drug Administration (FDA) is notifying health care providers and patients that Guidant Corporation is voluntarily recalling certain pacemakers. A seal within the devices can leak, allowing moisture to affect the electronic circuits. This defect can cause the pacemakers to fail to provide pacing or can cause a rapid heart rate. Other unexpected device behaviors are also possible. The problems may occur without warning and can lead to loss of consciousness, and possibly heart failure and death.

Only the following models are affected by this recall. All were manufactured between November 25, 1997 and October 26, 2000.

- PULSAR® MAX Models 1170, 1171, 1270
- PULSAR Models 0470, 0870, 0970, 0972, 1172, 1272
- DISCOVERY® Models 1174, 1175, 1273, 1274, 1275
- MERIDIAN® Models 0476, 0976, 1176, 1276
- PULSAR MAX II Models 1180, 1181, 1280
- DISCOVERY II Models 0481, 0981, 1184, 1186, 1187, 1283, 1284, 1285, 1286
- CONTAK TR® Model 1241
- VIRTUS PLUS® II* Models 1380, 1480
- INTELIS II Models 1483, 1484, 1485, 1384, 1385, 1349, 1499

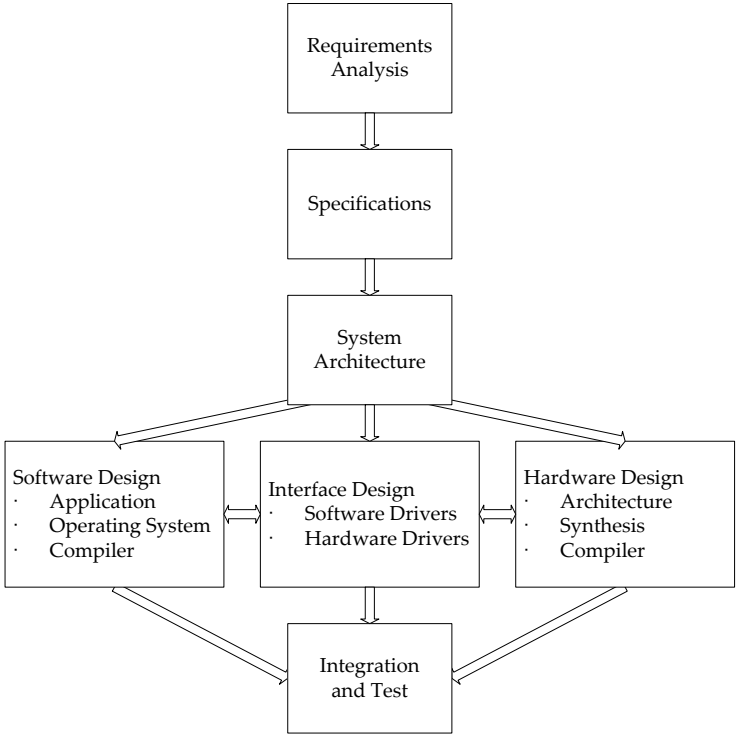
** VIRTUS PLUS II and INTELIS II models available only outside the U.S.*

Guidant announced the initiation of a voluntary recall on July 18, 2005. The recall action consisted of a letter to physicians that describes the problem and provides recommendations about how to minimize the risk of pacemaker failure.

The FDA has classified Guidant's action as a Class I recall. Recall classifications can fall into one of three categories, with Class I being the most serious. These numerical classifications are based on the probability that the device failure could lead to adverse health effects. In a Class I recall, there is a reasonable probability that the malfunctioning device will cause serious adverse health consequences or death.

# Concurrent Engineering

- Impact of working serially
  - Longer development time
  - Rule of 10: problems discovered late
- Concurrent Engineering
  - Employ Cross Functional Teams
    - Surface problems/issues earlier
  - Parallel Design
    - Reduce development time
  - Vendor Partnering
    - Involve key partners/vendors early
      - Be aware of lead times of critical components
      - Opportunities to tailor solutions to your needs
      - Ensure coherence of product roadmaps
        - Don't rely on key component scheduled to become obsolete
        - Be aware of new product development that can help you




- Requires
  - Communication
  - Coordination
  - Documentation

"Apple Inc. is building a new component manufacturing plant in Arizona, striking an agreement with GT Advanced Technologies Inc. that will provide sapphire material for use in Apple products.

GT said it entered into a multiyear supply agreement at an Apple-owned facility in Mesa, Ariz. GT said Apple would provide the company with a prepayment of approximately $578 million that GT will reimburse to Apple over five years, starting in 2015."

## 1. Proposal Phase

Product Investigation Proposal

## 2. Planning Phase

Product Planning Document
Conceptual Design
Concept of Operations
Impact Statements (Functions)
Product Transition Strategy
Business Case

## 3. Development Phase

Marketing
- Product Nomenclature
- Marketing Plan
- Collateral
- Beta Plan

Service
- Support Plan

Training and Technical Pubs
- Training Course Plan
- Manuals Plan

Engineering
- H/W Specifications
  - External/Internal
- S/W Specifications
  - External/Internal
- Mechanical Specifications
- Test (QA) Plan

Manufacturing
- Preliminary Processes
- Alpha Build
- Supplier Agreements

## 4. Verification Phase

Alpha Testing
Compliance Testing
Characterization
Final Specifications
Beta Testing
Product Documentation

## 5. Launch Phase

Pilot Manufacturing Builds
Customer Acceptance
Final Product Documentation
Service Readiness Review

## 6. Production Phase

Quality Reviews
Post-Mortem Analysis

## 7. End of Life Phase

# Documentation

- Coordinating work
- Communicating product requirements and design specifications
- Tracking status

- Engineering Logbooks
- Project Notebooks
- Weekly Progress Reports (WPRs)

today

- Project Documentation
  - PDS – Product Design Specification
  - Project Proposal
  - Requirements Documents
  - External Specifications
  - Internal Specifications
  - QA/Test Plans and Descriptions
  - Documentation Plans

Golden Rule: Leave others with the documentation you'd like to receive

# Revision Control and Version Management

- Documents evolve
  - Sometimes numerous revisions
  - Multiple authors
  - Several review/revision cycles
- Highlight changes
  - MS Word or other
- Use Revision Control System
  - RCS, SCCS, CVS, Subversion (SVN)
  - Google Docs
  - DropBox
  - Manage versions, track changes, backup (in repository/of repository)
  - Facilitate sharing while preserving notion of “current” version

# FAA WORKER ADMITS HE TOOK CODE WHEN HE QUIT

**By Matt O'Connor, Tribune Staff Writer. Tribune staff writer Jon Hilkevitch contributed to this report.**

*September 22, 2000*

A former engineer for the Federal Aviation Administration pleaded guilty Thursday to stealing the lone copy of a crucial computer code necessary to fix glitches in the automated system used to relay flight information between the tower at O'Hare International Airport and controllers at an air-traffic facility in Elgin.

Thomas A. Varlotta headed the team that worked several years to develop the so-called source code and took the software program when he resigned from the FAA a month after learning of plans to bump him down a pay grade, prosecutors said.

Varlotta, 43, of Tinley Park pleaded guilty "blind" to the single felony count, meaning he hadn't worked out any deal with prosecutors on the length of his sentence.

His prison term will largely hinge on how valuable a federal judge finds the software code to be. Prosecutors contend it is worth more than $1 million and that Varlotta should be given nearly 5 years in prison for the theft. Varlotta's lawyer maintains the code's value is far less.

Experts for both sides are expected to testify on the code's value at a hearing Nov. 11 in federal court. U.S. District Judge William Hibbler scheduled sentencing for Jan. 4.

Federal investigators recovered the software code in a raid on Varlotta's home two months after he resigned in June 1998, but it was encrypted with a 14-digit password and authorities were unable to unscramble it until February 1999. Authorities initiated the raid after they discovered the code was missing and Varlotta gave inconsistent statements when questioned about it.

FAA officials say there was no danger to the flying public while the only copy of the code was missing or unusable because no breakdowns in the automated system occurred. And even if there had been breakdowns, controllers at O'Hare and the Elgin facility would have used telephones to share flight information.

The FAA said the code couldn't be stolen now because of tightened security measures put in place over the last two years.

Authorities have said Varlotta told his boss when he resigned that he had "wiped"--or intentionally removed--the hard drive of his FAA laptop, thus destroying the only copy of the software code.

But in a letter a month later, Varlotta claimed the code had been accidentally lost when his computer malfunctioned, according to Assistant U.S. Atty. Brian Ellis.

Federal computer experts, though, examined Varlotta's laptop and concluded he had transferred the software code to another computer and then intentionally reformatted the laptop to make it appear it had malfunctioned, Ellis said.

# Consistent Look & Feel

- Whether written document or presentation
- Consistent use of
  - Font (typeface, color, sizes)
  - Margins
  - Section headers
    - Underlining vs. Bold
    - Numbers vs. Letters
  - Headers & Footers
    - Document name
    - Date/revision
    - Page number

# Engineering Logbooks

- Your own efficiency on the project
  - Pick up a thread/thought again after day(s) elapsed
  - Everything in one place
    - Names
    - Phone numbers
    - URLs of web pages
    - Citations for books, articles, papers consulted
    - Your own design work, thoughts
  - Your own use later
    - Next revision/enhancement
    - Called back by manufacturing when problem arises in field
- Protect intellectual property (IP) rights
  - Patent applications, defense, challenges
- Teams are dynamic
  - Normal turnover (people come/go)
  - Staffing often ramps up over time
  - Your successor

# Engineering Logbook Requirements

- A contemporaneous chronological record of your work
- Written so that someone else ("skilled in the art") can follow your design work and verify it with minimum effort
- A detailed record of every part of your design process
- Format should be neat, readable, durable, and orderly
- Maintained in a bound notebook (not loose leaf, 3-ring binder) with each page numbered and dated
- Ink only. A single line crossing out errors will keep things neat.
- Acceptable (and recommended) to attach printouts, web pages, other documents.
- Do not leave blank pages; make diagonal lines through otherwise blank pages. Start a new date on a fresh page, drawing a diagonal line through unused space on the prior page.
- In a company where patents are an issue a supervisor or other person will review and sign-off on your logbook periodically (e.g. weekly). The instructor for this course will serve that function.
- Avoid negative characterizations (specifically avoid terms with legal implications like "obvious", "novel", "useful", "unpatentable", "this will not work", "this solution is inferior").
- However, don't omit "failed" experiments; they serve to demonstrate not only work done but that the ultimate solution wasn't "obvious".

# Engineering Logbook

- Project Description
- Research
  - Sources
  - URLs (actual web pages can be pasted in)
  - Names, telephone numbers
  - A summary of the information obtained and an explanation/evaluation of how it relates to your project
- Your thought process on each part of the project
- All work
  - What you did
  - What results you obtained
  - Projected next steps
  - Equations
  - Calculations
  - Drawings
  - Block diagrams
  - Explanatory Text
- Contemporaneous meeting notes
- References to documents maintained in the Project Notebook

# Project Notebook/Wiki

Maintain in Wiki or loose-leaf 3-ring binder
Include:

- Agendas for all meetings
- Minutes of meetings
- Printouts of relevant e-mails
- Weekly progress reports
- Project Proposals
- Vendor Specifications
- Project Design Specification (PDS)
- External Specifications
- Test Plans
- Design documents

Personal project "library"

# Engineering Logs / Project Notebooks / Wikis

- Engineering Logbooks
  - Rigid requirements
  - Contemporaneous record of your work and thoughts
  - Used in pursuit of intellectual property (IP) rights

- Project Notebooks/Wikis
  - Resource throughout project
  - Gather variety of crucial documents in one place

# Weekly Project Status Reports

- Brief refresher on the overall project
  - Your part in the project
  - Your specific tasks and goals from prior week
- What actions you took
- What you accomplished
- Problems encountered and how you solved them
- Problems remaining and thoughts on possible solutions
- Action plan for the following week

# Weekly Project Status Reports

- Share what you're working on
  - Track progress: Relate to project schedule/task assigned
  - Allow others to assess impact of your progress (or lack of it) on them
  - Someone may have some useful input, contact, resource, suggestion
  - Someone may need something from you in a different order
    "could you do X first so that I can…"

- Early warning of problems/issues
  - Do your work, but don't wallow in a problem too long – get help early (no ego!)
  - Escalate problems (someone else can help solve them – obtain resources, etc)

- Plan/commit for immediate next steps (part of larger plan) and alerts others (motivation)
  - "Oh, Susan's going to need my spec by next week if she's to remain on schedule"

- E-mail sent to teammates, manager/project leader
  - Copy yourself and retain

# WPR

```
From: Mark Faust [faustm@ece.pdx.edu]
Sent: Friday, October 14, 2011 5:15 PM
To: Team
Cc: Faculty Sponsor, Industry Advisor
Subject: WPR: Wireless Remote Sensor Project

Last Week
---------
  Reviewed requirements for GUI
  Reviewed test plan for coin changer module
  Completed code for wireless base station communication
  Started code for error/exceptional condition reporting

Next Week
---------
  Complete code for error/exceptional condition reporting
  Debug code
  Start test cases for coin changer module

Issues
------
  Unable to get simulator working on lab PC
  Need base station stub module to complete debugging

--Mark
```