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**Using the UML and Object Oriented
Programming Techniques to Create a
Lean Software Environment**

By
Antar A Spearmon

SELP 695: Integrative Project

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Agenda

- The Problem
- Options Currently Available
- The Lean Software Approach
- The Object-Oriented Programming Paradigm
- The Unified Modeling Language
- Lean Thinking
- The Benefits
- A Brief Example
- Wrap-up
- Questions

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Software is Everywhere

- From Military Applications to Children's Toys
- Market Demand Drives Increase in System Complexity
 - ◆ Automobile Industry Example:
 - * Safety
 - * Comfort
 - * Performance
 - ◆ Leverage The Power of The Computer to Augment Mechanical Systems

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Increasing System Complexity

- Systems of Systems
 - ◆ Complex Systems Made up of Smaller Sub-Systems
 - ◆ Require Coordinated Efforts of Tens to Thousands of People From Various Backgrounds
- As the Role of Software Increases, Customers Demand:
 - ◆ Robust Quality Software
 - ◆ Reduced Development Cycles

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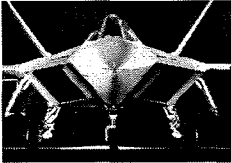

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Guess the # Lines of Codes ???

Lexus LS460 VS **USAF F-22 Raptor**

Retail: \$86,000 Retail: \$177.6 M



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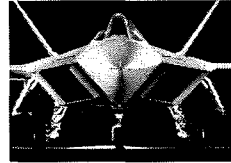

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Lines of Code

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7,000,000 **1,800,000**

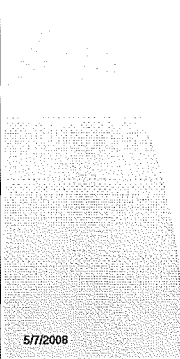


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The Problem

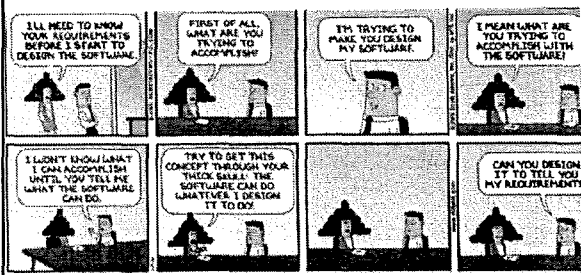


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The Problem



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The Problem

- RISK
 - ◆ Inaccurate Understanding of End-User Needs
 - ◆ Constantly Changing Requirements
 - ◆ Late Discovery of Serious Projects Flaws
 - ◆ Schedule slips
 - ◆ Poor Communication
 - ◆ Etc.

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Some Numbers

- According to the Gartner Group:
 - ◆ 74% of all IT/Software projects fail
 - ★ Over Budget
 - ★ Over Schedule
 - ◆ 28% Fail Altogether

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Shared Characteristics of Software Failures

- Ad-hoc Requirements Management
- Brittle Architectures
- Overwhelming Complexity
- Modules That Don't Fit Together
- Software That's hard to maintain or extend
- Team members in each other's way
- Poor Communication

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The Cause

- Traditional Programming Paradigms Lack the Scalability and Flexibility Required to Effectively Manage the Increasing Complexity of Current Systems

The Need

- What are Required are New Paradigms to Improve Programmer Productivity to Effectively Meet These Challenging Demands

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Options Currently Available

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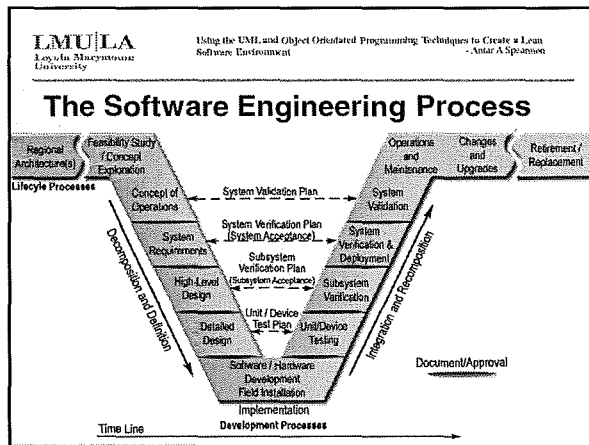
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Three Schools of Thought - Coding

- “Cowboy” Coding
 - ◆ Shoot From the Hip Approach to Software Development
- Task-Oriented
 - ◆ Traditional “Structured” Approach to Programming
 - ◆ Collection of Logical Functions
- Object-Oriented
 - ◆ Focus on Objects and How They Relate to Each Other

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Agile Software Development Paradigm

- Focus on Rapid Continuous Delivery of Working Software
 - ◆ Incremental Software Development Approach
 - ◆ Centered on Self-Organizing Teams
 - ◆ Constant Communication Between Business People and Developers
- Lacks Structure, Detailed Requirements Analysis, and Much Needed Documentation

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The Proposal

Lean Thinking
The Unified Modeling Language
Object Oriented Programming +
The Systems Engineering Process

LEAN SOFTWARE DEVELOPMENT

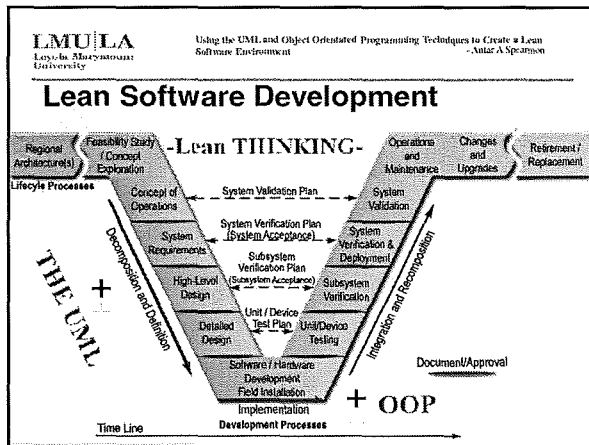
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The Lean Software Approach

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The Object-Oriented Programming Paradigm

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The UML

- The UML is comprised of a set of diagrams used to form a model of the system to be created
- Expands understanding of the system under development and how it is to work
- As a Blueprint is to a house, The UML Diagrams are to Software
- Language Independent

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Lean Thinking

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Lean Thinking

- Do more with less by placing an emphasis on waste minimization and flexibility in the development process

The diagram is a large oval containing two inverted triangles. The left triangle is labeled 'The Five Principles' and lists: 1. Eliminate Waste, 2. Establish Standardized Work, 3. Reduce Setup Times, 4. Level Production, 5. Visualize Work. The right triangle is labeled 'The Five M's' and lists: 1. Manpower, 2. Machine, 3. Material, 4. Method, 5. Money. The two triangles meet at their bases at the bottom, which is labeled 'Development Process'.

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Benefits of Lean

- Enterprise Improvements (Manufacturing):
 - ◆ Waste reduction by 80%
 - ◆ Production cost reduction by 50%
 - ◆ Manufacturing cycle times decreased by 50%
 - ◆ Inventory reduction by 80% while increasing customer service levels
- Goal is to leverage these same benefits in the software environment by applying the 5 principles of lean

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The Five Principles of Lean

- *Specify value*
- *Identify all the steps in the value stream*
- *Make the value flow*
- *Let customers pull value*
- *Pursue perfection through continuous improvement*

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The Benefits

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The Benefits of Lean Software Development

- A formalized approach to solving complex problems and ensuring the realization of successful software systems
- Considers the entire life-cycle
 - ◆ From Requirements to Future Upgrades
 - ◆ Business and technical aspects of system development
- Combines SE with LEAN, UML, and OOP

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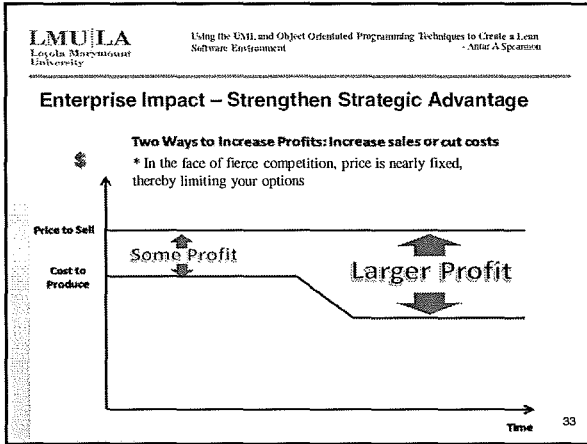
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The Business Benefits of Lean Software Development

- Cost savings yield:
 - ◆ Increased throughput
 - ◆ Improved cash-flows
 - ◆ Higher quality
 - ◆ Increased market response
 - ◆ Repeat business
 - ◆ Enterprise growth
 - ◆ Increased profits

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Long-Term Profitability

- Quality robust code that is reusable
 - ◆ Fully Tested
 - ◆ Tried & True
 - ◆ No more re-inventing the wheel
 - ◆ Extensible
- Continued success by leveraging past innovations
- More responsive to constantly changing customer needs

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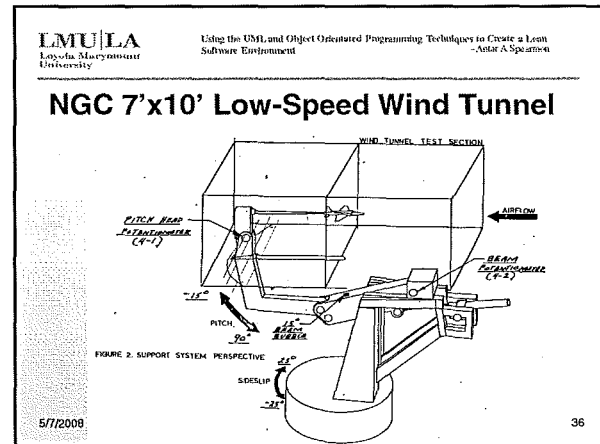
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A Brief Example

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Statement of Work

- Current System
 - ◆ Combination of 1950's and 1970's electronics
 - ◆ Analog System
 - ◆ Manually operated
 - ◆ Decreasing reliability
 - ◆ Limited availability of spares
- Proposed System
 - ◆ Updated Real-Time Controller System
 - ◆ Digital Based
 - ◆ Automatic Capabilities
 - ◆ User Touch Screen
 - ◆ Increased System Visibility

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Requirements

- Upgrade the Model Control System (MCS)

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From Blank Sheet to Architecture

- Constant Communication Required
 - ◆ Original Designers Have Long Retired
 - ◆ Operators/Technicians Primary Requirements Source
 - ★ Test Engineers Have Input But Know Far Less Than Techs Regarding System Operation
 - ★ Useful for Technical Specs
 - ★ Have Operators Test Early Iterations

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Use of UML & OOP

- Aggressive Budget & Schedule Constraints
 - ◆ Needed Quick Effective Tool to Generate Requirements
 - ★ Used Minimal Set of UML Diagrams
 - ◆ Small Software Team (2.5 Members)
 - ★ 1 Cowboy
 - ★ 1 OOPer
 - ★ .5 Impressionable Newbie
 - ◆ Needed Way to Have 3 Programmers Work on 1 System

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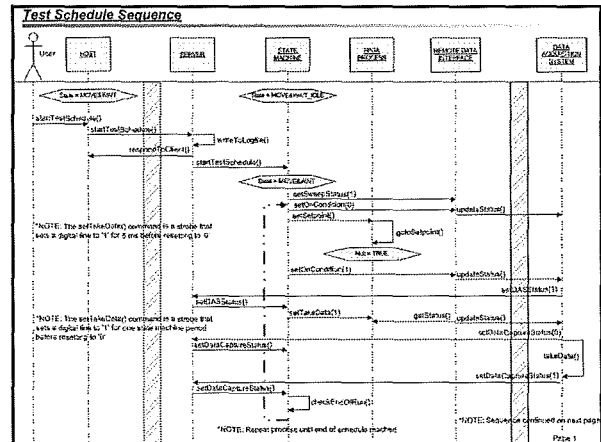
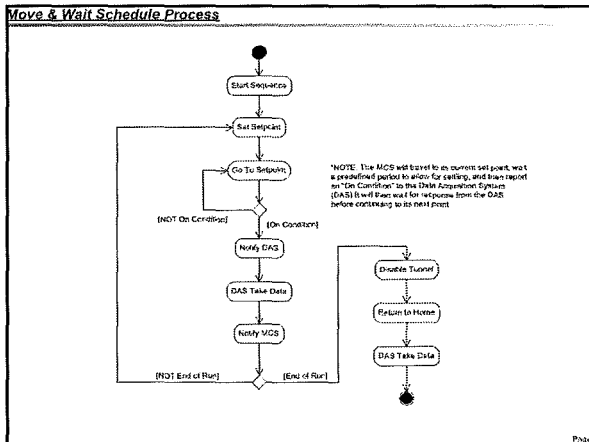
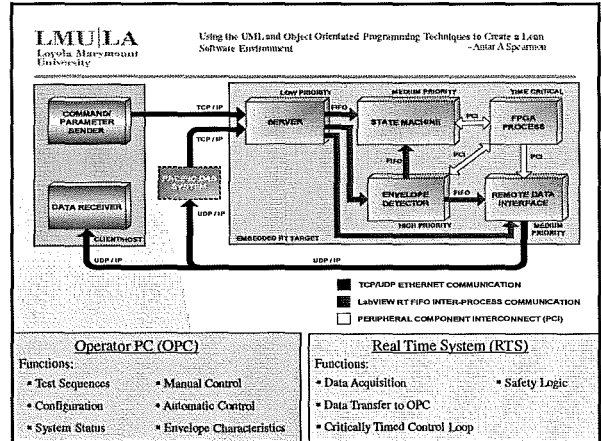
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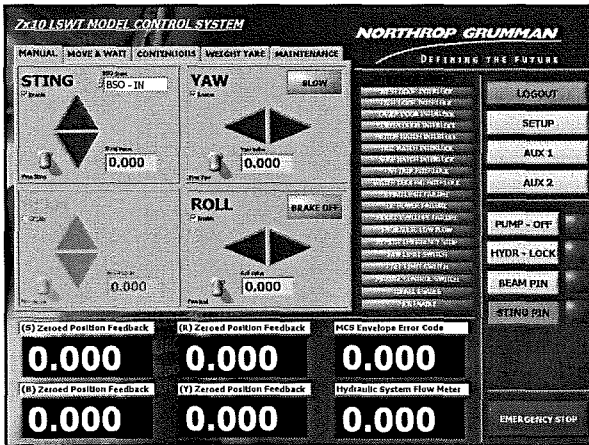
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OOP Is Given Due to Complexity

- Because Requirements Were Self-Generated Software Must Be:
 - Flexible
 - Extensible
 - Reliable
 - Robust
- OOP Paradigm Became Essential For Project Success
 - Code Reuse to Shorten Design Time

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Reasons for Lean Software Approach

- Because of Limited Knowledge Of Current Control System Functionality
 - ◆ Needed to Focus on Objects & Their Interactions With a Systems View
 - ◆ Full Reanalysis Required For Traditional Coding Approach
- Forced to do More With Less
 - ◆ Less Resources, Budget, Schedule
 - ◆ Produce Effective System Solution Under Fire

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Wrap-Up

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Wrap-UP

- Software is EVERYWHERE
- With growing complexity, increased need for systematic approach to ensure delivery of successful software systems
- The UML, OOP, Lean Thinking, and the Systems Engineering Process
 - ◆ Coupled together to ensure successful delivery of robust, high quality software components that amply meet customer needs while reducing overall software life-cycle costs

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Questions?

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Resources

- *Lean Thinking, Banish Waste and Create Wealth in Your Corporation*, James P. Womack and Daniel T. Jones, First Free Press Edition, 2003
- www.defense-aerospace.com/dae/articles/communiques/FighterCostFinal-July06.pdf
- www.slippy.com/japan-tech/computer-on-wheels/
- <http://www.ops.fhwa.dot.gov/publications/seitsguide/section3.htm>
- www.incose.org.uk/Downloads/AA04%20SE%20trends.ppt
- Lean Enablers for Systems Engineering, INCOSE Lean Systems Engineering Working Group, INCOSE 18th Annual International Symposium, Utrecht 2008
- Lean Methods, 2003 Bohdan W. Oppenheim, LMU, Los Angeles
- www.incose.org/practice/techactivities/wg/leansewg/docs/LeanSEWorkingGroupINCOSE-Jan2008WorkshopAZ.ppt
- <http://java.sun.com/docs/books/tutorial/java/concepts/object.html>
- <http://www.lean.org/WhatsLearn/Principles.cfm>

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