"Secrets" to System Design that Maximize Customers' Satisfaction

SELP 695 Integrative Project
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Agenda

• Introduction

• The "ilities"

• Systems Engineering Process

• Lean Product Development

• Ethics

• Conclusion
Modern World

- complex
- requires intensive integration efforts
- not only about functionality but also many other factors
- competitive
- fast pace of technology development
- many uncertainties
Introduction
The "ilities"
What is the "ilities"?

A short hand notation for various properties of systems e.g.) quality, reliability, safety, flexibility, and etc.
The "ilities"

Ranking of the ilities in terms of frequency of occurrence: the black bars indicate scientific journal articles published from 1884-2010, in thousands; the gray bars indicate number of hits on the internet, in millions [Weck and Roos, 2011, pg. 67]
The "ilities"

Cumulative number of journal articles where in which any ility appears in the title or abstract of the paper, 1884-2010 [Weck and Roos, 2011, pg. 67]
The relationship of a set of 22 most commonilities to each other
[Weck and Roos, 2011, pg. 83]
• Quality

"How well a system performs what it is intended to do."

"Ideally, a system should work during the intended life cycle in the way intended."

Source: [Weck and Roos, 2011, pg 70]
1986 - Start sales in the US

1999 - began quality improvement
   - 10 year / 100k mile warranty

2001 - Bad reputation remained

2004 - Rank #2 for Initial Quality, JD Power and Associates
   - Top 100 most valuable brand world wide

As recently as 1980s, manufacturers used to think that
An inverse relationship existed between profit and product quality

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The "ilities"

- Safety

*The condition of being safe from accidents or harm to people and property.*
• Engineers should always try to do more than the minimum required by law.

• Safety is for both the system users and the people interacting with the system.
• Flexibility

"The ability of a system to be changed by a system-external change agent with intent."

Similar term, Reconfigurability,
"The ability to change into different configurations that allow the system to perform multiple functions but not at the same time."

Source: [Beesemyer, 2012, pg. 31], [Weck and Roos, 2011, pg 84]
- Zero gallons of gasoline
- 8 year / 100k mile warranty on battery
- Range: 73 mile
- Chargeable by 110V / 220V

- Commuter Car only, lacks Flexibility

- First 40 miles on electric motor
- 8 year / 100k miles warranty on battery
- Any distance with gasoline if necessary

- Commuter Car + Fit American life style
Evolvability: "The ability of an architecture to be inherited and changed across generations [over time]."

Adaptability: "The ability of a system to be changed by a system-internal change agent with intent."

Source: [Beesemyer, 2012, pg. 31]
• Apple products

• PC with standardized interface
Interoperability and Compatibility

Interoperability: "The ability of a system to effectively interact with other systems"

Compatibility: closely related
"tends to relate to consumer products and systems although not exclusively, and describes how well components of the system can be connected and work together."

Source: [Beesemyer, 2012, pg. 31], [Weck and Roos, 2011, pg 93]
• Scalability and Extensibility

**Scalability:** "The ability of a system to change the current level of a system specification parameter"

the volume of users the system supports,
the number of daily transactions completed by the system

**Extensibility:** "the ability of a system to accommodate new features after design"

Source: [Beesemyer, 2012, pg. 31], [Weck and Roos, 2011, pg 86]
• Resilience

"the degree to which a system can recover quickly from a major disruption while regaining its original functionality."

Source: [Weck and Roos, 2011, pg 89]
In 1981,

- Over 13,000 US air traffic controllers went on strike demanding better working condition and higher pay

- Under The Taft-Harley Act of 1947 President Ronald Reagan ordered them to return to work

- Fired over 11,000 controllers who did not follow the order

- Training of replacements immediately organized by bringing in military air traffic controllers

- The system bounced back despite the expected disruption
Systems Engineering Process
The technical management process that is supposed to deliver systems with the best balance of cost and performance

Source: [The MITRE, 2012]

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• **SE Process**
  - Providing the control and traceability for solutions
  - Guidelines for program execution to make complex systems success.

• **When this process is not followed,**
  - Inconsistent work, stoppages, rework occur frequently
  - The scope of tasks tends to be unclear
  - Then, the program success is at risk
Lean Product Development (LPD)
• Lean Manufacturing
  Optimized manufacturing and logistics for the automobile manufacturer by reducing waste of overproduction, waiting, transportation, overprocessing, overstock at hand, unnecessary movement and making defective products.

• Lean PD
  a potential to save 25% to 80% of cost and time over traditional methods
1. The Process Pillar
   - Lean Value Stream Mapping
   - Standardization (re-use)
   - Takt time
   - Integrative Event
   - Capturing the need concept of requirement
   - Implementing the pull system
   - Quality process
   - Balancing and concurrency
   - IPT / concurrent engineering
eg.) Apple, good at figuring out how to divide work among teams work on common goals, touch base frequently, and bring results teams of people meet 3 hrs weekly

Source: [Oppenheim, 2011, pg. 359]
2. The People Pillar

- Leadership (chief Engineer)
- Teamwork
- Kaizen (continuous improvement)
- Trust
- Openness
- Honest
- Training and investing in people
- Lack of fear
3. The Tools and Technology Pillar

- Excellent communication (The A3 report)
- Computer Aided Design (The Cave)
Jaguar Land Rover (late adaptor)

- **Cost of The Cave:** ~£ 2 million
- **Redeem of the investment:** within a year
- **Use:** design, integration, simulated assembly for manufacturing additionally, the plant layout, alteration, problem solving
Ethics
With growing environmental concerns,

- The Govt. sets standards to reduce pollution
- Social duty: Do more than the regulated level
- Should NOT be pressured by the greedy investors
- The impact should be minimized during the entire life-cycle

⇒ the company image improve
⇒ users feel better about using the product.
Apple

- Smaller, thinner, and lighter by making the products more powerful and requiring less material
- Elimination of the use of toxic substances
- Use of recycled parts
- Reduction of gas emission
- Renewable energy to power facilities (TX, CA, Germany & Ireland)
- Commute Alternatives Program for employees
- Recycling program to collect Apple products

By reducing iPhone packaging by 42% from 2007 to 2011, 80 more boxes are shipped in each airplane transport. This saves one 747 flight every 371,250 units
Conclusion

To have great systems,
- The "ilities" => great systems characteristics
- SE Process + Lean PD => better and more efficient way
- Considering environmental factors => social duty

As a result,
- Ability to compete better in the uncertain environment
- Competitive price / system
- Ultimately,
  exceed customer expectation
  maximize customers' satisfaction
  increase the market share
Questions?

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